ISATE 2016 SENDAI

The 10th International Symposium on Advances in Technology Education

Future Prospects of Technology Education Models and Approaches

13-16 September 2016

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The 10th International Symposium on Advances in Technology Education

13-16 September 2016, ISATE Sendai

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National Institute of Technology, Japan

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About the Symposium

The theme for ISATE 2016 is "Future Prospects of Technology Education Models and Approaches"

13-16 September 2016, ISATE Sendai

Objective of ISATE

The International Symposium on Advances in Technology Education (ISATE) provides a platform for educators from higher education institutions to share their knowledge and experiences in practice-based engineering and technology education. Through the Symposium, stakeholders can benefit from sharing innovative teaching methodologies and practices used in schools.

The brief history of ISATE

ISATE started in 2007 as an international academic exchange between ten colleges of technology (known as Kosen in Japan) in the Kyushu and Okinawa districts of Japan, and three polytechnics in Singapore. Its aim was to enhance the quality of engineering education of each participating school.

In 2010, all other Japanese Kosen joined the Symposium under the initiative of the National Institute of Technology or NIT (previously known as INCT). In 2011, two more polytechnics from Singapore joined this international exchange effort, and in 2013, Nagaoka University of Technology and Toyohashi University of Technology also joined the symposium, helping to expand the scope of ISATE to its present state. Today, all Kosen in Japan and all polytechnics in Singapore are part of ISATE.

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Invited Oral Presentation

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9:30 –	Training project on regional rehabilitation for safer and more secure society in Fukushima without nuclear energy	Mr. Takayuki Nakamura	National Institute of Technology, Fukushima College
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Topic (2): Teaching and Learning

Topic (4): Educational Models and Approaches

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Invited Oral Presentation

Activities for Education Reform Relevant to the Model Core Curriculum in KOSEN

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Abstract

As a tentative plan, the model core curriculum (MCC) was formulated by the National Institute of Technology (NIT) in 2012. Skills and attainment target outcomes that students should acquire through the National Colleges of Technology (KOSEN) engineering education are summarized in the MCC. Therefore, the definition of the MCC is different from the conventional curriculum as a teaching guideline.

Several activities such as the development of a web syllabus system, the practice of active learning, and the evaluation of basic and experimental skills, have been attempted at NIT to promote education reform based on the MCC.

I would like to provide an overview of the MCC and these activities in this paper.

Keywords: *The model core curriculum, Web syllabus, Active learning, Computer based testing, Evaluation of experimental skills*

Introduction

The national college of technology (KOSEN) was founded in 1962 as institutions of higher education to train practical engineers who can support industrial development. The institute of national college of technology (current name is the national institute of technology, NIT) was founded as an independent administrative agency made up of 55 schools of KOSEN in 2004.

Because of the recent reform trend in higher education, it has become important to clarify to society the learning content and learning outcomes of each student who graduates from the KOSEN. Each student should obtain a minimum level of knowledge and skill (minimum standards) in common to all students who graduate from KOSEN. Consequently, teachers should nurture students to help them reach the minimum standards. Therefore, it is important for each KOSEN to develop a creative curriculum which covers the minimum standards and unique learning fields. However, minimum standards for quality assurance for each KOSEN in building the curriculum should be provided responsibly by the NIT.

As a tentative plan, the model core curriculum (MCC) was formulated by the NIT in 2012 [1]. Skills and attainment target outcomes that students should acquire through the KOSEN engineering education are summarized in the MCC.

Skills that students should acquire through the KOSEN engineering education are categorized into three parts such as, “Basic skills that engineers in any field should acquire”, “Specialized skills that engineers should acquire in their areas of expertise” and “Cross-sectoral skills that engineers should acquire” in the MCC. For each skill, the attainment levels are categorized into six levels.

Several activities such as the development of a web syllabus system, the practice of active learning, and the evaluation of basic and experimental skills, have been attempted at NIT to promote education reform based on the MCC.

Overview of the Model Core Curriculum

The conceptual diagram of the MCC is shown in Figure 1. Basic skills that engineers in any field should acquire (ex. Mathematics), specialized skills that engineers should acquire in their areas of expertise (ex. Mechanical engineering by field) and cross-sectoral skills that engineers should acquire (ex. Communication skills) are included in the MCC. However, the curriculum for each KOSEN is incomplete if only containing these skills. Each KOSEN should add distinctive educational content in order to complete the curriculum in consideration of its educational philosophy, regional characteristics, etc. Learning content, attainment target and attainment level are set for every skill. Therefore, students who graduate from the KOSEN should be able to reach not only the minimum standards of three core skills (basic skills, specialized skills, and cross-sectoral skills) but also the minimum standards of unique learning fields. As described previously, the definition of the MCC is different from the conventional curriculum as a teaching guideline.

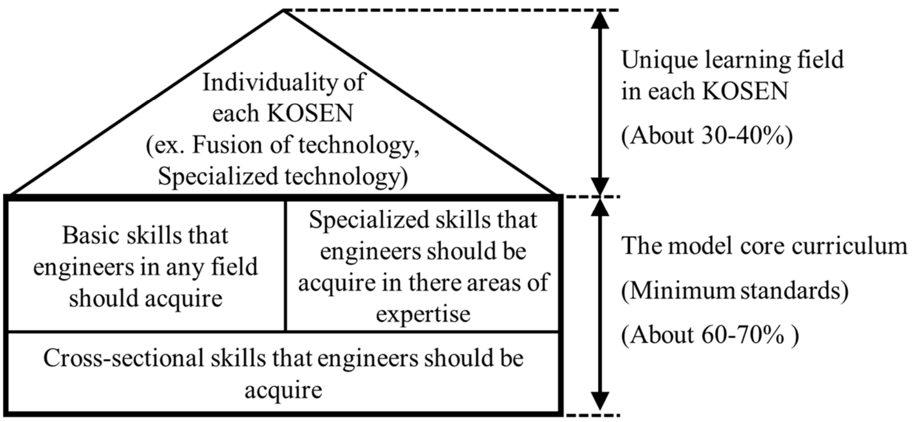

Figure 1 Conceptual diagram of the MCC.

Table 1 Attainment target by category required by KOSEN's regular and advanced courses.

Skills required for engineers	Attainment Target					
	1	2	3	4	5	6
	Knowledge and Memory Level	Comprehension Level	Application Level	Analysis Level	Evaluation Level	Creation Level
Basic skills that engineers in any field should acquire						
I Mathematics	K	K	K	A	S	S
II Natural Science	K	K	K	A	S	S
III Humanities and Social Sciences	K	K	K	A	S	S
IV Engineering Basics	K	K	K	A	S	S
Specialized skills that engineers should acquire in their areas of expertise						
V Special Engineering by Field	K	K	K	K	A	S
VI Engineering Experiments and Workshops by Field	K	K	K	K	A	S
Cross-sectoral skills required for engineers						
VII Application Skills	K	K	K	A	S	S
VIII Attitudes and Orientation (Personal Qualities)	K	K	K	A	S	S
IX Comprehensive Learning Experience and Creative Cogitations	K	K	K	A	S	S

Table 2 An example of attainment target of KOSEN's engineer education (basic skills that engineers of any fields should acquire).

	Attainment Target (Basic skills that engineers in any field should acquire)					
Required skills	**1** **Knowledge and Memory Level**	**2** **Comprehension Level**	**3** **Application Level**	**4** **Analysis Level**	**5** **Evaluation Level**	**6** **Creation Level**
I Mathematics	Students can recognize that a certain problem can be solved mathematically. **(K)**	Students can solve basic mathematic problems and explain important mathematical concepts. **(K)**	Students can employ a mathematical technique to resolve challenges in their specialized field. **(K)**	Students can identify, select and employ the mathematical knowledge required to solve more complex engineering issues in their field. **(A)**	Students can perform various types of simulations and analysis by integrating some of their knowledge in mathematics. **(S)**	Students can plan mathematical solutions to resolve complex challenges. **(S)**

Table 1 shows the attainment target by category required by KOSEN's regular and advanced courses. As shown in Table 1, the basic skills required for all engineers in common are categorized into four areas, specialized skills required for engineers in their areas of expertise are categorized into two areas and cross-sectoral skills required for engineers are categorized into three areas. In each skill set, the attainment targets are defined in the following six levels: 1. Knowledge and Memory Level; 2. Comprehension Level; 3. Application Level; 4. Analysis Level; 5. Evaluation Level; and, 6. Creation Level. Each level defines the attainment target and its content that are required in the regular and advanced courses of KOSEN. These levels were determined on the basis of the Revision of Bloom's Taxonomy (cognitive domains) [2].

The letter (K) in the Table 1 indicates the level of the regular course; (A) indicates the level of the advanced course; (S) indicates the attainment target for those who aim for earning higher-level qualifications such as manager or professional engineer. It is important to note that the attained level of KOSEN graduates or those who earned one of KOSEN's certificates is still positioned in the process of growth as an engineer in a company and the like. In order to continue at the (A) level, students should prove a certain level of attainment, which are the sections enclosed in the bold box.

Table 2 is the excerpt of the attainment target of KOSEN's engineer education. Students and teachers can confirm the attainment level against the attainment target in each field by using Table 2. Table 2 is used as a rubric in the MCC.

Table 3 shows the examples of learning content and attainment targets of the basic mathematical skill required for engineers. In order to solve the problem in their specialized field, students who graduate from KOSEN must be able to apply the mathematical skills listed in Table 3. Learning content and its attainment targets are also summarized in each field. These are the minimum standards in the MCC.

PDCA cycle for quality assurance of engineering education in the KOSEN

Figure 2 shows the PDCA cycle for quality assurance of engineering education in the KOSEN based on the MCC. The creation of syllabi which includes the rubric (Plan), introduction of the active learning (Do), evaluation of attainment level of basic and experimental skills (Check), and faculty development (Action) are very important to promote quality assurance of education based on the MCC. Therefore, several activities such as the development of a web syllabus system, the practice of active learning, and the evaluation of basic and experimental skills, have

Table 3 The examples of learning content and its attainment target of the basic mathematical skill required for engineers.

[Educational Attainment Objectives for Associate Degree Programs]
1 Target
Have the students learn mathematical knowledge, calculation technique and applications that are necessary to solve basic engineering problems, and he or she will develop the ability to utilize this knowledge and skill by relating to the phenomenon aspect in engineering.
2 Handling of Learning Contents
Learning contents shall be handled with consideration of the following items.
(1) While utilizing the learning outcomes of middle school, work closely with advanced course Math and Physics/specialized subjects, and create an instruction plan that would lead to a steady development of curriculum.
(2) The grade to complete each learning content shall not be specified, and the program can be run flexibly according to the student curriculum designed for each Kosen.
(3) This shall not prevent the students from taking specialized courses to learn the contents.
(4) This shall not prohibit covering the learning contents other than those listed below.

Learning Content	Attainment Objectives of the Learning Content	Attainment Objectives of the Advanced Courses
Calculation of Numbers and Formulas	The student is able to add, subtract, multiply and divide integral expressions.	
	The student is able to factorize by using formulas.	
	The student is able to add, subtract, multiply and divide fractional expressions.	
	The student understands the meaning of real number and absolute value and is able to conduct basic calculations of absolute values.	
	The student is able to conduct basic calculations of square root (including rationalizing of the denominator).	
	The student understands the equality of complex numbers and is able to add, subtract, multiply and divide complex numbers.	
Equation Inequality	The student is able to solve quadratic equations (including quadratic formulas).	
	The student is able to solve basic higher-degree equations by using factorization.	
	The student is able to solve basic simultaneous equations. Specifically, he or she is able to solve simultaneous equations with linear and quadratic expressions.	
	The student is able to solve basic irrational equations and fractional equations.	
	The student is able to solve basic linear inequalities.	
	The student is able to solve simultaneous linear inequalities in one unknown.	
	The student is able to solve basic quadratic inequalities.	
	The student understands the difference between identity and equation.	
Function and Graph	The student understands the characteristics of quadratic functions and is able to draw their graphs and obtain their maximum and minimum.	
	The student understands the characteristics of fractional functions and is able to draw their graphs.	

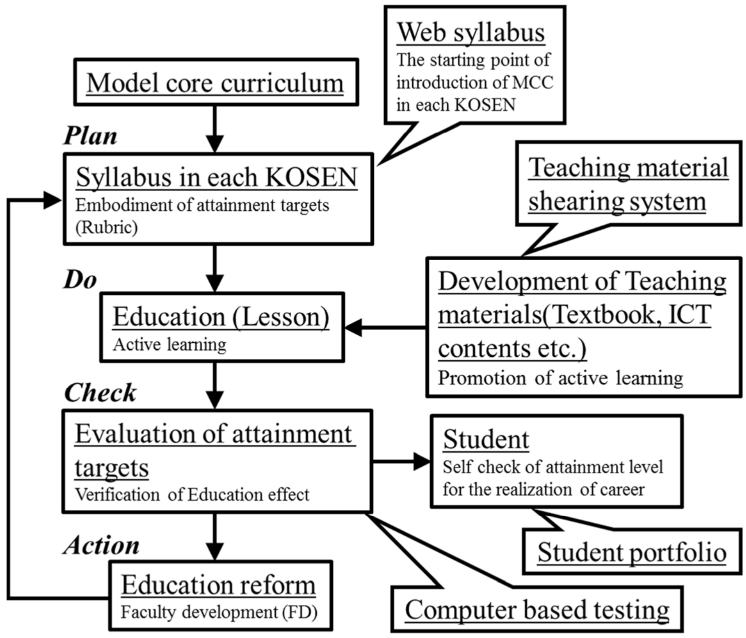

Figure 2 The PDCA cycle for quality assurance of engineering education in the KOSEN based on the MCC.

been attempted at NIT. An overview of typical activities are described below.

Development of a Web Syllabus System

As described previously, each KOSEN should create a curriculum which covers the minimum standards and unique learning fields. Therefore, it is important to confirm the lack of learning content and its attainment targets in the created curriculum. The lack of learning content and its attainment target are efficiently confirmed by using the web syllabus system. Students can confirm the curriculum map by using the web syllubus system as shows in Figure 3. The web syllabus system supports the student career education because students are able to ascertain the association of a subject visually. Teachers can reaffirm the learning content by using the web syllabus system. The web syllabus system became available in all KOSEN from 2015 [3].

Training and Practice of Active Learning

Teachers should nurture students to help them reach the minimum standards. For that purpose, the improvement of students' learning motivation is also important. Therefore, it is necessary to improve teachers' skills and knowledge about lesson planning, presentation, delivery, facilitation, and evaluation for classroom lessons. Teachers can assist students' comprehension and motivation for learning by using these skills and knowledge.

Training and practice of active learning has been energetically promoted by NIT. Two teachers in each KOSEN have attended the training of the Comptia CTT+ [4]. Training to improve teaching skills is assisted by CTT+ certified teachers in each KOSEN. In the Program for Promoting Inter-University Collaborative Education, teachers have attempted distance active learning by using several types of ICT tools (Figure 4).

Evaluation of Basic Skills in Mathematics, Physics and Chemical field

In order to evaluate the attainment level of students against the MCC, the computer based attainment test (CBT) has been tried by the Program for Promoting Inter-University Collaborative Education since 2012 [5]. This program is supported by the Ministry of Education, Culture, Sports, Science and Technology (MEXT). This program has been operated by the network of 7 KOSEN (Hakodate, Sendai, Ibaraki, Nagaoka, Suzuka, Toba and Kochi). This program is referred to as the Hakodate project in the NIT.

The CBT trial was started in the Hakodate project in 2013. The examination year, field for examination, and the number of examinees are summarized in Table 4. The examination questions of the LV3 from LV1 in compliance with the MCC for the CBT have been prepared by teachers in each field. An overview of the CBT is shown in Table 5. The difference between this CBT and conventional CBT is the implementation of a questionnaire of learning habits. After the examination, students can confirm a percentage of correct answers, and model answer, immediately. Teachers can confirm both overall results and personal results for the examination, immediately. Teachers can effectively support the students based on this information. In order to formulate the guidelines for creating questions, suitability of the questions has been statistically verified

Figure 3 An example of the curriculum map (in Japanese).

Figure 4 An example of the distance active learning by using several types of ICT

Table 4 Examination year, field for examination, and the number of an examinee of CBT.

Year	Field for examination	Number of an examinee
2013	Mathematics, Physics	About 1,000 students
2014	Mathematics, Physics	About 1,500 students
2015	Mathematics, Physics, Chemical	About 7,000 students

Table 5 An overview of CBT.

Method for examination	Computer based testing
Type of examination	Selection
Field for examination	Mathematics, Physics, Chemical
Time for examination	50 minutes
Number of question	30 questions in maximum
Examinee	From 1 to 3 grade of the regular course
Remarks	Questionnaire of learning habit (10 minutes)

using the examination results.

The CBT trial in the NIT started in earnest from 2016.

Future Deployment

As descrived above, we have promoted the ICT environmental arrangement not only for faculty development but also in order to support student learning. It is very important to develop both teacher skills and ICT infrastructure in order to promote the education reform in recent years. On the other hand, verification of the educational effects of the new educational methods such as active learning is necessary. The development of the KOREDA (formal name is Kosen Open. REsorce Database) that integrates each system such as web syllabus, CBT, and student portfolio, etc., has been promoted in the NIT with the aim of completion in 2018.

I hope for education reform using the KOREDA.

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[5] http://www.hakodate-ct.ac.jp/~w-loqa/

The Mentor@Work Programme for SkillsFuture: Enhancing Skills Mastery, Workplace Learning and Talent Development

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Abstract

Globally, there is an ongoing debate on the need for higher educational institutions to evaluate and re-design their programmes in order to support the demands of the industry through better job-skills match (McKinsey, 2012). In Singapore, there is a national movement – SkillsFuture launched in 2015 that is focused on providing Singaporeans with the opportunities to develop their fullest potential throughout life and to help Singaporeans develop a future based on skills mastery (SkillsFuture Council, 2015).

This presentation shares the experience of Republic Polytechnic (RP) in developing the Mentor@Work Programme to support this national movement. It discusses the three frameworks (Work-Study System for Enhanced Internship and Earn & Learn Programme, Integrated Course Design Model, and PEER Model) developed for this programme to enhance the quality of mentoring in both school and the industry.

Keywords: *SkillsFuture, Mentor@Work Programme, Work-Study System, Enhanced Internship, Earn and Learn Programme, Integrated Course Design Model, PEER Model, Quality of Mentoring*

Introduction

The shortage of labour in many economies around the world has created a new conundrum where employees with technical knowledge, professional skills and attitude are now a necessity to sustain growth and a competitive advantage (McDonald, 2015). This in turn requires both school and industry leaders to work collaboratively to equip students and workforce with the knowledge and skills to navigate the challenges amidst a fast-changing and globalized world.

Companies have an obligation to their employees and stakeholders to create environments with learning opportunities and career progression (McDonald, 2015). Therefore, both school and industry leaders must ensure they work together to develop a futures-oriented workforce with a lifelong learning disposition to enhance the students/employees' employability and professional dexterity amidst a changing employment landscape.

Competitiveness and Human Capital Challenges Faced by Singapore

In 2013, Singapore became the richest country in the world by IMF estimates, with a per capita GDP of USD 61,567 (Lee Kuan Yew School of Public Policy, 2014). The country is one of the most competitive and business-friendly in the world. The aggressive pursuit of upgrading Singapore to be a global city was the vision of its founding father and the first Prime Minister, Mr Lee Kuan Yew.

Over the past decade, the increased presence of foreign workers has been a major force shaping the human capital landscape in Singapore. As part of the strategy to transform Singapore into a global city, the government had followed a liberal foreign worker and immigration policy. While the open-door labour policy brought in a large number of highly skilled, high-wage foreign workers, it has also led to a huge influx of low-skilled, low-wage foreign workers (OECD, 2013). With the ready availability of low-wage foreign workers, firms in Singapore do not find many incentives to upgrade their technologies and production structures, or to invest in training or upgrading the skills of their workers (OECD, 2013).

In his 2015 budget speech, Mr Lim Swee Say, the Minister of Manpower, stated the Singapore Government remains committed to the slowing of foreign labour inflow in order to maximize the potential of Singaporean workers. Since 2010, Singapore has curbed the intake of foreign labour. In 2014, the foreign workforce shrunk to 26,000, down from 80,000 in 2011 (Chang, 2015). The manpower landscape saw a slew of measures introduced to tighten the foreign labour market.

SkillsFuture Initiatives

A key consideration in the government's human capital development policy in the past four years has been to help local workers adjust to the changing needs in the industry so that they can continue to remain "employable". This involves identifying industries that are seen to be sustainable over the long run and then providing workers with the necessary skill sets to stay employed within them.

The key initiative announced by Singapore government in 2015 to address this human capital issue is the SkillsFuture Initiatives (Saad, 2015). SkillsFuture is a national movement to enable all Singaporeans to develop to their fullest potential throughout life regardless of their starting points (SkillsFuture Council, 2015). Through this movement, the skills, passion and contributions of every individual will drive Singapore's next phase of development towards an advanced economy and inclusive society (SkillsFuture Council, 2015). SkillsFuture will enable each Singaporean to take advantage of a wide range of opportunities to realise their aspirations and attain mastery of skills (see Table 1). The Labour Movement Budget 2016 emphasized it will further enhance the Singaporean core at workplaces and develop sector-specific career ladders as part of the work done by the SkillsFuture Tripartite Committee on sectoral manpower (Saad, 2015) .

Table 1: Summary of "Building a future based on skills mastery"

<table>
<tr><th></th><th>In School</th><th>Starting Work</th><th>Growing your Career</th></tr>
<tr><td rowspan="2">Theme 1: Supporting Individuals in their lifelong learning journey</td><td colspan="3">➢ Strengthening Education and Career Guidance (ECG)
➢ Individual Learning Portfolio (ILP)</td></tr>
<tr><td></td><td colspan="2">➢ SkillsFuture Credit (aged 25 and above)</td></tr>
<tr><td rowspan="2">Theme 2: Building skills across individuals' life stages</td><td rowspan="2">➢ Enhanced Internships
➢ Young Talent Programme (YTP)</td><td>➢ SkillsFuture Earn and Learn Programme (ELP)</td><td>➢ SkillsFuture Mid-Career Enhanced Subsidy (aged 40 and above)</td></tr>
<tr><td colspan="2">➢ Skills-based Modular Courses</td></tr>
<tr><td>Theme 3: Targeted support for career progression</td><td></td><td colspan="2">➢ SkillsFuture Study Awards
➢ SkillsFuture Fellowships
➢ SkillsFuture Leadership Development Initiative</td></tr>
<tr><td rowspan="2">Theme 4: Collaboration with Industry</td><td></td><td colspan="2">➢ Sectorial Manpower Plans
➢ SkillsFuture Mentors</td></tr>
<tr><td colspan="2">➢ Sector Coordinators</td><td></td></tr>
</table>

Source: SkillsFuture Forum presentation slides on 21 April, 2015.

21st Century Competencies – Skills Mastery

To succeed in the 21st century, the learner and employee must be supported in acquiring the 21st century competencies. All 21st century competencies initiatives must focus on the following (The Partnership for 21st Century Skills, 2009):

1. Core academic subject's mastery: All 21st century competencies can and should be taught in the context of core academic subjects.
2. 21st century skills outcomes:
   · Critical thinkers
   · Problem solvers
   · Good communicators
   · Good collaborators
   · Information and technology literate
   · Flexible and adaptable
   · Innovative and creative
   · Globally competent
   · Financially literate

Since the emergence of a global movement that calls for a new model of learning in the 21st century, it has been argued that formal education must be transformed to enable new forms of learning that empower the learners to tackle complex global challenges. In a recent foresight study on the future of learning, Redecker and Punie (2013) found that 90% of experts surveyed agreed that schools must increase efforts to open up to integrate real-life experiences into teaching practices.

New Learning Option – Work-Study System

Coupling hands-on learning with education is not a new idea. John Dewey advocated education through experience at the turn of the last century (SCOPE, 2013). However, in reality, relatively few schools offer this integrated approach, typically limiting instruction to textbooks and lectures. To address this concern, a new learning option – "Work-Study System" was introduced as one of the key SkillsFuture initiatives (Ministry of Manpower, 2015). There are two types of work-study system in SkillsFuture initiatives (SkillsFuture Council, 2015):

1. Enhanced Internship:
   Both the polytechnics and Institute of Technical Education (ITE) in Singapore emphasise on applied learning and its relevance to work and the careers pursued by its students. Internships are an integral component of the courses offered by the polytechnics and the ITE. Such programmes aim to give learners exposure to the real work environment and enable learners to make a better transition into the workplace. To improve learners' learning experience, the polytechnics and the ITE are working with employers to enhance their internship programmes. Some of these enhancements include clear learning outcomes, better mentorship, and where relevant, extended durations of the attachments. This will enable students to take on more meaningful, real work activities during internship.

2. Earn and Learn Programme:
   The SkillsFuture Earn and Learn Programme is a work-study programme designed to give fresh graduates from polytechnics and the ITE a head-start in careers related to their discipline of study. It provides them with more opportunities, after graduation, to build on the skills and knowledge they acquired in school, and better supports their transition into the workforce (Ministry of Manpower, 2015). Participating employers can recruit young Singaporeans and prepare them to take up suitable job roles. Meanwhile, participants can

look forward to a structured career progression pathway within the organisation. This programme is designed in collaboration with industry to ensure work relevance and the growth of the sector.

To support the implementation of the work-study system, the SkillsFuture Council (2015) recommended the following measures to support the workplace learning of the students:

- Support from host companies, such as the deployment of experienced mentors to monitor and guide the interns at the host companies.
- Learners will be matched to suitable employers related to their disciplines of study, thus allowing them to deepen the skills acquired in school, through workplace learning and mentorship.
- Learners will undergo structured on-the-job training (OJT) and mentorship, leading to industry-recognised certification.
- Learners will be assigned mentors and be supported in continual skills development in accordance with the company's talent development plan.
- Learners will have a well-structured career development pathway in the company.

Mentoring - The Key Success Factor for Workplace Learning

As highlighted, earlier the success of such work-study programmes is contingent on workplace mentors who are tasked with the coaching and mentoring of learners within the ambit of the work-study system. These learners are concurrently registered as part-time students in a polytechnic that will lead to further qualifications recognised by the industry. Supporting work-based learners in busy working environment presents challenges as well as rewards for both learners and their workplace mentors.

Workplace mentoring

Mentoring is one of the oldest forms of influence and knowledge sharing. It is connected historically with ancient Greek mythology, and more recently in sixteenth century when young apprentices were indentured to older craftsmen who passed on knowledge and skills to develop competencies (Ragins ~~and~~ & Kram, 2007). Mentoring is a tool that organisations can use to nurture and grow their people by providing a platform for learners and employees to navigate organizational culture, solve problems and advance their career (Abbajay, n.d.).

Talent Management

Companies often invest hundreds of thousands of dollars in recruiting talent but often miss the opportunity to get the best return on their hiring investment. Talent management not only helps to build an effective workforce, it also reduces the cost associated with the training of new employees. Mentoring is one of the most effective strategies either as a standalone program or as part of an existing workforce development program. By implementing a "mentoring scheme", experienced employees can pass on tacit knowledge; act as positive role models and keep people engaged in an environment where attraction and retention were key issues (Wallace et al., 2011). However, it should be noted that mentoring may be jeopardized because of inexperienced or untrained mentors, social distance and a mismatch between the values of mentor and mentee, inadequate definition of roles and ground rules, relationship difficulties, and poor recruitment (Cull, 2006; Sarri & Petridou, 2006; Tabbron, Macaulary, & Cook, 1997).

The Mentor@Work Programme for SkillsFuture

Given the pivotal role of the industry mentor in the skills deepening and capacity building of the SMEs within the ambit of the SkillsFuture initiative (Spring Singapore, 2015), it is critical to address the issue of professional development for mentors (Holland, 2009). Therefore, high-quality and committed mentors are crucial to the success of formal mentoring programmes within organisations (Allen, Eby, & Lentz, 2006; Allen & Poteet, 1999; Ragins, Cotton, & Miller, 2000).

The Purpose and Intention

The intent of the mentorship training is to equip company mentors with the knowledge, skills and attitude required to (i) adopt a paradigm shift to embrace the mentoring role, (ii) strengthen capabilities in organisational learning and development, and (iii) position organisations' branding as employers of choice with attractive developmental and career growth opportunities as part of the talent management strategy. The training seeks to emphasise the paradigm shift in workplace learning, structured OJT, relevant development and career growth opportunities through timely mentoring intervention, that are essential for the success of the SkillsFuture initiatives.

The Design Principles of Mentor@Work Programme

a. **Bite-Sized:** In aligning with one of the SkillsFuture goals of providing an "Expanded Range of Skills-Based Modular Courses" for adult learners, all courses/topics offered in this programme will be chunked into accessible "Learning Bytes". Learning Bytes are organised under various domains for clarity.

b. **Flexibility:** Each "Learning Byte" is equivalent to 4 learning hours. Clients have the flexibility to complete different units of "Learning Bytes".

c. **Customisation:** The programme can be customised based on learning needs analysis for the client.

The Structure of Mentor@Work Programme

The learning bytes are organised into the following 5 learning domains:

1. Purpose and Induction: This domain seeks to provide learners with the background of SkillsFuture and the challenges confronting the workforce. It provides the rationale for stronger partnership between school and industry to lead to more structured internships and better career pathway as part of overall human capital development.
2. Planning and Evaluation: This domain covers learning bytes that introduce learners to the considerations taken for designing curriculum and learning plan, setting assessment, and developing the assessment rubrics in the context of workplace competencies through the development of OJT blueprint.
3. Presentation and Facilitation: This domain seeks to provide participants with enhanced coaching skills and more productive training methods for effective delivery of OJT. This domain also offers the opportunity for participants to learn and apply the Cognitive Apprenticeship approach to develop skills and knowledge.
4. Coaching and Mentoring: This domain seeks to strengthen the concept and practice of coaching and mentoring. Underpinning the practices of coaching and mentoring are interpersonal and motivational skills. This domain also provides opportunities for participants to apply their learning in various settings and to enhance their mentoring skills through peer learning.
5. Reflection and Portfolio: This domain seeks to provide participants with opportunities to articulate and reflect on their learning after applying the knowledge and skills acquired in the first four domains within their workplace.

The Three Key Frameworks

Three frameworks were developed to support and integrate the 5 learning domains into one holistic solution as the talent management strategies in workplace.

The first framework – "Work-Study System for Enhance Internship and Earn & Learn Programme" (see Figure 1) is to establish a seamless "integration of education and training" in schools and at the workplace. In order for the work-study system to be effective, educators need to become strategic drivers in facilitating better job-skill match for learners (Foo, 2015).

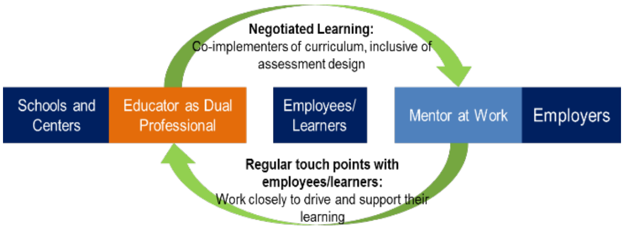

Figure 1: Work-Study System for Enhanced Internship and Earn & Learn Programme

The second framework – "Integrated Course Design Model" (Figure 2) articulates a systematic approach and guidelines in designing the work-based learning curriculum, on-the-job learning plan and performance assessment plan.

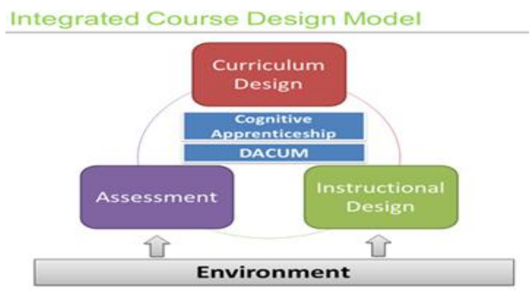

Figure 2: Integrated Course Design Model
(Adapted from Dee Fink, 2003)

The third framework – "PEER model" (Figure 3) illustrates the developmental approach to mentoring. The 4-stage model traces a mentor's development from the stage of initially engaging in task-oriented learning activities to one becoming independent, confident practitioners with the ability to innovate and solve problems.

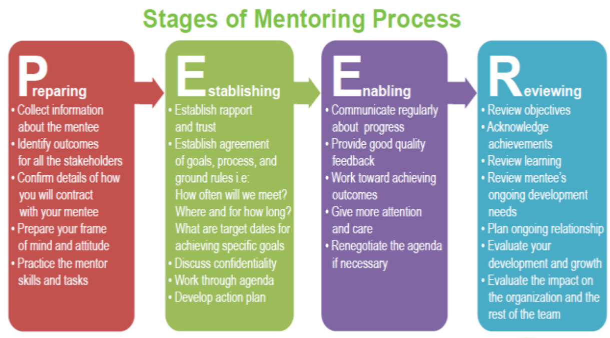

Figure 3: PEER Model

Conclusion

The full Mentor@Work programme consists of 37 learning bytes categorised under 5 learning domains. To promote lifelong learning, this programme is designed in a way that participants who have successfully completed the full Mentor@Work programme are eligible for further progression into the Specialist Diploma in Applied Learning and Teaching (SDALT), offered by the Centre for Educational Development, RP. This progression takes into account exemptions of modules to reduce the time taken to complete the

SDALT qualification. Since September 2015, RP started to offer Mentor@Work Foundation Programme which is a 3-day programme consisting of 6 learning bytes to meet the learning needs of industry mentors in the Enhanced Internship and Earn & Learning Programme under the auspices of the SkillsFuture initiative.

This presentation shares RP's experience in developing the Mentor@Work Programme to support this national movement. Specifically, it highlights the development process of the five domains of this programme with the three key frameworks to support the key measures recommended by the SkillsFuture Council for workplace learning. It also stresses on the importance of providing a structured mentoring training programme to help support mentors in their personal and professional growth.

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TRAINING PROJECT ON REGIONAL REHABILITATION FOR SAFER AND MORE SECURE SOCIETY IN FUKUSHIMA WITHOUT NUCLEAR ENERGY

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Abstract

The recovery and the rehabilitation of Fukushima are still on the way. Especially, it is pointed out that it takes several decades to abolish and terminate Fukushima Daiichi Nuclear Power Plant completely and safely. In order to make this process feasible, raising the younger generation who have the knowledge and the skills on regional rehabilitation for safer and more secure society in Fukushima without nuclear energy is very critical. National Institute of Technology, Fukushima College (hereinafter NIT-FC) established an office named the "Office for Regional Rehabilitation" in January 2012. The office takes the role to implement a training project which consists of three fields such as renewable energy, nuclear safety and disaster mitigation. The office is implementing a special course for regional rehabilitation at both the advanced course and the regular course of Fukushima College. Furthermore, the office prepares for a special program for the community too.

In line with the above-mentioned activities, NIT-FC is going to organize a creative robot contest on decommissioning in December 2016 under the cooperation with other higher educational institutions in Japan. This contest aims at raising younger students who become interested in the technologies for decommissioning and the robots being able to function on the process of decommissioning of Fukushima Daiichi Nuclear Power Plant. The students who participate in this contest are able to acquire the abilities to resolve the problems and to find out the problems at the same time. These abilities are able to be acquired through the training project based on the tasks which are appearing in the real world not on the theory on the desk. In this sense, this contest can contribute to the education of Project Based Learning and Active Learning at the same time.

Fukushima has become a worldwide known word recently. However, in order to achieve the real recovery in Fukushima from the devastated disaster, steady efforts for the sake of raising the younger generation are indispensable.

Keywords: Training project, Office for regional rehabilitation, NIT-FC, Renewable energy, Nuclear Safety, Disaster mitigation, Creative robot contest, Decommissioning, Project Based Learning, Active Learning

Introduction

Due to the Great East-Japan Earthquake which occurred on March 11, 2011 and the followed explosion of Fukushima Daiichi Nuclear Power Plant, Fukushima Prefectural Government determined and declared the change regarding energy utilization from nuclear energy to renewable energy. Based on the declaration, Fukushima Prefectural Government is implementing the policy to invite private industrial sectors which are related to renewable energy. In line with implementing this policy, National Institute of Technology, Fukushima College (hereinafter "NIT-FC") is expected to raise many engineers who have the knowledge and the skills regarding renewable energy, because NIT-FC is the only national technical institution of higher education in Fukushima Prefecture.

Furthermore, it is said that it takes several decades in order to abolish and terminate Fukushima Daiichi Nuclear Power Plant completely and safely. It means that Japanese institutions of higher education like NIT-FC will have to produce engineers for a long time in the future, who have the skills on the technology of nuclear power plant and the knowledge of radiation. NIT-FC is required to have a cooperative relationship with Japan Atomic Energy Agency (JAEA) for the sake of creating engineers specialized in nuclear safety. Based on the above-mentioned background, it is one of the important responsibilities of NIT-FC to implement the policy concerning educating students in the field of nuclear safety.

In addition, there are many devastated and still untouched areas in Fukushima Prefecture which were damaged by the earthquake and the tsunami and these areas still remain far from the recovery and the rehabilitation because of the radiation influence by the incident of Fukushima Daiichi Nuclear Power Plant. Based on this reality, the engineers who have the knowledge and the skills related to disaster mitigation for urban areas are needed by Iwaki City Government and other near municipalities.

In order to resolve the problems of Fukushima Prefecture, NIT-FC established an organization named the "Office for Regional Rehabilitation (hereinafter ORR)" in January 2012. This office is directly supervised by the President of NIT-FC and is implementing a project named "Training project in higher education on regional rehabilitation for safer and more secure society in Fukushima without nuclear energy" under the budgetary support by Ministry of Education, Culture, Sports, Science and Technology (hereinafter called MEXT) from FY2011 to FY2015. This office is also working for the purpose of human resource training on regional rehabilitation and research on regional industry development.

Figure 1, The Great East-Japan Earthquake

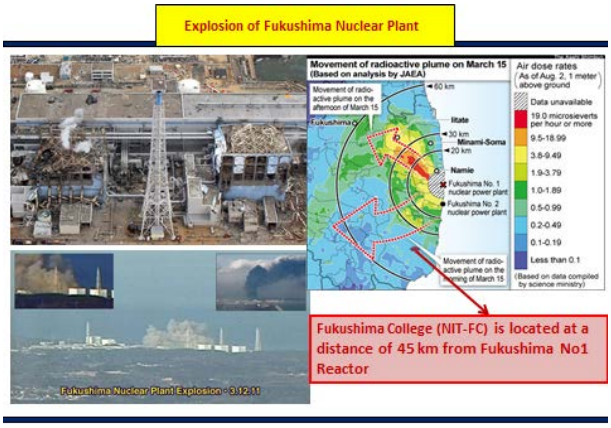

Figure 2, Explosion of Fukushima Daiichi Nuclear Power Plant

Outline of this Project

When the ORR started its works, two professors in charge of renewable energy, two professors in charge of nuclear safety and one professor in charge of disaster mitigation, totally five professors were newly hired by NIT-FC. In addition, approximately forty professors of NIT-FC join the ORR.

A special course for regional rehabilitation was established at the advanced course of NIT-FC from FY2013, and the number of students of the advanced course per year was increased from 20 to 25. The students who belong to the special course are able to obtain the credits of the lessons related to renewable energy, nuclear safety and disaster mitigation which are taught by newly hired professors and the professors who belong to NIT-FC.

In addition, the ORR of NIT-FC implements a special educational program for the employees of small and mid-sized private sectors which were damaged by the disaster. The purpose of this program is to improve their technical skills and knowledge. The program is able to contribute to enhance the company's competitiveness and increase the job-opportunities for the victims by the disaster.

Furthermore, the ORR carries out the measurement of radiation for the municipalities and the community, and the consultation to rehabilitate the damaged areas in Fukushima. Moreover, the office organizes community forums and seminars on regional rehabilitation.

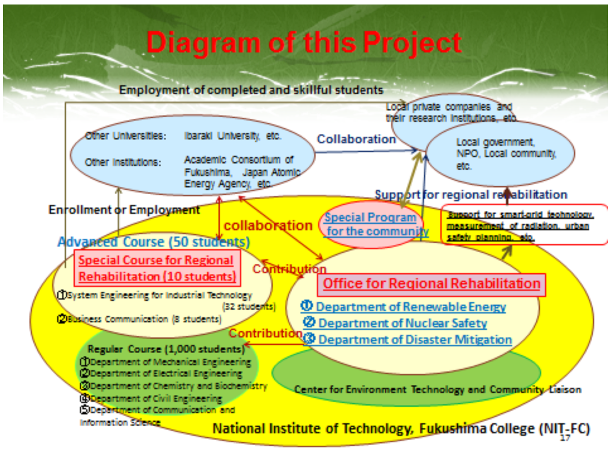

Figure 3, Components of this Project

Education: Special Course for Regional Rehabilitation

The number of subjects for the special course for regional rehabilitation is 12 and the titles of the subjects are shown in the Table 1. The students who belong to this special course at the advanced course have to take more than 5 subjects. In addition, the experiment related to rehabilitation is prepared for the students. Moreover, the students have to conduct special research related to regional rehabilitation. The inauguration ceremony for this special course took place at NIT-FC on May 9, 2013. In addition, 9 subjects related to regional rehabilitation which are shown in the Table 2 are prepared for the students who belong to the regular course. The length of regular course is five years and it is set before the two years advanced course.

Renewable electricity generation	Power delivery system engineering
Science and engineering nuclear reactor safety	Radiation engineering
Disaster prevention engineering	Applied communication engineering on protection on disaster
Industrial safety engineering	Environmental preservation engineering
Application mechatronics	Urban economics
Mathematical decision-making theory	Industrial economics

Table 1, Subjects at Advanced Course

Introduction to Radiational administration	Introduction to environmental and energy engineering
Communication engineering for disaster prevention	Nuclear decommissioning and society
Decommissioning of nuclear plant	Overview of nuclear plant accidents
Introduction to radioactivity and radiation	Fundamentals of nuclear decommissioning robotics
Introduction to nuclear power	-

Table 2, Subjects at Regular Course

Education: Special Program for the Community

The ORR of NIT-FC organizes a special program for the community. During FY2014, several programs for the community such as "Basic course for photo voltaic", "Basic course for radiation", "Raising engineers of civil-engineering who are in charge of regional rehabilitation", etc. were prepared.

Figure 4, Students listening to the Lecture

Figure 5, Teachers listening to the Lecture

Figure 6, Citizens listening to the Lecture

Research

Figure 7 shows the real scale experimental system of smart grid. This experimental system consists of gas cogeneration system, wind power, photo voltaic power, outdoor switchgear, simulator, etc. This experimental system supplies electricity to the loads at NIT-FC by connecting with normal electric system and sends heat to the bathroom of the dormitory of NIT-FC. Even though a blackout occurs when natural disaster hits NIT-FC, this experimental system is able to function properly and send electricity and heat to the important areas of NIT-FC. This system is able to be applied to the renovation or the rebuilding of hotels or schools.

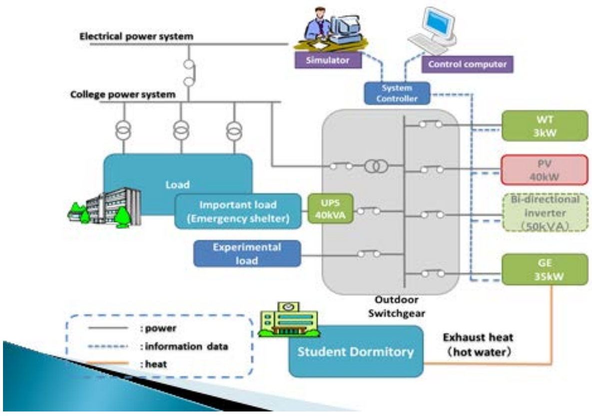

Figure 7, Real Scale Experimental System of Smart Grid

In addition, the ORR of NIT-FC implements the state-of-the-art research and development on renewable energy, nuclear safety and disaster mitigation under the cooperation with other universities and research institutions as the following Figure 8 and Figure 9 show.

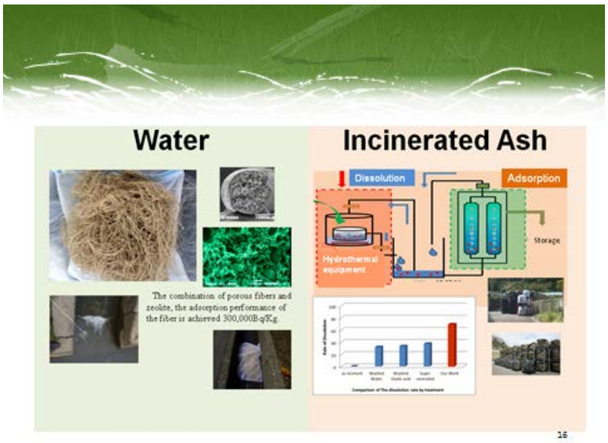

Figure 8, Removing and recovering cesium from water and incinerated ash

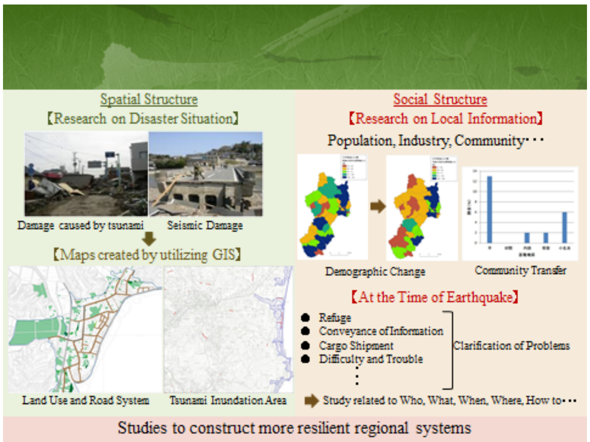

Figure 9, Studies to construct more resilient regional systems

Contribution to the Community

The ORR of NIT-FC fundamentally implements the measurement of radiation based on the requests from the municipalities like Iwaki City, public organizations, cooperative private sectors of NIT-FC, researchers and students of NIT-FC. In addition, the ORR also started the measurement of radiation based on the request by normal citizens from July 2013.

Furthermore, the ORR of NIT-FC organizes regional forums on renewable energy, nuclear safety and disaster mitigation in order to lecture related information and knowledge to the community. Several forums such as “Basic course for photo voltaic”, “Examples for nuclear safety”, “Countermeasures in the case of disasters” were held during FY2013. Lectures and panel discussion on the above-mentioned themes took place. A forum titled “Geothermal power plant and the utilization of geothermal heat” was held in June 2014.

Creative Robot Contest on Decommissioning

Reportedly, it will last for three or four decades to decommission the damaged Fukushima Daiichi Nuclear Power Plant. Therefore, it is indispensable to educate younger generation who are interested in decommissioning technology. On the other hand, robot contest is popular at National Institute of Technology. In order to take more attention on decommissioning from younger generation, the education through making robots which contribute to the decommissioning of Fukushima Nuclear Power Plant is effective. Therefore, NIT-FC is planning to organize a creative robot contest which is going to be held on December 2016. Although the idea and the technology which are introduced by the students of NIT are not necessarily directly applied to the real decommissioning process of Fukushima Daiichi Nuclear Power Plant, excellent ideas and technologies can be discussed about the possibility of utilizing them.

Prior to this creative robot contest, the students who are going to participate in the contest will join the summer school consisting of the lectures on decommissioning technology and the visit to Fukushima Daiichi Nuclear Power Plant. Through this summer school, the students are able to enhance their creativity to make their robots. It is inevitable for the students to see and experience the real decommissioning site in Fukushima.

Field of the Creative Robot Contest

The creative robot contest on decommissioning is planned to be held at the Naraha Remote Technology Development Center of the Sector of Fukushima Research and Development, Japan Atomic Energy Agency on December 2016. The field of this robot contest is considered to be at the mock-up stairs and the step field which are located in the building of Naraha Remote Technology Development Center. The mock-up stairs and the step field are built under the consideration of the real damaged building of Fukushima Daiichi Nuclear Power Plant.

Environment of the Field

The mock-up stairs and the step field have the following common circumstances.

- Dark without lights
- Robots can’t be seen directly due to remote control
- Radio waves can’t be reached due to the thick concrete walls
- There is a limit for the control of cameras and semi-conduct instruments due to the influence of strong radiation

Above-mentioned circumstances and the real situation of Fukushima Daiichi Nuclear Power Plant are going to be explained to the students who will participate in this robot contest through lectures and summer seminar in September 2016.

Tasks for the Robots

(Mock-up Stairs)

- Carry 5kg object from 1st floor to 2nd floor and return to the original position on 1st floor
- Detect an unknown object on 2nd floor
- Others related to the tasks for decommissioning

(Step Field)

- Detect the shape, the area and the up-and-down of step field
- Detect an unknown object which is set in the field
- Others related to the tasks for decommissioning

Number of the Participants

15 teams from 13 colleges of National Institute of Technology have expressed their participation in June 2016.

Figure 10, Mock-up Stairs

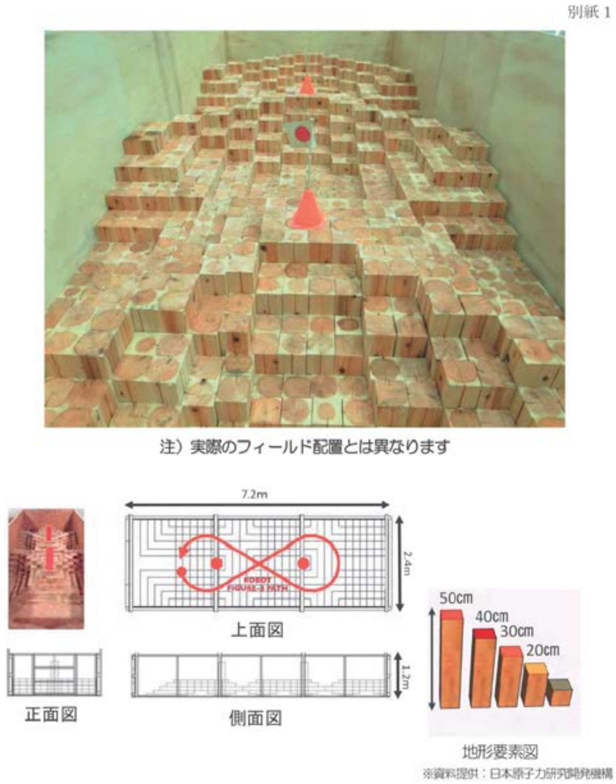

Figure 11, Step Field

Conclusion

At the graduation ceremony of NIT-FC on March 2015, 14 students were successfully able to get the credit to complete this special course of regional rehabilitation for the first time. Each of them mentioned her or his ambition to contribute to the recovery and the rehabilitation process of the affected regions in Fukushima. The recovery and the rehabilitation of Fukushima are still on the way, even though the rest area of Japan tends to forget the damages caused by the Great East-Japan Earthquake. Especially, it is pointed out that it takes several decades to finalize the decommissioning of Fukushima Daiichi Nuclear Power Plant and many cutting-edge technologies will have to be invented to realize the decommissioning of the plant. On this point, Creative Robot Contest on Decommissioning is a challenging event for younger generation and ought to be continued in the future. In that sense, NIT-FC will have to raise talented engineers and send them to the society for long time in the future under the cooperation with other related universities and research institutions.

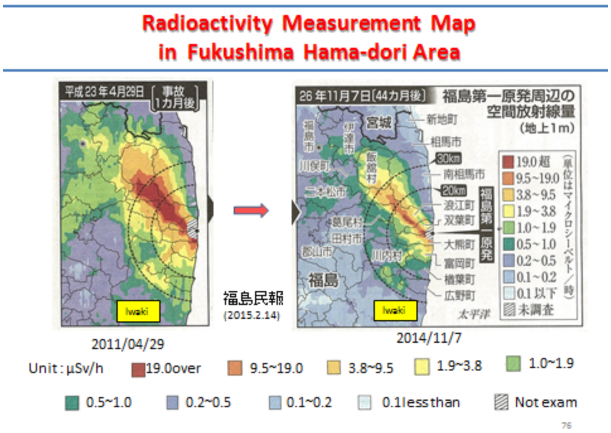

Figure 12, Shrinking Contaminated Area in Fukushima

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EFFECTIVE ACTIVE LEARNING – PEDAGOGY FOR EVIDENCE-BASED FLIPPED CLASSROOM

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Abstract

This paper shares an evidence-based pedagogic model for implementing a highly effective flipped classroom approach. The approach presented both maximizes an active learning approach and the learning affordances of info-communication technologies. It firstly explains what a flipped classroom is, its key pedagogic features and potential learning benefits in terms of the student learning experience and outcomes. Secondly, it highlights the importance of designing and facilitating student learning experiences based on instructional methods that, from extensive research, suggest the most positive effects on attainment, based on a measurement parameter known as 'Effect Size'. Examples of high effect size instructional strategies in the context of this work are outlined, as well as the creative blending of particular methods and e-tools, which can result in especially high impact learning experiences and attainment opportunities for students. The pedagogic approach also incorporates 'Core Principles of Learning' as fundamental design heuristics in the construction of instructional strategies, and strongly emphasizes that good pedagogy must come before technology in learning design. Technology will not make a poorly designed lesson an engaging and effective one; however, it can significantly enhance aspects of the learning process in the case of well-designed lessons. This is essential in the case of the flipped classroom as the important overall design consideration is how best to maximize the learning affordances of both online and face-to-face modes of instruction. Thirdly, there is a particular focus on creating an overall active learning environment to facilitate high levels of student engagement and two-way feedback relating to formative assessment, which has a particularly high effect size for enhancing student attainment. Quality feedback makes both student learning and faculty thinking visible, thus enabling accurate assessment of present performance levels, identification of learning gaps, and planning effective strategies to meet desired goals. The final section of the paper summarizes and illustrates the full pedagogic framework and how it can be systematically employed in designing and facilitating highly effective flipped classroom lessons.

Keywords: *Flipped classroom, evidence-based teaching, formative assessment, ICT Tools*

Active Learning and Flipped Classroom

Active learning is generally defined as any instructional method that engages students in the learning process. In short, active learning requires students to do meaningful learning activities and think about what they are doing (e.g. Bonwell & Eison, 1991). There are many forms of active learning strategies, and evidence from the literature shows that they can be effective in improving student learning compared to traditional lecture (e.g. Prince, 2004). The latest form of active learning that had caught widespread attention is flipped classroom. The flipped classroom is essentially a blended learning format for organizing the student learning experience utilizing the potential benefits of blended learning. While there are many definitions of blended learning, Garisson & Vaughan (2008) capture the key elements nicely when they assert it

> …is the thoughtful fusion of face-to-face and online learning experience…optimally integrated such that the strengths and weakness of each are blended into a unique learning experience congruent with the context and intended educational purpose.
> …combines the properties and possibilities of both to go beyond the capabilities of each separately. (p.6)

The basic approach in flipped classroom is that students are given an online learning experience before coming to class, often through a recorded lecture and related reading and activities (previous done through the face-to-face class lecture), which is to help them acquire the key underpinning knowledge relating to a topic area before the face-to-face session. This approach is to free up class time to apply the content knowledge thoughtfully in more real-world active learning application. Various authors had mentioned the potential benefits of flipped classroom (e.g. Fulton, 2012; Herreid & Schiller, 2013) which include:

- students being able to learn more at their own pace
- doing "homework" in class gives teachers better insight into student difficulties

- teachers can more easily customize and update the curriculum to meet students learning needs as they arise
- classroom time can be used more effectively and creatively
- students who miss class can watch the lectures in their own time
- students are more actively involved in the learning process
- a greater positive impact on attainment and the learning experience than the traditional mode (based on self-reporting)

At present, research relating to the effectiveness of the flip format is more descriptive rather than empirically validated (e.g. Waldrop & Bowden, 2015). Similarly, Murray, Koziniec & McGill (2015) noted that although flipped classroom has received a lot of publicity, there has been little formal evaluation of its impact on student satisfaction or performance. As will be introduced later, an evidence-based pedagogical approach offers greater effectiveness in evaluating the flipped classroom in terms of its potential for enhancing student learning experiences and attainment opportunities.

Evidence-based Approach to Teaching and Learning

Slavin (2008) argued that "throughout the history of education, the adoption of instructional programs and practices has been driven more by ideology, faddism, politics, and marketing than by evidence." Certainly for many decades, it seemed, as Sallis & Hingley (1991) commented, "Education is a creature of fashion." As a consequence, many teachers consider that effective teaching is such a common-sense endeavor that comes naturally (Halpern & Hakel, 2003). However, many typical practices of teachers, such as long heavy content lectures, do not concur with what is known about human learning (Saville, 2010). One therefore has to be cognizant of the need to continually improve our teaching to maximize student learning. Groccia and Buskit (2011) for example, noted that "…as teachers, it is always *necessary* (italics in original) to improve."

An evidence-based approach to teaching and learning refers to the pedagogical knowledge, method use and principles of learning that have shown, through extensive research, to promote better learning (Saville, 2010; Dunn et al, 2013). This is crucial to maximize student learning opportunities and for educators to have evidence about their learning and performance in order to support them to achieve better quality educational outcomes. To this end, the process of evidence gathering to inform teaching and learning must be an explicit and accountable one, which is equitable, representative, valid, and reliable (Bruniges, 2005).

Of particular significance in this area is the work of Hattie (e.g. 2009; 2012), which was an educational landmark in the movement away from more ideological-based paradigms towards evidence-based practice in teaching. Hattie synthesized over 800 meta-analyses of the influences on learning and most significantly, he was interested not just in what factors impacted learning, but the extent of their impact - referred to as *Effect-Size*. Effect size is a way to measure the effectiveness of a particular intervention to ascertain a measure of both the *improvement* (gain) in learner achievement for a group of learners and the *variation* of learner performances expressed on a standardised scale. By taking into account both *improvement* and *variation* it provides information to which interventions are worth having.

Hattie firstly identified the typical effect sizes of schooling without specific interventions, for example, what gains in attainment are we likely to expect over a one-year academic cycle? Typically, for students moving from one year to the next, the average effect size across all students is 0.40. Hence, for Hattie, effect sizes above 0.4 are of particular interest. As a baseline an effect size of 1.0 is massive and is typically associated with:

- Advancing the learner's achievement by one year
- Improving the rate of learning by 50%
- A two grade leap in GCSE grades

Table 1 shows examples of effect sizes in learner attainment from Hattie's meta-analysis which featured some high impact methods on student attainment, as demonstrated by their effect size.

Table 1. Examples of effect sizes (Hattie, 2009)

Influence	Mean Effect Size
Feedback Students getting feedback on their work from the teacher, their peers or some other sources. Note: some feedback has more effect size than others. For example, peer assessment is 0.63 and self-assessment is 0.54	0.73
Meta-cognitive strategies Students can systematically think about (plan, monitor and evaluate) their own thinking and affective processes (e.g. beliefs, emotions, dispositions) to develop effective learning to learn capability and self-regulation	0.69
Challenging goals Students having a clear frame on, and see purpose in, what they are learning, as well as experience realistic challenge in meeting goal expectations	0.56
Advanced organizers Giving students an overview (in an appropriate format and level of understanding) of what is to be learned in advance of the lesson, to help make meaningful connections between their prior knowledge and the new material to be presented	0.41

However, as Hattie notes, it is important to balance effect size with the level of difficulty of interventions. For example, providing 'advance organizers' (summaries in advance of the teaching) have an effect size of 0.41, which is pretty average, but they only take up a few minutes at the beginning of the lesson, and potentially offer the equivalent of moving up a year in terms of a student's achievement. He goes on to make relative comparisons of intervention use, which enables us to go beyond identifying the effect sizes for particular innovations (deliberative intervention involving strategy/method use for a group of students), and ascertain whether the effects of a particular innovation were better for students than what they would achieve if they had received alternative innovations.

Of particular significance is the fact that it is not just the effect size of one intervention that is important, but how a number of effective methods can be strategically and creatively combined to produce powerful instructional strategies that significantly impact student attainment. As Hattie (2009) pointed out:

> …some effect sizes are 'Russian dolls' containing more than one strategy. For example, 'Feedback' requires that the student has been given a goal, and completed an activity for which the feedback is to be given; 'whole-class interactive teaching' is a strategy that includes 'advance organizers' and feedback and reviews. (p.62)

Figure 1. Russian dolls (source: www.kzero.co.uk)

Core Principles of Learning

From an evidence-based perspective, it is not just the methods that work best, but also the underlying core principles of learning that facilitate the learning process (e.g. Ambrose, Bridges, DiPietro, Lovett and Norman, 2010; Willingham, 2009). For example, Sale (2015) offers the following 10 Core principles of Learning as key guiding heuristics from which teaching professionals can plan learning experiences and teach more effectively:

1. Motivational strategies are incorporated into the design of learning experiences
2. Learning goals, objectives and proficiency expectations are clearly visible to learners
3. Learners prior knowledge is activated and connected to new learning
4. Content is organized around key concepts and principles that are fundamental to understanding the structure of a subject
5. Good thinking promotes the building of understanding
6. Instructional methods and presentation mediums engage the range of human of senses
7. Learning design takes into account the working of memory systems
8. The development of expertise requires deliberate practice
9. A psychological climate is created which is both success-orientated and fun
10. Assessment practices are integrated into the learning design to promote desired learning outcomes and provide quality feedback

The 10 Core Principles of Learning are not exhaustive or summative as new knowledge and insights will continually enhance our understanding of human learning and the implications for how we teach. However, as Willingham (2009) rightly noted:

> Principles of physics do not prescribe for a civil engineer exactly how to build a bridge, but they do let him predict how it is likely to perform if he builds it. Similarly, cognitive scientific principles do not prescribe how to teach, but they can help you predict how much your students are likely to learn. If you follow these principles, you maximize the chances that your students will flourish. (p.165)

Furthermore, just as combining high effect methods can have a powerful overall impact on learner attainment, as captured in Hattie's (2009) analogy of 'Russian Dolls', the same applies to the thoughtful and creative application of core principles of learning. As Stigler & Hiebert (1999) highlighted:

> Teaching is a *system*. It is not a loose mixture of individual features thrown together by the teacher. It works more like a machine, with the parts operating together and reinforcing one another, driving the vehicle forward. (p.75)

Assessment for Learning (Formative Assessment)

As shown in Table 1, feedback given in the form of formative assessment is an important intervention with high effect size (0.73). Formative assessment is a planned process by which assessment-elicited evidence of students' status is used by teachers to adjust their ongoing instructional procedures or by students to adjust their current learning tactics (Popham, 2011). As noted by Marzano (2009):

> In terms of providing teachers with feedback, the focus must always be on student learning and the perspective must always be that the instructional strategies are a means to an end.

The evidence that formative assessment is a powerful lever for improving outcomes for learners has been steadily accumulating over the last quarter of a century. Over that time, at least 15 substantial reviews of research, synthesizing several thousand research studies, have documented the impact of classroom assessment practices on students. The general finding is that across a range of different school subjects, in different countries, and for learners of different ages, the use of formative assessment appears to be associated with considerable improvements in the rate of learning (Leahy and Wiliam, 2012).

Black et al (2003) noted that the concept of 'feedback' is central to the operation of any system that has to adapt to manage change, of which formative assessment is one. These authors listed four key components required for effective feedback:

- Data on the actual level of some measurable attribute
- Data on the desirable level of that attribute
- A mechanism for comparing the two levels and assessing the gap between them
- A mechanism by which the information can be used to alter the gap

Affordances in Info-Communication Technologies

The flipped classroom is fundamentally about good pedagogic design, and that needs to be evidence-based in terms of the methods that work best and what we know about how humans learn – the core principles of learning. However, in the context of this paper, info-communication technologies (ICT) are seen as offering key affordances in terms of enhancing effectiveness and efficiency in the learning process. ICT in this context refers to the freely available Web 2.0 Tools as well as specialized computer simulation and modelling softwares for use in teaching and in enhancing student learning. Reddi (2007) noted that when a decision is taken to use ICTs for educational purposes, we must be able to define and describe for what purpose the content will be used and also be very clear as to what delivery system we are going to use. Such a decision should not be based on the technologies but on the conditions and contexts in which we seek to use the ICTs; from simple access to modules or to enhance specific aspects of the learning process. Although the above-mentioned core principles of learning did not make explicit references to ICTs, their use is particularly noticeable in Principle No.10 for facilitating the feedback process. In practice, ICT tools are useful in supporting all core principles of learning. For example, Principle No.3 via web site links to earlier topics; and Principle No.9 by including in the learning process elements of play. ICT tools can also be used to promote good thinking (Principle No.5) but as noted by Sale (2014), we need to be clear from a pedagogical point of view about the types of thinking that we are trying to promote and provide practice in, as technologies themselves do not ensure good thinking.

Flipped Classroom: An Evidence-based Pedagogy

An example of the pedagogical model, which combines the most effective methods, principles of learning and the affordances of ICT, is shown in Figure 2. Student learning starts with learning of disciplinary knowledge outside of classroom. This is usually a video recording of a PowerPoint-based lecture created using Camtasia or YouTube videos uploaded by professional organizations. This is followed by a self-evaluation exercise (usually multiple choice questions or true/false questions, created for example using Socrative or Kahoot) for students to monitor his/her understanding of the topic concerned. Feedback is formative, whereby brief explanation for all answers (right or wrong) are provided. Evidence of students learning can be discerned from the result captured. When in class, the lecturer will engage students firstly by pointing to an advanced organizer that described the day's lessons and how the topics are tied into the overall module learning aims. The learning outcomes for the day are then explained. Depending on the difficulty of the topic concerned, the lecturer may use the concept checkpoint to further ascertain students' understanding before proceeding. The lecturer then introduces various class activities, based on the learning context requirements, using videos, short case studies, news clippings, simulations, etc so that students get to practice thinking and deliberate practice in applying the concepts learned. Again, depending on the difficulty of the topics, the lecturer may introduce additional concept checkpoints, usually by asking relevant probing questions. The lecturer can conclude the day's lesson with a summary of concepts covered, and where necessary, initiate another round of concept checking.

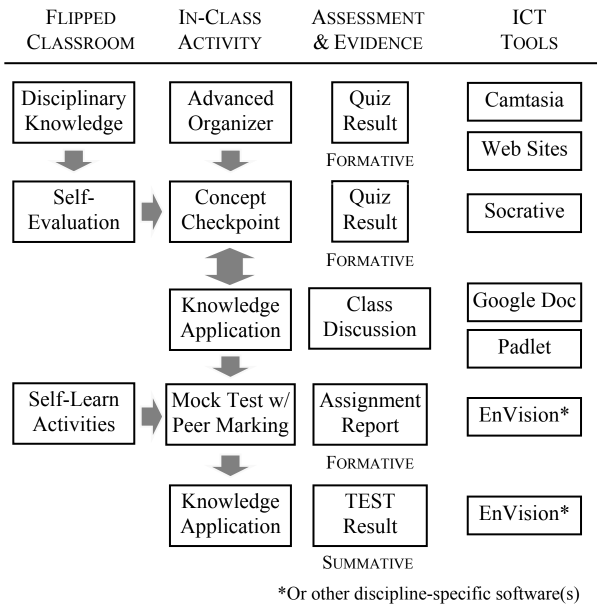

Figure 2. Example of an Evidence-based Flipped Classroom Format

This process may be repeated a number of times to facilitate the necessary practice and reinforcement for memory to build up of key competencies. Subsequent lessons will build on the topics covered earlier, and further concept checkpoints may be used as needed to ensure students are able to integrate earlier learning into the current context.

Classroom discussions may require students to provide answers in class, using platforms such as Google Doc, or Padlet (which is a form of digital Post-It notes). For example, students may be given a topic and are asked to discuss in groups and present a jointly-reasoned answer in Google Doc. Individual students may also be asked to provide input using Padlet. These student responses are projected onto the screen and allow the lecturer to quickly ascertain if students understand all the key concepts taught up to that point. Responses from groups that consistently missed out on an item may point to significant gaps and misconceptions relating to particular concepts in a topic.

To better prepare students for a graded-assessment, such as a written assignment, a mock test is administered, and the report submitted by students are marked with focused annotations to provide task- and process-specific feedback. Classroom discussion focuses on key areas of improvement so that gaps in knowledge and thinking can be made visible and collaboratively addressed. Another effective and efficient method to help students learn important process assessment skills is via peer marking using a given set of rubrics. Students are taught how to mark a set of model answers. It is worthy to note that some of the responses in the model answers were made to be deliberately less-than-satisfactory, challenging them to identify the shortcomings in the answers, and to offer ways to improve these answers. The rubrics thus serve to inform students of our expectations. For more challenging topics, additional self-learning activities are provided for students practice before embarking on the graded-assessment (summative).

Evaluating a Flipped Classroom

In evaluating the student learning experience of the flipped classroom, it is important to recognize that some areas are generic to the context of learning, e.g. the learning space, resource access and technical design and functionality. Hence, in conducting evaluation, such features may need to be ascertained and taken into consideration, as well as specific pedagogic focal areas.

In this work, we used an evidence-based approach as the guiding heuristics for evaluating the instructional design and teaching practices, as well as the students learning experiences. For the latter, the aim is to unpack the components of the experience and identify which features have most significantly impacted student learning (e.g. positively, negatively or other), and on what basis. To assist this process, we have enlisted the participation (voluntarily) of at least two students per class as “co-participants” (Lincoln, 1990) in the research process. They provide regular feedback on their learning, and that of classmates (where possible) through focus group interviews and questionnaires. This enables ongoing appraisal of the instructional strategy, evidence-based diagnosis of student learning, both in terms of attainment and experience. In this way, modifications and new components can be introduced with a high predictive capability of being effective and efficient in the learning stakes.

Conclusions

The challenge of designing and facilitating the student learning experience from an evidence-based teaching approach using the flipped classroom format was an exciting one. Certainly we feel that the approach shared in this paper is the most logical theory-based instructional model to underpin our teaching using the flip classroom format. This is crucial, as Black and Wiliam (1998) summarize:

> Teachers will not take up attractive sounding ideas, albeit based on extensive research, if these are presented as general principles which leave entirely to them the task of translating them into everyday practice – their classroom lives are too busy and too fragile for this to be possible for all but an outstanding few. What they need is a variety of living examples of implementation, by teachers with whom they can identify and from whom they can both derive connection and confidence that they can do better, and see concrete examples of what doing better means in practice.

Similarly, Dziuban, Hartman & Moskal (2004) point out:

> Maximizing success in a blended learning initiative requires a planned and well supported approach that includes a theory-based instructional model, high quality faculty development, course development assistance, [and] learner support. (p.3)

This approach is now being piloted with the Diploma in Chemical Engineering in Singapore Polytechnic, and detailed work is covered elsewhere by Cheah (2016). Our future goal is to improve the capability of maximizing the blend of high effect size teaching methods and the affordances of the flip format to create highly effective, efficient and creative learning experiences for the students we teach. This we feel is a real merging of the science, art and craft of teaching (Eisner, 1995).

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INTRODUCTION TO GRADUATE SCHOOL PROGRAM ON MANAGEMENT OF TECHNOLOGY

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Abstract

Since 2006, Toyohashi University of Technology (TUT), Japan, has offered a graduate school program on the Management of Technology (MOT). This program is mainly for Master's students in the Department of Mechanical Engineering. This paper introduces an outline of the MOT program. The program offers three types of subjects, with the first being typical mechanical engineering subjects. The second type includes social sciences subjects, such as management science. The third type of subject, which is the most characteristic feature and the active learning part in this program, is company internship based on collaborative research between TUT faculties and industries.

Keywords: *graduate school program, management of technology, company internship, industry–university collaboration, social science*

Introduction

In addition to its wide range of active learning programs, Toyohashi University of Technology (TUT), Japan, has introduced a graduate school program on the Management of Technology (MOT) in 2006. This program was introduced mainly for Master's students in the Department of Mechanical Engineering. Furthermore, it received government support for five years under Cooperative Plans for High-level Personnel Dispatch (renamed in 2008 to the Practical Human Resource Development Program by Industrial–Academic Cooperation).

The MOT is the management discipline that pursues understanding of technology potential and harnessing of such potential to the benefit of organizations that aim to create new technologies and products. As most students at TUT are from the National Institute of Technology, they typically excel in technological subjects. However, economic and administrative viewpoints are also required for them to take the initiative and be innovative in creating new products at a managerial position.

The MOT program offers three types of subjects. The first includes typical mechanical engineering subjects, such as the four major dynamics. The second includes social sciences subjects, such as management science. The third type, which is the most characteristic feature and the active learning part in this program, is company internship based on collaborative research between TUT faculties and industries. As university professors generally have little experience in creating new products for sale, students would do well to gain experience in developing commercial industrial products.

Although some educational programs stop accepting students after governmental financial support has terminated, approximately 10 students apply for the MOT program every year; moreover, TUT is extending the program to other departments.

MOT Company Internship

The MOT program aims to develop professional engineers who possess knowledge of both technology and management and can take a leadership role in industrial projects. Therefore, the program offers MOT company internship based on collaborative research with industries. This is because collaborative research allows in-depth discussion with industries on product development, including cost viewpoints.

Although typical internship periods in industries are around a couple of weeks, TUT offers an on-the-job training program for all undergraduate students. This is undertaken around the last two months of undergraduate study to enhance future Master's study. Around 200 companies have provided internship positions every year since the establishment of TUT. The MOT company internship offers a flexible period of study, in which the minimum requirement is only 90 hours, although the required period differs among companies. Typically, students participate in an internship program for more than a month.

Because experiences abroad are also important for taking initiative in R&D, overseas internships are allowed for PhDs, including internships at universities and research institutions.

The numbers of applicants are as follows:

2006: started with the support of Japanese government as a five-year project, 4 Master's students
2007: 1 Master's student
2008: 9 Master's students and 1 PhD student studied in Germany
2009: 14 Master's students and 1 PhD student studied in Germany and France

2010: 8 Master's students and 2 PhD students studied in Germany, Demark, and the US
2011–2016: around 10 Master's students each year

An example product (gantry crane) from a company that accepts MOT program students is shown in Fig. 1(a). After a company president gives a lecture on company management and the market for industrial machines, the student develops an experimental machine for verification by a control algorithm, as shown in Fig. 1(b).
One PhD student took the internship abroad and went to three major universities, two venture companies, and an established company in the US to study business start-up and administration and to research abroad.

(a) Company product (b) Designed testbed for control verification

Figure 1 Example of MOT company internship work

Course Structure

Table 1 presents the basic course structure of the MOT program. In addition, students take typical mechanical engineering subjects from four groups: mechanical systems design, materials and manufacturing, system control and robotics, and environment and energy.
As the MOT is the management discipline that pursues understanding of technology potential and harnessing of such potential to the benefit of organizations, the program offers several important social science subjects on management, research, and development. For example, management science is a compulsory subject whose contents are as follows:
basic probability, normal probability variable, geometric Brownian motion, interest rates, arbitrage trade, Black–Scholes formula, dividend, jump, volatility estimation, valuation by expected utility, stochastic order, optimization model, stochastic dynamic programming, and exotic option

The contents of other subjects are found in [1].

Conclusions

As knowledge of both technology and management are required for product development in industries, TUT established the MOT program based on collaborative researches with industries. Study abroad programs for PhD students are also provided to understand cross-cultural business administration and R&D. Although some educational programs stop accepting students after government financial support is terminated, approximately 10 students apply for the MOT program every year; moreover, TUT is extending the program to other departments.

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[1] Toyohashi Univ. Tech., *Dream Campus,* https://www.ead.tut.ac.jp/syllabus/SearchMain.aspx?

Table 1 Course structure of MOT program

Category		Compulsory/ Elective	Subject name	Credits	Classes (90 min.) per week					
					1st year				2nd year	
					Spring		Fall		Spring	Fall
					1	2	1	2		
General Subjects	Reseach Ethics	Compulsory	Ethics of Reseacher	1	1					
	Natural Science	Compulsory	Life Scienece	1	1					
			Environmental Science	1		1				
	Social Science	Compulsory	Management Science	2	1					
			Operations Management	2	1					
		Elective	Intellectual Property Law	2	1					
			Innovation Management	1	Intensive					
			Others(Omitted)							
	Humanities	Elective	Omiited							
MOT Program Specilized Subjects		Compulsory	Seminar in Mechanical Engineering 1	3	3					
			Seminar in Mechanical Engineering 2	2					2	
			Supervised Research in Mechanical Engineering	4	6					
			MOT Company Intermship	2			Intensive			
		Compulsory Elective	Technological Strategy and Intellectual Property Law	2			1			
			Real Options	2			1			
			Strategic Management	2	1					
			Marketing	2			1			
		Elective	Technical Writing in English	1	1					
			English Comprehension and Speaking	1			1			
			Advanced Topics in Mechanical Engineering 1	1	Intensive					
			Advanced Topics in Mechanical Engineering 2	1	Intensive					

TEACHING AND LEARNING – READY FOR 21st CENTURY?

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Abstract

Higher education institutes are supposed to be experts on teaching and learning. They should be the sources for future experts and professionals for the 21st century. Despite this expertise, we can for example hear concerns about the appropriateness of teaching and learning, and about the skills our graduates have. We know that everyone involved with the professional engineering education design have at some point stopped to think about the education from different perspectives. Higher education institutes have to understand the need they are educating for – they should know the professional roles and practical context of their graduates. They should also have the understanging of the knowledge, skills and attitudes their graduates should possess. In other words, they should be aware of the 21st century needs, requirements and possibilities. These two perspectives – the need and the learning outcomes – can be decided and agreed for example with discussions together with the industry and other stakeholders. Unfortunately, these are not enough – the HEI still needs to find correct ways of working to ensure that their students really learn. It means that HEI have to look at their programme from different viewpoints: curriculum, teaching activities, learning processes, workspaces and assessment. This is the difficult part of the work: curriculum structures are stopping the changes, teaching activities and learning processes are not relevant for the 21st century learner, workspaces are outdated and don't' support the skills of the 21st century, and assessment is assessing student's memory rather than student's understanding. The CDIO initiative tries to answer these challenges, but it doesn't give you the cookie cutters to solve your challenges. In this speech the learning and teaching needed in the 21st century is discussed and traditional approaches are challenged. Furthermore the best parts of CDIO initiate will be introduced and reflected on the 21st century teaching and learning.

Keywords: *Digitalization, Teacher's training, Faculty development, Innovation pedagogy, CDIO*

Introduction

Higher education institutes have a problem. They should be the sources for future experts and professionals for the 21st century. Higher education institutes have to understand the need they are educating for – they should know the professional roles and practical context of their graduates. Their education and training should produce skills at the right level and in the relevant areas for the needs of the labour market and the economy more broadly (Frey, Holmes, & Osborne, 2016). Using Rose's (2012) description of the challenge we could say that *higher education has to educate students for jobs that don't yet exist, using technologies that have not been invented, in order to solve problems we don't even know are problems yet.* It doesn't make the challenge any easier that we are today, according to many industry observers, on the cusp of a Fourth Industrial Revolution (World Economic Forum, 2016). Technological innovation will demand a new set of skills in the workforce. The accelerating pace of technological, demographic and socio-economic disruption is transforming industries and business models, changing the skills that employers need and shortening the shelf-life of employees' existing skill sets in the process (World Economic Forum, 2016). This rapid technological change is making increased investment in education as a number one policy suggestion. Many argue that science, technology, engineering and math skills are needed. On the other hand non-cognitive skills can be increasingly important too. Anyway the different factors and ideas are lowering the ability of education to adapt the space and scope of technological change. We need more coordination and communication between educational and employment sectors. (Frey et al., 2016)

Many countries have reacted to the changes and developments in the world. For example, the Finnish higher education is in change. There have been many recent reforms in the higher education sector in Finland. At the same time, Finland is losing competitive advantages in terms of highly educated workforce and innovation capacity (Ministry of Education and Culture Finland, 2015). Despite the reactions in higher education ministries in various countries, it seems that ensuring that the education system of a given country produces both the necessary level and mix of skills will continue to be a major challenge in the coming decades

(Frey et al., 2016). Unfortunately, during previous industrial revolutions, it has often taken decades to build the training systems and labour market institutions needed to develop major new skill sets on a large scale. Given the upcoming pace and scale of disruption brought about by the Fourth Industrial Revolution, however, this may simply not be an option (World Economic Forum, 2016). Therefore like Gerstein and Friedman (2016) write *Institutions of higher education have no choice but to adapt to changing conditions and focus on skills and competencies*. Higher education institutes won't be able to create more and more academic programs and department as an answer to the future requirements. Rather they need to create opportunities to collaborate and share knowledge and let students move from department to department, from course to course. Still, the most existing education systems at all levels provide highly siloed training and continue a number of 20th century practices that are hindering progress on today's talent and labour market issues (World Economic Forum, 2016).

These perspectives – the need and the learning outcomes – can be decided and agreed for example with discussions together with the industry and other stakeholders. Unfortunately, these are not enough – the HEI still needs to find correct ways of working to ensure that their students really learn. It means that HEI have to look at their programme from different viewpoints: curriculum, teaching activities, learning processes, workspaces and assessment. This is the difficult part of the work: curriculum structures are stopping the changes, teaching activities and learning processes are not relevant for the 21st century learner, workspaces are outdated and don't' support the skills of the 21st century, and assessment is assessing student's memory rather than student's understanding. We should move to measuring student competences and what is actually learned, we should move away from the old definition of x hours equalling one credit.

During recent years, different initiatives to reform education have been introduced. Some of these will be introduced in the next sections. Even new models to create new universities are being developed, but unfortunately the existing institutions of higher education are adapting to the changing business environment slowly (Gerstein & Friedman, 2016). If not changing the whole system, the education should take certain steps according to the Technology at Work v2.0 (Frey et al., 2016). Their study lists how education should adapt to equip people for the jobs needed in the future. Three top answers in the study were 1. Increase focus on STEM subjects, 2. Increase focus on soft skills and 3. Move to active learning. Interestingly these three are very high on the agenda of the different education initiatives too. For example the CDIO approach emphasizes strong expertise in engineering skills and soft skills (which CDIO call as professional skills). In addition, active learning is key teaching and learning ideology in CDIO approach with an own standard for it (CDIO, 2014b). Furthermore, skills that continue to be relevant are communication, creativity, critical thinking, collaboration, entrepreneurial skills and innovation abilities!.

In this paper different initiatives to improve education are introduced and discussed. Finally, paper concludes with key observations to teaching and learning for 21st century.

Different initiatives for future education

There are several examples and initiatives that have recognized challenges and problems in the current way of doing engineering education. There are for example initiatives such as CDIO (CDIO, 2016), Big Beacon (Big Beacon, 2016), New Model in Technology & Engineering (NMITE, 2016). In addition there are other - often university based - manifestos to change engineering education such as the work done in TU Delft (Kamp, 2014) and there are university based pedagogical strategies guiding the overall education development such as the Innovation Pedagogy in Turku University of Applied Sciences (Turku University of Applied Sciences, 2015). Most of them start with explanations or observations to rationale the need for change and reform. For example, Big Beacon states very strongly and directly about their concern about engineering education: "*But those who come to school in search of the excitement of creating cutting edge technology or helping people through engineering find something else. They find an educational system stuck in a rut, a rut not of the 1990s or 1980s, but a rut of the 1950s."*. NMITE on the other hand list several challenges of today's engineering education:

- Engineers and society do not interact enough
- We need more engineers to address current and future global challenges
- In the English-speaking world, engineering attracts few female or BAME students
- Insufficient numbers taking maths or physics
- Drop-out from current programmes is too high
- Student engagement is too low.

CDIO initiative started as a response to the industry concerns about students graduating with poor skills in engineering practice although technically adept. The TU Delft paper paints the big challenge engineering education still has: *We have to educate students for jobs that don't yet exist, using technologies that have not been invented, in order to solve problems we don't even know are problems yet*.

CDIO – Conceive, Design, Implement, Operate

The CDIO approach started in 2000 to improve engineering education to narrow the gap between the working life expectations and engineering education practices. The key elements of the CDIO approach are (E. Crawley, Malmqvist, Östlund, Brodeur, & Edström, 2014):

- understanding the context of engineering education,
- understanding the abilities needed by contemporary engineers and

- reforming education to ensure that students learn these abilities.

The CDIO approach provides a number of resources that individual programs can adapt and implement to meet these goals. The CDIO standards describe 12 principles to effective education and practice. The basic principle is that the authentic context of engineering education is the conceiving-designing-implementing-operating of products, processes and systems. Knowledge and skills are learned in a cultural surrounding and environment that contributes to understanding (E. F. Crawley, Malmqvist, Lucas, & Brodeur, 2011). The CDIO Standards define the distinguishing features of a CDIO program. They guide and support educational program reform and evaluation, and provide a framework for continuous improvement. The standards aim at improved learning results, students learning more and students having a better experience at their HEIs. The 12 CDIO Standards address program philosophy (Standard 1), curriculum development (Standards 2, 3 and 4), design-implement experiences and workspaces (Standards 5 and 6), methods of teaching and learning (Standards 7 and 8), faculty development (Standards 9 and 10), and assessment and evaluation (Standards 11 and 12) (CDIO, 2014a). Each standard is documented with a description explaining the meaning of the standard, with a rationale highlighting the reasons for setting the standard, and with evidence providing examples of documentation and events that demonstrate compliance with the standard.

The another key element and effective practice of CDIO approach – the CDIO syllabus – answers to the challenge that a program should have set "Specific, detailed learning outcomes for personal and interpersonal skills, and product, process, and system building skills, as well as disciplinary knowledge, consistent with program goals and validated by program stakeholders." The general objective of the CDIO Syllabus is to describe a set of knowledge, skills and attitudes desired in a future generation of young engineers. It offers rational, complete, universal and generalizable goals for undergraduate engineering education. The syllabus organizes learning outcomes in four high-level categories:

- technical knowledge and reasoning,
- personal and professional skills and attributes,
- interpersonal skills: teamwork and communication
- conceiving, designing, implementing and operating systems in the enterprise, societal and environmental context.

Although CDIO is not a quality assurance tool the CDIO approach supports it too. Standard 12 guides programs to identify areas of education that should be further developed. This self-evaluation tool supports comprehensive development of education for the purposes of continuous improvement (Kontio et al., 2012).

Big Beacon

The Big Beacon approach talks about a whole new engineer answering the needs of our current and future world that is changed by technological forces. Big Beacon has its roots in the work on engineering education transformation at the Illinois Foundry for Innovation in Engineering Education (ifoundry), Olin College, and the Olin-Illinois Partnership (OIP) (Big Beacon, 2016). The activities started in 2007 and in 2011 Big Beacon was first used to promote the needed change in engineering education. In 2012, the Big Beacon Manifesto was written. The manifesto describes "A Whole New Engineer" with 12 statements such as

- Is open, trusted, and trusting
- Has the courage to initiate, fail, and initiate again.
- Is technically competent and agile.
- Is a team player, a collaborator, and a community builder.
- Is a reflective thinker and a self-directed and persistent learner.

In addition, the manifesto provides description of "A Whole New Engineering Education" with another set of 12 statements. This part starts with a definition of engineering education saying that *Engineering education is not a mind-numbing math-science death march that casts aside thousands of capable young people who might otherwise have made effective engineers. It is a joyful, trusting process that delights in serving student aspirations, learning, and growth, unleashing the potential of each individual.* The statements say for example that A whole new engineering education

- trusts students, believing they are resourceful, creative, and whole.
- encourages diverse student aspirations and increases student autonomy and choice.
- accommodates diverse learning styles.
- listens to and collaborates with all stakeholders.

Finally, the manifesto talks about effective educational change or educational rewire which is by their definition not 1. A class-by-class process of content or pedagogical reform, or 2. Something that awaits new research. The effective educational change is described as an emotional and cultural process using known methods in a way that practically, systematically, and sustainably promotes the dual vision of the whole new engineer and a whole new engineering education.

The Big Beacon approach differentiates itself from other education reform approaches by saying its focus being in the changing of the culture instead of only focusing on content, curriculum and pedagogy. They are encouraging the shift from fear and odedience to trust and unleashing of the learner. More information on the needed change and background and rationale of the big beacon can be found from the book "A Whole New Engineer" (Goldberg & Somerville, 2014).

New Model in Technology & Engineering

NMiTE is an initiative to start a totally new university in Hereford in United Kingdom. The initiative is establishing a new university based on the following goals and principles (NMITE, 2016):

- Creating a beacon institution to help address the engineering skills shortage that threatens to hobble the UK's ability to compete globally.
- With a new approach to learning – based on real-world problem solving and the blending of high quality engineering, design, liberal arts and humanities with communication and employability skills targeted at the growth sectors of the future.
- Located on a new and different type of campus – designed for inspiration, collaboration and a deep connection to the global community.
- And reinforced by an innovation ecosystem of global corporations & SME entrepreneurs, coupled with global universities, not just to invest, but to contribute knowledge and expertise – with New Model students at its centre.

They are aiming at engineering education that produces engineers with a human face (Goodhew, 2016):

- Are articulate and persuasive, and work in teams
- Know why they are engineers and want to change society for the better
- Understand the world around them
- Can identify as well as solve problems
- Demonstrate grit, curiosity and passion
- Fail frequently and learn from this
- Show that engineering is also fun.

The initiative has many interesting and concrete ideas on building the new university such as:

- Very close collaboration with industry and academic partners on curriculum design, provision of real problems for classroom, and input on broader skill needs
- Interdisciplinary and problem-based/learning-by-doing engineering teaching
- Blended academic and practitioner faculty
- New approach to admissions reaches beyond traditional groups to focus on interviewing to identify those who balance academic ability with "curiosity, grit and passion"
- All students required to study relevant humanities, design/arts and social science topics
- Mandatory work 6-12 month placements
- 46 week academic year
- Faculty and staff rewarded for inspirational teaching, related scholarship, education innovation and for creating "safe to fail" experience-based learning environment
- Start up and growth companies to be supported by venture capital and 'angel' funds.

The plans of NMiTE follow and they collaborate both with the Big Beacon actors and with the CDIO initiative. The planned schedule for this new university is 2019.

Innovation pedagogy

Our pedagogical approach in the Turku University of Applied Sciences is innovation pedagogy (Kettunen, 2011; Kontio, 2015). The objective of innovation pedagogy, developed at the Turku University of Applied Sciences (TUAS), is to provide the students with innovation competences in order to enable them to participate in innovation processes in their future working places and develop them (T. Penttilä & Kontio, 2016). In the Faculty of Business, ICT and Chemical Engineering of Turku University of Applied Sciences innovation pedagogy is implemented with the CDIO approach (CDIO, 2016). Both innovation pedagogy and CDIO are not new to our university rather we have been working with them many years. Our university joined the CDIO initiative in 2007. Still, the latest strategy is our first that truly combines the strengths of both. Actually innovation pedagogy and CDIO complement each other well (Kontio, 2012; T. Penttilä & Kontio, 2014; Taru Penttilä, Kontio, Kairisto-Mertanen, & Mertanen, 2014). Innovation pedagogy integrates entrepreneurship, applied research and development, and internalization with education and working life (Kettunen, 2011).

Discussion

Looking into the future is a difficult task. Higher education has to educate students for jobs that don't yet exist, using technologies that have not been invented, in order to solve problems we don't even know are problems yet. The initiatives introduced here are trying to answer these challenges with their idea of the best education for the future and for the needs of society. The initiatives have differences, but they share some common themes too. The CDIO approaches education from several viewpoints and provides standards for each of the viewpoints. The CDIO approach provides the framework, but leaves each institute the freedom to adapt and work with these themes the best way that is suitable in their university context. The Big Beacon on the other hand does not provide very concrete tools for transforming the education, but provides strong statements on the cultural changes needed in the education. Following the presented cultural statements will change the education and influence on the solutions that should be implemented. The approach is different than in CDIO, but implemented solutions might be close to each other. CDIO does not speak much about the culture, but implementing CDIO will require changes in the learning and teaching culture. The Big Beacon on the other hand doesn't speak much on the actual steps to be taken, but is aiming at new teaching and learning culture. The NmiTE approach is combining the best parts of both CDIO and Big Beacon approaches. It is designed for a single university so far and it goes therefore into much more detailed and practical level.

The CDIO approach provides a list of competences, describes a set of knowledge, skills and attitudes desired in a future generation of young engineers. Big Beacon does not provide such list, but again we have to remember that we are educating our students to jobs that don't yet exist, using technologies that have not been invented, in order to solve problems we don't even know are problems yet.

The CDIO approach started in 2000 and it has attracted over 130 universities worldwide. The Big Beacon is much younger and number of universities is not provided similar way as in CDIO. Based on the popularity of these approaches it is reasonable to say that higher education institutes have reacted to the pressure of educating for 21st century. Universities and higher education institutes are changing their programs with proven and tested approaches.

Conclusions

The existing approaches are valuable tools for higher education institutes on their work to answer the teaching and learning challenges of the 21st century. However, since the different approaches emphasize various aspects on teaching and learning, it might be reasonable to create something more by combining the key elements of all. The combined solutions to aim for teaching and learning of the 21st century could consist of following elements:

1. Framework of structures, processes, pedagogy and workspaces of engineering education
2. Entrepreneurial working, teaching and learning culture
3. Set of skills and knowledge in 21st century.
4. Vision of the graduating engineer of the 21st century.

The framework is a combination of the CDIO standards and Big Beacon's engineering education manifesto items. The entrepreneurial working, teaching and learning culture follows mainly Big Beacon manifesto, but has elements from Innovation pedagogy and CDIO too. Set of skills and knowledge in 21st century is based on the CDIO syllabus and complemented with identified topics in other approaches and studies. This list has to be flexible and able to react changes in the surrounding world. Finally, every program should have a vision of their graduating engineer – not only the skills and competences, but also the other properties she/he carries with her/him to the working life such as innovation competences, critical thinking and creativity.

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ADVANCED PROGRAM FOR STRATEGIC ENGINEER PROMOTION WITH TECHNICAL COLLEGE COLLABORATION

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Abstract

Nagaoka University of Technology (NUT) has conducted the project "Advanced Program for Strategic Engineer Promotion with Technical College Collaboration (ADV-program)" in cooperation with national colleges of technology (KOSEN). The ADV-program aims to produce leading engineers who play an active role in the globalized industry. This is a 6-year program starting from 4th grade of KOSEN, and is composed of three stages: the 1st stage for 4th and 5th grade students in KOSEN, the 2nd stage for 3rd and 4th grade undergraduate students in NUT, and the 3rd stage for master course students in NUT. This project started in academic year (AY) 2010 as a pilot project with 6 colleges (KOSEN), and 5 other colleges participated in the pilot project in AY 2014. The pilot project has been finished in AY 2015 and the first enrolled students completed this 6-year program. After finishing the pilot project, the ADV-program continues and is opened for all the students of national colleges in 2016. On the basis of the pilot project, we have improved some courses of the 1st stage (4th and 5th grade of KOSEN) to enhance the educational effectiveness under the limited contact time between the KOSEN students and NUT staff.

Keywords: *engineer competency, global leadership, group discussion, internship, cooperative education*

Introduction

Nagaoka University of Technology (NUT) was established to aim at providing educational programs for promoting practical and creative leading engineers through the cooperative education with technical colleges. The NUT has produced excellent engineers who play important role in the industries.

Considering the globalization and diversification of societies, however, engineers are required not only to acquire skills and knowledge of their special field but also to have fundamental abilities on "Specialties of multiple fields", "Strategic technology management" and "Global leadership". In 2010, NUT established "Advanced Program for Strategic Engineer Promotion with Technical College Collaboration (ADV-program)" to cultivate "strategic engineer" who acquire the above-mentioned abilities in cooperation with national colleges of technology (KOSENs). This program aims to produce leading engineers who play an active role in the globalized industries on the basis of the educational continuity from KOSEN through NUT. The KOSEN-NUT long-term engineering education is beneficial for introducing advanced education in addition to the conventional course, because the students have studied basics of their special filed from the early stage of KOSEN and they have practical skills and knowledge of the field. In this paper, concept and overview of the ADV-program is presented.

Concept of the ADV-program

Almost 40 years has passed since the establishment of NUT, images of engineer sought in industries has been changed. Consequently, educational program for promoting leading engineer should be improved to meet the requirement of the industries. The ADV-program was designed to educate engineers who acquire fundamental abilities required by societies and industries at present and also in the near future. We decided the fundamental abilities as follows: "Specialties of multiple fields", "Strategic technology management" and "Global leadership".

Since the industrial innovation, mass production of high-value added products has been promoted intensively by the industrialization based on technology; particularly mechanical, electrical, material and energy technologies. In the end of the 20th century, development of information and communication technology and service-type industry lead to the transition to postindustrial societies. Furthermore, fusion of diverse fields, including not only traditional technological fields but also fields that deal complicated systems such as life science and social science, will be accelerated in the 21st century. Therefore, one of the fundamental abilities necessary for strategic engineer is "Specialties of multiple fields".

Industrial activities of Korea and China are expanding in the worldwide market with specific strategy. Companies of these countries produce specially designed products that meet the needs of the markets of rapidly growing countries in Asia on the basis of thorough research on the markets. Under such circumstance the technology strategy of Japan is required to be changed not only for high quality,

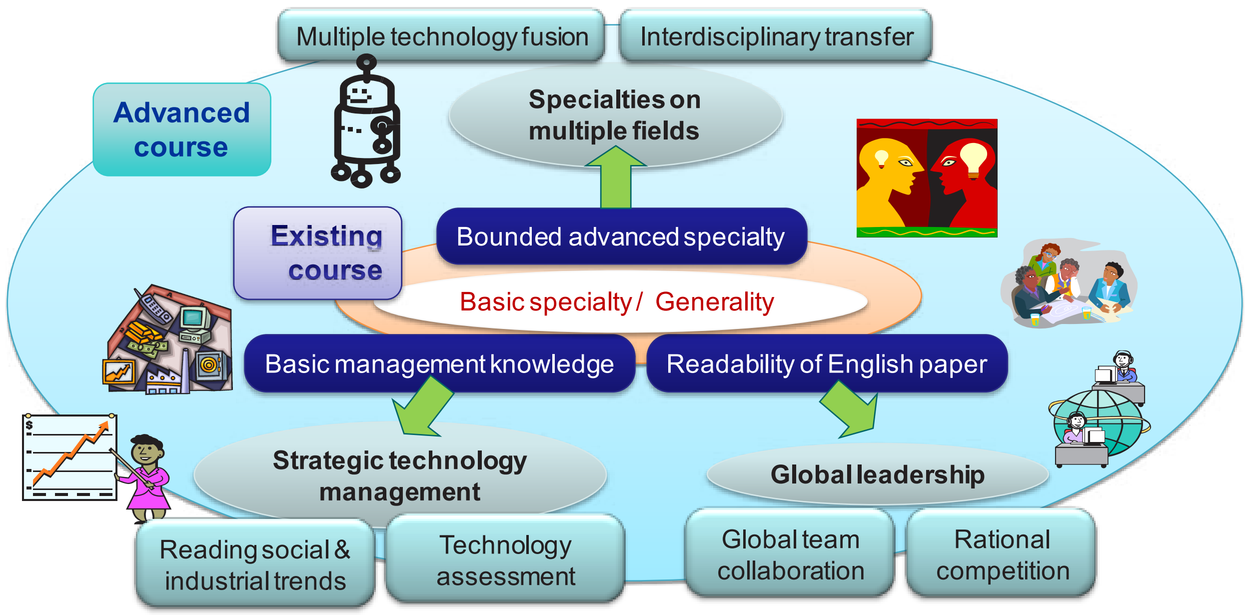

Figure 1 Conceptual image of the fundamental abilities to be enhanced in ADV-program.

function and reliability but also for flexible correspondence to variety of needs. The other fundamental ability for engineer is "Strategic technology management".

There is no doubt that expansion of business overseas is inevitable for further growth and development, because Japanese market is limited and globalization of manufacturing proceeds rapidly. Additionally, the common human problems on global environment, energy / resource conservation and coping with huge natural / artificial hazard require intellectual resolution by advanced technology, and international collaboration is essential. "Global leadership" is a necessary ability for strategic engineer.

Considering the above-mentioned social situation, we plotted out an image of engineer cultivated in this program as shown in Fig. 1. The abilities educated by the existing course are enhanced toward three directions corresponding to the three abilities described above. On the basis of this concept, we established a course ("Advanced course") and designed its curriculum to enhance the three abilities.

Structure of the ADV-program

This is a 6-year program starting from 4th grade of KOSEN, and is composed of three stages: the 1st stage for 4th and 5th grade students in KOSEN, the 2nd stage for 3rd and 4th grade undergraduate students in NUT, and the 3rd stage for master course students in NUT. The purposes and curriculum of each stage are as follows (see also Fig.2 and 3).

(1) Stage-1

We designed this the Stage-1 to enhance students' motivation for studying engineering through contemplating their future image as engineer. For that purpose, we provided opportunities to be exposed to innovative research and cutting-edge technology, to meet managers and engineers of companies, to consider Japanese and overseas industries, and to give a presentation in English. We hope that the students consider how the subjects studying at KOSEN are utilized in university and industry and what they should do for their future.

(2) Stage-2

In the Stage-2, the students acquire fundamental abilities for engineer in addition to their own specialized field. Particularly, the ADV-program provides a course "Engineer Competency Exercise" to train "engineer competency" including logical thinking, creativity, management capabilities, and communication skills. This is so-called "Active learning type" course, in which students learn and experience how to create ideas, how to think logically, how to stimulate discussion, how to construct strategy, and so on.

(3) Stage-3

The last stage is designed for the students to recognize their improvement in the program and also what necessary for further improvement through the activities in and/or out of university. For that purpose, this program provide "Strategic Engineer Competency Exercise" to consider "Leadership", "Strategy", and so on, through lectures by persons who take an active role

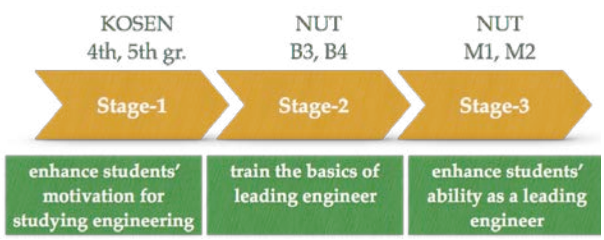

Figure 2 Structure of the ADV-program and purpose of each stage.

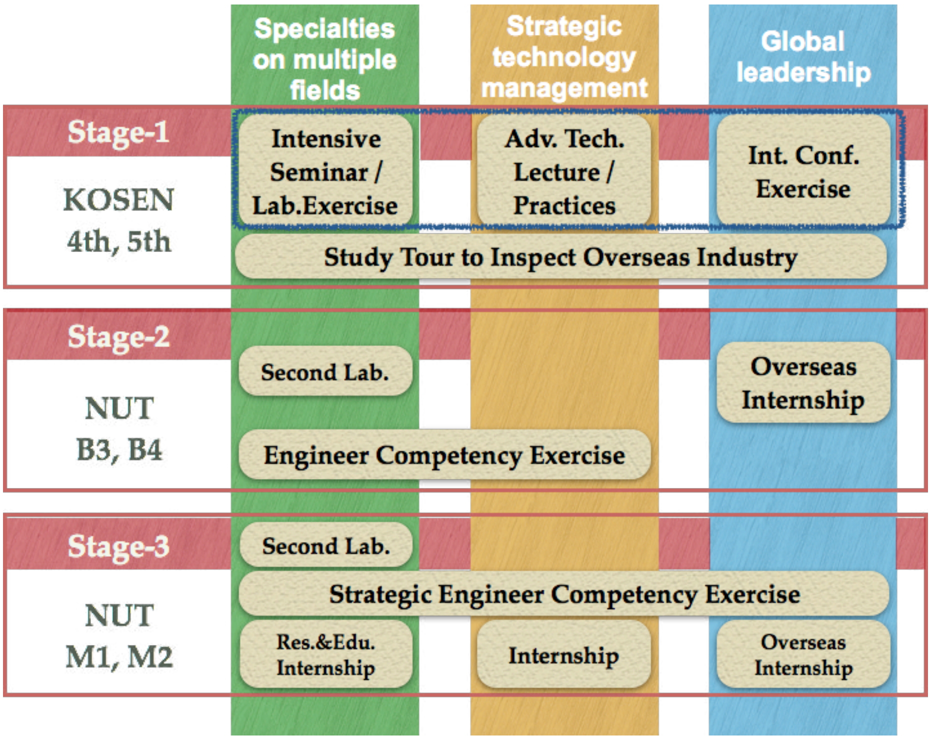

Figure 3 Lectures and exercises provided in the each stage and correspondence of the courses to the fundamental abililies.

in industry and society, and also through discussions about the topics given in the lectures. In the Stage-3, student must join one of the following internship: “Overseas Internship”, “Internship at Industry”, “Internship at KOSEN”. These lectures and internships make the students to enhance their motivation and make their image of engineer clear.

Achievements of the ADV-program

The ADV-program was established to enhance students’ abilities necessary for strategic engineer who leads the globalized industry in future. Although the courses are designed to improve those abilities, it is difficult to measure the improvement of those abilities, and the evaluation method should be developed. However, common characteristics of the students in this program are revealed by observation and interviews.

(1) Proper self-analysis

Many students of this program recognize not only their weak points but also strong points, while most of Japanese tend to pay attention to weak points. The proper self-analysis is important for improving abilities.

(2) Think about their future deeply

Every student has hopes and goal of future, but usually they are ambiguous. The students of this program are the same as others when they enrolled in the program. As the stage proceeds, their hopes and goal are getting clear, and the students also consider why they set the goal for future, or what kind of role in industry or society they prefer in the future.

(3) Plan for achieving goal

There are many students who plan to achieve their goal and think about what they should do at present and future. Having images approaching the goal is important to keep their motivation and to achieve the goal.

Students are required to write down the followings on their learning portfolio before and after each semester. Before the semester: “What do you expect for the courses?” and ”Do you have anxiety about the courses?”. After the semester: “What was valuable for you?”, ”What knowledge and skills did you acqure?”, and self-analysis. Additionally, students write down “What did you acquire?”, ”What did you NOT acquire?” and ”What was changed?” after each stage. Making the portfolio is effective to emphasize the sense of purpose, and recognize their improvement and lack of knowledge, skills and sense by reviewing the portfolio.

Conclusions

The concept of the ADV-program was established in 2010 on the basis of long-lasting collaborative education between NUT and KOSEN for producing leading engineer who play an active role in globalized industry. As described in this paper, the ADV-program came to completion in academic year 2015 after the 6-year pilot project cooperated with National Institute of Technology and 11 KOSENs. The ADV-program continues after finishing the pilot project, and is opened for all the students in national colleges in 2016. We have revised some courses in the Stage-1 (4th and 5th grade of KOSEN) to enhance the educational effectiveness under the limited contact time between KOSEN students and NUT staff. We continue improving the program. Activities of the engineer who finished the ADV-program will evaluate of this program. Although it will take little more time to do that, we are confident that the students surely acquire the fundamental abilities necessary for the strategic engineer.

Acknowledgements

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CONTEXTUAL TEACHING & LEARNING PEDAGOGICAL APPROACH TO TEACHING & LEARNING MOBILE DEVELOPMENT: POCKET ONEMAP PROJECT WITH INDUSTRY PARTNERSHIP

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Abstract

Our approach to teaching mobile app development fundamentally engineered the involvement of industry partners seamlessly into NYP's contextual teaching and learning (CTL) approach to polytechnic education, by directly involving industry players in all phases of development by the students, resulting to the development and launch of Pocket OneMap, a collaborative project between Nanyang Polytechnic and Singapore Land Authority. Pocket OneMap empowers the public with real-time access to government datasets from various public agencies. The project strongly affords CTL for the students, by engaging students in strong partnerships and borderless collaborations with the various agencies in delivering services to the public.

A conducive environment to implement the CTL pedagogical approach is in the form of the Centre for IT Innovation (CITI), was established as a multi-disciplinary learning environment that promotes vibrancy and cohesion by enabling students to work together on their final year projects. Cutting-edge technologies are being developed through conceptualize learning. Within this learning environment, strategical planned processes are put in place for corresponding with industry partners, setting up of facilities and allocation of industry projects for students to work on real-life projects, thereby learning skills beyond their textbooks. Students are ultimately exposed to real-life industry projects and able to experience the software development life cycle.

A total of 55 final year students have benefited from this project, developing technologies in GIS and Mobile App Development since 2013. This project is also used as practical case-study in our Year 2 mobile application development curriculum, thus this allows students to relate what they have learned in their syllabus to real-life projects. The Pocket OneMap also won the inaugural MOE Innergy Gold Award for the Most Innovative Project and was recently showcased in the Public Service Festival 2015. Since deployment, the app has high download numbers across all mobile platforms.

For technology-based education with strong alignment to industry practices, CTL employed by NYP has demonstrated an approach to teaching and learning (T&L) that enhances pedagogical advancement and improve students' learning. This approach to T&L not only bring forth the current trends and practices from the industry front to the classroom, it also prepares the students for the demands, skillsets and experience required directly from developing industry projects and placed them in good stead for employment upon graduation. The CTL pedagogical approach can be further introduced to collaborate with research institutions, and through research projects, allow students to gain research domain knowledge through conceptualize learning.

Keywords: *Teaching Factory™, Industry Partnership, Collaboration, Contextual Teaching & Learning*

Introduction

At the turn of the century, a growing focus on teaching and learning (T&L) has brought about an increasing number of research work done towards 21st century education (Saavedra and Opfer, 2012). This much deserving emphasis on T&L have led to a spectrum of characteristics in the subject, such as self-regulated learning, creative and critical thinking, and authentic assessments, just to name a few (Johnson, 2002). However, in her recent publication, Saavedra and Opfer (2012) have also asserted that there is a limit to what students can learn through these diverse sets of formal T&L. There is an urgent need to integrate these methods of teaching and knowledge transfer in the context from which the knowledge is developed and learned by the student. This new approach that harness the strength and potentials of student engagement is introduced in this research paper as contextual teaching and learning (CTL) that underpin NYP's approach in the provision of polytechnic education.

This paper reports the findings that focuses on the following primary research question:

How does contextual teaching and learning benefit students in their polytechnic final year projects?

The following sections will introduce theoretical perspectives for CTL, together with background, research methods, results and discussion, and conclusion.

Background

Centre for IT Innovation (CITI) in Nanyang Polytechnic (NYP), School of Information Technology (SIT), was established as a platform to provide an impetus towards several key objectives. These objectives focused on CITI as a launch pad for major industry collaborations and cutting edge R & D projects. The centre was started in the year of 2000 and has collaborated with more than 90 companies on 100 over projects to date.

CITI establishes itself as a multi-disciplinary hub that promotes vibrancy and cohesion by enabling students from the various IT diplomas, to work together on industry and in-house projects. This platform promotes the concept of borderless integration within the entire Polytechnic. It also enables students with different skill-sets to interact and leverage one another's strengths.

A typical breakdown on the type of projects undertaken by CITI is as follows:

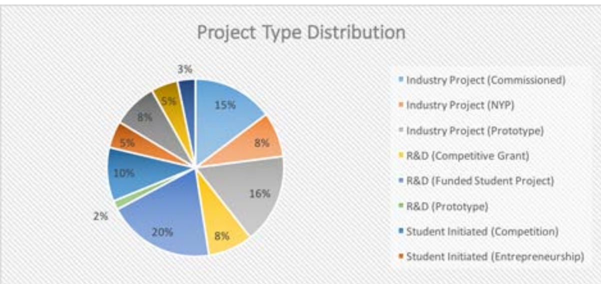

Figure 1: Project Type Distribution

The applied learning model is adopted in CITI where both staff and students work together to develop and deliver innovative software solutions and services to the industry. The centre will take in about 150 final year students every 3 months and they have the opportunity to work on industry commissioned projects that solve real life problems.

The school forms strategic collaboration with industry partners that plays a crucial role in creating capability development opportunities for both staff and students. They bridge the gap between students' learning from the textbooks and the real life industry, thereby providing a contextualized learning environment. The table 1 shows the industry partnerships that was formed from the year 2004 to 2016.

Table 1: SIT Industry Collaborations since 2004

Date	Centre Name
Jun 2016	NYP-Microsoft Smart Nation Innovation Centre
May 2016	Cyber Security Centre of Excellence
Apr 2016	NYP-Splunk Operation Intelligence Lab
Mar 2015	NYP-Microsoft Ambient Intelligence Computing Centre
Feb 2015	Cyber Security and Solutions Centre
Nov 2014	NYP-Accenture Emerging Technologist Development Centre
Aug 2014	Big Data & Analytics Innovation Centre
Sep 2013	NYP-StarHub SmartHub Research and Development Centre
Mar 2013	NYP-Splunk Operation Intelligence Lab
Mar 2013	Digital Convergence and Mobility Innovation Centre
Dec 2012	IBM-NYP Service Science Collaboration Programme
Nov 2012	NYP-SLA Collaboration on Geospatial Education, Training, Research and Development
Sep 2012	Business Analytics Translational Centre
Apr 2011	Cloud Innovation Centre
Mar 2011	Centre for Social Media & Analystics
Feb 2011	NYP-SiTF Cloud Enablement Centre
Sep 2009	Mobile Inno Sphere Centre
Jun 2009	Enterprise Business Rule Solutions
Jan 2009	Enterprise Information Architecture Centre
Mar 2008	Business Software Innovation Centre
Aug 2007	Centre for Software Quality and Security
Nov 2006	Enterprise Technology Innovation Centre
Aug 2005	NYP Oracle Grid Innovation Centre
Dec 2004	IBM-NYP RFID Integration Zone
Sep 2004	RosettaNet Architecture Centre of Excellance

Contextual Teaching

To begin ones understanding of the concept of T&L, it is important to appreciate each term on its own. In teaching, it has been highlighted that teachers are not merely the advocates of passive knowledge. In their recent work, Misha and Koehler introduces a model that describes that teachers must possess the knowledge for effective pedagogical practice in a holistic learning environment supported by content, pedagogical and technological knowledge as primary elements (Mishra & Koehler 2006). This forms the contextual teaching mechanism called Technological Pedagogical Content Knowledge (TPACK).

Content Knowledge

From the model, content refers to subject topics, theories, ideas, or organizational frameworks (Shulman, 1986). This paper focused on the development of industry project called Pocket OneMap, where the know-how is based on the fundamentals of mobile app development and deployment. Teacher mentors assigned to students for this project were experienced developers with years of experience in commercial software development and production. This practice is critical, as content mastery is necessary for good contextual teaching, where educators must know the subject content thoroughly in order to teach well (Shulman 1986; Corrigan & Haberman 1990).

In this research, it has been highlighted that educators for this CTL concept must be strong in both content and pedagogical knowledge. Thus, the concept embarked on two approaches; social affordance with industry practitioners through technology, which will be elaborated in the following section; and blended identity of lecturers.

The professional identity disposition of educators between industry professional and academic brings to mind the concept of blended professionals (Whitchurch, 2009), who:

> not only cross internal and external institutional boundaries, but also contribute to the development of new forms of third space between professional and academic domains. (p. 407)

Polytechnic lecturers are appointed to teach in area of their industry experience of relevant domain areas, such as engineering, accountancy, etc. Their job responsibilities therefore span across diverse areas of work, which include programme management, school outreach, course coordinating, industry partnerships and business connections.

Lecturers' 'dual' professional identities due to the diverse and complex roles as industry professional and academic can be seen as a unique disposition. Lecturers can take the form of 'bridging' roles, bringing together learning and business partners from within the institution and the industry communities. This unique form of blended professional identity having interfaced roles will enable lecturers to build a foundation for merging credentials, respected and trusted by both professional and academic communities.

Pedagogical Knowledge

NYP's Teaching Factory™ and Teaching Enterprise pedagogies are undergirding by CTL as highlighted by Berns and Erickson and it offers a unique and industry-relevant training platform for its students to have first-hand experience in carrying out industry-commissioned projects (Ho E., 2009). These pedagogies, as observed by Guile and Okumoto (Guile & Okumoto, 2007) with references to earlier works, exhibit the main features of skill formation in apprenticeship in the 'industrial relations' model, where a combination of work experience and off-the-job training and both were 'geared to helping apprentices to acquire a trade' (Ryan, 1999, p.41). Skill formation generally took this mode of teaching because, on one hand, the process of hands-on learning and the comprehension of technical knowledge is assumed to have a tacit nature and is therefore acquired best through seeing an experienced practitioner perform the activities of the technical field and subsequently absorbing the implicit hands-on skills (Kvale, 1997), and on the other hand, acknowledging the fact that learners need to be exposed to scientific and technical knowledge that they cannot acquire 'on the job' (Ryan, Gospel, and Lewis, 2006).

CITI provides students with the opportunities to engage in complex industry-related projects with the help from industry practitioners, which would otherwise be beyond their current abilities. This form of scaffolding to enrich students with industry experience from the practitioners is a key strategy in cognitive apprenticeship, thus enabling students to learn by taking increasing responsibilities and ownership for their role with structured guidance of more knowledgeable industrial mentors (Collins, Brown, & Newman 1988).

Technological Knowledge

Technological knowledge refers to the educators' competencies in ICT tools, which forms the technology affordance in T&L. These communication technologies bring about social presences and affordances for scaffolding and support from peers and software developer communities (Wilson & Lowry, 2000). The media technology to enhance student engagement ranges from emails, video conferencing and messaging (Aragon, 2003). It is also highlighted that different media affords different potentials, and that educators must have the knowledge to choose appropriate media when embracing contextual teaching (Harris, Mishra & Koehler, 2009).

Contextual Learning

The concept of learning has been studied to some extent, and has mainly revolved around how students are aware of how they learn, first introduced by Flavell (1976). In his book, Flavell first introduced the term metacognition to describe learning to learn. Together with mastering this skill in learning, other activities towards the development of metacognition is the skill of mentally contextualizing one's learning. This form of contextual learning is introduced in a strategy called REACT (Crawford, 2001). REACT is an acronym for; *Relating* – Ability to associate the prior and new knowledge; *Experiencing* – Learning in the context of exploration and discovery. *Applying* – The ability to relate the concepts in context; *Cooperating* – Learning in the context of sharing, working together to discuss or share with other learners; and *Transferring* – Building upon what the students have already understand.

This strategy was practiced in CITI, where final year students worked on industry project as a team where they apply and relate concepts and knowledge they acquired in the past two years. Thus, improving their learning, developing critical thinking, collaborative skills and bridging the gap of knowledge and real world scenarios.

Contextual Teaching and Learning

To put it all together, Contextual Teaching and Learning are defined as a concept that helps educators and learners to relate the meaning and real world scenarios (Berns and Erickson, 2001). CTL is an active learning process, which encourages learners to be responsible of their learning and associate the knowledge and its application to the various contexts. These two pillars of CTL is evident in TPACK and REACT respectively.

As is evident, the uniqueness of NYP's practice of conceptual T&L expands these established concepts by putting in place the foundation of a contextual environment in which key players interact with each other. Students, teachers, industry practitioners and context form key components of the educational system. Thus, it is important to recognize that context is the much needed environment where players interact (Wang, 2009). Below show the essences of the CTL in CITI.

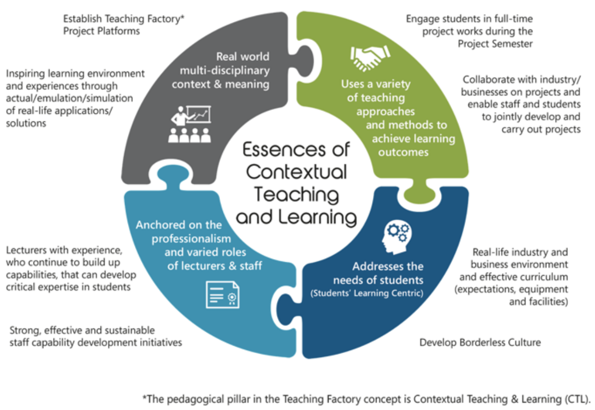

Figure 2: Essence of CTL in CITI

CITI also acts as an incubation zone for creative ideas to be generated and conceptualized. In the process of conceptualization, cutting-edge technologies are being employed. Through this, CITI enables both staff and students to stay abreast of technological advances. As part of its capabilities development, CITI engages in applied R&D in core competencies such as Information Security, Cloud Computing, Social Media and Business Analytics, Business Rule Solutions, Enterprise Technology, Next Generation Network, and Wireless and Mobile Computing such as Windows Phone, iOS and Android.

Pocket OneMap is one the projects undertaken by the centre, a 3-year long collaboration project with the public agency, Singapore Land Authority (SLA) which aims to deliver 12 public services on 3 major mobile platforms to the general public by end of 2015. The project aims to deliver at least 1 services across 3 mobile platforms (iOS, Android, Windows Phone) to the public every quarter. Pocket OneMap is the first of its kind mobile app in Singapore, with mobile access to a comprehensive suite of government data and services. Comparing to other map applications that are already available in the competition mobile app market, Pocket OneMap is extremely popular and useful, observably from the number of local downloads on smart devices. This application empowers the public with real-time access to government datasets from various public agencies such as Housing & Development Board, Ministry of Education, Land Transport Authority and many more.

NYP forms strategic collaboration with industry partners that plays a crucial role in creating capability development opportunities for both staff and students. They bridge the gap between students' learning from the textbooks and the real life industry, thereby providing a contextualized learning environment.

Through our industry project (Pocket OneMap) with SLA for example, staff and students have since gained technological competencies in Mobile Application Development, Usability Design, and Geospatial Information System (GIS), which are also translated into our Year 2 core module which focuses on mobile app development, taken by all students before their final year.

In this project, a total of 55 final year students was involved in the full software development life cycle from requirement gathering, system design, implementation and testing. These students are exposed to real-life industry projects and technologies such as GIS, OneMap and Mobile App Development. This project also won the inaugural MOE Innergy Gold Award for the Most Innovative Project (Stat Board) and was showcased in the recent Public Service Festival 2015 in Singapore.

Materials and Methods or pedagogy

A survey was conducted with 55 students who were involved in this project at the end of their final year project. This study aims to find out how CTL has enhanced education in CITI. Several challenges that contributed to the learning curve are identified. These challenges, when overcome under the guidance of a lecturer, will become a major learning milestone and achievements. Each student was surveyed to answer the following questions as follows:

1. Which of the following best describe the challenges you face during the course of the project?
2. Which of the following best describes the way you overcome the challenge as described above?
3. Select the top 3 skills you have acquired through the project.
4. Do you think you will be better apply these skills if you learn it through a classroom environment, as compared to CITI environment?
5. Which year would you think that the learning pedagogy in CITI should be introduced?
6. How well does the CITI environment has improved/enhanced your understanding in mobile development?

Results and Discussion

In this section, we will discuss the results that was derived from the methods that were explained above. The results from the survey shows that students find the learning curve is the steepest when learning to use the Software Development Kit (SDK). However, it can be mostly overcome with minimal to medium level of guidance from the lecturer. The hands-on experience from the project allow them to gain skills in Mobile Application Development and at the same time, improve their overall coding skills. 53 out of the 55 students surveyed find that this mode of learning is effective in helping them to apply the skills they learn immediately to the project. Results has also shown that more than 90% of the students felt that the learning pedagogy: CTL used in CITI should be introduced in Year 3, as the students felt that the CITI environment enhances their knowledge that they have learnt in the past semesters in particular mobile application development and they can relate better with real-life projects.

The following are the key results of the responses collected from the survey.

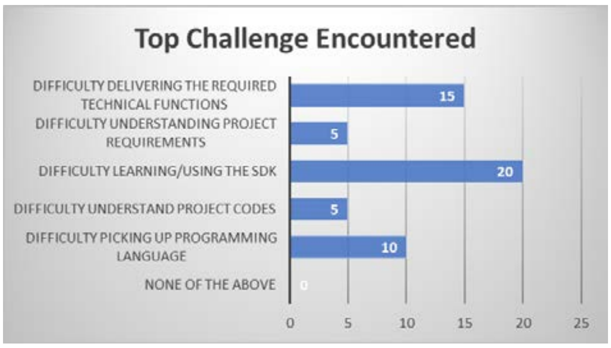

Figure 3: Which of the following best describe the challenges you face during the course of the project?

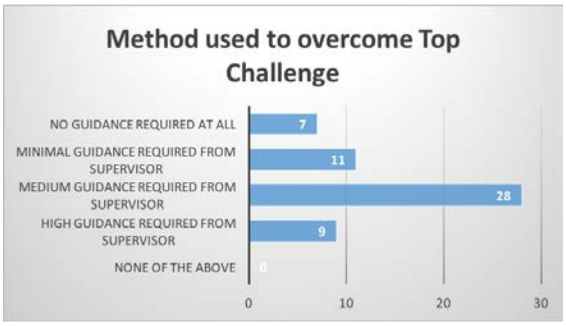

Figure 4: Which of the following best describes the way you overcome the challenge as described above?

Table 2: Select the top 3 skills you have acquired through the project.

Rank	Skill	Percentage
1	Mobile Application Development	81.82%
2	Coding skills improved	76.36%
3	Software Project Methodology	58.82%

Table 3: Summary of responses to Q4, Q5 and Q6

Question	Response
Do you think you will be better apply these skills if you learn it through a classroom environment, as compared to CITI environment?	Yes (3.64%) No (96.36%)
Which year would you think that the learning pedagogy in CITI should be introduced?	Year 1 (1.82%) Year 2 (7.27%) Year 3 (90.91%) None (0%)
How well does the CITI environment has improved/enhanced your understanding in mobile development?	Extremely (52.73%) Very (27.27%) Moderate (10.91%) Slightly (9.09%) Not at all (0%)

Conclusions

The present study is administered to analyze the advantages of using CTL approach in the industry projects especially mobile-related projects. The data are collected through observations, students' survey and their performance in their final year projects. It is evident that this approach is beneficial for the final year students.

CTL enables students to connect or associate what they have learnt from educator's content to real world scenarios, especially in CITI, the study has shown that students find that the learning pedagogy used is effective and they can relate their concepts learnt from the past years to be applied to their final year projects and deepening their skills and knowledge. This ensures that our curriculum will always stay up-to-date and remains relevant to industry needs so that students can be assured of being equipped with skillsets required when they join the industry in near future.

For technology-based education syllabus and curriculum with strong alignment to industry practices, the CTL rooted from Teaching Factory™ Education Model employed by NYP has demonstrated an approach to T&L that enhances pedagogical advancement. This approach to T&L not only bring forth the current trends and practices from the industry front to the students, it also brings the students to prepare for the demands, 21st century skillsets and experience required directly from developing industry projects. Thus, preparing the students for the demands of both industry and further education.

Acknowledgements

We would like to thank the management of the Nanyang Polytechnic, Singapore Land Authority and industry partners, who have provided the opportunity of collaboration in project development in CITI over the years, as well as the students' valuable feedback to our study.

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KMITL Enjoyneering: A Case Study on How to Teach Creativity for Interdisciplinary Engineering

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Abstract

Creativity is one of essential skills of the 21st century for engineering students on designing products and enabling innovation. The purpose of this paper is to introduce how to inspire and enhance creativity capability of information engineering students of KMITL. To prepare our senior students for starting up their own companies, we offer a project based-learning in innovation design course with case study on their own products. The best practice is conducted on "play-and-learn" pedagogy. A role-play company, namely, "KMITL Enjoyneering" is signified as a model and a brand for in-class actitivities.

The pilot class has 25 information engineering students, the first assignment is design a can of juices in KMITL brand for senses of tropical refreshing and having fun. The second assignment was free idea designed by using crative tools learned from the class mixing with imagination to design logos, products and advertizing material and business models. The first assignment was evaluated by using novel ideas and aesthetic appeals as criteria. Most designs are satisfied by KMITL faculty members. The evaluated criteria for the second assignment are utility, novelty and engineering design. Some idea is accepted from professional industrial experts and is able to commercialize.

Keywords: *Creative teaching, 21st century learning, project-based learning, learning design, teaching entrepreneurships*

Introduction

According to the US engineering education, the National Academic of Engineering(NAE , 2004), the new released vision in 2020 of engineers in a new century declares important attributes of engineering skills as analytical skill, practical ingenuity, creativity and communication competencies. These skills are also set as criteria for accrediting engineer program in curriculum (ABET, 2016) of bachelor degree which expect that the engineering science of student field studied have their root in mathematics and basic sciences but carry knowledge features forwarding to creative applications. In Thailand, the country moves toward to Thailand 4.0: a name of new economics model in which the core of engine is food sector, smart device technology, IOT and creative services. To serve this policy, the faculty of engineering, KMITL, changes learning style to outcome based learning and provokes student to create innovation in active learning class room. To accomplish learning outcome, this paper presents a case study of how to teaching creativity for student in information engineering course.

The course is organized into a series of lectures and two individual projects. The lectures start from commercial logo design philosophy to meaning presentation and value creation. The creative TV advertising and commercial posters in real-world engineering products are used as examples in effective communication. Idea generation techniques are logical methods, SCAMMPER, association techniques, analogies methods and perspective technique, reverse thinking, are introduced to the students as well.

In order to convert ideas to design, we teach the principle of aesthetics for a creative design thinking focused on nice looking shape, attractive color and miracle spaces to the students and assign them integrating value creation and product design in their own styles. To demonstrate design to invention, we exploit patent database to show and teach the novelty and level of inventions. We also employ business model canvas for students to prepare and design their own business models. Details are as follows.

Course structure

An information engineering course at KMITL is designed to integrate interdisciplinary engineering program, coordinate the information technology and practice communication in engineering.

The new curriculum has been reconstructed since 2013, the pioneer students graduated from this program in the academic year of 2016. In the curriculum of first year in engineering subjects, students start to learn basic engineering in programming language and basic electronics. In second year, the courses provide students fundamental knowledge in information infrastructures, telecommunication network and information including information services, data base and E-commerce. In the third year, students focus on major subject such as Internet network design, information security, wireless network and broadcast engineering.

In the last or final year, students work on senior project and elective course such as AI, digital forensics and design of innovation products:DIP.

A DIP course consists of mainly two parts: the first part is creative thinking and the second one is innovation design. In the first part, we train students in diverse thinking and converse thinking to create new products. The new possible ideas to a solution or multiple solutions or answers to a problem are exercised in a classroom. Meanwhile the second part starts after students find best answer to mock up the presented product or decide to design novel software or services. We give lecture topics in critical thinking, logical thinking and business model to make profit from ideas to products. The DIP course lectured for 3 hours per week. After 15 weeks, students will take tests and present their own product in the classroom. Figure 1 summarizes the proposed concept.

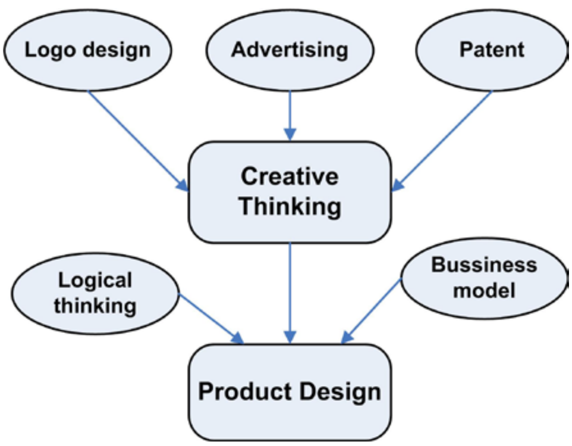

Figure 1 Design of innovation product course structure.

Creativity

The well-known quote, "necessary is the mother of invention," creativity plays role as the father, and engineering knowledge is a midwife. Creative response is novel, good and relevant (Kaufman and Sternberg, 2010). In definition of US patent, creativity means new, useful and nonobvious or creativity is ability to produce new invention or new solution to a problem by imagination skills.

The following techniques used to teach for example in this course included:

- Metaphor thinking,
- Reverse thinking, and
- SCAMPER.

A metaphor (Linsey, 2008) is a soft thinking technique connected two different universes of meaning, this technique includes bionics, similarity and imitation. In bionics design, several engineering design adapt to implement in the real world such as Shinkanzen high speed train and VW Beatle automobile. An example for similarity is that some tablet product is an imitation of Apple computer design.

Reverse thinking is a kind of lateral thinking (DE BONO, E. 1973). The method is a reversed point of view. For example, a concept of Henry Ford conveyor belt is that bring people to work reverses to bring work to people.

SCAMPER is invented by Osborn (1993). The idea is one of a structure creativity thinking method. The idea is based on a checklist consists of series of questions from transforming the question into new idea by substitution, combination, adaptation, modification, putting to another use, elimination and rearrangement.

Methodology

In the first lecture module, we start with logo design. The idea is to provoke the students to create unique symbol for identifying themselves and to communicate with other people. In this topic, we showed them ours product designed, "KMITL snack box" shown in Fig. 2, which is designed to use as a souvenir of KMITL engineering faculty.

To serve the faculty slogan "be the best, be social advocate" and to accomplish active learning style, we have motto, "play and learn". Hence, we decided to address the name "KMITL enjoyneering" for our logo. In addition, we also discussed the strong influenced commercial logo. There are several logo designs that students familiar were in the top most valuable global brands. Then the meaning and what logo represented were explained in the class. The philosophy of logo design is exactly as the same as engineering design concept which is simplicity. The metaphor design for meaning can be obtained by some product. The uniqueness with creativity design is recommended for students. The golden ratio and the representation of colors are also discussed. The exercises in classroom are interpreted the meaning of an influenced commercial logo and the students' assignment is to design their own ones.

(a)

(b)
Figure 2(a) KMITL engineering logo
2(b) KMITL Enjoyneering box

After the student designed the logo, the second topic lectured is effective communication or making relevant connection to target audience. In this topic, we teach student how to sell ideas by writing, making posters or movies or video clips. Creative TV-commercials in 30 seconds use for case study. The best example of metaphor thinking in a high speed and luxury car is clearly explained to students how ordinary peoples are enjoy learning an engineering concept. The favorite TV-commercial advertising is employed to illustrate presentation in story telling style. The creative idea for posters and movies for communicating to the target such as mixing and matching, comparative, double meaning, symbol and signs are lectured in detail. After we show example of creative writing, the activity in the classroom is writing advertizing scripts for selling IT product and design a commercial poster depending on each student product. Figure 3 gives an example of a poster designed by a student.

(a)

Figure 3(a) Example of student advertise idea "How to sell Solid state Hard disk" (b) Example of creative writing on the package label by the lecturer.

Creativity topic is the third module giving lectures for two time. We initiate with famous Jobs quote "think difference" showing a Picasso bike and a Picasso's bull head. And then we ask students to imagine their own bikes. Students' imagination are not necessary to be replicated to Picasso stylists but also are encouraged to take the design in the Dada commercially made with or without modification.

Creative blocks such as logical thinking, follow the rule and fear to failure are removed by class activities with Einstein quote that "play is highest form of research".

The night dots and birthday cake cutting problems are introduced to students to know as many ways to solve a problem. To conduct diverse thinking, Chidogo or a crazy idea are shown and exercised by students in their invention with free ideas. After the exercise, example of the best low-cost airline product and service adapted from a crazy idea is demonstrated to students. In creativity training, in the first step, we show reverse problem-solution by some of advertizing movies and bottom up brewery product. From the quote of Jobs "creativity is just connecting things", we use force connection method for quick exercise in the classroom. Metaphor thinking for students to create new idea is demonstrated by video and story of automobiles, buildings, stadiums, towers, commercial logo and movies story. In SCAMPER method after showing students about food packages, IT products and services, we assign exercise to invent new mouse for classroom activity. Figure 4 shows an example of the concept.

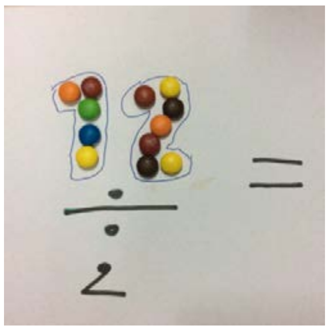

Figure 4 Example of remove blocking creativity by a haft-of-twelve problem.

The forth module is aesthetic design. Even though concept of design by Steve Jobs is "design is not just what it look like and feel like design is how it works," but an attractive design would perceive as easier to use.
In this module, the art compositions are line, color, texture, and form considered as elements of design and balance, unity, emphasis, rhythm considered as principle of beauty of design are addressed and discussed. The example method of designs are simplicity. Ockham' razer design, form follows function and multifunction design with the attractive products are explained to enhance students' creativity. The assignment of this module is to design juice can in KMITL brand. Students can adapt creativity techniques and design idea with their imagination to implement their works.

The last module of creative teaching is intellectual property. To teach novelty and level of invention of product design, patent database searching is provided as a workshop for student to verify and modify their ideas from patent pending inventions.
Patent classification, keyword, background of invention, why the invention is deferent from prior and what is claimed are explained to students. Some of US patent invented by children is illustrated to inspire the students. The case study of patent prosecution of IT company in design patent and utility patent is also demonstrated how much value of the idea is. The last in this module is to search patent with idea only without implement. The exercise is to quick think about creative gadget invention.

Results

Figure 5 shows KMITL product evaluation committee comprised members from industrial sectors, faculty members from Department of Food Engineering, Telecommunication Engineering , and Electronics Engineering. The score system is based on novel ideas, design appearances and uniqueness.

Figure 5 KMITL product evaluation committee.

Level of creativity design is justified by:

1. Imitation from product in market;
2. Adaptation or modification of specific products; and
3. Synthesis on KMITL identity.

In the first level, students designed by searching the example of products in the market and imitated the idea from their selective products. From the second level, the students employed the aesthetic design concept such as balance, emphasis and rhythm in their designs for specific products as orange juice, lemon juice or coffee.
The third level is synthesis on KMITL identity, students created their ideas and use art composition to enhance aesthetic. The simple, colorful and attractive graphics are composed for teenager targets on each can of juice. The best design can of juices voted by the committee is second from the left in Fig 6(c). The orange color of KMITL has a background with drawing graphic which represents the activity in faculty of engineering. The student redesigned "Enjoyneering" with the symbol of meaning "I love you" for KMITL. The best design will be selected to use in the real KMITL juice can which will manufacture in this coming academic year.
The results were categorized and shown in Figures 6-8 in accordance with the above justification.

(a)

(b)

(c)

Figure 6 (a) Imitation level (b) Adaptation or modification level (c) Synthesis of KMITL identity.

Assignment product design
In this assignment, the committee has a consensus vote for Veggie product design shown in Figs. 9 (a) and (b). In addition, one of the student's product can be commercialized under the brand "linear," which is a USB smart charger. In the middle of the semester, the student opened a start-up company and was able to sell his products. As far as active learning under this teaching experiment is concerned, we believe that, for develop students' competency, "to innovate better, need creative thinkers!"

(a)

(b)
Figure 9 (a) Best product design (b) poster.

Conclusion

We have taught a key to advancement and well-being in entrepreneurial aspects by introducing creativity and innovation to engineering students in the senior year. Among 25 students attended the class of 2016, a product designed from the class can be commercialized. This reflects an effectiveness of the pedagogy under an innovative way of integrating design, art,entrepreneurship, and technology into an information engineering curriculum.

Figure 10 Students' start-up real product.

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HOW LEARNING ANALYTICS TOOLS IN A LEARNING MANAGEMENT SYSTEM CAN HELP AN EDUCATOR TO SUPPORT AT-RISK STUDENTS

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Abstract

This research focuses on how an educator can provide interventions to enhance student learning by using the learning analytics tools in a Learning Management System (LMS) to analyze students' online learning behavior. Studies show that early intervention can help enhance student learning, as seen in improvements in their performance (Arnold and Pistilli, 2012; Hattie, 2011; Zhang et al., 2014). However, educators' ability to provide effective interventions has been hampered by the increasing adoption of online learning because they no longer receive the same level of feedback as they had during face-to-face lessons (Mattingly et al., 2012).

An LMS captures a large amount of student data that can be used in lieu of face-to-face feedback but educators find it hard to makes sense of this large volume of data (Lockyer et al., 2013), so they need guidance in analyzing the data to know how to intervene effectively. This research is in line with a key thrust of the Singapore Infocomm Media 2025 Masterplan, which advocates the need to employ data analysis in education to provide teachers with key insights into students' learning so teachers can customize their lessons to match students' learning needs (MCI, 2015).

This research adopts a case study methodology (Yin, 2003). The context of this case study is students in the Temasek Polytechnic School of Informatics & IT who took subjects from April to June 2016. The author will report on how he and his fellow educators used the LMS learning analytics features to track online student learning behavior and provide relevant interventions to support at-risk students. The author also tracked students' performance in formative assessments and learning activities during the subjects to evaluate the effectiveness of the educators' use of the LMS learning analytics features.

In conclusion, this research will provide two key insights:

1) Identifying which student data and learning analytics reports in the LMS are most useful for an educator to understand students' online learning behavior

2) Describing how an educator can use this data and reports to provide timely interventions to support at-risk students

Keywords: *Learning analytics, At-risk students, Learning management system, Student performance, Intervention*

Introduction

Learning analytics may be one of the most dramatic factors shaping the future of higher education, as it can help educators to enhance teaching and learning (Long & Siemens, 2011; van Barneveld, Arnold and Campbell, 2012). The potential of analytics to transform and facilitate data-driven decision-making is evident in many other fields, such as in healthcare (Long & Siemens, 2011; Picciano, 2014; van Barneveld et al., 2012). In healthcare, practitioners are moving from treating patients based on personal experiences to adopting detailed data collection and clinical decision-making (Long & Siemens, 2011). The healthcare industry is even exploring computational modelling by using analytics to predict who may fall sick so practitioners can act on these predictions to pre-emptively help their patients to improve their health (Long & Siemens, 2011).

The education industry is similarly starting to apply learning analytics to the academic domain to collect, analyze and report on student data so that educators can understand and support students and their learning process (Ferguson, 2012; Lockyer, Heathcote and Dawson, 2013; Long & Siemens, 2011; Mor, Ferguson and Wasson, 2015; van Barneveld et al., 2012). In particular, this will enable educators to provide more relevant and timely interventions to support at-risk students and enhance student retention (Long & Siemens, 2011; Picciano, 2014; Pirani & Albrecht, 2005; van Barneveld et al., 2012; Vozniuk, Rodriguez-Triana, Holzer, Govaerts, Sandoz and Gillet, 2015). Research has shown that such early intervention enhances student learning as evidenced by improvements in their performance and retention (Hattie, 2011; Zhang, Fei, Quddus and Darvis, 2014). For example, Long and Siemens (2011) analyzed differences in the online learning behavior between more successful and at-risk students, and concluded that successful online learning was dependent on the time spent by the student on their online tasks and the frequency of their online participation.

However, one challenge is that today, educational institutions rely more frequently on online learning and

Learning Management Systems (LMS), as seen in the USA, where about one-third of their higher education students were enrolled in fully online college courses in 2013 (Picciano, 2014), so educators no longer receive the same degree of feedback about student learning that they previously received during face-to-face lessons (Mattingly, Rice and Berge, 2012). Educators thus seek guidance on how they can gather and analyze students' online learning data, particularly via LMS, and when and how they can consequently provide timely and relevant interventions to support their at-risk students (Ferguson, 2012; Lockyer et al., 2013; Vozniuk et al., 2015).

This paper offers some guidance for educators by presenting an overview of learning analytics and sharing the insights gained from the author's personal experiences and interviews with educators from the Temasek Polytechnic School of Informatics & IT to understand how educators can use the learning analytics features in an LMS to analyze student data and intervene accordingly to support their at-risk students.

Literature Review

Learning analytics can be applied in several ways, depending on the intent of the exercise (van Barneveld et al., 2012). The most common and basic form of learning analytics is descriptive analytics. This is not about making decisions for educators. This is about how student learning data can be integrated and presented in a meaningful way so educators can monitor student learning behaviors and performances to identify pertinent trends that enable them to provide timely interventions to support their students (Pirani & Albrecht, 2005). Next, there is predictive analytics, which is more forward looking, as the analytics tools are able to not only integrate the student data, but also analyze the data and derive reliable conclusions that anticipate possible future student learning behavior so educators can focus on devising pertinent interventions accordingly (van Barneveld et al., 2012). Finally, at the apex is prescriptive analytics, where the analytics tools could take the next step of actually proposing the best possible interventions that could be undertaken by the respective educators (Picciano, 2014). At present, many learning analytics solutions only offer descriptive analytics and some degree of predictive analytics.

There have been various reported cases of learning analytics solutions that have been implemented in institutes of higher learning around the world. One of the most widely cited solutions is Purdue University's Course Signals System. This system integrates online student learning behavior data with student demographic data to monitor student performance and flag students who are not doing well, in one of the first applications of learning analytics in a blended learning environment (Picciano, 2014). By analyzing this student data, educators at Purdue University were able to provide more timely and effective interventions to their students, which resulted in a 10.37% increase in As and Bs, and 6.41% drop in Ds, Fs and withdrawals in the university (Arnold and Pistilli, 2012). Subsequently, several major LMS providers, such as Blackboard and Desire2Learn modelled elements of their respective learning analytics early warning systems after this Course Signals system (Picciano, 2014).

The University of Phoenix (UOP) felt that they were "drowning in data" so they developed a data-driven environment that comprised of a combination of several systems to monitor their activities and attainment of their goals to facilitate informed decision-making (Pirani & Albrecht, 2005). For example, they implemented an Academic Quality Management System that monitored educational processes to assess the quality of their programs and offer interim program diagnoses, included data dictionaries to help their staff to easily find the data they needed, and offered customizable analysis and dashboards for the staff (Pirani & Albrecht, 2005). In one example, their Dean of the School of Advanced Studies shared how the systems enabled his team to pinpoint the specific times when students tended to drop out of the introductory course for their online doctoral degree and that a key reason was not their lack of intellectual capacity but rather their unfamiliarity with the online classroom environment and the way the educators facilitated the online course, and this enabled his team to better prepare and support new students during the critical first three weeks of class (Pirani & Albrecht, 2005).

Through such examples, we can see that learning analytics offers a multitude of benefits, such as in the area of descriptive analytics. It automates the consolidation and analysis of student data, particularly the data generated by student-produced data trails in LMS (Long & Siemens, 2011; Pirani & Albrecht, 2005). It enhances the ability of educators to monitor on-going student learning, performance and difficulties (Picciano, 2014; Pirani & Albrecht, 2005; Vozniuk et al., 2015). Insights into student learning could extend beyond the educator's specific subject, as the educator could benchmark students' learning behavior and performance against other students taking the same or other comparable subjects (Picciano, 2014; Pirani & Albrecht, 2005; Vozniuk et al., 2015).

Learning analytics solutions can also provide benefits in the area of predictive analytics, such as by incorporating automated early warning processes that flag educators when interventions may be required to support at-risk students (Long & Siemens, 2011; van Barneveld et al., 2012). Such features enable educators to focus on providing more timely and personalized interventions to support their students (Long & Siemens, 2011; Picciano, 2014; Vozniuk et al., 2015). The provision of such interventions in turn can help students to improve their online learning behavior, performance and confidence (Long & Siemens, 2011; van Barneveld et al., 2012).

In the long term, these learning analytics solutions can potentially facilitate the enhancement of teaching and learning practices by supporting prescriptive analytics, as they move beyond merely integrating student data and reporting on trends, to predicting what could happen in the future (Long & Siemens, 2011). Consequently, this could lead to innovative transformations and improvements in academic models and pedagogical approaches in line with what students need (Long & Siemens, 2011; Picciano, 2014).

Despite these benefits, there are several challenges to the effective widespread adoption of learning analytics in institutes of higher learning. There are many sources of student related data that can serve as input for learning analytics. This includes data about their online learning behavior in the LMS (e.g. their clicking behavior, content pages viewed, participation in online activities, duration spent viewing content), learning behavior in the classroom, formative and summative assessment answers and grades, interactions with educators or their fellow students, personal data in student information systems, library use and even feedback during academic advisement (Agudo-Peregrina, Hernandez-Garcia and Iglesias-Pradas, 2012; Lockyer et al., 2013; Long & Siemens, 2011; Mor et al., 2015; Tempelaar, Rienties and Giesbers, 2015; van Barneveld et al., 2012; Wolff, Zdrahal, Nikolov and Pantucek, 2013).

One challenge is that despite this potential wealth of data, most current predictive models can still only explain up to 30% of students' academic performance (Tempelaar et al., 2015). There is thus still no consensus as to what combination of data is most appropriate for learning analytics (Agudo-Peregrina et al., 2012; Pirani & Albrecht, 2005; Tempelaar et al., 2015). Effective adoption of learning analytics requires clarity about what we need to know and which sets of data can tell us what we need to know (Long & Siemens, 2011). This wide variety of potentially insightful data sources may be easily accessible but the bigger challenge is how to integrate and make sense of all this data (Long & Siemens, 2011; Picciano, 2014; Pirani & Albrecht, 2005; van Barneveld et al., 2012), particularly since the data set is often too big to be analyzed with typical database tools and systems (Agudo-Peregrina et al., 2012; Rebholz, Libbrecht and Muller, 2012). This can be overwhelming and daunting for educators (Pirani & Albrecht, 2005).

There are also often substantial delays in traditional analysis of student data in higher education, as such analysis is often done after major assessment points or at the end of the semester, so educators can only provide useful interventions to help students for their next subject or assessment, instead of integrating academic evaluation more closely into instructional activities to provide more timely support during the semester (Long & Siemens, 2011; Picciano, 2014). Another challenge for learning analytics is the ability to support suitable and differentiated time frames for analysis, as educators may require more immediate, day-to-day measurements so they can support their students with more timely interventions during the semester while course managers may only require less regular updates as they merely require a holistic overview of all their subjects without being swamped by the daily details of each subject (Pirani & Albrecht, 2005).

Finally, there have been several studies that explored possible interventions by educators, such as in the seminal work on visible learning by John Hattie (2011), where he explored and ranked 138 general educator interventions. This list has since grown to include 195 interventions (Hattie, 2015). The challenge, however, is that there have been few researchers that have explicitly studied such interventions in the context of learning analytics, particularly for online learning via LMS (Wise, Zhao and Hausknecht, 2013).

Overview of Study and LMS

This study focuses on how educators from the Temasek Polytechnic School of Informatics & IT used the learning analytics features built into the Blackboard Learning Management System used in Temasek Polytechnic. This LMS is called the Online Learning Interactive Virtual Environment (OLIVE).

OLIVE has several features which enable educators to leverage off the student data that is captured in the system to track online student learning behavior in OLIVE and identify trends that provide insights into key issues such as student engagement, performance and retention. These include the Grade Center, Course Reports, Performance Dashboard and Retention Center.

The Grade Center provides a summary of individual student grades and completion status of all the e-learning activities in the subject. It is also a dynamic and interactive tool that has other features to help educators track student online learning progress. For example, it includes Smart Views that enable educators to categorize students into groups according to certain criteria so that they can better track and subsequently support students with similar characteristics.

Course Reports allow educators to generate customized reports that describe student usage and statistics for particular areas of the subject site. For example, educators can generate a report that summarizes what students are doing in the entire subject site or specific content areas so that the educators have information such as which students are actively accessing and engaging the content, on which days of the week that students are most active, and how much time that students spend on the site or content area.

The Performance Dashboard provides real-time information on student activity in the subject site. This includes information such as the number of content items that students accessed, which adaptive release items are currently visible or invisible to each student, and details of students' discussion forum posts. Most importantly, this feature allows educators to set rules to flag at-risk students. For example, educators can request to flag students who score below a certain grade for a quiz, do not complete an e-learning activity by the due date, or have not accessed the subject site in OLIVE for a minimum number of days.

The Retention Center works in conjunction with the Performance Dashboard. It automatically monitors and displays all the students who are at-risk in real-time, based on the rules set in the Dashboard. Educators can then use this feature to communicate with these struggling students or intervene to support them. This feature also facilitates the tracking of patterns of student performance and online learning behavior over time in the subject. Educators can also set up their rules such that they can monitor students who are doing well so that the educators can provide other forms of interventions to push such students to perform even better, such as by providing them with additional more challenging online tasks. This is the main feature in OLIVE that is based on the same basic philosophy as Purdue University's Course Signals.

Student information, such as when they accessed OLIVE and their results, is consolidated and displayed at a glance by these features in OLIVE, thus helping educators to save time in tracking student performance and learning behavior in OLIVE. The information and views are customizable as educators can choose which students, groups of students or e-learning activities to focus on, define specific criteria to enable auto-flagging of at-risk students, or provide personalized feedback to students. The information can be accessed in real-time so educators can provide pertinent interventions to support students on a daily or weekly basis during the course of the semester instead of merely intervening to help students for future assessments or subjects after reviewing the students' summative results at the end of key assessment points or semester.

Data for this study was collated from the author's personal experiences in using these features in OLIVE and through one-on-one interviews with five educators from the Temasek Polytechnic School of Informatics & IT. Each interview lasted about one hour.

Findings and Discussion

The educators used the features in OLIVE to track student performance and participation in e-learning activities on a weekly basis to ensure that they achieved the learning outcomes, and to identify trends that showed persistent negative learning behaviors among students. The educators also used this information to gauge student interest in the contents and mode of delivery of the subject, as they found that this was often indicative of students' potential performance as those students with low interest would typically not be actively involved in the online learning process and thus do poorly in the subject. In general, the educators shared how the learning analytics features in OLIVE were important because most students, particularly those who were at-risk of doing poorly in the subject, were not very forthcoming in speaking to their educators about their learning issues. Below are several examples of how the educators used the learning analytics features in OLIVE and intervened accordingly to support their at-risk students, and what we can learn from these experiences.

As a pre-emptive measure, one educator shared that during his first lesson he showed his students the educator's learning analytics pages to reinforce the message that he could truly monitor students' detailed participation in OLIVE throughout the semester. The educator repeated this every few weeks in class so that all his students could see the statistics about their own online learning behaviors as well as those of their peers. The educator reported that this resulted in fewer students with poor online participation compared to prior semesters before he started doing this. Then, for students who did not complete their online activities, the educators started to intervene by reminding them via emails or during in-class lessons. This helped students that genuinely forgot or had technical problems, as they typically became more careful and less likely to repeat their problems.

However, there were still other students who persisted in not completing their online tasks so the educators adopted a firmer approach in handling such students. One educator described how he would adopt a more serious tone in his correspondence with the students and explicitly describe the impact of their continued non-completion of the online tasks on their participation marks, attendance or ability to do well in their assessments. One educator even made a student stay back after class to complete the online activity in-class under his supervision. The educator shared that this was quite effective as the students realized that the lecturer was really able to identify specific students who were not engaging in the online learning activities. The students thus subsequently completed the activities and did not forget to complete their other tasks as they did not want to affect their grades or be singled out again.

The educators however, shared that despite such efforts, there were still a few students who persisted in not completing their online activities. In such cases, the educators shared that they would check the Temasek Polytechnic Student Profile System or speak to other educators to get a more holistic understanding of the student, such as their performance in other subjects, whether they had financial issues, or if they were undergoing counseling, so that the educators could provide more effective interventions such as extended deadlines or extra lessons. The educators though feedback that ideally, all this information should be integrated so that they could access them from a single portal to provide more timely interventions instead of searching for the information from multiple sources.

In other cases, the educators shared that students may be completing their work promptly but their grades for the formative activities may be poor. Several educators revealed how they used the analytics features in OLIVE to pinpoint the areas in which individual or groups of students were weaker, such as by identifying exactly which questions that the students answered wrongly in their e-quiz. The educator could then speak to the students, check their performance in other e-quizzes or track if and how often they accessed their online learning materials, to better understand why the students did not do well. Finally, the educators could provide targeted interventions, such as by providing extra lessons, or revisiting or setting additional tutorial questions for the specific topics that the students did not understand.

For example, one educator shared how he could now provide more personalized feedback to each student based on that student's specific online learning behavior and performance in the online activities. So, when the student completed an e-quiz, the educator could check exactly what the student did wrong, and provide feedback that was explicitly tied to that activity or question so that the feedback was more contextualized, instead of merely providing general feedback to the whole class that may or may not be relevant to that particular student.

A few educators shared how they even started going beyond merely monitoring students' online learning behavior and performance for specific e-learning activities for their subject. These educators used the analytics features in OLIVE to provide insights into more holistic trends in their students' online learning behavior throughout the semester or in comparison to other subjects taken by the students. One educator shared how he noticed that his students from a particular diploma were showing a gradual decrease in their online participation as the semester progressed. Upon further investigation, he realized that the other subjects that the students were taking for that semester had several summative assessment points in the latter weeks of the semester, and students thus had less time to complete his formative online activities.

The educator proceeded to extend the deadlines for his online activities and send the students more frequent e-mail reminders about the deadlines. In this way, he was able to get his students to start completing his online activities again. Identifying trends thus helped the educators to know when they needed to intervene. As one educator explained, sometimes, the poor performance of a student could be a one-off incident and no intervention may be required. However, in other cases, the poor performance could persist and this should be a cause for concern and more timely interventions should be quickly provided.

The educators concluded by proposing how these learning analytics features in OLIVE could be better utilized and educators could provide more meaningful and timely interventions to support their at-risk students. One comment from most of the educators was that OLIVE provided a lot of student data. However, some of the data did not exactly fit what the educators required. Educators also had to spend a lot of time searching for some of the data that they wanted to study. They were also unsure about which sets of data would give them the best insights about their students. As such, the educators generally agreed that to save time and resources, there should be more detailed guides and a common set of ready-made templates that they could refer to and use so that they could quickly start to make sense of the data provided by OLIVE and ascertain how they could intervene accordingly.

The educators also described the importance of being able to easily toggle between aggregated student data that provide a holistic view of online student learning in their subjects, and individual student data so that more personalized interventions could be provided to specific students. They shared that this required a good early warning system to help flag at-risk students based on certain pre-defined criteria, because otherwise it would be too time consuming to try and click on each student's data set one at a time, especially when they had several hundred students in the subject.

In summary, this study raised several useful points for educators to consider as they used the learning analytics features in their LMS to provide meaningful and timely interventions to support their at-risk students.

1) Educators should foster close multi-tiered communication with students, where the scope of communications is escalated based on the continued monitoring of students, such as if they persist in not completing their work.
2) While the student online learning data in the LMS is quite comprehensive, it would be useful if this data was integrated with other student data, such as from the student profile system, for a holistic understanding of the students.
3) While personalized interventions are ideal, the analytics features enable the identification of subsets of students who are facing similar challenges so resources can be optimized by providing targeted interventions to these groups of students instead of to each student separately.
4) While it is insightful to obtain snapshots of student online engagement and performance at specific times in the semester or for specific e-learning activities, it would be more useful if educators could identify trends in student online learning behavior throughout the semester.
5) Educators would like detailed guides and ready-made templates so that can quickly and effectively start using the analytics features in the LMS.
6) Learning analytics should have a combination of aggregated and personalized student data with a built-in early warning system so that educators can more easily monitor their classes as a whole while simultaneously tracking specific students.

Conclusion

The 2016 NMC Horizon Report on Higher Education is a report by The New Media Consortium and EDUCAUSE about emerging trends and technologies that could affect higher education institutions, and it predicts that learning analytics will likely enter the mainstream in one year or less ("NMC Horizon Report", 2016). It is thus timely for educators and institutes of higher learning to start deepening their understanding and application of learning analytics to enable educators to support at-risk students. This paper is a step in that direction as it offers educators an overview of several of the learning analytics features in an LMS and how they can use these features to understand student learning behavior and performance, particularly in the LMS, and consequently provide more timely and personalized support for their at-risk students.

Educators should however be mindful that while learning analytics can be a powerful tool to facilitate timely interventions to support at-risk students, care should be taken to avoid an over-simplification of the prediction of future trends based on an analysis of current data because the analytics algorithms are currently probabilistic and not definitive (Long & Siemens, 2011). Furthermore, there are many other issues that still need to be addressed, such as data privacy, student profiling, transparency of the analytics algorithms, and how we can synthesize online learning behavior data from LMS with other facets of student-related data (Long & Siemens, 2011; Picciano, 2014; Vozniuk et al., 2015). In summary, it is clear that learning analytics is still evolving but its presence is already being felt so it cannot and should not be ignored (Long & Siemens, 2011; Picciano, 2014).

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Promotion of STEM Education in Vocational and Professional Education and Training (VPET)

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Abstract

Vocational and Professional Education and Training (VPET) enhances learners to acquire professional knowledge, apply practical skills and develop positive workplace attitudes to support the long-term development of a country or a city. Established in 1982, the Vocational Training Council (VTC) is the largest vocational and professional education and training provider (VTC 2016) in Hong Kong. Through a wide range of pre-employment and in-service programmes, it establishes valuable credentials for approximately 250,000 students each year with internationally recognised qualifications. As a member institution of VTC, the Hong Kong Institute of Vocational Education (IVE) offers full-time and part-time programmes - covering an array of disciplines and at levels ranging from higher diploma to certificate - nurturing talents valued by industries.

STEM (Wikipedia 2016), an acronym that refers to the academic disciplines of Science, Technology, Engineering and Mathematics. STEM (Education Bureau, Hong Kong 2015) plays a pivotal role in educating students to meet the rapid changes and continuous challenges in our society and all over the world due to swift economic, scientific and technological developments. In alignment with this worldwide trend in education, the promotion of STEM in VPET, especially in the Applied Science (AS), Engineering (ENG) and Information Technology (IT) Disciplines, has been the major focus of development in VTC for years.

In this paper, various STEM education strategies under VTC will be addressed. One important milestone is the setup of STEM Education Centre to serve as a platform for cross-disciplinary projects for STEM students and to promote STEM education to the public and primary/secondary school students through seminars, workshops and international events.

Pertaining to the internationalisation of vocational and professional education, the implementation of exchange programmes in STEM study with overseas countries, local students and their counterparts is another strategic development of VTC. It broadens students' horizon and generates their inspirations in team work and collaboration projects. The Engineering Discipline in IVE has completed a number of successful workshops with MIT (Massachusetts Institute of Technology) students, in which IVE students were inspired to explore their learning, employing different learning methods and have gained insights into the development of STEM industries, as well as interests in STEM subjects.

In June 2016, as another important event to internationalise VPET, VTC organised an international STEM Students Forum in the WorldDidac Asia in Hong Kong. This provided a golden opportunity for the local and overseas students from Australia, UK and Singapore to exchange a wealth of information from different perspectives in STEM education. A similar international STEM forum is underway for 2017 covering sessions with outstanding STEM projects from academic institutions, to study STEM teaching and learning pedagogy, and to look into the STEM project development with VTC students.

Other strategies such as Science and Mathematics Help Desk, Technology Enhanced Learning and Teacher Support will also be discussed in the paper.

Keywords: STEM Education, VPET, International Exchange, Technology Enhanced Learning, Multiple Institutions Collaboration.

Introduction

The HKSAR Government will step up efforts to promote STEM education and encourage students to pursue the study of these subjects as addressed by the Chief Executive of the HKSAR. (Policy Address 2016) The Curriculum Development Council under the Education Bureau of Hong Kong（Education Bureau， Hong Kong 2015) developed strategies for promotion of STEM education among schools in Hong Kong.

Hong Kong students performed well in Science and Mathematics over the years as revealed from international studies and competitions. However, integration of STEM subjects and enhancement of hands-on activities in schools are important to strengthen the ability of students to solve daily life problems with practical solutions and innovative designs. Throughout these activities, it can nurture students' creativity, collaboration and problem solving skills, as well as to foster their innovation and entrepreneurial spirit in the 21st century.

The report (Education Bureau, Hong Kong 2015) recommends the following key proposals. In the science curriculum, learning and teaching activities are enriched for students to integrate and to apply knowledge and skills in problem solving to create solutions and to make inventions with hands-on and minds-on activities such as project and design-and-make activities. In the Technology and Engineering curriculum, programming, information and communication technology (ICT), material & structure, manufacturing engineering, system and control engineering, and technology & living will be enhanced. Theme-based and design-and-make learning activities are promoted to enhance integration and application of knowledge and skills through project learning among students. In the Mathematics curriculum, data handling and probability content will be strengthened so as to develop students' ability to make informed decision based on calculated risk. The report also recommends various e-resources related to STEM education for effective learning and teaching.

In Hong Kong, number of students taking STEM related disciplines, such as IT and Engineering, at post-secondary level was relatively low which resulted manpower shortage in corresponding industries.

The need for STEM skilled professional is expected to keep increasing. Driven by the government's policy and society needs, focus for future development will be on infrastructure projects and innovation & technology aspects, expected vacancies in related fields are likely to be increased in Hong Kong or even in the Asian region.

Countries like the UK, US and Australia have already kick-started their STEM education promotion. Various efforts have been put to set up STEM Centres to organise various programmes in order to raise the public's interest about the importance of STEM education. Taken an example of the UK, the South West College has established a STEM centre with Multimedia room. The focused activities delivery through the centre support teaching and learning of STEM subjects and design to nurture and to grow innovation and interest in technology. Another example in UK is the STEM Centre of Bournemoth and Poole College, it accommodates a host of renewable technologies including photovoltaic installation, solar heating, heat pumps, water harvesting and wind power which will support sustainability in the region and beyond. Students have the opportunity to study emerging technology fields such as biological sciences with access to cutting edge laboratories. The University of Sydney set up the STEM education centre. It shares a common goal to motivate and engage the next generation of scientists and engineers. It is designed to forge links between high school students, researchers and scientists and will also be accessible to students at other high schools in Sydney's Greater West.

In response to the government policy to promote STEM education and training as well as the market needs, VTC takes proactive role to promote STEM education in VPET. Liu (Liu 2016) proposed a framework to establish three STEM education centres in VTC to serve a platform for cross-disciplinary development. The IVE Engineering Discipline (Lee 2015) continues to develop international exchange activities with STEM elements to foster talented engineers globally. In June 2016, VTC (IVE engineering discipline newsletter 2016) hosted an international STEM students forum aims to engage youth in STEM studies by inviting STEM students from all over the World to share ideas. Participants included students from Australia, United Kingdom, Singapore and Hong Kong. All students are studying STEM-related subjects ranging from electrical, mechanical and civil engineering; to digital media and medical science. Students presented their joint projects as well as STEM career development in their countries. Similar event with larger scale will be organised by VTC in June 2017.

VTC STEM Education Centre

After considering the local situation and the experience of other countries, 4 strategies are proposed to promote the STEM education effectively.

1. **STEM Student Support:** To strengthen education support to students studying Higher Diploma and Diploma programmes offered by VTC. Since a considerable number of students are came from non-STEM background, their proficiency in fundamental STEM subjects such as Mathematics or Science are needed to be enhanced.
2. **Study Interest in STEM related subjects:** To raise students' interest in STEM subjects and their awareness of STEM related careers, and consequently, increase uptake of STEM subjects at secondary schools and VTC programmes.
3. **STEM Teacher Support:** To enhance professional development of STEM teachers in secondary and vocational education which help to stimulate the teaching and learning quality.
4. **Career Interest in STEM related Industries:** To attract young students to STEM careers which may help to create a stable manpower pool to support the sustainable development of the industries.

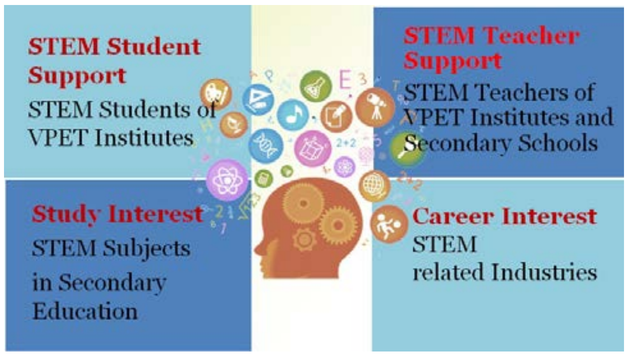

Figure 1 STEM Education Strategies

STEM Education indeed should be delivered at cross-disciplinary level. The establishment of the STEM Education Centre in VTC could pool the resources of the three STEM disciplines from Applied Science (AS), Engineering (ENG) and Information Technology (IT). It serves as a platform for relevant students and staff to deliver curriculum on related trade and cross-disciplinary projects. Moreover, the proposed Centre could help to inspire innovative pedagogy to enhance the learning and teaching experience at post-secondary and secondary level. At publicity angle, the Centre could serve as iconic facility in town to promote STEM education through organizing seminars, workshops and even international events.

For the STEM student support, there are a considerable number of secondary school students from non-STEM background to study VTC programmes, their proficiency in fundamental STEM subjects such as Mathematics or Science are needed to be enhanced. Mathematics and Science Help Desk will be setup to provide them with additional support outside classroom. Teaching staff will be on-duty to provide necessary assistance. Peers influence is always important to young people. To ride on the vehicle of internationalization, Hong Kong students could broaden their horizon and get inspiration on STEM study through exchange with overseas STEM students. Taken the successful MIT summer workshop organized by IVE Engineering Discipline as an example, IVE students were inspired by the MIT students in various areas, such as study method, insight of STEM industries development as well as interests in STEM subjects. STEM exchange activities can be conducted in the Centre locally or through video conferencing at different countries. The use of new technology to enhance learning and teaching of STEM subjects including theory and practical training is essential to youngsters. Taking the AR/VR based learning as example, through 3D simulation, the facility can allow student to expose into a virtual environment such that they can gain a better understanding about the real workplace and, particularly, the possible danger behind.

Support to STEM teachers is equally important. The Centre aims to provide online resources and teacher training. Online resources for teachers of secondary schools on STEM subjects and pedagogical content knowledge, and ultimately enhance the teaching and learning quality. Teachers training programmes will be focused on problem-based learning and project-based learning as a form of continuing professional development. New technology comes and supersedes the old ones. Our society moves with technological advancement everyday. Teachers are also required to connect with latest technology and to understand the trend and move of the industry. Therefore, two approaches are also proposed as support to STEM teachers. The first approach is to encourage VPET teaching staff to conduct Applied Research. The second one is to engage VPET teaching staff with industrial attachment as a form of staff development.

Secondary schools students are the main target for the STEM education promotion. The STEM Education Centre aims to inspire secondary students by providing venue and support for organizing STEM activities including hands-on workshop and competition to cater for their interests and abilities, and to unleash their potential. To further inspire secondary students, introduction of STEM careers through experiencing in virtual workplace would be more effective. The proposed Centre will equip AR/VR facility to provide students with an interesting touch with the industry. They can also gain a better understanding about the workplaces and the professions. The Centre will also partner with various STEM related industries to organise industry talks and study visits to cutting-edge STEM research and development institutions, such as Hong Kong Science & Technology Park and Cyberport. Moreover, the Centre can help to drive the development of other STEM related programmes for secondary students such as Applied Learning (ApL) programmes and summer camp to help them to explore STEM study at post-secondary level.

The STEM Education Centre is mainly comprised of 4 main zones: Virtual Experience Zone, Mathematics and Science Corner, Engineering and Technology Zone and STEM Activity Workshop. Each zone is embedded with different focus. In virtual experience zone, through virtual reality, the zone can provide students with immersive simulated environment for virtual workplace experience. In Mathematics and Science corner, teaching staff will be on-duty to provide additional support to students, hoping to enhance their proficiency in mathematics and science subjects under a more relaxed setting. In Engineering and Technology Zone, showcase of outstanding STEM projects, such as robotics, solar car, bridge building etc. can be set up to arouse students' interest of STEM education. Finally, the STEM Activity Workshop will equip with hands-on tools and latest equipment such as 3D printers and laser scanner. Interesting STEM related activities will be organized for secondary school students.

In summary, the STEM Education Centre will serve as a cross-disciplinary platform to support relevant students for better study of STEM related programmes, support staff to deliver curriculum on related trade with innovative pedagogy to enhance the learning and teaching experience. It also serves as a focal point of VPET to interface with secondary schools with the aim to help promoting STEM education in Hong Kong and ultimately nurture young STEM skilled professionals for the sustainable development of the Region.

Figure 2 STEM Education Centre

International Exchange Activities

IVE Engineering Discipline (KNCT 2011, Lee 2013, Shirahama & Lee 2013) has started student exchange programmes with NITs from Japan; Ngee Ann Polytechnic and ITE from Singapore; MIT from US and RMIT from Australia etc. since 2009. Both staff members strongly believe that STEM elements are the key successful factor for student exchange programmes. Therefore, the team designed a number of STEM projects in the past eight years. It included control of path tracking mobile robot, design and make of air balloon, control of solar tracking system, and efficiency analysis of a renewable energy system etc. The STEM projects can enhance their hands-on ability to solve daily life problems. On top of STEM project, each exchange programme also included factory visit, cultural exchange and sightseeing activities. The proportion between STEM project and factory visit to sightseeing and cultural activities is around 80% to 20%. This golden rule adopted for many years with good feedback from students, staff members and fund supporters. Throughout these exchange programmes, students can gain more insight of STEM education and career development in different countries.

Project competition is another channel to promote STEM education. Throughout the years, VTC students attended a number of STEM project competitions. For example, VTC students have a long record to participate World Skills Competitions in various trades such as mobile robotics, mechatronics, and software applications etc. The Solar Car and Robocon teams from IVE Engineering Discipline attended the World Solar Challenge in Australia and the Hong Kong Robocon Contest with good achievement. Students are strengthened to solve real life problems with sound engineering principle solution through STEM project competitions. Students also exchange view for code of practice to apply STEM principles to solve real life problems from various countries.

Figure 3 Path Tracking Mobile Robot STEM Project

International STEM Students Seminar/Forum

Apart from the student exchange programmes, international symposium and seminar are also important event to promote STEM education globally. In 2013, VTC hosted the 3rd International Symposium on Technology for Sustainability (ISTS) and the symposium provides golden opportunity for students to exchange their outstanding STEM projects. It also enhances the understanding the STEM career development in different countries.

In June 2016, VTC organised an International STEM Students Forum in Worlddidac Asia 2016. The theme of the forum is “STEM Students Conversation: What’s Next”. The forum aims to exchange views about STEM students’ learning and teaching experiences and their career development in their countries. There are three sessions of the forum. The first part is outstanding STEM project presentations. Students from RMIT, Australia; the University of the West of England, United Kingdom; Nanyang Polytechnic, Singapore to present joint STEM projects with IVE Engineering Discipline, IVE Information Technology Discipline and Thei students respectively. The second part was an invited presentation from the University of the West of England (UWE) to share how UWE engages youth in STEM studies through their signature “Bloodhound” Project. It is a design and make of a supersonic car project. The last part was a student-centre forum. Students from different countries shared their STEM learning experience, career development and views on STEM education and development in their home country. The forum is a successful event with over 300 participants globally.

An International STEM Student Seminar 2017 will be hosted by VTC in June 2017 in Hong Kong. Theme of the seminar is “Voice of Youth: International STEM Students Exchange on Vocational Learning”. The seminar is scheduled for two days and sessions include (i) STEM Students’ forum with Executives, (ii) Invited presentations from STEM teachers/practitioners, (iii) Joint-institute student project presentation, (iv) Student project presentation from different institutions, and (v) Student poster session. Oral presentations and poster session will be reviewed by a technical programme committee. The poster session provides an opportunity for STEM students to present their projects to the Hong Kong and overseas participants in a lively style. Throughout these seminars, it aims to establish an intercultural dialogue among young people from different parts of the world on STEM issues. Also, it can expand the professional networks available to STEM students intending to enter the job market.

Figure 4 International STEM Students Forum 2016

Conclusions

The paper reported vaious promotion channels of STEM edcuation in vocational and professional education and training (VPET). STEM education centre, international exchange programme, project competition and international student symposium/seminar have been addressed as key elements to promote STEM education.

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DEVELOPING PROFESSIONAL COMPETENCIES IN CURRICULUM @ NP: A BUSINESS STUDIES APPROACH

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Abstract

Research shows that students learn better when they apply concepts to practice, solve real problems, make decisions and reflect on the consequences. Based on these principles, the Learning & Development (LD) module ensures that students' learning is active and connected to real life. Its main aim is to prepare students for the Learning & Development role at the workplace and to ensure that they are employable with relevant work skills.

LD uses the experiential learning approach to enhance students' learning of the end-to-end training process. The key learning experience is the Organisational Behaviour (OB) Workshop project, where LD students (known as student trainers) design and conduct a workshop for OB students. In the process, they engage in activities around the training cycle which include needs analysis, training design, training delivery and training evaluation.

Student learning is emphasised in a few ways. There is peer teaching and learning, which benefits both the LD trainers and OB participants. The trainers experience learner-centred learning when they actively engage in posing questions, exploring, being curious, and working in teams when developing the workshops for OB students. There is also scaffolding of learning when students use knowledge learnt in previous foundational modules in the BS course, and apply it in the execution of the workshop, integrating and synthesising their past learning into one whole experience. The students' learning results in their holistic development and they develop a repertoire of 21st century work skills.

A variety of assessments (both formative and summative) are used to allow the different learner types to showcase their abilities. Continuous feedback is provided to students throughout their experiential learning experience to help them to reflect on their learning and to make improvements.

The LD students have been given opportunities to extend and apply their acquired skills further in other contexts. This end-to-end training experience has also been replicated under a similar module where students have developed and conducted training workshops for external parties such as corporate clients and secondary schools.

LD is continuously updated and refined based on feedback and reflection. Every year, new changes are implemented to provide students with better student engagement and learning experiences.

Keywords: *experiential learning, learning and development, training, industry relevant, 21st century competencies, peer learning*

Introduction

This report highlights the Learning & Development (LD) module and showcases its use of experiential learning and the holistic development of students in its curriculum. Research shows that students learn more effectively when they can apply concepts to practice, solve real problems, make decisions and reflect on the consequences (Kolb, 1984). They also learn better when teaching and learning is active, connected to real-life and designed with the students and their unique qualities in mind.

Students' ability to apply concepts learnt in the class in an authentic setting is important as they will need to be able to test ideas discussed in the classroom on real life situations. This link to reality is required to prepare a student for life's unpredictable experiences (Kolb, 1984).

Based on this, the LD module was designed to prepare students for the learning and development (L&D) role in a dynamic work environment and to instil relevant work skills to ensure their employability in the changing work landscape. This was achieved by incorporating an experiential group project called the Organisational Behaviour (OB) Workshop project into the module.

Background

The LD module is a core module taken by final year students in the School of Business & Accountancy (BA) at Ngee Ann Polytechnic. These are final year students who choose to specialise in the Human Capital Management (HCM) option under the Diploma in Business Studies (BS).

The BS diploma aims to equip students with a broad range of business knowledge required in business management. Students who specialise in the HCM option are trained to be professionals in the field of human resources (HR). The specialisation equips them with essential skills in the key HR areas such as recruitment and compensation, through a variety of specialisation modules such as Global Talent & Mobility, Total Rewards Management, Employee & Industrial Relations, and LD, amongst others.

Scaffolding Learning: Diploma in Business Studies - The Human Capital Management Option

The LD module leverages on the scaffolding of the students' learning across three years within the BS course (Refer to Figure 1).

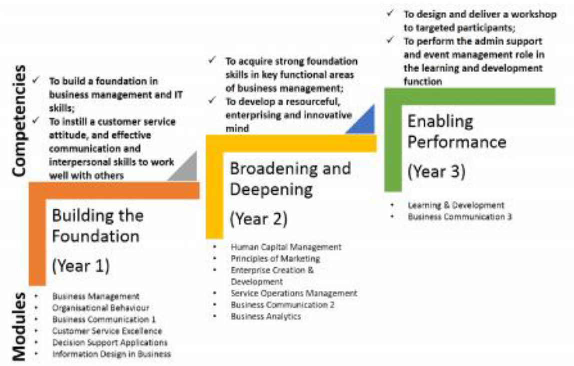

Figure 1: Scaffolding of learning in the BS HCM Option

In Year 1, the students learn fundamental business modules that cover topics in business management, customer service and business communications. At this foundational level, they build a foundation in their business management skills and basic interpersonal skills.

In Year 2, students broaden and deepen their business knowledge, and are exposed to the functional areas of business such as human resource management and marketing. They continue to deepen their skills in business communication and to develop an innovative, resourceful and enterprising mind. In addition, they are first introduced to the function of learning and development in the basic Human Capital Management module.

In Year 3, the students use their foundational knowledge previously acquired to enable performance. They make use of all prior learning acquired in previous Year 1 and 2 modules to prepare for and deliver the OB Workshop. Using higher-order thinking skills, the students integrate and synthesise all their past learning and skills acquired into this one whole experience, which is often the real experience of working professionals in the workplace.

The LD Module

In LD, students learn the role of Learning & Development (L&D) in organisations, including the fundamentals and the wider and emerging trends that impact L&D in organisations. More importantly, through the group project, students also develop L&D skills that will enable them to conduct the Training Cycle by assessing training needs, designing, conducting and evaluating simple training programmes.

The 4 phases in the Training Cycle are taught in the first six lecture topics so that students are equipped with the necessary theoretical knowledge of training design before embarking on their group project. Figure 2 illustrates the four phases in the Training Cycle and their corresponding lecture topics.

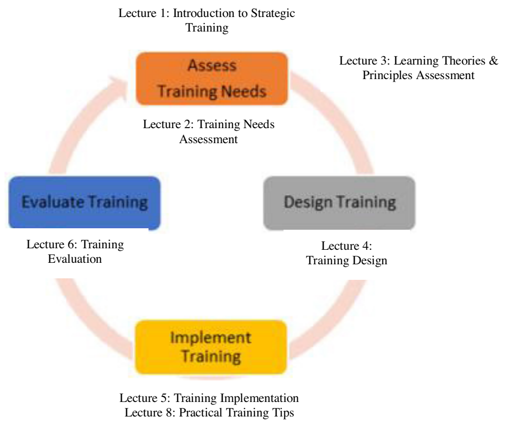

Figure 2: Phases in the Training Cycle and corresponding lecture topics

Redesigning the LD module

Previously, students taking LD were passive learners. They learnt about the Training Cycle in lectures, and applied their learning through case studies in class. There were few opportunities for the students to apply what they learnt in any real-life context. However, as future HR professionals, it is important that the students are given the opportunity to have practical knowledge of the Training Cycle, and to experience the types of work situations, tasks and challenges that training professionals encounter in the workplace. The students also need to develop professional competencies and skills that are required of training professionals in implementing the HR concepts in the workplace.

In order to provide more engaging and practical learning opportunities for students, the LD module was purposefully redesigned to incorporate experiential learning which gives students the chance to put into practice the theories they learnt in the classroom (Wharton & Parry, 2003). Literature has also evidenced that learning increases when students' experiences and knowledge are utilised in their learning process, and when they are able to interact and reflect on the subject matter.

In addition, the experiential learning opportunity also allows students to develop skills and attributes which are essential to training professionals that cannot be easily acquired from content knowledge. These are practices and behaviours that can only be developed through practical and "real-life" situations.

Redesigning LD for experiential learning through the OB Workshop

The design of the LD group project uses an experiential learning approach based on David A. Kolb's Experiential Learning Theory which states that "learning is the process whereby knowledge is created through the transformation of experience" (Kolb, 1984). In Kolb's model, learning through experience is a four-stage cycle, where learners learn through experiences that they reflect on to conceptualise new ideas or thoughts, which they then apply. Through the application, they experience and reflect again, and the cycle continues.

i. Implementation of LD

Experiential learning was used when designing the LD group project to provide students with an authentic and applied learning experience. In this LD group project, also known as the Organisational Behaviour (OB) Workshop project, the LD students are "appointed" as student trainers by their "client" – the School of BA. They work in teams to design, propose and eventually conduct a 2-hour workshop for first year students around OB topics such as conflict management, stress management, and teambuilding. At the end of the project, the LD trainers are also required to evaluate the outcomes of the OB Workshop that they have conducted. Through the project tasks, students practise the Training Cycle learnt in class and apply it to a "real" situation to successfully implement the training programme to the client's (or lecturers') requirements.

The LD trainers apply the four phases of training design learnt in lectures to complete the main project tasks, which are to:

1) conduct needs assessment and submit a training proposal and programme for the workshop;
2) work collaboratively with other teams to run the workshop as trainers;
3) submit a training evaluation report evaluating the workshop's effectiveness; and
4) submit a personal reflection on their learning experiences.

Table 1 provides an overview of the project tasks in the OB Workshop that the students engage in.

Table 1: Project tasks in the OB Workshop

Phase	Project Tasks	Assessment
Assess Training Needs	To conduct training needs assessment to assess needs of trainees through: • gathering information from class observations, surveys and interviews with OB stakeholders • collating and analysing the information to propose suitable activities to suit needs	Training Proposal
Design Training	To design and propose a training workshop programme that includes: • relevant learning activities • a detailed lesson plan • class layout and materials needed	Training Proposal
Implement Training	To conduct the OB Workshop and facilitate the workshop learning activities, with autonomy to make decisions on: • sequence of training activities • trainer roles within the team • time-fillers, materials or props to be used	OB Workshop Delivery
Evaluate Training	To evaluate the effectiveness of the OB Workshop by: • gathering and analysing feedback using appropriate evaluation methods • reflecting on feedback collected • assessing strengths and weaknesses • making recommendations for future improvements	Training Evaluation Report, Reflection Journal

The series of project tasks sequenced in the OB Workshop deliberately mimic the four phases of the Training Cycle so that the LD trainers are able to experience each phase and put into practice the theoretical concepts that they learn in class.

ii. Assessment of LD

A variety of summative and formative assessments are used to fairly assess a broad range of skills and knowledge which range from academic knowledge to analytical skills to practical training skills.

Summative assessment of LD will include the Training Proposal and Training Evaluation Report which are submitted as written reports. Students will be assessed on their analytical ability, creativity and writing skills as well as the ability to gather and synthesise data.

Formative assessment is conducted during the OB Workshop where the students are observed and assessed by lecturer assessors who will evaluate them on their stand-up training competencies, teamwork, communication and presentation skills, as well as their workshop facilitation skills. Students are also expected to submit a personal reflection where they are assessed on their reflective and evaluative ability.

Redesigning LD for the development of business and functional competencies

The learning activities in LD were redesigned to integrate the objectives of both the diploma course and the module, which are to equip students with a broad range of business knowledge whilst preparing them for a career in L&D and training. It gives students opportunities to hone a wide array of business management and workplace-relevant skills, such as interviewing and interpersonal skills, teamwork, communication, decision-making capability, time management, stress and conflict management, resourcefulness, and ability to think on their feet. These are skills that are crucial for every business graduate to possess.

The project also develops the professional abilities of the students and enhances their employability. Through the project activities, the students acquire specific functional and L&D-related skills that are important in the role of an L&D professional in the workplace, such as knowledge in learning theories, needs assessment, curriculum development, training and facilitation skills, and evaluation skills. These are all skills that an L&D professional would need to possess in order to succeed in today's workplace.

Redesigning LD for learner-centred learning

The design of LD also provides many opportunities for the students to engage in learner-centred learning. Throughout the OB Workshop project, students are actively engaged in learning through posing questions, exploring, reflecting, collaborating, being curious and solving problems. They become self-directed, independent and collaborative learners, and develop into active yet reflective learners.

Students experience active engagement through this hands-on experience with the OB Workshop, and it appeals to kinaesthetic learners who are usually disengaged from the more traditional and academic approach to learning. In addition, each phase of the project is designed for them to gain a wide array of both functional and soft skills through the tasks, such as L&D skills, initiative, decision-making and accountability.

In planning the workshop, the students experience the role of trainers in helping to carry out the overall objectives of the School of BA, and are thus able to draw parallels to the workings of a real organisation and appreciate the very important role that training plays in an organisation's strategy. Students are also actively engaged in the learning activities through learning by doing, learning by discovery and learning by collaboration. This leads to some students being more motivated about learning.

In their reflection journals, many LD students have reflected on how this experience has sparked their interest in the profession and the relevant skills they have gained to help them to pursue this career path.

Effectiveness of Learning: Feedback

The LD trainers are given opportunities to gather and receive feedback from several parties at all stages in the project. Providing feedback helps to build the students' skills, and gives them more confidence to carry out future tasks (Kenny, Brown & Ralph, 2000).

At the training proposal stage, students receive feedback on their submitted proposals from the lecturer on the feasibility of ideas proposed for the workshop. In preparing for the OB Workshop, project teams rehearse their sessions. These sessions give the students the opportunity to practise their training facilitation techniques and work out the flow of the training session within their teams. During such dry runs, students receive feedback on their delivery techniques from both the lecturer and their peers in the project team. Students gain greater confidence through the practice of their training delivery. They anticipate and carry out contingency planning during the dry runs, and practise giving and receiving feedback.

After the workshop, they receive feedback on their actual workshop delivery from their lecturer assessors and OB participants. The students then make use of all the feedback collected to reflect on their performance and to make improvements throughout the project process.

Effectiveness of Learning: Reflection in experiential learning

The importance of reflection is emphasised throughout the feedback process. The students reflect on the feedback received from the various sources. Encouraging continuous feedback and reflection develops critical thinking in the students as they think of new ways to improve the OB workshop. It also develops a sense of personal awareness and development as upon reflection, the students seek to overcome their personal weaknesses and improve themselves.

Based on Kolb's model of experiential learning, the LD students learn through their previous experiences and reflect on them to conceptualise new ideas or thoughts which they then implement. Although experience is the basis for learning, experience cannot be assumed to be an indication that learning has occurred. Reflection on an action must take place in order for learning to occur (Kenny et al., 2013; Beaudin, 1995). Therefore, reflection after an experiential activity should be a conscious effort, actively pursued after every learning experience. It is the reflection process which turns experience into experiential education (Joplin, 1981).

Reflection is used to help students explore their thoughts and feelings and to work through an experience, in an attempt to gain new understandings, fresh insights and self-awareness. This type of learning helps to move the student from surface to deep learning.

After the workshop, the LD trainers are required to pen their learning and reflections in a reflection journal. This assessment component allows students to step back from their learning experience to help them to improve on future performance by analysing their experience. Reflective writing also encourages critical thinking and analytical skills, and helps students to increase their metacognitive skills. (Gorlewski & Greene, 2011; Plack et al., 2007).

Effectiveness of Learning: Developing 21st century professional competencies and values

Students today face a world of challenges when they step out into the working world – challenges brought about by technological advances, demographic change and globalisation forces. Students need to be well-equipped with 21st century competencies that include skills such as creative and critical thinking, collaboration, and social and cultural skills to face such challenges of the future and to grasp the opportunities created by them.

Experiencing the OB Workshop has provided value and impact to the students in terms of their holistic development. In the process of guiding the students throughout their project, the lecturers have observed how the students have developed these 21st century competencies. For example, in analysing training needs, the students engage in critical and analytical thinking. They apply out-of-the-box thinking when creating interesting workshop activities to generate participants' interest. Students also engage in self-directed learning through exploring and researching the OB content, and in reflecting on their experiences. They not only learn their content skills but have also picked up other relevant competencies that would be useful for them in their future work.

> *"Interpersonal skills such as facilitation skills were also acquired in through this experience – where I learnt how to present information to the trainees in an effective manner to grab their attention, encourage participation……as well as to manage and deal with trainees of different personalities…"*
>
> *LD student, quote from reflection journal*

During the actual workshop, the lecturer assessors also observe many such examples of holistic development e.g. during the OB Workshop, the students are required to be energetic and enthusiastic in order to motivate their trainees to participate fully, and to display confidence in carrying out the workshop activities. They have to be resourceful in order to propose new and engaging workshop activities.

Another skill observed by the lecturers is the ability of the students to adapt to changing situation. While students can be prepared to deliver the workshop with the best-intended outcomes, they may have to handle a class of participants of different learning needs. They have to think on their feet to make quick decisions to respond to the learning climate. This helps to hone their situational adaptability and ability to respond to and handle unanticipated situations, which is a desired competency in the workplace.

> *"…I have learnt how to be more flexible such as being responsive to the environment in order to be able to cope with unexpected changes of situations that may occur. This includes quick thinking and making effective decisions on the spot…"*
>
> *LD student, quote from reflection journal*

Basic values such as resilience are instilled when students encounter unforeseen challenges in conducting the workshop, and their persevering attitude is tested. The students are also taught that showing respect and consideration for their trainees' unique profiles, personalities and learning styles are also important in conducting a successful and engaging workshop. Similarly, empathy is inculcated when students try to understand the needs of their audience and modify their training approaches to meet these needs. The final year students act as role models and positive examples of seniors that their trainees can aspire to become.

Most recently, through a partnership with a special school, the LD students were given opportunities to broaden their learning with service learning elements through an alternative project. Students who chose to do this project planned and organised a workshop to teach life skills to students with learning disabilities. The LD students had the opportunity to engage in service learning in a realistic environment. In interacting with their special needs students, they also got a chance to reflect on their own personal situations and show gratitude, appreciation and compassion for others.

Effectiveness of Learning: Cross-level collaboration and peer learning

The OB Workshop project also facilitates close and continuous working collaboration and interaction between the staff and students of OB (a first year module) and LD (a third year module).

Staff leading both modules work closely to determine workshop outcomes, and to mentor the LD students. During the OB Workshop, each class is assigned both a first year and third year lecturer, who work collaboratively to observe and assess the OB trainees' participation and LD trainers' delivery. This cross-level collaboration gives all OB and LD tutors involved an appreciation of each other's work domains. There is mutual learning and respect, greater understanding and co-operation that also spills over into other areas of work. The cross-level cooperation between the staff has resulted in better working relationships, and has helped to open up possibilities to work together on other projects. In addition, lecturers roped in to help assess the workshop delivery also hone additional skills in conducting live assessments and giving verbal and immediate feedback to students.

The LD students also actively engage with the OB lecturers and tutors (who play the role of "client") to gather the requirements for the OB Workshop. This collaboration between the LD students and their "clients" helps to hone their service mindset and attitude, which are also important attributes to possess in the workplace. LD students also experience the importance of questioning & communication with clients, and also start to develop greater sensitivity to the needs of their stakeholders.

Peer learning is another key feature of the OB Workshop that has benefitted both the LD trainers and OB participants. The OB students benefit from being taught by their seniors as the OB content is contextualised by their senior peers at a level that is meaningful to them. The LD trainers also benefit from peer learning as "to teach is to learn twice". The LD students have mentioned in their reflections that in teaching the OB content to their juniors, they refresh their previous OB knowledge and also learn to connect with their juniors and form new friendships. As trainers, the process also instils a sense of responsibility in making them accountable for the learning of their peers, and in being role models that the junior students can approach easily. The OB students have also commented in their post-workshop evaluations on how they were able to identify better with their trainers and how they had gained more knowledge about the specialisation during the workshop.

Feedback from students and industry

Validation from various sources attest to the value and impact of the design of the LD module and the OB Workshop project. Students, as well as industry practitioners, have commented on the usefulness and practicality of the OB Workshop. The specialisation's external examiner, who is an industry practitioner, highlighted the practicality of the experiential learning approach and its "excellent approach used to equip students with the skills necessary for real work life in the corporate world".

LD students have also found the module and its learning activities of great value. In their comments during the yearly module experience surveys, they have commented that the group project allows them to experience the handling of what a real project in the workplace would feel like. It gives them an opportunity to experience the complexities of planning and organising a real training event within the Polytechnic environment. This hands-on experience is especially significant for students when they are posted out for their internship, as the skills and know-how they learnt from the organising the OB Workshop are highly relevant in the industry.

Conclusion

The OB Workshop project has been running for the last few years with constant refinement and enhancements made. Some of the key features in the current model were the result of previous enhancements made based on previous feedback and reflections from staff and students. Examples of these enhancements include the provision of detailed marking rubrics to the students, the implementation of practice dry runs, and the use of technological tools for reflections, which were made to improve students' overall learning experience.

Overall, the LD module and its OB Workshop project has helped to develop our students into L&D professionals, equipped with industry training skills, and 21st century competencies and values. The use of experiential learning and peer learning in LD has proven successful in giving the students an innovative way to learn that is tailored to their abilities. Students are more engaged in learning about L&D, and are able to apply their practical skills in the workplace easily. Armed with these skills, they are ready to cope with the demands of an ever-changing workplace to become competent and respected HR professionals.

Acknowledgements

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Round Table Oral Presentation

Topic 1

Education Research & Practice

1101

Digital-Analogue hybrid enhanced collaborative group work in introductory experiment of water rocket

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Abstract

For 7 years, the water rocket has been used as introductory education for freshmen of mechanical and systems engineering. During the process of making and improving performance of the rocket, students were expected to earn basic skills in experiment, such as critical thinking, data handling, graphing data, data analysis, collaborate each other, and so on. In this class digital video camera was used for obtaining data from flying rocket. With using projector and big papers, students joined the force to plot trajectory and attitude of the rocket. In this paper the method will be described.

Keywords: *Group work, Digital video, Experiment, Digital-analogue hybrid, physics*

Introduction

In engineering field, not only theory but experiment skill is important, because the engineering problem often occurs beyond expectations. The experiment sometimes gives us unexpected result which indicates wrong assumption or approximation, when the obtained data was analysed carefully and properly. And also to write report about experiment is one of essential skill to tell others information. Yet it is hard to acquire these skills, and often teachers complain about that students are luck of these skills. One reason was that usual experimental class does not aim to develop these skill but learning specific physics subject.

In order to make student gain these skills, the experimental class was made for freshman of mechanical and systems engineering. Considering the age and skill of freshmen, the topic for experiments should be easy to observe and make. Furthermore, the topic is better to have experiences based on the mechanical engineering theories, such as dynamics, fluid dynamic and thermodynamics. From these points of views, the water rocket was selected to use for the topic. The water rocket was used for the educating all over the world. It was easy to made and non-expensive, fun to play with. Even elementary school children can make and play with it. But to analyse motion of the rocket properly, the knowledge including dynamics of solid body, fluid dynamics, thermodynamics and calculus was needed. With rapid development of the computer, digital cameras and open sources programs for educations, changes the situations. It made freshman to observe and analyse the basic motion of rocket easily. In this paper the method will be explained.

Methods

The water rocket is made by plastic bottle used for sodas. The rockets was consists of four parts, pressure tank, wing, nose cone and releasing mechanism. The rocket was lunched using rocket launcher that also has 3 parts, launch base, pump and switch for release (Figure 1).

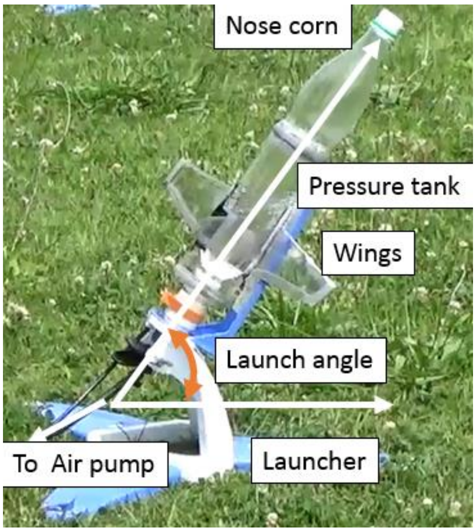

Figure 1: Water Rocket and Launcher

In the pressure tank some amount of water was filled as propellant. After connecting rocket with launcher, the pressure tank was pressurized by air pump to provide thrust.

With using the releasing switch, the rocket was disconnected from the launcher. Due to the difference of pressure, the water inside was pushed out to outside and gaining momentum according to the Bernoulli's principle (fluid dynamics.) The momentum of the water gives the momentum of the rocket to opposite direction. In the pressure tank, the inner pressure decrease along with adiabatic expansion (thermodynamics) caused by decreasing water. When the pressure inside became same as atmospheric pressure, the acceleration of the rocket was finished.

After acceleration, the rocket states changes to projectile motion. In this state, path of the motion be different due to the initial velocity, projectile angle, drug force, lift force and attitude of the rocket.

Students asked to compete in distance rocket flied. The parameter students can change was amount of the water and angle of launch which may change its initial velocity and projectile angle. For the rocket, everything but pressure tank size they could be modified. Thus to make their rocket fly farther, it is important to know behaviour, such as initial velocity, initial angle of motion and posture angle, which can be analysed from video. In order to learn treatment of video and how to analyse motion from them, Galileo's experiment was done as preliminary experiment. Four balls with almost same size and different weight were dropped from the 3rd floor as shown figure 2. The free fall experiment was recorded by the digital video camera (Sony HDPRJ540 1024x768 pixel 30Hz).

Figure2: Schematic view of Galileo's experiment

The recorded video file was send to the personal computer which was connected to the projector that can project image on the table. Then the video file was projected on the paper as shown in figure 3.

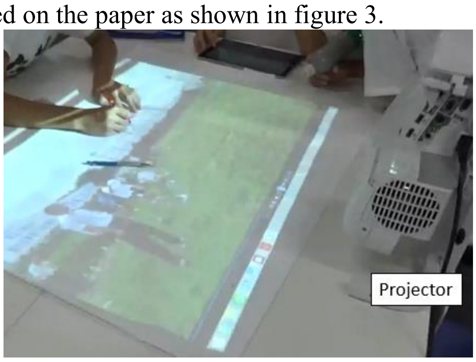

Figure3: Table projection of recorded videos

The video was played flame by flame using Microsoft Media Player. The position of the ball was plotted on to the Paper to make position-time graph as shown in figure4. From the graph and the object with known size in the video, real scale position was calculated then from the position data, velocity and acceleration was calculated. Through the experiment, students were expected to learn how to obtain data from videos and the concept of air resistance.

After Galileo's experiment students made water rocket based on the blueprint that handed out (basic rocket). To find out the proper parameter of water and angle of launcher, rocket was launched with changing these parameter and distance was majored. While the experiment, motion of the rockets were recorded by the digital video camera as shown in figure 5. Video was recorded from the launch to the end of accelerations.

Figure4: Example of the plotted positions of the Galileo's experiment.

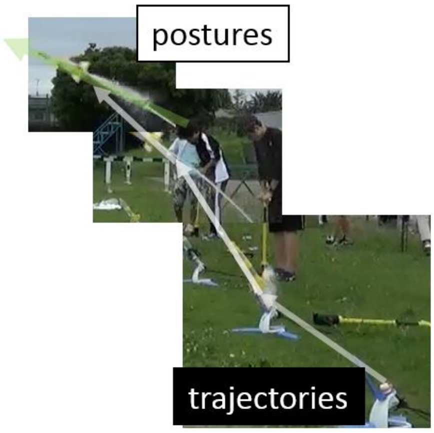

Figure5: Water rocket launch images: three sequential flames.

From the video, the trajectories of rocket and postures of rocket was plotted on to the paper as shown in figure 6. Different from the Galileo's experiment, not only the position but also the posture of the rocket was plotted on the paper to calculate the initial angle, initial velocity.

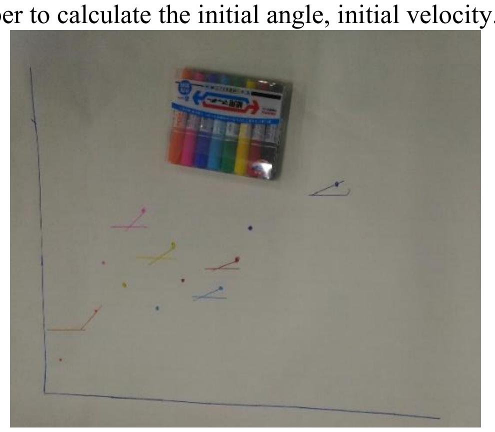

Figure6: Example of the position and posture angle of the rocket

To know the drag coefficient of the rocket they made, Phet(e.g. W.K.Adams, et.al.(2008)) projectile motion simulation was used (Figure 7). In this simulation, three parameter, initial velocity, angle and drag coefficient could be changed. Using obtained velocity and angle, the distance was simulated with varying the drag coefficient. Comparing simulation and measured distance, student can be find the value of the coefficient.

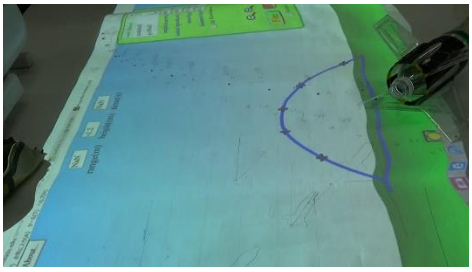

Figure7: Phet Projectile motion simulation.

Results and Discussion

This project was started 8 years ago, and gradually modified to enhance student's skills in experiment. At first we starts making rocket using 1.5 l bottles, and three cameras which video format was motion Jpeg. At that time we had extra 2h in week for analysing videos using computer room. To analyse the images, ImageJ was used as shown in figure 8.

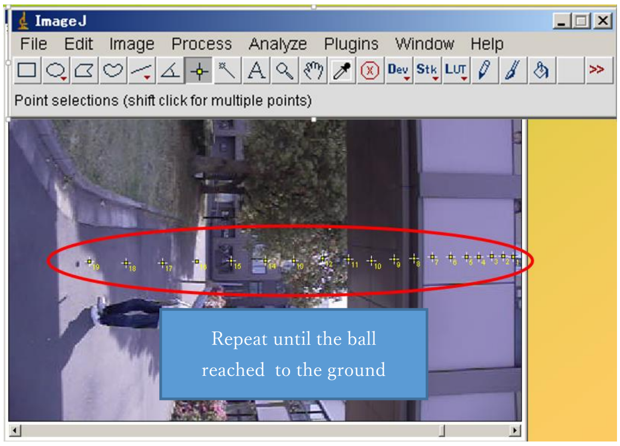

Figure 8. Example of ImageJ analysis

Using digital only analysis, there was students not good at computers and such kind of students tend to be discouraged to learn. But as far as we have time, it was not big deal. Another problems was simulating projectile motions. Because the computer in computer room has limited capability to install applications for simulations, there was no other way to use Microsoft excel as numerical analysis (figure 9). With the handout sheets, it was possible to calculate motions with different parameter but for student the spread sheet was hard to understand. There was not much difference between calculation by programing and excel simulations for mechanical engineering students.
But two years ago, things became worse. The extra 2h could not be used because of the curriculum change. Then we need to find another way to analyse data and doing simulation in easy way. For simulations, thanks for the trend of the open education in American universities, many web based application was developed. One of them was phet simulations from Colorado University. It was easy to use and doesn't need install new programs. For digital analysis, at first we made it as homework, but it did not work because not all students own PC in home.

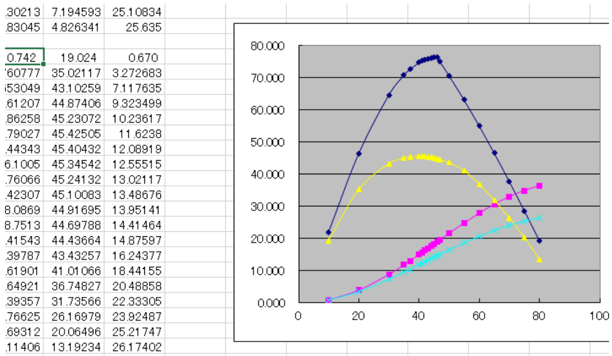

Figure 9: Projectile simulation using Excel

Then we split job into controlling video and plotting position. It was not only time effective but also had good effect for student to enhance collaboration. They start sharing job to finish experiment. Furthermore, from this year every students bring their own PC to school, it make much easier to them to share results.
Improvement of time efficiency gives students extra time for experiment in extra conditions. Before the analogue-digital hybrid analysis they tend to wait for the result of analysis to do extra experiment. As a result they only can acquire only 4 to 6 case of the flight data and they can analyse two or three data. But with this method, student become eager to do extra experiment. The number of the case done increases at most 12 (4 different angle, volume of water and shape of the wing), all teams can be analysed 6(water and angle difference) or more case. These difference changed discussion in improvement of the rockets and quality of the report.

Conclusions

With changing digital only analysis to digital-analogue hybrid, time for analysing data was decreased. And it gives student extra time for additional experiment. Data from additional experiments improved quality of the report and discussion.

Acknowledgements

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AN "AWAKENING" IN STUDENTS' CROSS-CULTURAL COMMUNICATION THROUGH SKYPE

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Abstract

Nowadays we live in a multi-cultural society where it is inevitable that we understand and receive cultural differences with sympathetic understanding. Not only to master English as a communication tool but also to nurture the attitude to accept different cultures will most likely be an essential issue that we have to deal with. Therefore, we need to explore a way to enhance these two aspects: the levels of target languages among students and understanding different cultures. In order to promote the enhancement of them both, training methods using Skype have begun between students in National Institute of Technology, Kure College, "Kosen" and foreign exchange students studying in Nagaoka University of Technology in Japan. We currently aim and focus the enhancement of their communication and understanding of different cultures as a cooperative research project, utilizing Skype.

In the Skype sessions, we conduct the tandem education method which is so called a reciprocal method where they use their target languages alternately. Eventually, both groups of students could benefit from each other, in terms of developing their target language skills along with broadening their own horizons while exchanging details of their own different cultural aspects.

Both Kure Kosen and NUT students are informed beforehand of the specific topics about their cultures so that they can do some research on the given topics in preparation for smooth conversation. I'll examine how effective Skype sessions in a 'real' situation, face to face on the screen, are in terms of the enhancement of crosscultural communication

As a result, more and more students from both grops are intrigued enough to conduct research before the Skype sessions in order to understand the differences in culture, which could eventually promote them towards better and faster acquisition of their target languages. Combining the crosscultural understanding and the language learning could bring an "awakening" among students.

Keywords: *Skype, crosscultural understanding, crosscultural communication, tandem education*

Introduction

Living in a multi-cultural society, we're now under the necessity of understanding and receiving cultural differences with sympathetic understanding. It is not only a matter of language acquisition but also that of the development of attitudes toward different cultures. In order to enhance both elements, a cooperative research project on training methods using Skype has currently begun between students in National Institute of Technology, Kure College, and foreign exchange students studying in Nagaoka University of Technology, which offers Twinning Programs with Hanoi University of Science and Technology, an interdisciplinary program to nurture leading engineers proficient in the Japanese language.

Before Skype sessions, both groups are informed of the specific topics about their own cultures that they are going to introduce. In the Skype sessions, the reciprocal tandem education method has been conducted. I'll examine how effective they are to enhance cross-cultural communication, using the sources from both groups as follows:

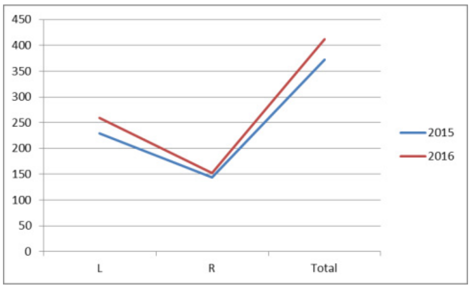
1. The transition of scores of English tests
2. Questionnaires on the knowledge of cross-cultural information
3. Questionnaires on learning different languages and cultures

Consequently, the integration of the cross-cultural understanding and the language learning could effectively bring an "awakening effect" among students toward better and faster acquisition of their target languages.

1. The transition of scores of English tests

This research was conducted among 27 4th year Kosen students who took an elective English class. Comparing their TOEIC transitional scores of two consecutive years, it is clear that their English was improved especially in the Listening Section (L).

Figure 1: The transition of scores of TOEIC tests



The scores in the Listening Section increased by an average of 31 points, while the Reading Section only increased by 8. The total increased an average of 39 points. It is also noteworthy that in the Listening Section one student increased their score from 200 to 320. This student tried hard when communicating with foreign students. According to the questionnaires from other students, they realized that their listening ability improved by working hard to understand English speakers. This Skype class is a major reason for these results.

As for the NUT students, one student commented on his own Japanese ability: "Although it's expected that English is used most of the time, there were some moments that we had to switch to Japanese. When Kure's students didn't understand what we were saying or didn't know the words in English to express their idea. To keep the conversation going, either Kure's students or we actively spoke Japanese. And for each different topic, there were some relevant new words or phrases that we didn't know popped up, especially in Japanese traditional sports or food topics. Although we could look up these new words ourselves, Kure's students helped explaining the meaning, when and where to use them and sometimes showed us pictures or video clips that they found on the Internet for a better understanding. Not just new words that we learned, Kure's students also helped us correcting and choosing the right pronunciation of some Japanese words especially in the case of kanji, where one character has many ways to pronounce. Despite the few number of Skype sessions, we had chances to review and gain a little knowledge about Japanese."

2. Questionnaires on the knowledge of cross-cultural information

The list of designated topics for each session was given to the students in their first lesson as follows. The schedule and topics were shown in advance so that they could plan their necessary research at their own pace.

Figure 2: A list of given topics for each session

#	Date	Topics
1	April 18	Self-Introduction, Major, Hobbies, Hometown
2	April, 25	Cross-Cultural Communication 1: Food Culture
3	May 9	Cross-Cultural Communication 2: Sports
4	June, 6	Cross-Cultural Communication 3: Campus Life
5	June, 20	Cross-Cultural Communication 4:Sightseeing Spots
6	July 4	Cross-Cultural Communication 5:Communication Style

NUT student's impression on cross-cultural information is as follows: "Depending on the topic of the day and the direction of the conversation, the amount of knowledge about Japanese culture varied a lot. For example, about the topic Food, we already know about sushi, ramen, udon and so on. If we only talked about what we like to eat in Japan, there is almost nothing new to learn. So we extended the context of where foods are different. Such as what people eat on Christmas, New Year's Day and so on. We learned that Japanese like to eat fried chicken on Christmas after an advertising of KFC a long time ago. We learned that Japanese typical New Year's dishes are not always the same and some dishes are different for different provinces. For different topics, such as Sightseeing spots or Sports, it's easier to learn more about Japanese culture since they're common interest and available information on the Internet are huge. But for Campus life or Communication Style topics, the former is trivia and the latter is too difficult to talk about. We couldn't gain much knowledge about these kinds of topics. In general, talking with Kure's students did help us improve knowledge about Japanese culture. Furthermore, Kure's students also gave good suggestion for us about what foods to taste and which places to visit. "

Kure students' questionnaires about cross-cultural items they have known showed that they have come to be familiar with some different items in foreign cultures.

Figure 3: Cross-cultural items they have known

2nd Topic: Food Culture
-Vietnam traditional dishes -They serve all the food in one plate. -The large amount of food-Many different k inds of food-Okonomiyaki in Vietnam -Similar food with different names -Passion fruits such as Dragon fruits, litchis, Chowchow -Beans -Tom yum goong -Each dish has a lot of vegetables in Myanmar. -Fish es pecially crab, crayfish -Kangaroo meat is eaten. -They don't care about how to serve food. -African native dishes -They don't eat rice very much.
3rd Topic: Sports
-Taekwondo is their national sport in Taiwan. -Cricket,-Soccer, mountain climbing -Rugby, American Football, Kick boxing -Badminton is very famous in China.
4th Topic: Campus Life
-The academic year schedule is different from Japanese universities. -University starts at 8:30 and ends at 16:00. -They have many tests.-Both Japanese and English are used in class.

5th Topic: Sightseeing Spots
-Nanoi Bay and Hue, the terraced paddy fields -Halong Bay -Beautiful seascape -Skydiving spots -A temple above the water -Ho Chi Minh City, Sài Gòn -Scuba diving (The license is cheap to get in Philippine) -Hot springs -Son Doong Caves, in Viet nam, the longest cave in the world

According to the list above, they started to understand cross-cultural differences through exchanging information about their own cultures. Some NUT students prepared power point slides or pictures from the internet to show their cultures effectively.

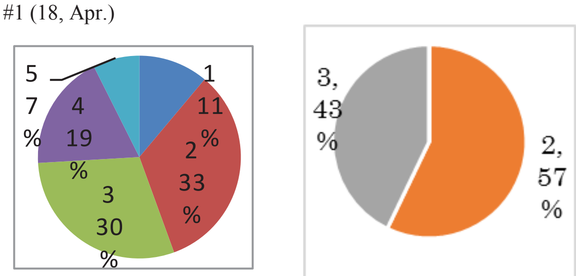
The questionnaires were conducted right after each session on both Kure and Nagaoka students. The questions were as follows:

A-1. Self-communication ability with foreigners.
A-2. Understanding a foreign culture better than before.
A-3. Spoke and listened to other languages.
A-4. Had chances to express my thoughts
A-5. I have an advantage of social media.
A-6. I have trouble communicating in a foreign language
B-1. Not interested in today's topic but I attended the class.
B-2. I tried my best exchanging ideas with foreigners.
B-3. I positively asked questions in order to study with foreigners.
B-4. I did some research on today's topic before the class.
B-5. I positively attended today's class.
C-1. Teacher's support
C-2. Free discussion among students
C-3. To choose an interesting topic
C-4. To share what we have made with Skype mates
C-5. To have a good and effective ICT.
D-1. Evaluation on today's topic
D-2. Interaction among the students in two schools.
D-3. Schedule
D-4. Topic
D-5. The number of attendees

It's difficult to graph the results of all the questions above, so I'll pick up some of the noteworthy results. The transitional results of the questionnaire "Understanding a Foreign Culture Better than Before." are as follows (1: Yes, very much, 2: Yes, 3: So so., 4: Not very., 5: Not at all.).

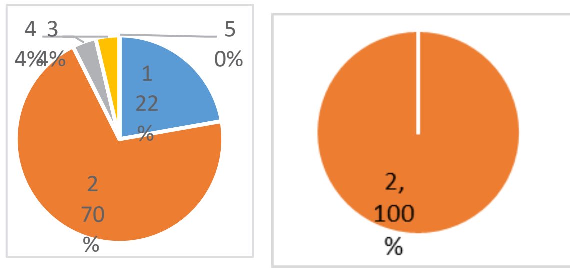
Figure 4 : A-2"Understanding a Foreign Culture Better than Before."

#1 (18, Apr.)



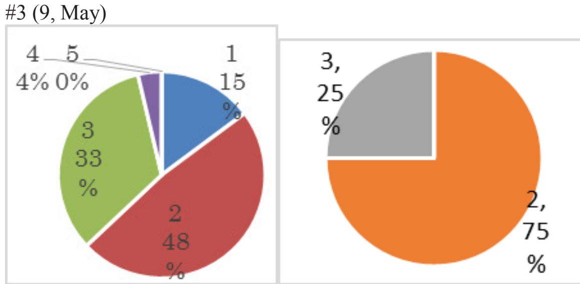
Kure Nagaoka

#2 (25, Apr.)



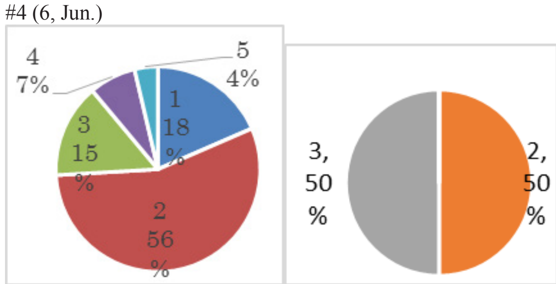
Kure Nagaoka

#3 (9, May)



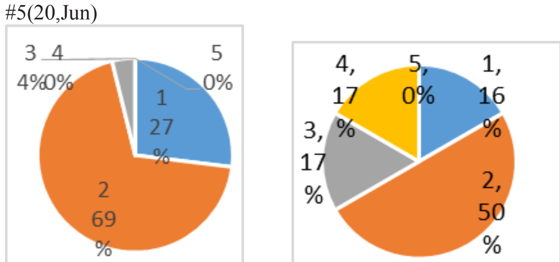
Kure Nagaoka

#4 (6, Jun.)



Kure Nagaoka

#5(20,Jun)



Kure Nagaoka

The number of Kosen students who felt "Understanding Foreign Cultures" improved from the 1st through the 5th session increased. In the 5th session, 96 % of the students felt Yes (very much) while only 44 % of them felt so in the 1st session. NUT students' results showed a simple characteristic where "Yes" and "So so" were the only answers given from the 1st to the 4th session. However, in the 5th session, 16 % of the students said "Yes, very much" and 50 said "Yes", which showed a significant improvement on understanding different cultures.

3. Questionnaires on learning different languages and cultures

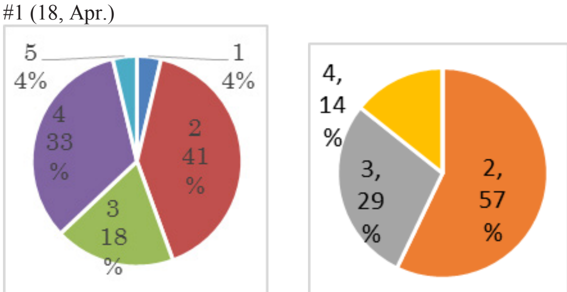
Between April and June, we had 5 Skype sessions with common designated topics used to create discussions. The questionnaires on the students' impressions on their cross-cultural communication showed how motivated they became.

The transitional results of the questionnaire A-1“Self-communication ability with foreigners” were as follows (The dates and answer examples are the same as Figure 1&2).

Kosen students’ answers of “Yes (very much)” double from 47 % at the end of the first session to 92 % at the end of the 5th. Even though the reciprocal tandem education method has been conducted in these Skype sessions, NUT students didn’t notice a significant improvement in their Japanese whereas Kosen students did with English. Nagaoka students improved from a 57 % “Yes” at the end of the 1st session to 67 % at the end of the 5th .

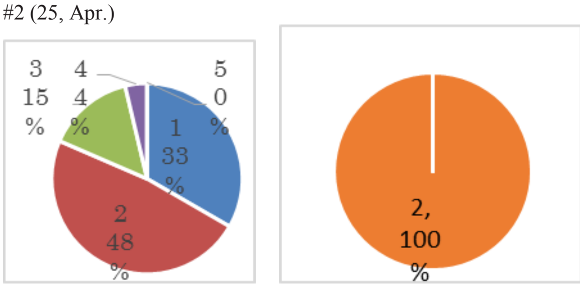
Figure 5: A-1 “Self-communication ability with foreigners”

#1 (18, Apr.)



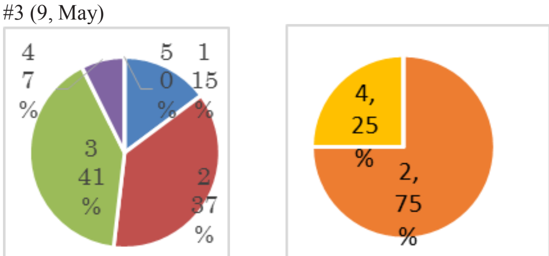
Kure Nagaoka

#2 (25, Apr.)



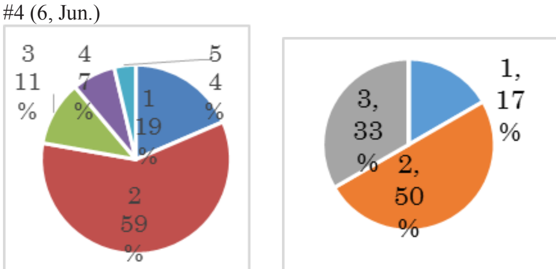
Kure Nagaoka

#3 (9, May)



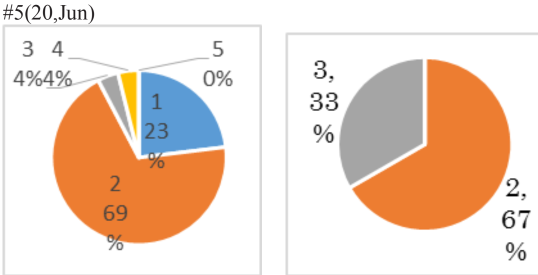
Kure Nagaoka

#4 (6, Jun.)



Kure Nagaoka

#5(20,Jun)

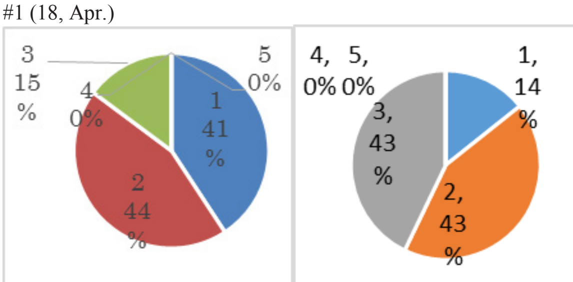


Kure Nagaoka

The transitional results of the questionnaire B-2 “I tried my best exchanging ideas with foreigners.” were as follows (The dates and answer examples are the same as Figure 1&2).

Figure 6: B-2 “I tried my best exchanging ideas with foreigners.”

#1 (18, Apr.)



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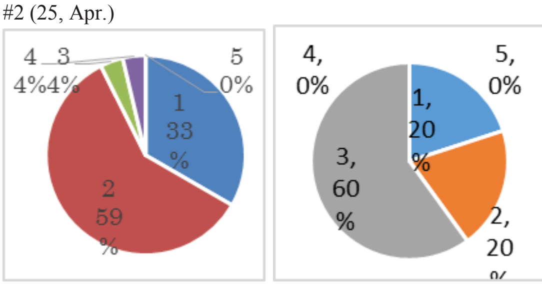
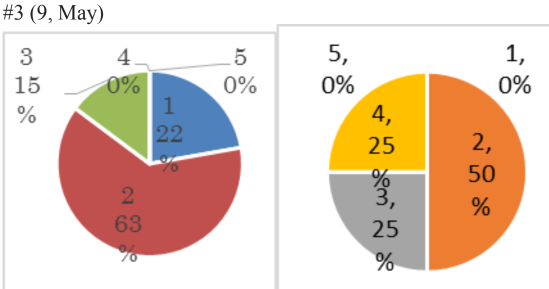
#2 (25, Apr.)



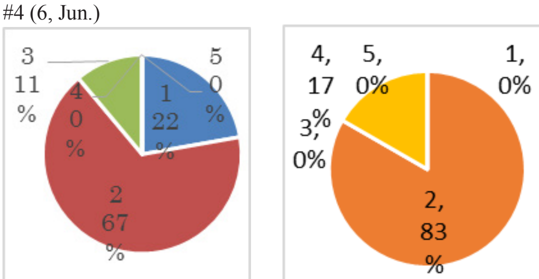
Kure Nagaoka

#3 (9, May)



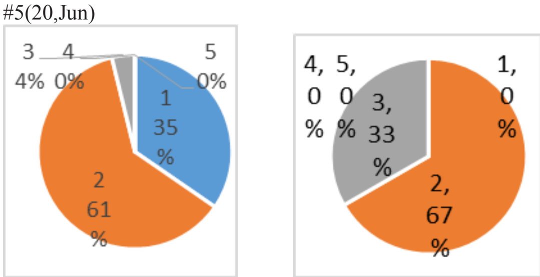
Kure Nagaoka

#4 (6, Jun.)



Kure Nagaoka

#5(20,Jun)



Kure Nagaoka

The NUT students tended to respond with "So so" during the first 2 sessions and "Yes" was greater than half from the end of the 3rd to the end of the 5th session. Kosen students often responded with "Yes (very much). Kosen students seemed to try harder to exchange ideas with exchange students in NUT, using English. One obvious reason for that can be the gap in their English levels.

Conclusions

Through the development of cross-cultural learning and understanding topics such as food, religion, weather, sports, and places to visit, they started to realize what a small world they live in. They came to know of a different world, which could broaden their own perspectives. The more interest they have in different cultures, the more motivated they became to gain more knowledge.

With the desire to convey information about their own culture to their partners, who seemed to be close to them on the monitor, students always felt like their partners were literally in front of them so realistic that they were even able to see their partner's facial expressions. An important factor of using Skype is that they always felt that their partners were close to them not only physically but also mentally. They could even show their prepared power point slides or web pictures with each other at the same time. Importantly, studying with partners or with others from a different culture makes a significant difference in the language acquisition process.

A significant difference about how to prepare for the Skype sessions between Kosen and NUT was noticeable and influential especially for Japanese students. It can be said that Nagaoka students were well-matured and organized as a representative from their home countries. Noticing such difference could be an important urge for the Japanese students to learn English harder.

The Japanese students have studied English for 8 or more years but it is true that they haven't had many chances to use it. As a result, Skype sessions give them real situations where they are supposed or sometimes forced to use English. This real environment can make them realize how important it is to "use" the target language. During these realistic experiences of speaking English, failure itself can be a great chance to motivate themselves toward the better acquisition of English.

Whenever they face difficulties such as careless mistakes, helplessness, and incompetency, it could be a great chance of an 'awakening' which could make them realize an urgent need to conquer their weak points. At that phase, they are determined to study harder to become a better English speaker with higher motivation. It is because of this 'awakening' during the Skype sessions that a negative experience can eventually bring them a positive one.

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ASSESSING VOCABULAY SIZE AND ITS RELATIONSHIP WITH READING COMPREHENSION OF THAI EFL UNDERGRADUATE STUDENTS

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Abstract

This research study aimed to measure the vocabulary size of Thai first-year undergraduate students and to determine the relationship between their vocabulary size and reading comprehension. Previous vocabulary size studies in Thailand were conducted mostly with a small sample size of undergraduate students. Therefore, to gain more current insight, the samples of this study were selected from four public universities and three private universities in Thailand. The total of participants was 483 freshmen in the academic year 2014. The research instruments were Bilingual English-Thai Version of Vocabulary Size Test adapted from English version of Nation and Begalr (2007) and Reading Comprehension Test. The results indicated that their vocabulary size was between 3,100 - 4,000 word families. The second large group was between 4,100 – 5,000 word families. The third large group was between 2,100 – 3,000 word families. Moreover, a correlation analysis was used to measure the relationship between vocabulary size and reading comprehension scores. The result, based on Pearson product moment correlation coefficient, showed a significant correlation between vocabulary size and reading comprehension scores. The positive relationship between vocabulary size and reading comprehension was confirmed. Even though the participants were from different backgrounds (i.e., fields of study, types of universities, geographical regions), the result still showed that students with larger vocabulary size could comprehend reading passages better. Therefore, helping EFL students to increase their vocabulary size could help them to comprehend a reading passage better. At the end, implications for vocabulary pedagogy and future research are included.

Keywords: *vocabulary size, vocabulary breadth, reading comprehension, EFL, Thailand, Thai students, undergraduate students*

Introduction

Vocabulary knowledge is a primary element for EFL student to learn and comprehend English. Students with limit vocabulary knowledge could find difficulty in using English. Scholars have been conducted studies on vocabulary knowledge, especially vocabulary size. Students need a certain size of vocabulary in order to comprehend different skills of English. Many research studies found that vocabulary size strongly related to students' reading comprehension (Baleghizadeh & Beheshti, 2010; Hirsh & Nation, 1992; Hu & Nation, 2000; Huang, 2006; Kezhen, Li, 2015; Laufer, 1997; Pringprom, 2012; Sen & Kuleli, 2015). Basically, in order to understand basic English, students needed to know vocabulary at 3,000 to 5,000 levels (Nation & Waring , 1997). To understand unsimplified texts, 5,000 word families were required (Hirsh & Nation, 1992) and to read newspapers, around 8,000 to 9,000 words families were necessary (Nation, 2006). Moreover, Hu and Nation (2000) indicated that for students to read a fiction without external supports, they needed vocabulary around 98% of text coverage. Therefore, in order for students to be able to comprehend English texts better, increasing students' vocabulary size could be one influent way.

In Thailand, English has been a main foreign language that all Thai students need to learn. It has been added in Thailand's basic education core curriculum for decades. The Thailand's Basic Education Core Curriculum B.E. 2544, and 2551 (A.D. 2001, and 2008, respectively) indicates that Thai students who graduate from high school (Grade 12) need to know vocabulary of around 3,600 to 3,750 word families (Ministry of Education of Thailand, 2008). For reading, high school graduates would be able to read for main ideas, analyse, make a conclusion, interpret and express opinion from articles, news, media and learning sources as well as gather information and conduct a research.

However, when students came to a university, many of them had problems with reading and complained that they did not know many words in a reading text. A Thai classroom contained students with mixed ability as they came from different schools and different parts of

Thailand. It is difficult for teachers to prepare a lesson to match their students without knowing students' proficiency. Students' vocabulary size could be the first step that teachers should know as vocabulary is one of the basic for learning a foreign language.

Even though Basic Education Core Curriculum prescribed that Thai students need to have vocabulary around 3,600-3,750 word families when they graduate from high school, less is known if Thai students really have that certain amount. Previous studies mostly conducted on elementary and secondary students or a small sample size of undergraduate students who studied in the same school or university. Therefore, to gain more insight, the present study was conducted with the larger size of samples and data were collected from different universities in different regions of Thailand. There were two research questions for this study:

1) How large was the vocabulary size of first-year undergraduate students?

2) To what extent did students' vocabulary size affect their reading proficiency?

Materials and Methods

Participants: The participants of this study were 484 Thai first-year university students in year of 2014. The simple random sampling technique was used to select the samples. The participants were from different faculties. 370 participants were from four public universities, and 113 participants were from three private universities. All participants were high school graduates.

Instruments: There were two research instruments:
1) Bilingual English-Thai Version of Vocabulary Size Test (B-VST) adapted from English version of Nation and Beglar (2007). The test included 100 items. The test was verified by three experts using the back-translation method and was piloted with 40 freshmen. Then the test was revised before used. Here is a sample of the test:

English Version

Figure: Is this the right **figure**?
a. answer
b. place
c. time
d. number

Bilingual Version

Figure: Is this the right **figure?**
a. คำตอบ
b. สถานที่
c. เวลา
d. ตัวเลข

The answer of the this question in the Bilingual Version was "d" the same as the English Version.
2) Reading Comprehension Test (RC): The test was developed in the multiple-choice format containing 40 items with three short passages and three long passages. Each passage was calculated with the readability index to assure that the passage was suitable for students' level of proficiency. Then the test was validated from three experts for construct and content validity before revised and tried out along with the B-VST.

Procedure: The B-VST and RC were piloted with 40 first-year students who were high school graduates. Then test items were calculated for their difficulty and item discrimination. The students' total scores of the tests were calculated for the test' reliability using Kuder-Richarson Formula 20. After the tests were revised, they were used in the main study.

In the main study, B-VST and RC were distributed to each student. The students needed to complete the B-VST first and then RC. They had 45 minutes to finish the B-VST and 90 minutes to finish the RC. The researcher explained the test instructions in Thai to be sure that students would understand what they needed to do. Before doing the tests, they were informed that scores of the test would not affect their score or grade in any classes they were taking. They were free to withdraw their participation at all time. They were encouraged to do their best because the result could reflect their own proficiency and would benefit to other students as it was an important part of a research study. Students were allowed to hand in the tests before the time ended if they completed them earlier.

Data Analysis: To answer research questions 1 and 2, the scores of B-VST and RC were analyzed using SPSS. Descriptive analysis was used to find percentage, mean, and standard deviation of students' vocabulary scores and reading scores. To identify the relationship between vocabulary size and reading comprehension, Pearson product-moment correlation coefficient was used.

Results and Discussion

For the research question 1, the B-VST was used to answer the question. The result revealed that the first-year undergraduate students mostly had the vocabulary size between 3,100-4,000 word families. The second lard group was between 4,100-5,000 word families. The third large group was between 2,100-3,000 word families. The result of all students' vocabulary size demonstrates in Table 1 below.

Table 1: Students' Vocabulary Size

Word Families	Frequency	Percentage (%)
1 – 1000	6	1.2
1100 – 2000	27	5.6
2100 – 3000	87	18.0
3100 – 4000	122	25.3
4100 – 5000	102	21.1
5100 – 6000	66	13.7
6100 - 7000	33	6.8
7100 – 8000	10	2.1
8100 - 9000	28	5.8
9100 - 10000	2	.4
Total	483	100.0

From the result, it could assume that most Thai university students would be able to understand the basic English since they had the vocabulary size of at least 3,000 word families. Moreover, according to the Thailand's Basic Education Core Curriculum B.E. 2544 (2001) and 2551 (2008) that required Thai students to acquire the vocabulary size of between 3,600 to 3,750 word families, the result revealed the large numbers of students that could acquire this curtain requirement. However, there were still many students who could not reach the requirement. In order for students to reach the Basic Education Core Curriculum's requirement and to have the same standard, schools may need to find ways to help students to learn and increase their vocabulary size.

Figure 1 below is a bar graph that shows more details of each vocabulary score. It demonstrates the numbers of students in each vocabulary score.

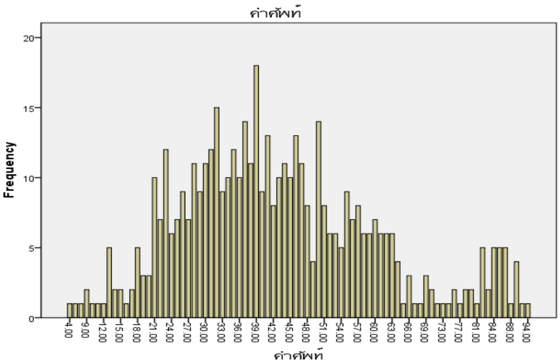

Figure 1: Students' Vocabulary Scores

From the graph, it shows that 39 points is the most frequent one. The second is 32 points and the third is 50 points. It could be interpreted that most students have 3,900, 3,200, and 5,000 word families, respectively. Moreover, the graph also shows that there are some students that have very high score of between 82 to 94 points (8,200 to 9,400 word families). The score from the B-VST here reveals that most Thai students have a curtain number of vocabulary size that could help them comprehend the basic English. Besides, many of them have a large size of vocabulary that could aid them to understand even more difficult reading texts.

To answer the research question 2, RC's scores and B-VST's score were analysed for their correlation. Table 2 shows the mean and standard deviation of RC's scores and B-VST's scores of students from public and private universities. The mean scores of RC between students from public and private universities are quite closed to each other. On the contrary, the B-VST's mean scores between students from public and private universities are much different.

Most Thai students would like to study in a public university. Students need to complete the admission examination against each other. Many high proficient students are studying in a public university. This reason could be a factor that affects the difference between B-VST's score of public and private university students.

Table 2: Comparing Reading's and Vocabulary's Score of Students from Private and Public Universities

Descriptive Statistics				
Universities		Mean	Std. Deviation	N
Private	Reading	10.1858	4.55825	113
	Vocabulary	35.5398	15.34428	113
Public	Reading	11.4027	4.31013	370
	Vocabulary	45.4757	17.99083	370

In order to examine the relationship between vocabulary size and reading comprehension, Pearson's correlation was used to analyse the data. Table 3 demonstrates the correlation between these two variables.

Table 3: Correlation between Vocabulary Size and Reading comprehension (N=483)

Correlation			
		Reading	Vocabulary
Reading	Pearson Correlation	1	.190**
Vocabulary	Pearson Correlation	.190**	1
**. Correlation is significant at the 0.01 level (2-tailed).			

From Table 3, it reveals that there is a statistically significant correlation between vocabulary size and reading comprehension. The Sig. (2-tailed) value is .000. However, the result shows a weak relationship between them (r=.190).

The result of the relationship between vocabulary size and reading comprehension of this study was quite different from previous studies. Even though it also showed the positive relationship among these two variables, the relationship was very weak. It could be some other factors that affected students' scores.

One important factor that could have an effect on the students' test performance is the test-taking motivation. The tests in this study were considered as a low-stakes test as the result of the tests would not affect students' scores or grades. For the low-stakes test, students may not put all their effort to do the test and the results might not be able to identify their true level of proficiency (Penk, Pohlmann, & Roppelt, 2014). Many researches found that students' motivation could affect students' performance (e,g. Hawthorne, Bol, & Pribesh, 2015; Pintrich & DeGroot, 1990). Mislevy found that for low-states test, students may not have high motivation to perform well on the test (as cited in Finn, 2015, p. 1). Wise and DeMars (2005) examined the relationship between students' test-taking motivaton and low-stages tests. The resutl indicated that low test-taking motivation related to the decrease of test performance.

Therefore, the test-taking motivation may play a role in the present study and had affected the result of the test.

Even though the result from this study revealed a weak relationship between vocabulary size and readign comprehenson, many previous studies have confirmed the relationship among them. It could not be denied that vocabulary size had an important role on English learning and using. Teachers should pay much attention in helping students to increase their vocabulary size. As mentioned earlier, a Thai classroom, normally, contains students with mixed ability. It could be seen from the result of students' vocabulary size. Even though students were in the same education level, they still had different size of vocabualry, from very small to very large size.

To manage a classroom with mixed ability, there are various strategies teachers could do. Mandalena (2002) suggested that instead of preparing a lesson that concerned the lower level students but bored the higher level students or vice versa, the advance students could play in a role in the class as teacher assistants. Advance students could help lower level students in a class to complete a task. This could also create a collaborative learning environment. For an individual task, teachers could assign students to perform differently. Mandalena gave an example for her task. Students were asked to complete a questionnaire, two sets of questionnaire were prepared. For advance students, the questionnaire was written in English and students needed to answer it in English. For lower level students, the questionnaire was bilingual, and students were allowed to answer with their first language if they did not know how to write in English; however, writing in English was encouraged.

This teaching strategy, not only provides students with the task that is suitable for them, but it also creates collaborative learning that students helps and supports each other.

In a mixed ability class, students should be allowed to learn as individual (Bremner, 2008). They should learn to be an independent learner. Teachers could play a role as a facilitator. In vocabulary learning, teachers may ask students to find out meaning of the word by themselves and try to create a story with the word they have just known. Students could work in a group so that high level students could help lower level students. Various activities could create a lively classroom that both high and low level students could work and leaner together in the same classroom

Conclusions

From the result of the study, it could be concluded that Thai EFL undergraduate student mostly had reach the basic requirement of vocabualry size to comprehend the basic English that was at least at 3,000 word level. The result also revealed the positive relationship between vocabulary size and reading comprehension even though their association was weak. Test-taking motivation might be one important factor that affected the result of this study as the tests were considered as a low-stakes test. Therefore, for the future resarch, the study can be conducted with different groups of students. Other aspects of vocabulary such as vocabualry depth should be conducted in Thai contexts in order to gain more understand and to see what Thai students need to improve their English.

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CALL CLASSROOM UTILIZATION AT KOSEN

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Abstract

In recent years, CALL (Computer Assisted Language Learning) classrooms have been installed at great expense at various Kosen (National Institute of Technology Colleges) throughout Japan. In 2013, a CALL classroom was opened at the researcher's own college, National Institute of Technology, Wakayama College. Since then the researcher has made use of the classroom for teaching oral communication and English presentations skills classes. The installed software allows learners to communicate as pairs or groups using microphone-equipped headsets, work collaboratively using screen sharing, and undertake self-directed learning activities via online learning platforms. In addition, Internet connectivity allows students to research topics in English, and installed applications, such as Microsoft Office, facilitate the preparation of English presentations. As well as these educational uses, the classroom also features heavily in promotional activities at the college, being open to visitors to the college during events such as open campus, Girl's Kosen Stay, and public lectures. It is the researcher's belief that CALL classrooms are a valuable asset to Kosen and provide positive environments for fostering active, collaborative, and self-directed learning. Despite these advantages, however, the CALL classroom has proved less popular with other language teachers at the researcher's school and remains relatively under-utilized.

In this paper, I will describe how the CALL classroom has been used to integrate active and collaborative learning objectives into the English curriculum at National Institute of Technology, Wakayama College. Through interviews, attitudes and experiences of other teachers at the researcher's college concerning the CALL classroom will be investigated. Results of a survey of teachers at other Kosen will also be presented, and CALL classroom utilization and teacher attitudes will be compared. Based on these results, suggestions as to how to make better use of CALL classrooms at the researcher's college and other Kosen will be made.

Keywords: *Computer Assisted Language Learning, active learning, collaborative learning, self-regulated learning, oral communication, teacher attitudes*

Introduction

Unlike previous generations of language laboratories, Computer Assisted Language Learning (CALL) classrooms allow for a more interactive language learning experience. Whereas previously students could only listen to and repeat taped conversations, students can now communicate in groups or pairs through headsets, research topics on the Internet, and prepare presentations using preinstalled word processing and presentation software. In addition to the powerful learning environment provided by CALL technology, digital delivery of course content allows teachers to accommodate the different learning styles and speeds of students through self-regulated learning (Bilgin, 2013).

Recent years have seen a rapid increase in the use of technology in language learning and education in general (Cowie & Sakui, 2015). CALL classrooms are common in universities across Japan, and in light of their perceived educational benefits, have also been installed, at great expense, in colleges belonging to the National Institute of Technology. In 2013, the CALL classroom at the researcher's own college, National Institute of Technology (NIT) Wakayama College was opened. In this paper, the researcher will describe how the CALL classroom is used at Wakayama College, and compare that to the results of a survey collected from other NIT colleges across Japan.

The CALL Classroom at NIT, Wakayama

The CALL classroom at NIT Wakayama was opened in November 2013. Forty-eight student terminals and an instructor terminal were installed in what was previously the school's audio-visual classroom. Each terminal was installed with the language laboratory software CaLaboEX, produced by Chieru, in addition to Microsoft Office. According to Chieru, CaLaBoEX is the most popular computer-assisted language lab software in Japan (Chieru, 2011). This software allows the streaming of audio-visual content from the teacher's PC, grouping of students for pair and group work activity, instant messaging, and file sharing, as well as classroom management features for instructors such as screen monitoring, direct control of student terminals, and automated attendance taking. In addition to CaLaBoEX, Chieru's online learning platform, CalaBo Bridge, was also installed complete with several TOEIC, grammar, and listening courses. Accessible from outside the CALL classroom, CaLaBo Bridge allows students to complete courses and submit assignments from their own computers in the dormitory or at home. Due to budgetary constraints, the system was purchased without a contract for on-going technical support, and some optional features such as video calling were omitted.

All full-time English and foreign language teachers at the school attended a 90-minute training session conducted by staff from NTT West Japan on how to use the basic features of the software. Because of time restrictions, teachers were only given a basic overview of the main features of the installed software and invited to try it for themselves and ask questions. There was little time, however, to cover the various uses of the software in depth.

CALL Classroom Utilization at NIT, Wakayama

Initially, several teachers, including myself, were eager to use the new classroom in our lessons. During the first semester after opening, the classroom was used for TOEIC, English composition, English presentation, and English conversation classes. Nearly three years later, only one teacher (myself) regularly uses the CALL classroom, mainly for English conversation and presentation skills classes.

The following reasons for not using the CALL classroom were given in informal interviews with other teachers:

- Lack of confidence with computer technology in general
- Lack of familiarity with the computer software, and a lack of time to become familiar with the software
- Lack of time to prepare materials to use in CALL lessons
- CALL technology does not suit teaching style
- Perceived lack of educational benefits

Language Classes in the CALL Classroom

Currently the CALL classroom is used mainly for English conversation and presentation classes. In these classes, the CALL system used for active and collaborative learning activities in the following ways:

- Pair or group conversation and information exchange activities using headsets
- Group / individual research projects (using the Internet) and report writing
- Group / individual presentations (PowerPoint presentations can either be cast to other students' screens or projected onto the main screen)
- Grammar discovery activities using online corpus tools
- Self-regulated listening activities (students can control playback of prerecorded conversations themselves)
- Peer feedback and evaluation of written work (students use the "track changes" feature of Microsoft Word to annotate and edit each other's written work)

Other Uses for CALL Classroom at NIT, Wakayama

Aside from language classes, the CALL classroom is also put to a variety of other uses. It is used occasionally (with prior permission from the academic affairs office) to teach specialized subjects and show videos, as a venue for extra-curricular activities such as the English Club, and for supplementary English classes.

The CALL classroom also features heavily in promotional activities at the school. Compared to senior high schools in the area, NIT Wakayama is equipped with facilities more commonly found in universities. Because of this, the CALL classroom is often used in promotional events to attract new students, such as open lectures and Girls' Kosen Stay, an event organised to introduce female junior high school students to our NIT college. In these events, a short lesson is given in the CALL classroom in which students can use the computers and communicate with each other through the headsets. This is followed by a tour of the school in English during which prospective students can see and use the other facilities at the school.

Student Impressions of the CALL Classroom

Although no formal research regarding student attitudes to the CALL classroom has yet been conducted at Wakayama Kosen, in class evaluations students reported enjoying being able to communicate with their classmates via headsets. Several students also commented that they felt less nervous about communicating in English when using the headsets. Responses to questionnaires conducted after Girls' Kosen Stay and open lectures were also favourable, with most attendees reporting enjoying using the computer terminals to communicate in English.

Purpose of Research

The purpose of this research is to investigate how CALL classrooms are utilized at other NIT colleges in Japan in order to suggest ways in which language laboratories might be better utilized in the future.

Method

Teachers at NIT colleges throughout Japan were invited to participate in an online survey about CALL classrooms at their schools via a Council of College English Teachers (COCET) mailing list. Teachers who do not currently use or have CALL classrooms at their schools were also invited to participate. In total 47 teachers from 34 different institutions responded.

Results and Discussion

Installation of CALL Classrooms

Of the 34 NIT colleges represented in the survey, 79% (27 colleges) reported having a CALL classroom. As shown in Table 1 (see next page), most CALL classrooms are over 3 years old, and two thirds are over 5 years old.

Table 1. Reported date of construction of CALL classrooms

Reported date	Number of colleges (N=27)	Percentage
More than 5 years ago	18	66.7%
Between 3 and 5 years ago	2	7.4%
Between 1 and 3 years ago	2	7.4%
Less than 1 year ago	0	0%
Don't know	5	18.5%

In the case of NIT Wakayama College, the CALL classroom was installed 2.5 years ago, more recently than many other colleges. Even so, the software is already dated (Windows 7, the operating system, is already classed as “legacy software” by Microsoft), and there are no upgrades planned by the school. It is probable that the hardware and software at other NITs is even more dated.

Usage of CALL Classrooms

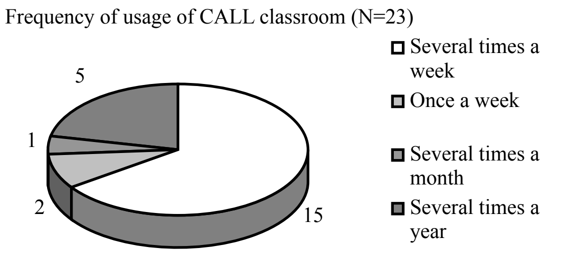

Figure 1. Frequency of usage of CALL classroom

Of 36 teachers who worked at schools with CALL classrooms, 23 (63.9%) reported using the CALL classroom for language classes. As can be seen in Figure 1 below, most teachers who made use of the CALL classroom did so several times a week.

Teachers who used the classroom reported using it for a various different courses, including General English, Communication, Technical Writing, Grammar, Conversation, TOEIC, Scientific English, and Communication. The wide variety of pedagogical activities employed by teachers in the CALL classrooms can be seen in Table 2 in the next column.

The most popular uses for CALL classrooms reported by teachers were listening, audio-visual, online, and pronunciation activities. The data seem to indicate that CALL classrooms are extensively used by at least one teacher at most NIT colleges surveyed.

Table 2. Classroom activities used in the CALL classroom

Activity type	Number of teachers using activity (N=27)	Percentage
Pair / group work using headsets	6	26.1%
Listening activities	15	65.2%
Audio-visual activities	15	65.2%
Pronunciation practice	11	47.8%
Student presentations	10	43.5%
Online learning activities	14	60.9%
Internet research	9	39.1%
Other	5	21.7%

Training

As described earlier in this paper, training in the use of the CALL classroom at NIT Wakayama was brief and limited in scope. Since then, there has been no formal training for teachers who started working after the CALL classroom opened. Other NIT colleges reported a similar lack of training. In fact, over 60% of teachers reported having received no initial training at all. Of those teachers who did receive training, 66% described it as adequate, only covering the basics and lasting one to two hours. On-going training was reported by only 10% of respondents.

Reasons for Not Using CALL Classrooms

Table 3. Reasons for not using CALL classroom

Reason	Number of teachers (N=27)	Percentage
CALL technology is not useful in the subjects I teach	5	38.5%
Don't know how to use the equipment	4	30.8%
Not comfortable with computer technology	1	7.7%
Doesn't suit my teaching style	6	46.2%
Can't see benefits of CALL technology	1	7.7%
Scheduling problems	4	30.8%
Other	1	7.7%

As can be seen in Table 3 above, twelve respondents (36.1%) reported not using their school's CALL classroom. The beliefs that CALL technology does not match the subject matter or teaching style were widely cited reasons for not using CALL classrooms. A lack of knowledge of how to use the equipment was another major factor, along with scheduling problems.

Other Uses for CALL Classrooms

The following other uses for the CALL classroom were given respondents to the survey:

- For teaching *senmon* specialized subjects
- As a venue for tests
- As a meeting room
- For teaching information technology / ICT classes
- For staff meetings
- For English club
- For speech and presentation contests
- Supplementary lessons

At NIT Wakayama, the CALL classroom is reserved for language teaching during scheduled lesson times. Other subject may be permitted to use the room if a scheduling slot is available. However, the situation seems to be different at several other NITs: In total, 8 respondents reported regularly sharing their school's CALL classroom with teachers of other subjects.

Conclusion

The results of this preliminary survey seem to indicate that CALL classrooms are relatively well utilized at NITs in Japan. A large proportion of teachers reported regularly using the classroom to teach a wide variety of classes. There are, however, causes for concern. Firstly, there seems to be a lack of continued support for teachers. Ninety percent of teachers reported no further training after the initial post-installation training session. This also means that teachers starting after the CALL classroom was opened may have received no official training at all. In addition to this, 30% of respondents who do not currently use their CALL classrooms cited a lack of knowledge of the system as a reason. Another area of concern is scheduling, with 30% of respondents who do not currently use their school's CALL classroom citing scheduling problems as a reason. Several teachers also reported that their classrooms were regularly used to teach *senmon* and computing lessons in addition to language classes.

Although only a preliminary survey, the results highlight the need for on-going training and support for both new and existing teachers. In addition to formal training, colleges could hold workshops for experienced users to share knowledge and ideas with colleagues. The next step at Wakayama Kosen is to conduct regular CALL training workshops from the next academic year in order to share knowledge with new teachers and provide support for existing teachers who are less confident in using the CALL equipment.

The data also indicate that class scheduling may be a problem, with several departments competing for the same resources. More research will be conducted to investigate in more detail how other departments use the CALL facilities at Kosen in order to determine how usage should be prioritized.

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DEVELOPMENT OF PRACTICAL VOCATIONAL TRAINING CLASS MAKING USE OF VIRTUAL REALITY-BASED SIMULATION SYSTEM AND AUGMENTED REALITY TECHNOLOGIES

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Abstract

Virtual reality (VR) refers to the technologies creating a virtual environment to provide users a sensory simulation of the environment being presented. In Hong Kong Institute of Vocational Education (IVE), we are in the process of developing a VR-based simulation system having four screens surrounding users to simulate an immersive environment. This application is commonly known as the cave automatic virtual environment (CAVE). The objective of our VR-based simulation system project is to apply the virtual reality and the augmented reality (AR) technologies for practical training in vocational education and training (VET).

Our system is used for various training programs in the engineering areas. These include simulation of any workspaces for operations and maintenance training in electrical and mechanical services. Workspace training is important and beneficial to VET students in addition to practical training in school settings. Meanwhile, some workspaces are full of danger and severe casualty can be resulted if inappropriate operations are performed. Our VR-based simulation system manages to provide a solution to complement the shortfalls of workplace training and ensure that students can acquire a range of skills including safety operations under various environments. In this paper, we introduce our design of a class making use of the CAVE system and augmented reality technology. The class aims at providing training for VET students to perform inspection and maintenance procedures in a virtual engine plant room. The class was found to be educational and managed to promote the skill development among students.

Keywords: *CAVE, simulation, virtual reality, vocational education and training*

Introduction

Virtual reality

Cave automatic virtual environment (CAVE) is a computer system impressing users with a feeling that they are inserted into a virtual environment. A pair of stereoscopic glasses is provided to each user to view a huge image that is projected onto four to six connected screens surrounding the user. Some of the CAVE systems also provide each user with a head mounted device to detect the orientation of the head. The contents of the screens are view-dependent and are updated according to the head movement to simulate what the user should see in the reality. Therefore, it is sometimes called virtual reality (VR).

CAVE was firstly introduced in 1992 by Cruz-Neira, Sandin, Defanti, et al. (1992); (1993). It provides users with a very broad field of view that significantly improves the feeling of presence in the virtual environment. Moreover, users do not have to rely on a virtual representation of their own bodies. Instead, they could physically enter the virtual space that greatly enhances the immersive feeling (Cruz-Neira, Sandin, Defanti, et al. 1992; 1993; Kuhlen and Hentschel 2014). The immersive virtual environment allows users having a faster and more comprehensive understanding of complex spatial relationships and allows interacting with objects in the environment using more natural controllers. For example, a user can use LED gloves (motion can be tracked by a camera tracking system) to magnify and rotate the 3D brain structure data in the virtual environment (Defanti, Dawe, Sandin, et al. 2009; Kuchera-Morin, Wright, Wakefield, et al. 2014).

Primarily, there are two categories of CAVE systems, panel-based system and projector-based system. For a panel-based system, each screen is made by a matrix of LCD panels. These LCD panels can display images with higher brightness and contrast compared with the projector-based system. These virtues can alleviate the undesired mismatch between vergence and accommodation which causes less eyestrain. This is particularly important when users focus on near-field virtual objects (Kuhlen, and Hentschel, 2014). However, panel-based system usually lacks floor projection, which significantly limits their immersive character. CAVE2 at the Electronic Visualization Laboratory is an example of the panel-based system (Reda, Febretti, Knoll, et al. 2013). For a projector-based system, images are projected onto the screens using digital projectors. However, the resolution of the system is usually low compared with the panel-based system. To increase the resolution, a number of relatively small projectors are arranged in a matrix with slightly overlapping image tiles. The soft-edge blending technique allows achieving a seamless transition between the tiles to increase the quality. The aixCAVE (Kuhlen and Hentschel, 2014) at the RWTH Aachen University and the StarCAVE (Defanti, Dawe, Sandin, et al., 2009) at California Institute for Telecommunications and Information Technology at the University of California San Diego are two examples of the projector-based system. Researchers applied CAVE in different visualization applications. Bryson and Levit (1991) demonstrated the virtual wind tunnel using CAVE. Nowke, Schmidt, Albada, et al. (2013) applied

CAVE to simulate biologically realistic neural networks. Sampaio, Henriques and Martins (2010) and Sampaio, Ferreira, Rosario, et al. (2010) applied the techniques for development of models related to the construction process in civil engineering education. Gibbon (2008) applied the virtual reality technologies (Cheung, Siu, Feng, et. al, 2008) to demonstrate the circuit issues concerning operational amplifiers and a resonant circuit in the electrical engineering field. Su, Hu, and Ciou (2006) proposed simulation control testing in electrical engineering field.

Augmented reality

Augmented reality (AR) is another set of technologies which overlay extra information on real scene. Generally speaking, virtual reality replaces reality with digital objects while augmented reality integrates digital objects or information on real objects (Milgram, Takemura, Utsumi, et al. 1995). AR systems are characterized with the features of (1)combining real and virtual objects in a real environment, (2)aligning real and virtual objects with each other, and (3)running interactively in real time and in 3D space. (Azuma, Baillot, Behringer, et al., 2001) There are various kinds of AR applications making use of different devices. For example, some apps are developed making use of hand-held devices like mobile phones or tablet computers which capture real-time video and overlay digital objects or information on the video. Another example applications which make use of a camera and a projector. The applications first capture videos and recognize target objects in the scene. Subsequently, digital objects or information are projected over the recognized objects in the scene using the projector. If the projected digital objects do not align well with the real objects, the system can automatically adjust to achieve alignment. This process is very much similar to the process of image registration (Cheung and Siu, 2007).

The first AR system was developed by Sutherland I. at the Harvard University and the University of Utah using a see-through to present 3D graphics. (Tamura, 2002) Caudell and Mizell (1992) developed an experimental AR system to help workers putting together wiring harnesses. Feiner, MacIntyre, Hollerer, et al. (1997) proposed a mobile AR system registering 3D graphical tour guide information with buildings and artefacts. Yamabe and Nakajima (2013) proposed a system framework for augmenting traditional training environments making use of AR technologies. They considered VR-based systems replacing original apparatus with digital devices is not appropriate as this widens the gap between training and practice. They considered look-and-feel of training environment should be as similar to the real one as possible. Krevelen and Poelman (2010) surveyed the state of the art of AR technology as well as some known limitations regarding human factors in the use of AR systems. Vera, Russo, Mohsin et al. (2014) studied the application of AR system in surgical education. Simon, Baglee, Garfield, et al. (2014) proposed an AR-based training programme to identify necessary maintenance tasks for preventive or corrective maintenance.

Project initiative

Conventional vocational training for students is usually restricted to workshop environment. If emergency situations including fire and leaked gas arise, trainees might not be able to respond properly and might result in catastrophic consequences. The reason

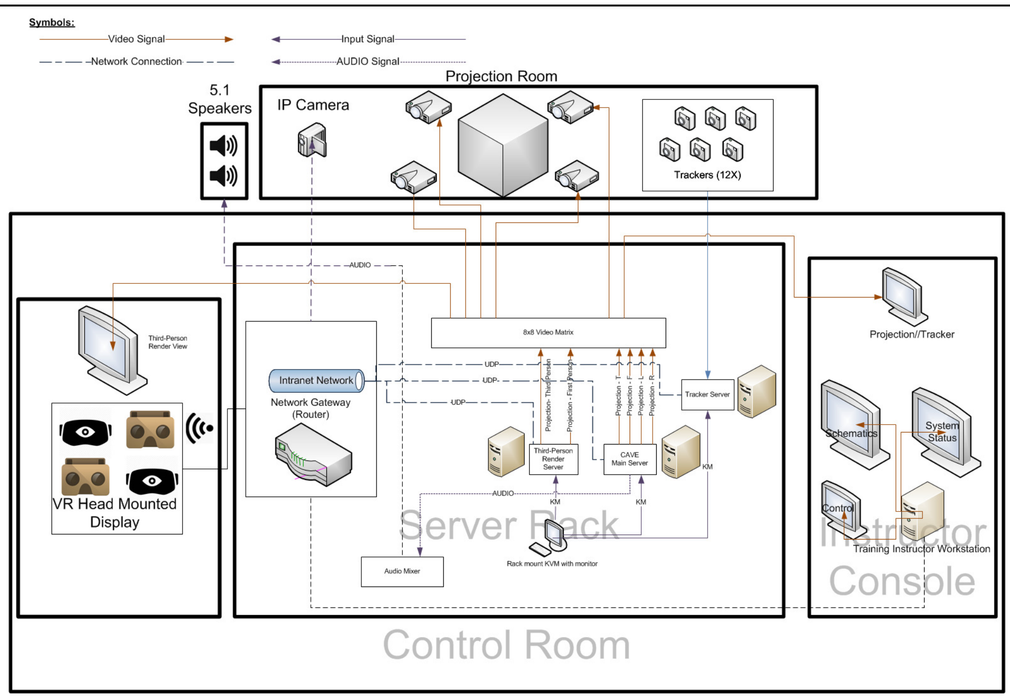

Figure 1, our VR-based simulation system consists of scenario control system, tracker system, image generation system and projection system.

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for the inability to respond properly is the lack of training in emergency situations. Using the CAVE system, teachers are allowed simulating various emergency situations for training purpose. The immersive 3D virtual reality feature of the CAVE system manages to allow the students familiarizing with various situations without actually facing the associate danger and train them to react properly. The use of simulation training in transportation industries in the form of flight, train and car simulators has been proven to be extremely useful for decades. However, simulation training for other industries is not widely used due to high cost in development and maintenance. With technological advancements in necessary hardware and software, the cost is substantially lowered recently.

In order to provide vocational education and training (VET) a mean to improve its effectiveness in training, Engineering Discipline of Hong Kong Institute of Vocational Education (IVE) is in the process of developing an interactive VR-based simulation system equipped with a projector-based CAVE system. The system aims at creating training experiences for trainees and let them become more competent in performing maintenance tasks in multiple locations and improve the ability to react in emergency situations. Students can engage with different situations and directly apply knowledge they learnt from classes. This learning mode well fit into the constructivist learning model (Piaget, 1964) which suggested that students learn by expanding his/her knowledge through experiences.

The system will also adopt a student-centred approach that provides learners with an experience of working on a simplified simulated world. At the same time, the simulation manages to maximize training safety and minimize risk. It will provide a range of flexibility in customizing different parameters of the scenarios and the trainings that allow flexible training time for individual or group trainings.

Figure 2, the primary user has a gamepad. Both the gamepad and the 3D glasses have a "target".

System design of our CAVE

Our virtual reality based simulation system primarily consists of four hardware components, including scenario control system, tracker system, image generation system and projection system. Figure 1 briefly illustrates the system architecture and design of our CAVE. We have a projection room with four screens, which are 4m x 2.75m in size, forming the front, left, right and bottom screen. We use four 3D projectors to project stereoscopic images onto the four screens. Several users wearing 3D glasses walk into the projection room to view the contents of the virtual environment. One of them, primary user, has a remote gamepad controlling the progress of the exercise and both her 3D glasses and the gamepad are attached with a tree like stureture called "target" for tracking purpose as shown in Figure 2.

The purpose of the tracker system is to detect the position and the orientation of the gamepad and the 3D glasses (of the primary user). The two "targets" (attached to the gamepad and the glasses) are composed of several spheres, called markers, which are coated with highly retro-reflective film. The coating essentially is a reflective surface which is capable of reflecting infrared radiation into the direction of the incoming light. There are several infrared cameras, mounted above the projection room, which can detect the reflected infrared light beams. Each marker essentially reflects an infrared light beam back to each infrared camera forming a 3D line in the 3D space as illustrated in Figure 3. If we have two infrared cameras, there are two 3D lines. The tracker server computes the intersection point of the two 3D lines which gives the 3D position of the marker in the 3D space. This method is called triangulation (Hartley and Zisserman (2004)). In theory, we need at least two infrared cameras to position the 3D coordinates of a marker. If we have more infrared cameras, the robustness and accuracy of the computed 3D position is higher.

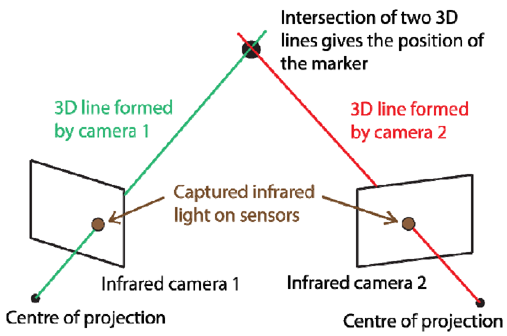

Figure 3, triangulation method to determine the 3D position of a marker using two infrared cameras

Detecting the 3D positions of some markers is not sufficient to identify if the "target" belongs to the 3D glasses or the gamepad. To differentiate the two, it is necessary to detect the 3D spatial configuration of detected markers. Note that the spatial configuration of the two "targets" are different as shown in Figure 2. I.e. the gamepad has a "target" with 3 markers while the 3D glasses with 4 markers. This spatial configuration difference not only identifies the 3D glasses from the gamepad, but also tells the orientation of each "target". In practice, each "target" must have at least 3 markers and must have a unique spatial configuration for the tracker system to work properly. The computed 3D position and orientation information of the gamepad and the 3D glasses are sent to the image generation system which has a game engine to generate the 3D contents of the front, left, right and bottom screens. The whole process, including the tracking and 3D view rendering, is done in real time which accounts for both the immersive feature of the CAVE system and the interactivity between the trainee and the virtual environment.

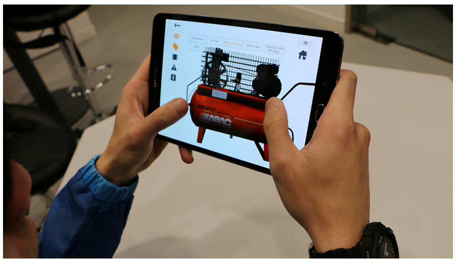

Figure 4, the Browser app showing the details of an air compressor

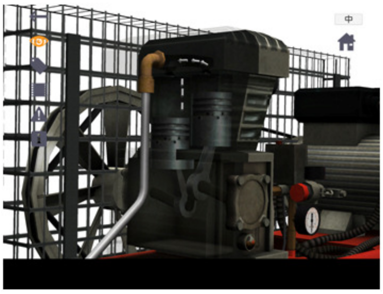

Figure 5, the Browser app allows a close inspection of the details of an air compressor

Other tools for vocational training

In addition to developing the CAVE system, we also develop two applications to be used on hand-held devices like tablet computers. One of the applications is called Browser (our engineering code) which carries some learning materials like the descriptions of an air compressor as shown in Figure 4. The apps models some plant room machines in details allowing detailed inspection. For example, a user can drag, rotate and magnify a part of the air compressor for close inspection as shown in Figure 5.

Another application is called Fixer (our engineering code) which is similar to the Browser apps. It allows user searching for faults and using a set of tools to fix the problems. For example, as shown in Figure 6(a), we have four fault cases. In Figure 6(b), a user observes that the water pump is leaking water and uses a spanner to replace a damaged gasket to stop water from leaking.

In addition to the plant room machine inspection and the maintenance service training provided by the two apps, we also develop a tool making use of augmented reality (AR) technology. Our tool is built as well on a hand held device like a tablet as shown in Figure 7(a). The key elements of the AR technology is to make use of the in-built camera to capture a video and to keep searching for some specific pre-defined 2D pictures or patterns in the video in real time. If the pre-defined pictures are recognized in the video, the position and the orientation of the pictures are computed. Finally, we compute a perspective transformation matrix for each recognized picture and use it to map a pre-built 3D object onto the video frame.

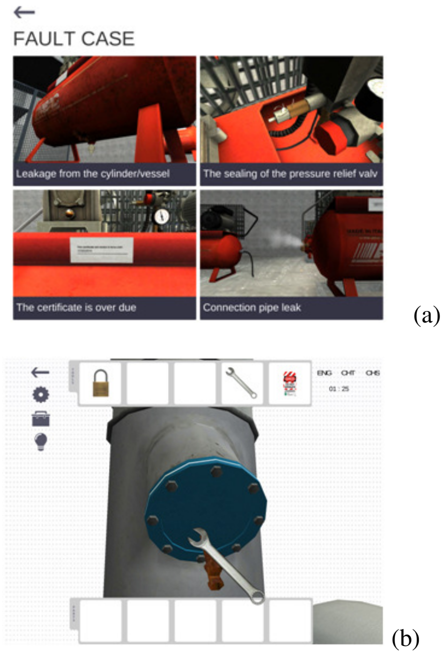

Figure 6, the Fixer apps showing (a)four fault cases, and (b)a user using a spanner to replace a damanged gasket in a water pump to stop water from leaking

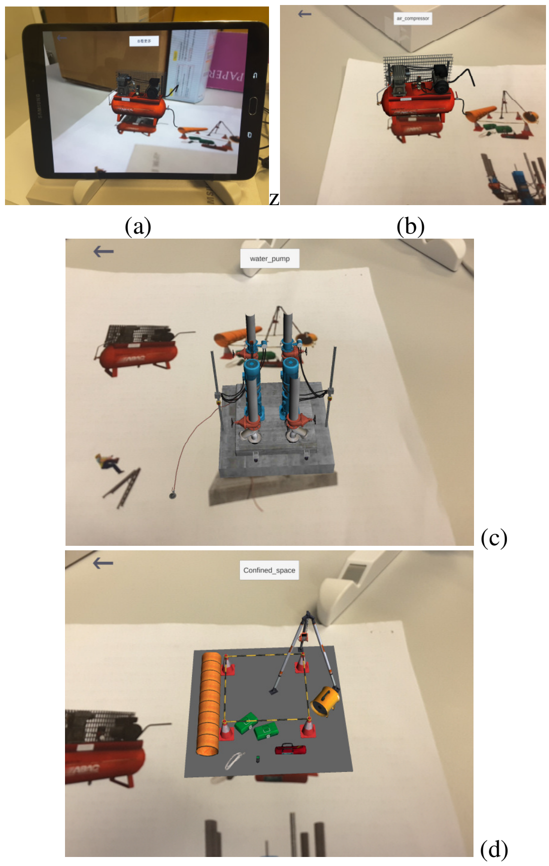

Figure 7, augmentation of 3D models including an air compressor, a water pump and the equipment for confined space using AR technology

If the relative position and orientation of the recognized picture changes in time, the perspective of the mapped 3D object on the video frame is also changed accordingly in real time. Therefore, if the user rotates the tablet computer about the picture slightly, a slightly different perspective of the augmented 3D object is shown on the tablet. It appears to the user that a 3D object is placed on the paper and it allows the user inspecting different perspectives of the 3D object by rotating the tablet computer. Figure 7(b) to (c) show the augmentation of three 3D objects including an air compressor, a water pump and the equipment for confined space respectively.

Class design using VR and AR technologies

With our developed CAVE system and the two apps, we design a class for a group of 20 vocational trainees leaded by an instructor. We simulate an engine plant room environment with reference to the engine plant room of Tsuen Kwan O Hospital in Hong Kong. The objective of the class is to train the students the procedures to locate and inspect a faulty machine in the virtual plant room. The class is divided into 5 groups with each group having 4 students. The instructor makes use of the scenario control system to set different scenarios to the groups. For example, a group may have one of the six air compressors unexpectedly having pressure drop from 10 bar to 7 bar.

The instructor initially briefs the students about the plant room and all the groups starts their learning using the Browser apps installed in a tablet computer to prepare themselves performing the inspection procedures in the CAVE system. The instructor select one group of students each time to enter the projection room of the CAVE system while all other 4 groups keep learning with the Browser apps. For the selected group entering the CAVE, one of them is assigned to be the primary user controlling the avatar to navigate inside the virtual environment. They need to locate the faulty machine, to inspect and to identify the problem associated with the machine. In addition, they also need to identify any inappropriate case in the virtual environment. For example, they need to observe and point out that a non-player character is climbing a ladder without enforcing all the safety measures.

After finishing the task in the CAVE, the group leaves the projection room and another groups use the CAVE in turn. If the students manage to identify the faulty machine, they proceed to use the AR tool and the Fixer apps to examine the faulty machine and to try performing the maintenance procedures. If the students successfully complete all the tasks, they can proceed to the workshop to work with the actual machine in the following workshop class.

Discussion

After running the class, most of the students generally found it interesting, educational and playful. They reported that they managed to promote the skill development and to sustain motivation to learn during the training. However, some of the students found that the experience in the projection room caused sickness. This was especially severe for the users other than the primary user when the primary user navigated in the virtual environment.

To alleviate the sickness problem, we modify the game settings including to brighten the virtual environment (VE), to include fewer objects in the VE, to avoid excessive navigation in the VE, to apply simple texture to objects and to avoid objects coming too close to the users. After running the class again, no trainee complained about the sickness problem and enjoyed very much with the class. It appears that these measures are efficacious in alleviating the sickness problem.

(a) (b) (c)

Figure 8, (a) A group of student studied the machine using the Browser apps on a tablet computer. (b) The group entered the projection room of the CAVE system to identify the faulty machine. (c) The group performed maintenance procedures in a workshop.

Conclusions

In conclusion, the Engineering Discipline of Hong Kong Institute of Vocational Education developed a VR-based simulation system which is equipped with a projector-based CAVE system. We also developed two applications and a AR tool on hand-held devices to assist student training. A class was designed making use of the CAVE system and the developed tools to train students performing inspection and maintenance procedures. After some trial runs, we found the class is educational and playful for students. It managed to promote the skill development and to sustain the motivation to learn. However, some students reported to have sickness problem using the CAVE system. In view of this, we deployed some changes in the settings and managed to greatly alleviate the sickness problem. We believe this training class surely can well impress the students and well accomplish the training objectives.

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UTILIZATION OF UPPER ATMOSPHERE OBSERVATION FOR EDUCATION

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Abstract

Students achieve their various skills by approaching science which contains "observation (obtaining data and developing observational systems)", "data analysis" and "presentation". For the upper atmospheric science, we have been developing ground-based observation. The upper atmosphere is the upper region of the Earth's atmosphere which is a compound system consisting of the mesosphere, thermosphere, ionosphere, plasmasphere, and magnetosphere. Ground-based observation is the most common method to understand such regions. The data obtained by our observation systems are airglow images, atmospheric electric field, ground magnetic field, and so on. We also utilize these data for student education at the National Institute of Technology, Kagoshima College. The students have analyzed our observational data by themselves and made a total of 6 presentations at scientific symposiums since 2012. For example, one student of the information engineering course analyzed the airglow data which were accumulated as binary format. She wrote some programs for handling the data and presented them at a symposium in 2013. Thus, she experienced both "data analysis" and "presentation" through science. These activities were not for her graduation research. In her opinion, she gained knowledge of an unprofessional area and acquired new techniques of data analyzing. Another student, who also analyzed our data and made a presentation, thought that there are advantages to be exposed to science. In order to involve the students in our activities further, we are now planning to expand our observation. In particular, we are preparing for the installation of a new instrument, which is a fluxgate magnetometer (a three-component magnetometer), and development of its system with the students. They will experience "observation" through such an activity. In addition, the new instrument can measure the three-component magnetic field accurately with high time resolution and will enable us to discuss the direction of currents and electromagnetic waves in the upper atmosphere. In this paper, we will introduce our ground-based observation systems and their utilization for student education.

Keywords: *science education, observation, data analysis, presentation, upper atmosphere*

Introduction

Science contains "observation (obtaining data and developing observational systems)", "data analysis", and "presentation". These components are helpful to expand human capacities. Recently, science has received a lot of attention in terms of capacity building (e.g., Yumoto, 2011) and students can achieve their various skills by approaching science.

The upper atmosphere is the upper region of the Earth's atmosphere which is a compound system consisting of the mesosphere, thermosphere, ionosphere, plasmasphere, and magnetosphere. The outer region of the magnetosphere is a region of the solar wind. The solar wind interfaces with the magnetosphere and electromagnetic phenomena occur in the magnetosphere. The upper atmosphere regions are closely coupled through complicated physical processes. Thus, there are a lot of open issues in the upper atmosphere.

For the upper atmospheric science, we have been developing ground-based observation. Ground-based observation is the most common method to understand the upper atmosphere. The data obtained by our observation systems are airglow images, atmospheric electric field, ground magnetic field, and so on. These observations are shown in the next section. We utilize these data for the education of students at the National Institute of Technology, Kagoshima College (Kagoshima Kosen) as well as the research in the upper atmosphere.

The science projects also extend their activities in capacity building and education in the field of the upper atmosphere. For example, CAWSES-II (Climate and Weather of the Sun-Earth System II) and IUGONET (the Inter-university Upper atmosphere Global Observation NETwork) focus on such activities. CAWSES-II coordinated international activities for scientific research and involved scientists in developed and developing countries. It also provided educational opportunities for students of all levels (Yamamoto et al., 2016). Similarly, IUGONET is building a metadata database of ground-based observations which is also utilized for education and capacity-building activities (Yatagai et al, 2015; Hayashi et al., 2013). As stated above, science projects contribute to education as well as research activities. It is expected to utilize scientific data for student education.

In this paper, we will introduce our observations and their utilization for student education. In Section 2, we introduce our upper atmospheric observation and student education is provided in Section 3. Results and discussion are given in Section 4. Finally, Section 5 shows conclusions.

Upper atmosphere observation

We are developing ground-based observation for upper atmospheric science at Kagoshima Kosen (northern latitude of 31.73 degree, east longitude of 130.73 degree). The data obtained by our observation systems are airglow images, atmospheric electric field, ground magnetic field, and so on. A part of the observation systems was installed in cooperation of Dr. Kazuo Makita. Here, we introduce some of our instruments.

Airglows are faint emissions from atoms, molecules and ions in the thermosphere. They contain thermospheric information such as wind direction, wind velocity, temperature, and so on. They are so faint that observational period is limited to moonless nighttime. We can obtain airglow images by using a CCD (charge coupled device) camera without optical filters. They are taken every 1 minute with exposure time of 50 seconds. Some images are shown in the next section. We started airglow observation at Kagoshima Kosen in 2010.

Atmospheric electric field is observed by a field mill which is a device based on electrostatic induction. The atmospheric electric field is a part of the global circuit. The global circuit is a huge current system connecting the ionosphere, atmosphere, and the ground electromagnetically (e.g., Williams, 2014). Thus, the variation in the atmospheric electric field reflects the state of the global circuit. There are a lot of factors which fluctuate atmospheric electric field. For example, the change of the weather (Minamoto and Kadokura, 2011), density of ambient aerosol, and radioactive material (Yamauchi et al, 2013) have an effect on the atmospheric electric field. Especially, lightning and clouds fluctuate the atmospheric electric field drastically. We installed a field mill in 2013 at Kagoshima Kosen and the observation continues up to now (Figure 1). The data is digitized at 1 second.

Figure 1 Sensor of a field mill.

Magnetic field is one of the essential physics parameters for the upper atmospheric science. Currents and electromagnetic waves in the upper atmosphere often appear as variations of the ground magnetic field. A proton magnetometer is one of the most accurate instruments to measure the absolute value of the ambient magnetic field. Protons precess around the direction to the external magnetic field. The frequency of the precession is directly proportional to the magnetic field. Thus, the proton magnetometer measures the magnetic field from the frequency of the precession (Huggard, 1970). We now measure the absolute magnetic field at Kagoshima Kosen (Figure 2).

Figure 2 Sensor of a proton magnetometer.

A fluxgate magnetometer can measure the vector field accurately with high time resolution (e.g. Matsuoka, et al., 2013). It enables us to detect phenomena ranging from about 10 seconds to several days, which are magnetic pulsations (i.e. electromagnetic waves), magnetic storms, and so on. In addition, we can discuss the direction of currents and electromagnetic waves in the upper atmosphere by the three-component magnetic field (northward, eastward, and downward components). We will install the fluxgate magnetometer in the summer of 2016 at Kihoku, Kanoya, Kagoshima, Japan (northern latitude of 31.55 degree, east longitude of 130.88 degree). The instrument has the advantage of being small and is easy to handle (Figure 3).

Figure 3 Flux gate magnetometer. The components are an amplifier (and data logger), a sensor, and a GPS antenna (from left).

Scientific Education

We encouraged some students at Kagoshima Kosen to improve their skills through the upper atmospheric data. The students have analyzed our observational data by themselves and made a total of 6 presentations at scientific symposiums since 2012. Their presentations have continued for 4 years. They make one or two presentations every year. These activities were not for their graduation researches.

Here we give examples of two students' works. One student of the information engineering course analyzed the airglow data which were accumulated as binary format. She wrote some programs for handling the data of light intensity at 630 nm by photometers. She also compared airglow images and the light intensity. The light intensity at 630 nm corresponds to light by atomic oxygen at an altitude of 200-300 km. From the comparison, she found that the wave structure in the airglow images appeared when light intensity at 630 nm changed. Figures 4 and 5 show the airglow images at 17:56 and 17:57 UT on 10 January, 2013. The black and white lineal structure in Figures 4 and 5 moves. The structure is remarkable on the southeast side (in the lower right of the images) in the figures and it propagates northeastward. The tendency of the observed wave structure is similar to the gravity waves which propagate horizontally at an altitude of about 100 km (e.g., Suzuki et al., 2010).

Figure 4 Airglow image at 17:56 UT on 10 January, 2013.

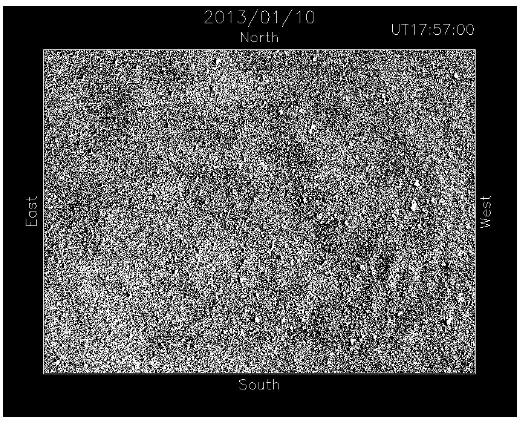

Figure 5 Airglow image at 17:57 UT on 10 January, 2013.

The above results were presented by the student in 2012 and 2013 at scientific symposiums. Thus, she experienced both "data analysis" and "presentation" through science. In her opinion, she gained knowledge of an unprofessional area and acquired new techniques of data analyzing.

The other student, who also belonged to the information engineering course, evaluated performance of a solar panel system for a proton magnetometer. We installed a new power system for the proton magnetometer (Figure 6). The new power system is composed of a solar panel, a battery, a battery charger (charge controller). He analyzed the data of the proton magnetometer operated by the new power system. As a result, he found that the observation by the new system can be continued more than 1 month only by solar power. He further found that the proton magnetometer outputs error data when ambient temperature is high and the magnetometer needs countermeasures for temperature.

Figure 6 Power system of proton magnetometer.

He made a presentation of the above result in 2014 at a scientific symposium when he was fourth-year student at Kagoshima Kosen. He also answered questions well at the end of his presentation. He experienced both "data analysis" and "presentation". In his opinion, he gained experience in a presentation. He exploited the experience for his graduation study in the next year.

Results and Discussion

We have been developing ground-based observation for upper atmospheric science. Examples of our observations are airglow images, atmospheric electric field, ground magnetic field, and so on. We will further install a fluxgate magnetometer in the summer of 2016. These data are utilized to educate students as well as understand upper atmospheric science.

We encouraged the students to improve their skills through the upper atmospheric data. They handled and analyzed the data by themselves. They also presented the obtained results at scientific symposiums. In our hearing investigation, the students thought that there are advantages to be exposed to science. Thus we concluded that the scientific data can be utilized for student education at Kosen and improve students' skills.

We further plan to give opportunity to experience "observation" to students. Our new installation of the fluxgate magnetometer can give them such opportunity and provide us more information about the upper atmosphere.

Conclusions

We are obtaining ground-based data for upper atmospheric science. The data are also utilized for student education at Kagoshima Kosen. The students have analyzed our observational data by themselves and made a total of 6 presentations at scientific symposiums since 2012. According to the interview from the students, scientific education yields profit of the skills of data handling/analyzing, and presentation. In order to promote scientific education further, we will continue to have the students involved in our activity and expand our observation.

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Active Learning for International Education: A Report on Science Demonstrations in New Zealand

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Abstract

In 2006, National Institute of Technology, Tomakomai College signed the agreement on academic exchange with Eastern Institute of Technology (EIT) in New Zealand. Ever since, with the aim of training the engineers who can play active roles in the international community in the future, we have promoted the international education in cooperation with EIT, and offered an opportunity to participate in a short-term study abroad program at EIT for our students. In the program, the participants visit a local elementary or junior high school, and demonstrate scientific experiments using their engineering knowledge in English. In 2015, 17 students took part in the study abroad program from our college, and conducted 4 scientific experiments with one unified theme. The results of a questionnaire given to the participants suggest that the "Science Demonstrations" activity had a positive influence on their English learning. This paper describes the contents of the activity as one of the practical examples of active leaning that Tomakomai College has promoted for the international education, and discusses its educational effects.

Keywords: *active learning, international education, engineering education, study-abroad program, science demonstrations*

Introduction

In recent years, the educational effects of Active Learning approaches have received a growing amount of attention in the field of education as a method to foster students' independent and autonomous learning.

Meanwhile, as the significance of English as an international language has been increasing with the rapid progress of globalization, it has been recognized that the cultivation of students' communication ability in English, as well as the development of their spirits of international understanding, is one of the most important objectives which higher education is required to achieve.

National Institute of Technology, Tomakomai College also aims to educate internationally-minded personnel with the greater interests to the world and the basic communication ability in English, and has made efforts to promote the international education. In the year of 2006, Tomakomai College signed on the agreement on academic exchange with Eastern Institute of Technology (EIT), a tertiary education institution in New Zealand, and launched a short-term study abroad program at EIT. This study abroad program was named "Collaborative Education (CE)", and over the past 10 years, more than 100 students from our college have participated in the program. The aims of CE are not only to provide an opportunity for the participants to improve their English abilities, but also to train them to become engineers who can play active roles in the international community in the future by having them engaged in engineering-related activities in it. As one of those activities, since 2009, we have been practicing "Science Demonstrations" in the program, where the participants visit local elementary / junior high schools and give demonstrations of scientific experiments in English. Science Demonstrations in 2015 was held at a local junior high school in NZ, and the participants demonstrated 4 experiments with one unified theme.

This paper describes the details of the activity, and discusses its educational effects based on the results of a questionnaire given to the participants.

Method

1. <u>Schedule and Participants</u>

The study abroad program was held for 2 weeks during the summer holiday, and a total of 17 students participated in the program from our college. Table 1 illustrates the majors and grades of the students.

Table 1 Majors and Grades of the Participants

Majors	3rd	4th
	# of students	
Mechanical Engineering	5	1
Electrical and Electronic Engineering	4	1
Computer Science and Engineering	1	
Science and Engineering for Materials	3	
Civil Engineering	2	
Total	15	2

2. Preparation for Science Demonstrations

For three months until the program at EIT began, the participants had meetings every week. The preparation for Science Demonstrations proceeded as follows:

(1) Deciding Experiments

For a safety reason, it is requested by EIT that the participants do not conduct scientific experiments which require to use chemicals or involve any possibility of danger. Paying careful attentions to these points, the contents of experiments are discussed and decided by the participants.

In the previous years from 2009 to 2014, Science Demonstrations were organized with one or two independent experiments which had no unified themes each other. In 2015, however, the participants decided to conduct 4 experiments with one unified theme, which was “air”. The details of the experiments are shown in Table 2.

Table 2 Contents of Science Demonstrations in 2015

1. *Moving Snake* Put a “snake” made of chenille on a paper cup, and give vibration to the cup by acoustic pressure. The vibration makes the snake spin around on the cup. This experiment helps the observers visually understand the fact that sound is the vibration of air.
2. *Kundt Tube* Make a kundt tube using a transparent hose with polystyrene beads in it. Blow breath into it, and it leads the beats to vibrating into a wave-like shape. Through this experience, the observers can understand that sound is air vibration, and visually see “the shape” of sound.
3. *Air Cannon* Seal up a four-cornered cardboard box with packing tape, and make a hole 10 to 20 centimeters in diameter on one side of the box. Using a fog machine, fill the box with smoke. Now ask some of the observers to stand in front of the box, and hit the two sides of the box hard toward them. The air comes out from the hole swirling with great force, and the people in front of the box feel the hit from the air. The aim of this experiment is to make the observers visually understand the flow of air, and physically feel the great power of it.
4. *Vacuum Pump* Get two glass jars ready; one with a balloon and the other with water inside. Using a vacuum pump made of a syringe, remove the air from both of the jars. Then it can be observed that, as the air get removed, the balloon gets expanded and the water comes to the boil. By watching these changes, the observers can learn about air pressure and its relation with temperature. This is the last experiment of Science Demonstrations, and it aims to make the pupils think about air with a different point of view from the previous experiments, and deepen their understanding of air by making them guess “what will happen if we *lose* it?”

By organizing the whole demonstrations with plural experiments on the same theme, it is aimed that the demonstrations encourages the observers (i.e. the pupils in NZ) to think and understand about air step by step. Therefore, the participants gave careful thoughts on the order of and the link between each experiment.

The advice on the experiments was given by a teacher who is in charge of a science club at our college. The club has been holding science events on a regular basis for children at a neighboring community center, and the leader of the club took the lead in organizing and preparing for Science Demonstrations as the student was also a participant of the program.

(2) Writing Scripts in English

After deciding the details of the demonstrations, the participants were divided into 4 groups, each of which took charge of one experiment. One group consisted of 4 to 5 members, and they made drafts of the scripts to demonstrate their experiment in English. According to the results of the questionnaire answered by the students, for many of them, this was their first experience at using English with the purpose of explaining things to others.

The English scripts were uploaded on Microsoft Office 365 by each group, and the first author of this paper, an English teacher, gave advice on their compositions, especially on vocabulary and grammar. According to the advice, they made improvements to their scripts, and uploaded the revised versions of them on Office 365, which were later checked by the teacher.

(3) Practicing Experiments in English

After several meetings, the students started practices in giving the demonstrations in English, liking the members of the other groups to the pupils in NZ. After each experiment, they exchanged their opinions on how it could be improved, and added improvements on their demonstrations. At the same time, they repeatedly made corrections and changes to their English scripts as needed, and the revised scripts were checked by the English teacher on Office 365. The practices of the demonstrations as well as the revisions of the scripts were continued in the weekly meetings.

In addition to that, they were also given the time to prepare for the demonstrations while studying in NZ, and they received a lot of advice from English teachers at EIT on their speech and pronunciation in English.

Figure 1 Preparing with an English teacher at EIT

3. Implementation

Science Demonstrations in 2015 was conducted at Taradale Intermediate School in Napier, NZ, on the second week of the English program. The participants were divided into two groups, and each of them conducted the same experiments in two different days. Taradale Intermediate is a specialist school for pupils aged 11 to 13, and 45 pupils participated in the demonstrations as an audience in total; 20 for the first day and 25 for the second. According to the results of the questionnaire given to the pupils, over 95% of them had never seen such science demonstrations before.

The tools and materials for the experiments had been prepared by the participants in Japan, and were sent to EIT before they left Japan, although the delivery of a fog machine was rejected due to the regulation of overseas transportation. For that reason, the participants gave up the idea of using the machine to generate smoke for *Air Cannon* experiment, and decided to use incense sticks instead. However, the participants were asked not to use the incense sticks from the local school on the first day of the demonstrations as it could operate the fire alarm in the classroom. Consequently, the experiment was conducted without smoke.

The pupils in the school were interested in science, and enthusiastically watched every experiment: many of them willingly became volunteers to try the experiments and excitedly asked questions about each experiment in question-and-answer sessions (see: Figure 2 and 3). As the Japanese participants were not used to being asked questions in English, they seemed quite nervous at first. Yet, they managed to answer them by using gestures or drawing pictures on a whiteboard. At the end of the demonstrations, the experiment tools were given to the pupils according to their requests.

Figure 2 Demonstration of *Moving Snake* (Day1)

Figure 3 Demonstration of *Kundt Tubes* (Day2)

Results and Discussion

After the completion of the study abroad program at EIT, the participants were given a questionnaire in Japanese for the purpose of evaluating the activity. The questionnaire consists of closed-response questions and free-response questions. Although the questionnaire was given to all the 17 participants, 15 of them completed it. Therefore, the total number of the respondents discussed here is 15. The results of the questionnaire suggest the following as the educational effects of the activity.

1. Fostering positive attitudes toward English communication

For many of us who live in Japan where English is a foreign language, there are very limited opportunities in our daily lives to communicate with others, especially those from other countries, in English. That is also true to the participants of this program, and as indicated in Table 3, for many of them, this was their first time at speaking English for the purpose of communication (JP-Q1). Therefore, despite the fact that all the participants have experiences in giving presentations in Japanese on the topics of their engineering majors in school, it can be easily imagined that many of them found it difficult or challenging to prepare for Science Demonstrations in English (JP-Q2), and half of the participants answered in a free-response question that the biggest concern they had in the process of preparation was whether the audience in NZ could really understand their English.

Table 3 Questionnaire Results (JP participants: N=15)

JP-Q1. I had experience at using English to explain things to others before. (If yes, what was the context?)	
No: 10 (67%)	
Yes: 5 (33%) * no context from one student	Contexts *(authors' translation)* *- In a English conversation school (3)* *- I was asked the way to go to a place by a foreigner (1)*

JP-Q2. It was difficult to prepare for Science Demonstrations in English.				
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
2 (13%)	8 (53%)	1 (7%)	4 (27%)	0 (0%)

Despite their anxiety, however, the pupils who joined the demonstrations gave quite positive responses to a questionnaire which asked their reactions to the performance given by the Japanese students. As shown in Table 4, most of them answered that they enjoyed the demonstrations (NZ-Q1, NZ-Q2), and would like to have another opportunity to participate in such science events in the future (NZ-Q3). Moreover, regarding the intelligibility of the Japanese students' English, over 85% of the pupils answered that it was clear enough to understand (NZ-Q4), and the result seems to indicate that their English helped the pupils understand the contents of the experiments.

Table 4 Questionnaire Results (NZ pupils: N=45)

NZ-Q1. How enjoyable were Science Demonstrations?				
Extremely	Very	Moderately	Slightly	Not At All
9 (20%)	33 (73%)	3 (7%)	0 (0%)	0 (0%)

NZ-Q2. Of the four experiments you saw today, which was the most enjoyable experiment for you?			
Moving Snake	Kundt Tube	Air Cannon	Vacuum Pump
12 (27%)	12 (27%)	7 (16%)	14 (31%)

NZ-Q3. Would you like to see Science Demonstrations like today if you have a chance in the future?	
Yes : 45 (100%)	No : 0 (0%)

NZ-Q4. Was their English clear enough to understand?				
Extremely	Very	Moderately	Slightly	Not At All
1 (2%)	9 (20%)	29 (64%)	5 (11%)	1 (2%)

Table 5 indicates the answers to the questions in which the Japanese students were asked how they felt in/after conducting the demonstrations. The results seem to suggest that the positive reactions from the audience gave them a sense of enjoyment as well as a feeling of accomplishment (JP-Q2, JP-Q3), and increased their confidence in their English (JP-Q4). Moreover, by seeing the audience being excited and enjoying the experiments they demonstrated, many of the Japanese students, who once had anxiety about their own English intelligibility, became positive about giving demonstrations in English in the future (JP-Q5).

Table 5 Questionnaire Results (JP participants: N=15)

JP-Q2. I enjoyed conducting Science Demonstrations in English for local pupils in NZ. (N=15)				
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
7 (47%)	7 (47%)	0 (0%)	0 (0%)	0 (0%)

JP-Q3. What was the most enjoyable part of conducting Science Demonstrations in NZ? (Free Response: N=14*)*	
Response *(authors' translation)*	
"The audience showed us positive reactions and enjoyed our experiments. "	10
"*I could make myself understood in English"*	4

JP-Q4. Did the experience of Science Demonstrations give you confidence somehow? (*Free Response:* N=12)	
Response *(authors' translation)*	
"I gained confidence in my English as the audience understood my English"	10
"I could become more positive about having communication in English"	2

JP-Q5. I would like to have an opportunity of using English to explain things to others again.				
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
5 (33%)	7 (47%)	3 (20%)	0 (0%)	0 (0%)

From these results, it is suggested that the activity worked effectively for the development of the students' positive attitudes toward English communication, and cultivated their self-confidence in their own English.

2. Improving motivation for English learning

Considering the fact that most of the participants rarely have a chance to communicate with others in English on a daily basis, it is quite understandable that many of them found it difficult to demonstrate scientific experiments in English (JP-Q6), and about half of them commented that the most difficult part of the activity was to listen to the questions given by the audience and respond to them quickly and correctly in English.

Table 6 Questionnaire Results (JP participants: N=15)

JP-Q6. It was difficult to conduct Science Demonstrations in English for local pupils in NZ.				
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
2 (13%)	8 (53%)	1 (7%)	4 (27%)	0 (0%)

JP-Q7. I found that the experience of using English with the purpose of explaining things to others is an effective way of learning and improving English.				
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
11(73%)	4 (27%)	0 (0%)	0 (0%)	0 (0%)
Comments from the participants *(authors' translation)* - *I found it very effective to* ***speak English actively*** *as I usually don't have a chance to use English to explain things to others.* - *I could* ***improve my communication ability*** *by thinking about the effective ways of speaking which can* ***attract the audience's attentions.*** - *This activity* ***improved my presentation skill*** *with which I am careful of using English which is easy to understand for the audience.*				

JP-Q8. Through this experience, did you find any new objectives for your future English learning? (*Free Response*)
Comments from the participants *(authors' translation)* - *I was disappointed of myself for having limited* ***vocabulary****. I felt that I need to learn more vocabulary,* ***especially verbs*** *and* ***nouns****.* - *Because of my limited* ***vocabulary****, I sometimes gave the audience roundabout explanations. So I felt the need to improve my* ***vocabulary****.* - *I found it important to pay attention to not only the meanings but also the* ***pronunciations*** *of the words when I learn new English words.* - *I need to practice* ***speaking****, focusing on* ***pronunciations*** *and* ***intonations****.* - *I want to improve my* ***speaking*** *ability which enables me to make myself understood to others.*

However, while feeling the difficulty of achieving smooth and successful communication in the process of giving the demonstrations, all the participants answered that they felt the positive effect of the activity on their English learning, especially on the development of their communication abilities (JP-Q7), and 14 of them answered that the activity helped them to discover new objectives for their future English leaning (JP-Q8) as indicated in Table 6. Some of their comments given to each question are also shown in the table.

It seems that the comments given to JP-Q7 suggest that this activity was not only a valuable experience for them to have practical communication with foreigners in English, but also a chance for them to have practices on giving presentation to the audience. Moreover, their comments to JP-Q8 seem to indicate that the activity helped them to recognize the weaknesses of their English: by using English as a communication tool, some realized their limited amount of vocabulary, others felt the need to improve their speaking ability including pronunciation, and many learnt the difficulty of having mutual conversations with others, which are often established on the repetitions of question-and-response. With such awareness, furthermore, it can be seen that the students discovered new challenges they need to address for overcoming their weak points to improve their English. Given these results, it can be claimed that the activity had a positive influence on increasing the students' motivations to keep learning English as it encouraged them to decide the directions of their future English learning.

3. <u>Developing autonomous attitudes for learning</u>

Positive influence the activity had on the participants was also recognized in their actions. Before leaving Japan, for example, the students repeatedly practiced the demonstrations in English in the weekly meetings. At first, they were constantly looking at their English scripts and speaking from them during the experiments. However, with each practice, they started to think how they could "entertain" the audience and explain each experiment in an easy way for them to understand, and kept making improvements to the way of carrying out the demonstrations by, for example, using familiar topics to the audience, or using diagrams and pictures in the explanation. Furthermore, in order to make the activity interactive, where the audience can be actively involved, they conducted some parts of the demonstrations in a quiz format, and made time to let the audience try the experiments.

Figure 4 Explaining the mechanism of "Vacuum Pump" with a picture

In addition to the above, after the first group finished the demonstrations at Taradale Intermediate, some of the students who were going to do the same experiments on the next day asked how the demonstrations went to the first group, and decided to make a handout shown in Figure 5. The students later made copies of the handout, and distributed them to the pupils on the demonstrations day to explain the procedure of *Moving Snake* experiment.

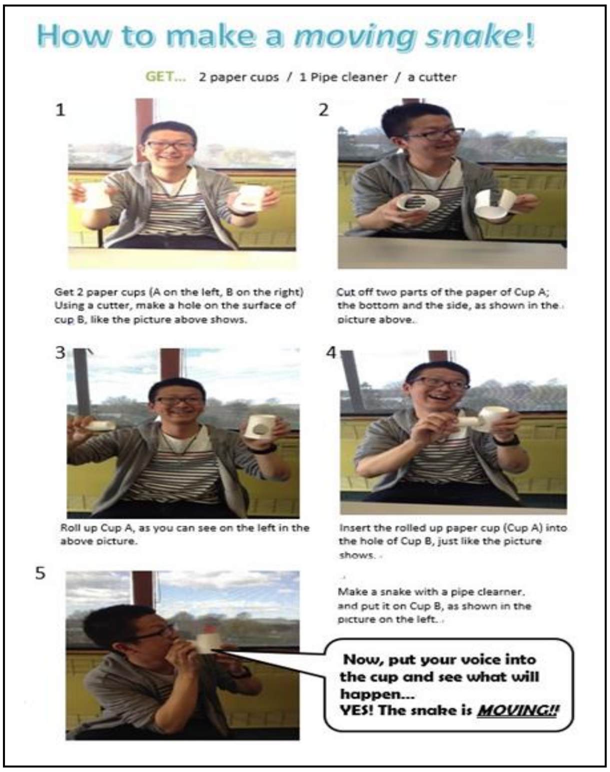

Figure 5 Instruction for *Moving Snake*

Those actions of the participants described above were not made on the instructions of the teachers: it was on their own initiative that they acted that way. Although it is often pointed out that Japanese students are dependent and passive in their learning, the participants' actions observed in this activity were far from that.

In the field of Second Language Acquisition (SLA), the importance of developing learner autonomy has been recognized for achieving successful language learning, as described by Dickinson (1995), Schearle and Szabo (2000) and others. Although it is not quite reasonable to conclude that this activity "developed" autonomy among the participants, it is apparent that the activity encouraged them to have autonomous attitudes toward learning: with the autonomy, they set a goal by themselves, identified challenges on the way to the goal, and figured out the ways of addressing the challenges to accomplish the goal. Such active and autonomous attitudes are certainly essential for their successful language leaning, and therefore, it can be claimed that the activity was effective for their English learning as it facilitated the development of learner autonomy among the participants.

Conclusions

This paper described the contents of Science Demonstrations conducted in 2015, and discussed its educational effects. In the activity, the participants visited a local junior high school in New Zealand, and demonstrated 4 scientific experiments with one unified theme using their engineering knowledge in English. For many of the participants, this was their first experience at speaking English with the purpose of communication, and giving any kinds of presentations in English.

The results of the questionnaire suggested that, through this activity, the participants gained confidence in their own English and became more positive about having communication in English. There was also some evidence that the activity was effective on improving their motivations for English learning, and cultivating their active and autonomous attitudes toward learning.

Recognizing all these positive effects of the activity, however, it needs to be reminded that the students' English abilities, including communication abilities, cannot be developed through one activity, and that it is quite difficult to keep their motivations high when they have very limited chances to use English in their daily lives. Therefore, whether the students take part in the study abroad program or not, it is important that we provide more opportunities for our students to get involved in activities where they use English as a communication tool to interact with others. By participating in such activities throughout the five-year education at school, the students will surely develop their communication abilities in English with higher motivations for learning.

With these in mind, the international education at our college will be further enhanced for the development of international engineers in the future.

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STUDY OF MAIN FACTORS INVOLVED IN THE SOLVING PROBLEMS PROCESS USED BY EXPERIMENTAL SCIENCES STUDENTS

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Abstract

Many educational institutions around the world recognize that the ability to solve problems is essentially a fundamental skill for students can successfully join the society, for they can function successfully in their working lives and for they can actively participate in the processes of social improvement. However, the development of this skill requires work and dedication because solving a problem is to find a way where there is no way known previously, solving a problem is to find ways to overcome a difficulties or obstacles and to achieve the objective desired using appropriate means. It is appropriate to point out that we only can teach students the correct attitude towards problems. In this regard, the best method is not to tell them things but motivate students to answer questions and to reason their own answers. The most important thing is not to get the solution but the way that led us to it. The ability to solve problems is one of the basic skills that students will use both when they leave school and throughout their lives. In this project the impact of factors involved in the problem solving process was studied. In order to achieve this goal, we take as a starting point the idea that any problem solving process involves the following steps: a) understanding of the problem (Reading-Comprehension), b) data analysis, c) to design a plan (identify a solution algorithm), d) to Implement the plan (mathematical manipulation) and to evaluate the obtained solution (validation). Considering the above stages, a test that identified the progress of students in solving the problem was designed. The test was applied to a representative sample of students using the statistical principles of sampling. The main factors affecting the performance of students in the process of solving problems were also identified using this assessment tool. From these results, different strategies focused at strengthening and improving student performance were proposed. The most important factors that prevented an adequate performance of students were associated with the understanding of the readings and mathematical manipulation.

Keywords: *Solving-Problems, process, teaching, learning, effectiveness*

Introduction

Nowadays, the institutional philosophy of the universities is to provide its students with an education based on the development of fundamental values for social coexistence. The Universities have with a main goal focus the respect in all its dimensions, solidarity, service, tolerance, communication, work, democracy, responsibility, faith, gratitude and creativity in the development of different educational, scientific and artistic skills. All educational institution wants to educate citizens with commitment and social projection and with a strong sense of belonging and aware of the importance of the welfare of his family, institution and community. In order to reach this goal, the universities need to consolidate fundamental structures of knowledge such as: Learning to be, learning to know, learning to do and learning to live together.

In our institution the student population comes from families where both parents working all day. For this reason, students have a poor academic support that directly impact their educational level. There are numerous studies that talk about the factors that influence academic achievement of students. All of them are agree that the nature of the problem associated with low academic performance is multifactorial.

Duron and Oropeza (1999) established the presence of four main factors, Figure 1, which are:

a) **Physiological factors.** It is known that these factors affect students, although it is difficult to determine the impact associated with each of them because they usually are interacting with other factors. The main physiological factors are: hormonal changes, malnutrition and others health problems.

b) **Pedagogical factors.** They are associated with the quality of teaching. The main pedagogical factors are: the number of students per teacher, teaching methods used, student motivation and time spent by teachers preparing their classes.

c) **Psychological factors.** They are associated with basic psychological functions such as perception, memory and conceptualization. This factors are very important in order to reach a successful teaching-learning process.

d) **Sociological factors.** They are associated with socioeconomic characteristics such as economic status, education level and occupation of parents and the quality of the environment surrounding the student.

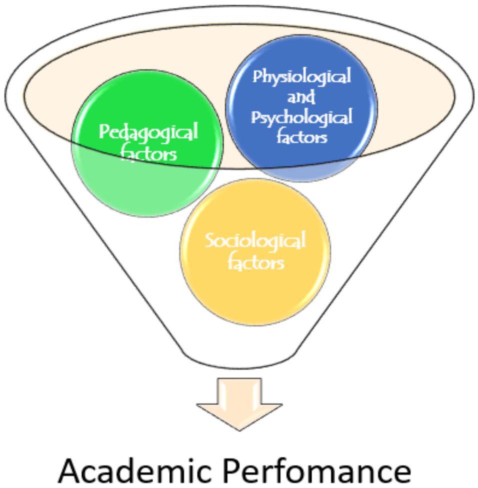

Figure 1. Main factors associated with de academic performance.

Robles and Martinez (2007) found that the low academic performance in high school level in Mexico is multidimensional and multifactorial. They suggest at least two proposals to remedy such problem: (1) early detection of the problem of low achievement (2) implement a proactive culture supported human, sensitive and committed part of good teachers.

All developed countries invest a large percentage of their efforts and their economic and material resources in order to reach a high level in scientific and technological developments. This trend is motivated by the belief that scientific knowledge and technology are the answer to many of the modern social problems. However, if we want to reach a successful technological development is necessary that students develop and improve their skills related to problem solving and the management of large amounts of information. In this way, educational institutions should promote the development of skills related to problem solving and innovation in order to be recognized as agents of change and social transformation and to reach the growth of the region and the country.

This project is associated with the study of the stages involved in the process of problem solving and modeling factors affect the performance of students during it. The study of the stages will allow us to identify the main factors involved in the efficient resolution of problems and areas of opportunity related with the impact the teaching-learning process. Through the study of these factor we will be able to know the factors involved in each stage we will be able to model the solving process and design strategies that allow us to improve educational indicators such as the percentage of approved students in institutional test. It is important to note that a process of teaching and learning more efficient is aligned directly with the fundamental objective of the institution, which is the education of integral citizens that become agents of change, transformation and social renewal. We believe that a better performance in the solving process will impact other areas of knowledge. The solving problems process develop skills used in other areas of knowledge due to students have the opportunity to think about the problem carefully, testing, research and argue. Besides, there is greater participation and a greater degree of understanding by students thank to this experience generate knowledge more durable and meaningful. Finally, the solving process motivates students to build their own systems of learning and understanding. In the case of teachers this project represents a direct invitation to the renewal of teaching practice and the improvement of a teaching-learning process.

Materials and Methods or pedagogy

The factors involved in the process of solving problems, associated with experimental subjects such as physics or math, were studied in order to model this process and generate strategies that improving the teaching and learning processes. For the development of this project, the first step was associated with the design of an assessment tool that allowed us to obtain a diagnosis of the stages that represent areas of opportunity. For the design of the evaluation instrument was selected the Bloom's taxonomy (1956), Figure 2, by the extensive knowledge and acceptance among media and educational authorities in our country. We must remember that the Bloom's taxonomy has the following levels of knowledge:

1) Knowledge. This level is associated with universal information and specific methods related with processes, structures and models. It gives greater emphasis to the psychological processes of remembrance, involving organization and reorganization of a problem, to provide signs and clues associated to useful information.
2) Understanding. This level represents the lowest level of understanding. It refers to a kind of understanding such that the individual knows what he is communicating and can use the material or idea without necessarily relating it to other material, or without the need to know their full implications.
3) Application. This level implies the use of abstractions into concrete situations. Abstractions can be in the form of general ideas, rules of procedure or generalized methods. The abstractions may also consist in technical principles, ideas and theories which must be remembered and applied. For example: the application of terms and concepts used in scientific research work to the phenomenon discussed in another investigation or the ability to predict the effect of a change in a biological factor or situation that is in equilibrium. In the level associated with the application we can recognized four different kinds of problems such as: a) problems associated with a fictional situation, b) Problems associated with materials focused to simplify a complex situation, c) Problems that demand the generation of several solutions associated with ordinary situations and d) Figure out new ways of looking ordinary phenomena.

Besides, we can recognize two kinds of conduct when people have to solve a problem. These conducts are: a) The student select the correct principle and he show how it applies to the problem. The student understands the full application process and explain the concepts involved and b) the student shows the solution and we can infer if the principles applied in the solution are corrects.

4) Analysis. This level is associated with the separation of a communication into its elements or components in order to clarify the relationship between the ideas expressed.
5) Summary. This level is associated with the ability to unite different parties and form a new element. This may involve the production of an essay or speech, a plan of operations (research proposal) or a set of abstract relations (schemes for classifying information).
6) Evaluation. This level is associated with the ability to judge the value of materials such as declarations, novels, poems or research reports for a particular purpose. The judgment should be based on defined criteria. These criteria may be internal (organization) or external (relevance or purpose). The student can determine the criterion or he can receive it from others. The outcomes obtained in this area are the highest in the cognitive hierarchy because they contain elements of all other categories.

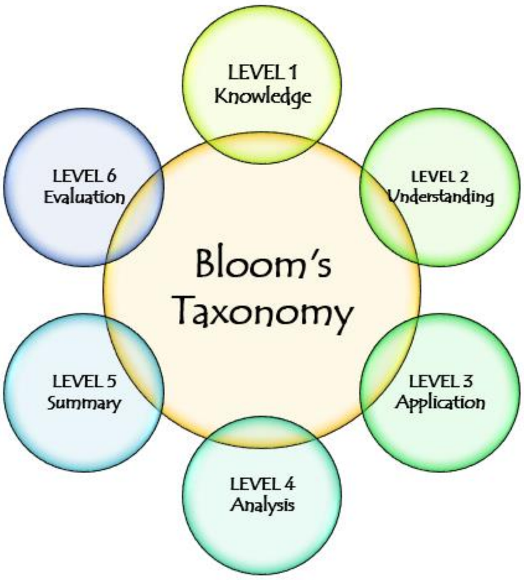

Figure 2. Levels of Knowledge associated with the Bloom's Taxonomy

The second step was associated with the selection of the sample used for this study. The selection of the representative sample of the population was made by taking the following points:

a) To choose a parameter (level of Bloom´s Taxonomy to be evaluated) with the desired confidence level. A parameter is an element that is considered essential and guidance to achieve assess or evaluate a given situation.
b) Detecting a particular difference, if it really exists, between the study groups with a minimum guarantee.
c) Establish a balance between feasibility, costs and speed the study.

The calculated sample was divided into three groups to facilitate the implementation of the assessment instrument (test based on Bloom's Taxonomy). The test was applied in the subjects of Physics I and II at the beginning and end of the semester in order to have a comparative basis. Some strategies (implemented actions to achieve improvements in student performance) were developed from the application of the test at the beginning of the project in order to improve the process of solving problems. Finally, the impact of these strategies was observed during the implementation of the instrument of assessment at the end of the project. The test was structured as follows:

Table 1. Structure of test.

Process of Solving problems (Stages)	What is evaluated?
I) Understanding the Problem	Reading-Comprehension
II) Analysis of the information	Identification Highlights
III) Design of a plan	Identification Algorithm
IV) Implementation of the plan	Operations and Mathematical Manipulation
V) Examination of the solution obtained.	Validation

At the beginning of this project the students signed a commitment letter in which they are agree to attend a weekly counseling during the semester and participate in the assessment sessions. The signature of this letter was mandatory to be part of the sample group. From the results obtained was possible to measure the progress reached in the different stages of research and the areas of opportunity to improve the study.

Likewise, the first analysis of results evidenced how to modify or redirect the study. For evaluation of reagents four classic indicators are proposed:

a) Index of difficulty. All questions have a specific difficulty level. A question with a low frequency of success is more difficult than another with a high frequency. The index of difficulty is the frequency of responses obtained on the total number of people.
b) Index discrimination. The discrimination index allows us to determine if a question is answered most often by students with high academic performance or by student with a low academic performance.
c) Validity. The validity of an instrument is associated with the possibility of measure what we want to measure.

d) Reliability. It refers to the accuracy with which we can get the same measurement under different conditions. In some cases, the condition will be associated with the temporal stability. In these cases, the element measured at two different times should give the same answers to the instrument.

Using these indicators, we were able to measure the quality of the questions.

Results and Discussion

In this project, the first step was associated with the design of an assessment tool (test) that allowed us to obtain a diagnosis of the stages that represent areas of opportunity. For the design of the evaluation instrument was selected the Bloom's taxonomy (1956). Table 2 shows the distribution of questions in the evaluation instrument according to the taxonomic level.

Table 2. Distribution of questions according to the taxonomic level.

	Bloom's Taxonomy*					
Levels	1	2	3	4	5	6
Number of Questions	5	5	5	2	1	3
Total	21					

*1=Knowledge, 2=Understanding, 3=Application, 4= Analysis, 5= Summary and 6= Evaluation

Table 3 provides a description of the sample of students participating in this project. Characteristics such as age, gender, education level, ability to use computers and Internet access are included. Furthermore, Table 4 show important aspects associated with the vision that students had about physics and solving process before developing this project. The results in table 4 show that most of the students believed that a problem is an exercise proposed in order to know if they have learned a definition, a formula or procedure. It is not always applied to a situation, and it does not involve learning new knowledge and skills, to plan activities, to develop strategies and to connect knowledge from different areas. Besides, the students don't know which are the main features of a problem, Table 5. They can't determinate if a problem has only one correct answer or if they can apply different procedures to get the solution. Finally, they can't recognize if the solution of a problem requires creativity or if it doesn't depend on the procedures used. Before the project, the students were able to recognize which aspects need to be considered to solve a problem. However, they don't consider it to solve a problem. After this project, students changed the concept of what should be a problem. They think that a problem must be an exercise based on a real situation and it must involve learning new knowledge, skills and attitudes.

Table 3. Description of the sample of students participating in the project.

Total Students	Male		Female	
202	44%		56 %	
Average Age	15-16 years old			
Level of education	High School (Grade 10-11)			
Tech gadgets at home				
Device	Yes (% Students)		No (% Students)	
Desktop	80.2		19.8	
Lap top	83.4		16.6	
Tablet or Ipad	52.6		47.4	
Smartphone	58.3		41.7	
Internet access at home	Yes (% Students)		No (% Students)	
	86.3		13.7	
Tech gadgets in the classroom				
Device	Yes (% Students)		No (% Students)	
Projector	100.0		0.0	
Desktop or Lap top	100.0		0.0	
Ability to use computers (% Students)	very skilled	Skilled	moderately skilled	unskilled
	9.2	28.3	58.3	4.2
What do you prefer?	Teamwork		work individually	
	32.5 %		67.5 %	

Table 4. Vision of students about a problem before making the project.

Question What is a problem?	*Scale *of degrees of Certainty/ (%students)*				
	1	2	3	4	5
An exercise which the teacher proposes in order to know if the student has learned a definition, a formula or procedure.	9.2	6.5	19.3	37.2	27.8
An exercise in which we can apply a procedure to a real situation	15.5	24.2	29.5	25.2	5.6
A situation that motivates students to learn new definitions, formulas or procedures.	8.3	24.3	30.8	22.6	14.3
A situation that allows students to develop new skills.	4.8	31.2	28.4	10.3	25.3
A situation that motivates students to learn new concepts, plan activities, develop strategies and propose solutions to real situations.	20.4	22.3	29.8	15.7	11.8
A situation which connects knowledge from different areas.	20.4	34.3	21.9	13.2	10.2
A situation that involves the development of competencies (knowledge, skills and attitudes).	5.6	20.5	19.8	38.6	15.5

Table 5. Vision of students about solving problems before making the project.

Question Which are the main features of a problem?	*Scale of degrees of Certainty/ (% students)				
	1	2	3	4	5
There is only one correct answer.	5.8	20.1	20.9	18.9	34.3
There is only one correct procedure.	10.3	21.4	12.6	20.5	35.2
The solution of a problem requires creativity.	14.3	21.8	38.7	11.3	13.9
The solution of a problem does not depend on the procedure used.	0.0	4.9	38.6	10.5	46.0
The problems must solve useful and practical situations.	10.6	13.0	18.9	32.0	25.5
The solution of a problem is specified.	13.8	22.6	19.8	16.4	27.4
Question If you want to solve a problem, which aspects need to be considered?	***Scale of degrees of Certainty/ (% students)**				
	1	**2**	**3**	**4**	**5**
You must be able to recognize the relevant data contained in the statements.	4.2	8.3	15.2	28.3	44.0
You need to make the mathematical operations required by the method of solution.	3.2	21.3	9.3	25.2	41.0
The most important element to solve a problem is to discover that operation you must calculate.	1.3	11.2	23.1	15.6	48.8
The solution involves the relationship of concepts previously studied and understood.	6.4	17.2	29.7	24.3	22.4

Finally, we identify benefits about the development of projects associated with solving problems from surveys and evaluation reports. These benefits are included in Table 6.

Table 6. Benefits about the learning based on solving problems.

Feature/ % of students	I agree	I disagree
It provides meaningful learning	90.7	9.3
It develops communication and values.	84.3	15.7
It promotes teamwork.	88.3	11.7
It promotes creativity.	86.4	13.6
It motivates to learn new concepts, plan activities, develop strategies and propose solutions.	81.5	18.5
It promotes learning of new knowledge and develop new skills.	82.3	17.7
It connects knowledge from different areas.	92.1	7.9
It promotes the generation of multiple solutions.	85.4	14.6
It involves real problems.	80.8	19.2
The solution takes time and often is of a general nature.	78.7	21.3

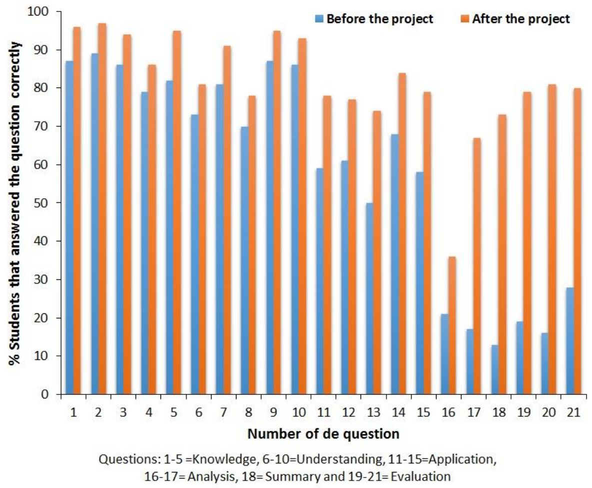

Figure 3. Percentage of student that answered the questions correctly before and after this project.

The distribution of the answers obtained in this study is shown in the Figure 3. The study of the stages associated with the process of solving problems allowed us to identify the main factors involved in the efficient resolution of problems and areas of opportunity related with the impact the teaching-learning process. Through the study of these factor we were able to know the factors involved in each stage we built a model related with this process and we designes strategies that allow us to improve educational indicators such as the percentage of approved students in the institutional test. The model of this process is shown in the Figure 4.

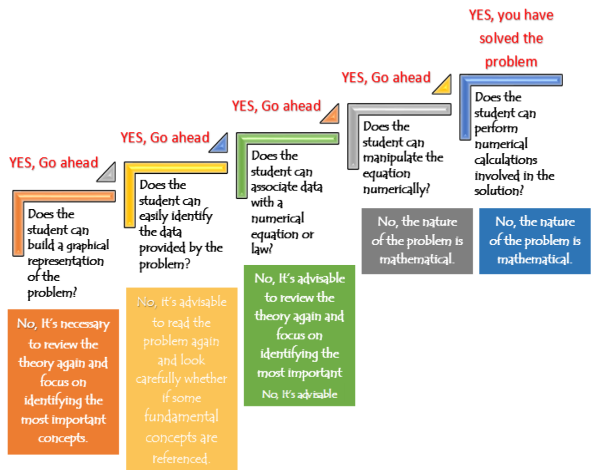

Figure 4. Model associated with the process of solving problems.

Conclusions

The study of the stages involved in the process of problem solving allowed us to identify the main factors involved in the efficient resolution of problems and areas of opportunity related with the impact the teaching-learning process. Through the study of these factors, we were able to build a model the solving process and design strategies that allow us to improve educational indicators such as the percentage of approved students in institutional test.

It is important to note that a process of teaching and learning more efficient is aligned directly with the fundamental objective of the institution, which is the education of integral citizens that become agents of change, transformation and social renewal. We believe that a better performance in the process of solving problems will impact other areas of knowledge. This process develops skills used in other areas of knowledge due to students have the opportunity to think about the problem carefully, testing, research and argue. Besides, there is greater participation and a greater degree of understanding by students, thank to this experience generate knowledge more durable and meaningful. Finally, the solving process motivates students to build their own systems of learning and understanding. In the case of teachers this project represents a direct invitation to the renewal of teaching practice and the improvement of a teaching-learning process. Besides, when we design a strategy focused on solving a problem, we indirectly attach importance to knowledge and we converge knowledge, skills, attitudes and values in the same activity. It is important to remember that solving a problem promotes the development of creativity and imagination, which involves fundamental processes such as research, reflect and discover that generate satisfaction in people and increase their knowledge.

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ICT-ENHANCED SELF-DIRECTED LEARNING USING INTERACTIVE VIDEOS WITH LEARNING ANALYTICS

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Abstract

This action research study investigated the use of ICT-enhanced videos to help students learn the subject content in SDL mode before attending a flipped classroom with hands-on activities. The study was conducted in Year 2015 Semester 2 with 57 students from a Business Analytics & Project module in the Diploma in Financial Informatics program at the School of Information Technology. An interactive video editing platform from Zaption was used, which allowed the incorporation of interactions such as multiple-choice quizzes, open-ended questions and discussion forums directly into the flow of the video. Students had to perform the incorporated tasks before the video could be advanced. Besides providing learning analytics on the interactions at both individual and class level, Zaption also captured user engagement like viewing time, number of attempts to view, skip forward and backwards for each video. Both quantitative and qualitative feedbacks were collected from 56 students and 2 instructors. The results showed that the interactive videos were perceived as favourable as face-to-face lectures by students. Pre- and post-test results revealed that the interactive videos helped the students to learn some module content before participating in the flipped classroom hands-on activities. The data provided by Zaption Learning Analytics helped the instructors to quickly identify learning gaps and adapt instructions for individuals and the whole class. Finally, the students' mid-term test scores on the study module topic were compared against a similar score obtained from a control group with comparable students from previous year learning the same module topic in a traditional classroom setting. The results did show that there was an improvement in student learning through using ICT-enhanced videos in SDL mode before attending a flipped classroom with hands-on activities. ICT-enhanced videos can be deployed as a useful platform to promote active learning for SDL. The learning analytics data can be used to help instructors understand the topics which students are weak in to improve on the module content. Exploration on the relationship between students' learning styles and their engagement can help instructors understand students' learning preferences and hence design more engaging videos for differentiated learning in the future.

Keywords: *ICT-enhanced learning, self-directed learning, learning analytics, interactive video, active learning, flipped classroom, learning style, learning tool, action research*

Introduction

There is a growing trend of using videos in higher education institutes, especially as a medium for students to complete SDL (Self-Directed-Learning) before attending a flipped classroom. However, most videos used have minimal or no interactive elements, so students became passive consumers of the contents. ICT (Information Communication Technology)-enhanced videos would allow instructors to track students' engagement with video-based learning.

In this paper, the authors discuss their action research project on using ICT-enhanced, interactive videos via Zaption.com, a proprietary online platform that allows instructors to embed interactivity into videos, in a flipped classroom for SDL on a specific topic in Business Analytics & Project, a Year 2 module read by Diploma in Financial Informatics students from School of Information Technology, Nanyang Polytechnic. As learning analytics has been touted as a key means to shorten or even eliminate delays between collecting data and intervention on students' learning (Siemens & Long, 2011), the authors performed learning analytics on the data collected via Zaption.com as well as data on the learning styles of the students.

Literature Review

ICT-enhanced learning environments are becoming more and more dominant in education (Barak, 2007). Instructors' perception of the use of ICT in education has been changing, from resisting technologies as they deem them distractive, to embracing them as instrumental in education progress (Barak, 2014). The use of ICT in education has come a long way, from the use of slideshows to replace chalk boards and transparencies, to one-to-one technology-enhanced learning that enables "seamless learning spaces" (Chan, 2006). ICT-enhanced learning thus fits into the SDL pedagogy, as one-to-one technologies enable learners to formulate and pursue their own learning objectives (Rothwell & Sensenig, 1999). Admittedly, SDL is best viewed as a continuum (Hiemstra, 1994), for example when mass-directed teaching materials are made accessible to individual learners to use asynchronously (Breslow et al., 2013). It is hence no surprise that with advancements in ICT-enhanced learning comes a proliferation of flipped classroom models (Zhong et. al., 2013).

The flipped classroom refers to a model of learning that moves content delivery outside of the lecture hall or classroom (often via ICT means), so as to free up face-to-face class time for active learning (King, 1993), which leads to better student attitudes and improvements in students' learning and retention of material (Bonwell & Eison, 1991). The flipped classroom addresses the common criticism of in-class lectures as being ineffective in helping students to learn (Schwerdt & Wupperman, 2010), as the activities conducted during the in-class sessions help students to remember more content (Prince, 2004), yet in-class lectures still continue to prevail as the predominant instructional strategy in most education institutes (Prober & Heath, 2012). Flipped classrooms have been shown to improve student-teacher interactions and student engagement by providing real-time feedback (Bergmann & Sams, 2012), and they are viewed favourably by students who prefer a flipped classroom style of learning to in-class lectures (Nwosisi et al, 2016).

There are earlier studies concluded that video-based instruction has not been sufficiently effective because learners were passive in the learning process. However, relatively few studies on video-based instruction have actually engaged learners in active learning. Later study has aimed to investigate the potential of video instruction based on constructivism that is devised to engage learners in active, authentic, and collaborative learning (Choi & Johnson, 2005). Although the use of videos for asynchronous content delivery in implementing flipped classroom models is quite common (Herried & Schiller, 2013), there has been few studies done on the use of interactive videos. Videos with interactivity in them are starting to gain popularity not only for student learners, but also for teacher education (Marsh, Mitchell & Adamczyk, 2010). It has been demonstrated that micro-level interactive features such as being able to skip forward or backwards in a video are more beneficial for learning than macro-level activities like hyperlinks from a table of contents (Merkt, Weigand, Heier & Schwan, 2011). Research have shown that students achieve better performance and were more satisfied when interactive videos are used in their e-learning environment (Zhang, Zhou, Briggs & Nunamaker, 2006).

The advent of flipped classrooms is in part a response to the particular learning preferences of millennials. Millennials, defined as individuals born between 1982 and 2002 (Wilson & Gerber, 2008), show a decreased tolerance for lecture-style dissemination of content (Prensky, 2001), and at the same time, a preference for 24/7 connectedness to information, environments that support multitasking, and an inclination toward group activities and the social aspects of learning (McMahon & Pospisil, 2005). Yet, even among millennials exist a plurality of learning styles, and a knowledge of the learning styles of students is instrumental to laying the groundwork for understanding students' learning performances (Gadzella, Ginther & Bryant, 1997). Kolb's learning theory sets out four distinct learning styles based on a four-stage learning cycle, in which 'immediate or concrete experiences' provide a basis for 'observations and reflections' which can be assimilated and distilled into 'abstract concepts' producing new implications for action which can be 'actively tested' in turn to create new experiences (Kolb, 1984). Although a number of research findings have shown that learning outcomes are effective if students practice study habits according to their learning styles (Anjali, 2015), few research have been done to investigate the relationship between the learning styles of students and their engagement with interactive videos. Such a study is important as it has been reported that students, according to their learning styles, adapt differently to on-campus vs distance education (Tucker, 2000), and in particular to web-based learning (Lee, 2001).

Methods

Research Study Participants

A class of 57 (33 females and 24 males) Year 2 students taking the Business Analytics & Project module in Diploma in Financial Informatics course from School of Information Technology, Nanyang Polytechnic were selected to participate in the research study.

Research Study Treatment

In the past, this module had adopted a traditional teaching approach where topics were delivered in a lecture theatre using presentation slides to a large group of students, coupled with corresponding tutorials with class size of 20. The diverse learning abilities and needs of the students made this heavily conceptual and theoretical module even more difficult, with students scoring less than satisfactory results in certain topics in the mid-term test.

Against this backdrop, the authors had identified the topic 'Data Warehouse Design' for the action research to analyse the effectiveness in using ICT-enhanced videos to help students learn the topic content in SDL mode before attending a flipped classroom with hands-on activities.

In finding a suitable ICT-enhanced learning environment with interactive video features, the authors evaluated various platforms including EdPuzzle, EduCanon and Vialogues before settling for the platform from Zaption with Premium Teacher option. This platform allowed instructor to incorporate interactions such as multiple-choice quizzes, open-ended questions and discussion forums directly into the flow of the video lesson. Students had to perform the incorporated tasks before the video could be advanced.

The one-hour lecture on the "Data Warehouse Design" topic was segmented into six smaller churns of self-recorded videos with various interactions incorporated to promote active learning. Students were instructed to learn the content in SDL mode before attending a flipped classroom with hands-on activities in the following week tutorial lesson. They were rewarded with up to 5% of module mark for completing the SDL learning content.

Instructor could view the learning analytics provided in the Zaption platform at both individual and class level before conducting the face-to-face flipped classroom with hands-on activities.

Data Collection

With an intention to explore how students' learning styles could affect their SDL using interactive video, participants were asked to complete a survey to identify their learning styles based on Kolb's experiential learning model which viewed the learning process as a context of people moving between the modes of Concrete Experience (CE/Feeling), Abstract Conceptualization (AC/Thinking), Reflective Observation (RO/Watching) and Active Experimentation (AE/Doing). Experiential learning theory has focused on the concept of learning style using the Learning Style Inventory (LSI) to assess individual learning styles and identified four learning styles that are associated with different approaches to learning: Diverging (CE & RO dominant), Assimilating (AC & RO dominant), Converging (AC & AE dominant) and Accommodating (CE & AE dominant) (Kolb & Kolb, 2005).

To gain insights on students' participation in the learning activities, we downloaded the data captured by Zaption system on each student's viewing time, answers provided for the incorporated interactions, number of attempts to view, skip forward and backwards for all the six video segments.

To assess learning effectiveness in the formative stage, we got the students to take a test with seven multiple-choice questions to assess their understanding on the various concepts covered in the SDL interactive video before the flipped classroom with hands-on activities. Then they took the same test after the hands-on activities to assess their understanding again. For summative assessment, students took a mid-term test two weeks later. In order to assess the effectiveness of the interactive videos used in SDL, we compared the students' mid-term test score on the SDL topic question against a control group with homogenous students from previous year learning the same module topic in a traditional classroom setting. In this question, the students were required to apply higher order thinking to come out with a star schema design based on the given scenario and requirements.

To assess students' learning satisfaction, a learning survey questionnaire was designed and administered to investigate how the students perceived the different content delivery methods had help them learnt the module content. Students were asked to rate the different module content deliveries on a 5-point Likert scale: 1=Poor, 2=Fair, 3=Satisfactory, 4=Good, and 5=Excellent. They were also asked to provide written comments to justify their ratings. Quantitative responses were analysed using descriptive statistics, means and standard deviations. Qualitative free responses on why the participants found a particular content delivery helpful or not helpful were collected and manually screened and themed under the common reasons that had the highest frequency.

Results and Discussion

Out of 57 students in the class, we managed to collect data from 56 students with most items adequately responded to for analysis, which in turn were finally analysed and discussed in the following sections.

Insights on Student's SDL Participation

First of all, we would like to find out if the students had actually accessed the learning content in SDL mode before attending the face-to-face flipped classroom session. From the data captured in the Zaption platform, we managed to summarise the students' participation in the six-part interactive video according to their learning styles in Table 1 below:

Table 1: % of Students' SDL Participation by Learning Styles

Learning Style	Part 1	Part 2	Part 3	Part 4	Part 5	Part 6
Diverging	100%	100%	100%	100%	100%	100%
Assimilating	100%	100%	100%	100%	100%	100%
Converging	100%	100%	100%	100%	98.2%	98.2%
Accommodating	100%	100%	96.4%	94.6%	91.1%	89.3%

From this table, we could see that all students started their learning in SDL mode, with 87.5% of them participated in all the six parts. One student with "Converging" learning style stopped learning after part 2. Among students with "Accommodating" learning style, two stopped after part 2, three stopped after part 3, five stopped after part 4 and six stopped after part 5. This result was not surprising as students with "Accommodating" learning style generally prefer more 'hands-on' with feeling and doing rather than watching videos and completing reflection exercises.

Next, we would like to examine how the students had actually used the interactive videos to learn the content in SDL mode. Using the data downloaded from Zaption platform, we managed to summarise the students' usage patterns according to their learning styles in Table 2 below:

Table 2: Students' SDL Usage Patterns by Learning Styles

Learning Style	N	Mean Attempts to View All Parts	Mean Time Spent (mins)	Mean Attempts to Skip Forward	Mean Attempts to Skip Backward
Diverging	12	9.8	34.8	30.8	23.6
Assimilating	7	8.3	31.4	26.0	17.1
Converging	12	9.8	31.6	41.7	21.4
Accommodating	25	8.5	31.4	28.8	19.3
All	56	9.1	32.3	32.4	21.5

From this table, we could see that students with "Diverging" (feeling & watching) and "Converging" (thinking & doing) learning styles had higher average number of attempts to view the learning content. Students with "Diverging" learning style also spent more time to complete the SDL learning activities than the other students. However, these observed figures are not convincing enough to claim significant differences between the means across different learning styles from one-way Anova test.

Learning Effectiveness

To analyse learning effectiveness, we summarised the students' scores from the pre- and post-test taken before and after the flipped classroom with hands-on activities, as well as the mid-term test question on the SDL topic into mean scores according to their learning styles in Table 3 below:

Table 3: Students' mean scores (100 based) by learning styles

Learning Style	N	Pre-Test	Post-Test	Test Improvement	Mid-Term Test
Diverging	12	32.5	81.7	49.2	69.8
Assimilating	7	43.0	95.3	52.3	68.6
Converging	12	40.3	90.5	50.2	73.3
Accommodating	25	35.9	87.1	51.2	70.5
All	56	37.2	87.7	50.6	70.5

From the Pre-test results in this table, it showed that the students did learn some module content before attending the face-to-face flipped classroom session, where students with "Assimilating" and "Converging" learning styles scored slightly better than the others. From the Post-test results, we could see that the mean scores improved by about 50 marks across all the four learning styles. The effect size of the mean score (Cohen's d) for measuring the magnitude of difference in mean between the pre- and post-test is computed to be 2.6462, indicating a large effect gained from the face-to-face flipped classroom with hands-on activities. According to the instructors' feedback, the improvement in mean score could be attributed to the data provided by Zaption on each student's view and answers to the incorporated tasks in the videos which had enabled them to quickly identify learning gaps and adapt instructions at the class and individual level more accurately.

To compare the learning effectiveness between the control and experimental groups, the mean scores of the mid-term test of both groups are depicted in chart 1 below:

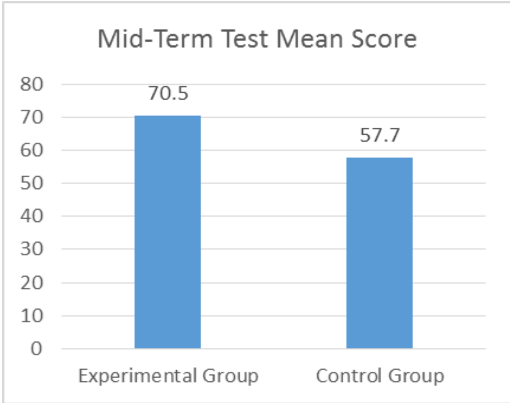

***Chart 1**: Comparing students' mid-term test mean score*

From Chart 1, we can see that the use of interactive videos with learning analytics had provided students with a more effective learning platform than traditional one without the ICT tools, with experimental group achieving a mean score of 70.5 marks over control group of 57.7 marks. The effect size of the mean score (Cohen's d) for measuring the magnitude of difference in mean between the two groups is computed to be 0.6811, indicating a medium effect on the use of interactive videos with learning analytics in the improvement of mean score.

Learning Satisfaction

The level of student satisfaction on the use of different module content deliveries was based on the learning survey feedback collected from the experimental group after the mid-term break. The results showed that the interactive videos were perceived as favorable as the face-to-face lectures with a mean rating of 3.95. The breakdown of the ratings is depicted in Chart 2 below:

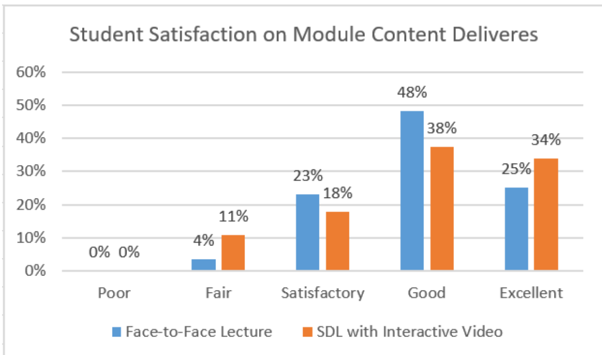

***Chart 2**: Students' satisfaction on Face-to-Face lecture and SDL with interactive videos*

From this chart, we could see an affirmative answer with 90% of the students surveyed found the use of interactive videos as a learning platform in SDL mode satisfactory and 72% had rated it good and above. According to the qualitative responses given, the two top cited reasons were "the ability to replay the videos" and "enhanced understanding gained from clear and well-structured videos".

Conclusions and Recommendations

In this paper, we presented our action research project on using interactive videos via a proprietary online platform that allowed instructors to embed interactivity into videos, in a flipped classroom for SDL on a specific topic. The students' test results had validated the learning effectiveness of using interactive videos as an SDL tool. The satisfaction of students had also confirmed their acceptance on replacing traditional face-to-face lectures with ICT-enhanced videos which promote active learning. The introduction of learning analytics as a key instrument to shorten delays between data collection and intervention on students' learning, had enabled the instructors to identify areas where students were weak in to quickly and accurately improve on their module delivery.

With the positive outcomes gained from this action research study, we recommend further action could be taken to export and embed these interactive videos lessons into the school's Learning Management System (LMS). This will allow synchronisation of the students' grades obtained from the video lessons into the LMS's gradebook directly to cut down administrative overhead in creating students' groups and accounts on a separate platform. Further research could be done to explore on the students' learning styles and their engagement patterns in SDL to help instructors understand students' learning preferences and design more engaging videos for differentiated learning in the future.

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MARITIME ENGLISH SEMINAR WITH INSTRUCTORS FROM MAAP PHILIPPINES ADOPTED IN MARITIME TECHNOLOGY DEPARTMENT CURRICULUM IN FIVE NIT COLLEGES IN JAPAN

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Abstract

The maritime technology departments in the five National Institute of Technology (NIT) colleges in Japan namely Toyama, Toba, Hiroshima, Yuge and Oshima are working together to enhance motivation and ability of the students to be international maritime officers and ship managers at sea through "Maritime human resources developing project" sponsored by the Japanese Government. Maritime Academy of Asia and the Pacific (MAAP) in Philippines collaborated with K Line Maritime Academy Philippines (KLMAP) to develop a new international internship program. After this, Yuge and Oshima colleges invited English instructors from MAAP and requested them to conduct the "Maritime English Instructor's Training Course", "Student's onboard ship training in English", and "Daily English conversation educational program" for maritime colleges. New teaching style, discussion learning, role play active learning, U shape seat arrangement, among others, were first introduced to Japanese instructors and then applied in the classes. "Onboard Fire Fighting training in English" was held in Oshima College. The statistical results of pretest and posttest for the program were reported in the paper. The content of program has already been edited and published into the textbook entitled "Let's Enjoy Maritime English". Then it will be introduced into the common curriculum in five NIT maritime colleges.

Now, we suggest that the English training combined with the internship program in the Philippines should be affordable for every student in maritime colleges.

Keywords: *MAAP in Philippines, Five NIT colleges in Japan, Maritime human resources developing project, Maritime English Seminar, Common curriculum*

Introduction

The maritime technology departments in the five NIT colleges in Japan namely Toyama, Toba, Hiroshima, Yuge and Oshima are working together to enhance motivation and ability of the students to be international maritime officers and ship managers at sea through "An approach to study method easy to understand and to fix in maritime department - All maritime college study method improvement project" from 2006 to 2011 (2013) and "Development of human resources training system with corporation between college and industry in maritime area - Maritime human resources developing project" from 2012 to 2017 (2012)(2013) sponsored by the Japanese Government.

To develop a new international internship program, Maritime Academy of Asia and the Pacific (MAAP) in Bataan and K Line Maritime Academy Philippines (KLMAP) in Central Manila were surveyed in February 2013 (2014). Unfortunately, we could not get an understanding and cooperation for this program at colleges due to the security condition of the Philippines.

MAAP held "the maritime English instructors' training course", for instructors from Japan, Indonesia, Thailand, Myanmar and Vietnam sponsored by the Japanese non- government organization in September 2013 (2012). This seminar gave a basic idea to "Professional maritime English instructor's training seminar" and "Professional student's onboard ship training" for five NIT maritime colleges.

Class and evaluation

Yuge College invited two English instructors, Jane MAGALLON and Ma. Celeste ORBE, from MAAP and requested them to conduct the seminars for two weeks sponsored by "Maritime human resources developing project" in November 2013. Subsequently, Oshima, Hiroshima and Yuge College invited Jane MAGALLON from MAAP again in 2014 and 2015. This time, the seminar was performed for instructors and for students at the same time for one each week. New teaching style, discussion learning, role play active learning, U shape seat arrangement, among others were first introduced to Japanese instructors and then applied in the classes (see Photo 1).

Photo 1 Seminar view with active learning for 3rd grade students at Oshima College

On board ship training were provided in English with school training ship, Yuge Maru at Yuge College and Oshima Maru at Oshima College. Yuge Maru travelled from Yuge port to Matuyama port through Kurushima channel for 2nd grade students in common course before separating into Navigation and Engineering course for 2 days in November 2013. Kurushima channel is very famous rapid and strong current in very narrow channel and have special navigating rule. Role playing of “starting main diesel engine”, “starting diesel electric generator”, “departing port procedure”, “arriving port procedure”, etc. were done in this on board ship training (see Photo 2).

On board ship role playing of fire-fighting and trouble shooting for deck winch were conducted at Oshima Maru for instructors in November 2014. Before role playing, the scenario were made in detail based on IMO Standard Marine Communication Phrases (SMCP), and discussed each other. Movies were taken and reviewed and discussed after the role playing. Photo 3 shows the active learning of fire-fighting training on board.

Photo 2 Active learning of starting the diesel electric generator on Yuge Maru

Photo 3 Active learning of fire-fighting training on Oshima Maru

Questionnaire for how much students can enhance their motivation to be seaman through the seminar was sent out at the end of the seminar. Next shows a list of questionnaire about it.

Questionnaire for MAAP Maritime English seminar. Just choose one number from listed below for each question. 1: Very false 2:False 3:Neither true and false 4:True 5:Very True

Q.1 Do you understand teacher's instruction in English? Q.2 Do you like this seminar style (presentation, roll play, work shop and etc.)? Q.3 Can you join the seminar proactively? Q.4 Can you enhance your motivation to communicate with foreigner through the seminar? Q.5 Can you enhance your motivation to study maritime English through the seminar? Q.6 Can you understand what kind of maritime English is needed as seaman? Q.7 Is the seminar useful for passing seaman license examination? Q.8 Can you enhance your motivation to be international ship officer and ship manager at oversea through the seminar?

The pretest and posttest were conducted before and after the seminar to evaluate the educational effect of the seminar. Next shows example questions for 3rd grade in the engineering course at Oshima and Hiroshima College. Pretest and posttest are composed with same question set. They differ with grade and college depending on the content of the seminar.

MARITIME ENGLISH Pretest and Posttest
Read the questions carefully and choose the best answer. Circle the letter of your answer.

1. Where do you see the graphic panel? (A. control room B. engine room C. bridge) 2. What is the purpose of the generator? (A. source of heat B. gives electric power C. makes fuel) 3. The _____ controls the flow of the liquid in any pipe. (A. steering B. pump C. valve) 4. What is the main component of the valve? (A. body B. stem C. bonnet) 5. What do you call the book in the engine department that has all the information of the engine room? (A. bellbook B. logbook C. manifest) 6. What machinery in the engine room that has combustion to make power stroke? (A. generator B. purifier C. main

engine) 7. What is the first event in a four-stroke engine? (A. compression B. power stroke C. suction) 8. What connects the piston and the crankshaft? (A. piston rod B. crank C. cylinder)

Result and discussion

Figure 1 to 4 show statistical results of the questionnaire survey of motivation enhancement in percentage at each grade at Yuge College in the seminar of November 2015. All sectors show gain of motivation through the seminar. The motivation increases with increasing grade which was similar behaviour among other maritime colleges. It is because of the increased level of understanding of English as its grade level increases. We conclude that the seminar is successful to enhance their motivation to be seaman.

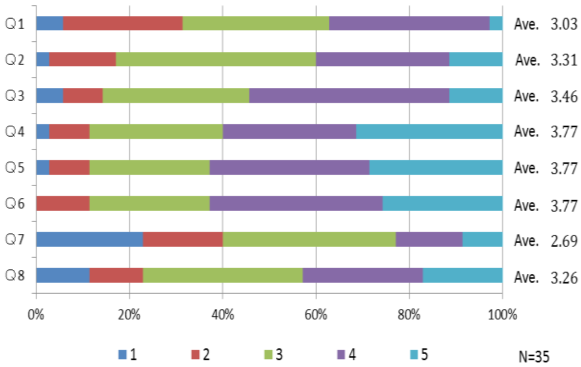

Fig. 1 Statistical results of the questionnaire survey of motivation enhancement at 4th grade at Yuge College

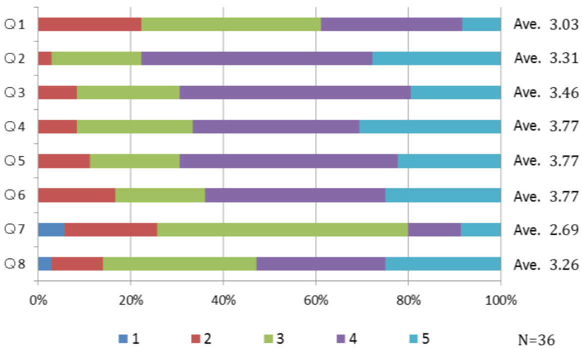

Fig. 2 Statistical results of the questionnaire survey of motivation enhancement at 3th grade at Yuge College

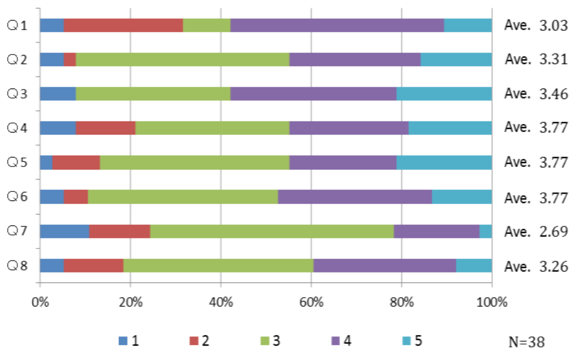

Fig. 3 Statistical results of the questionnaire survey of motivation enhancement at 2th grade at Yuge College

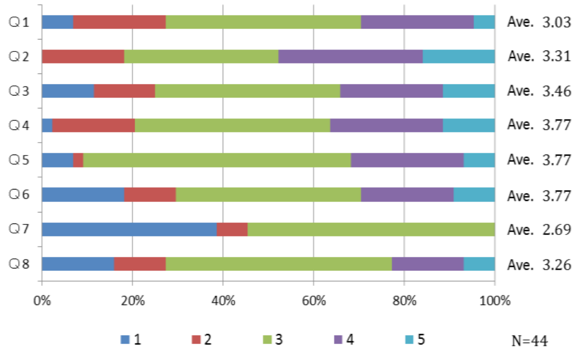

Fig. 4 Statistical results of the questionnaire survey of motivation enhancement at 1th grade at Yuge College

Table 1 and 2 show statistics result of score gain between pretest and posttest at each grade in engineering course at Hiroshima and Oshima College in the seminar of November 2015. They checked true or false at each question, give a score 1 for true and 0 for false and input into Microsoft Excel files. Score for each question is added and gain score for each student is computed by subtracting pretest score from posttest score. The score is totalled in the class and normalized with number of total students in the class.

Table 3 show statistics results of score gain between pretest and posttest at each grade in common, navigation and engineering course at Hiroshima and Oshima College in the seminar of November 2015. All results show score gain after the seminar. However, it is a little bit small because the seminar is very short in time, seven hours each for Oshima and four hours each for Hiroshima. The seminar needs a longer time span such as a month or a semester. We conclude that the seminar successfully enhances professional English communication ability for future seaman.

Student No	Pre Test									Post Test									Gain Score
	1	2	3	4	5	6	7	8	Tot Al	1	2	3	4	5	6	7	8	Tot Al	
1	1	1	1	0	0	1	1	0	5	1	1	0	0	1	1	1	0	5	0
2	1	1	0	0	0	1	1	0	4	1	1	0	1	1	1	1	0	6	2
3	1	1	1	0	0	1	0	0	4	1	1	1	1	1	1	1	1	8	4
4	1	1	1	0	0	1	1	1	6	0	1	0	0	1	1	1	1	5	-1
5	1	1	1	0	0	1	0	0	4	1	1	1	0	0	0	0	0	3	-1
6	0	1	1	1	0	1	0	0	4	1	1	0	1	0	1	1	1	6	-1
7	1	1	1	0	0	1	1	1	6	1	1	1	1	1	1	1	1	8	2
8	1	1	0	0	0	1	1	1	5	1	1	0	0	1	1	1	1	6	1
9	1	1	0	0	0	0	1	0	3										
10	1	1	0	0	0	1	0	1	4	1	1	1	1	1	1	1	1	8	4
11	1	1	0	0	1	0	0	0	3	0	0	0	0	1	0	0	0	1	-2
12	1	1	0	0	0	1	0	1	4	1	1	0	0	1	1	1	1	6	2
13	1	1	0	0	0	1	1	1	5	1	1	0	0	1	1	1	1	6	1
14	1	1	1	0	0	1	1	0	4	1	1	1	1	1	1	0	1	7	3
15	1	1	0	0	0	1	1	0	4										
16	1	1	0	0	0	1	1	0	4	0	1	0	0	0	0	1	0	2	-2
17	1	1	1	1	0	1	1	1	7	1	1	1	0	1	1	0	0	5	-2
18	0	1	1	0	0	1	0	1	4										
19	1	0	0	0	1	1	0	1	4	0	1	1	1	1	1	1	1	7	3
20	1	1	1	1	0	1	0	0	5	1	1	0	1	1	1	1	0	6	1
21	1	1	1	0	0	1	1	1	6										
22	1	1	0	0	0	1	1	1	5	1	1	0	0	1	1	1	1	6	1
23	1	1	1	1	0	1	0	1	6	1	1	1	1	1	1	1	1	8	2
																			17

Table 1 Statistics result of score gain between pretest and posttest at 3rd grade in engineering course at Hiroshima College in the seminar of November 2015.

Student No	Pre Test									Post Test									Gain Score
	1	2	3	4	5	6	7	8	Tot Al	1	2	3	4	5	6	7	8	Tot Al	
1	1	1	0	0	1	1	1	1	6										
2	1	1	0	0	0	0	0	0	2	1	1	1	0	1	1	1	1	7	5
3	1	1	0	0	1	1	1	1	6	1	1	1	0	1	1	1	1	7	1
4	1	1	1	1	0	0	1	1	6	1	1	1	0	1	1	1	1	7	1
5	1	1	1	0	1	1	1	1	7	1	1	1	0	1	1	1	1	7	0
6	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	1	1	7	7
7	1	1	1	1	0	1	1	0	6	1	1	1	0	1	1	1	1	7	1
8	1	1	1	0	0	1	0	0	4	1	1	1	0	1	1	1	1	7	3
9	1	1	1	1	0	1	1	0	6	1	1	1	0	1	1	1	1	7	1
10	0	1	1	0	1	0	1	1	5										
11	1	0	1	0	1	1	1	1	6										
12	1	1	1	1	0	1	1	1	7										
13	1	1	1	1	1	1	1	1	8	1	1	1	0	1	1	1	1	7	-1
14	1	1	1	0	0	1	1	1	6	1	1	1	0	1	1	1	1	7	1
15	1	1	0	1	1	1	1	1	7	1	1	1	0	1	1	1	1	7	0
16	1	1	0	1	1	1	1	1	7	1	1	1	0	1	1	1	1	7	0
17	1	1	0	1	0	0	0	0	3										
18	1	1	0	0	0	0	1	1	4										
19	1	1	1	0	0	1	0	1	5	1	1	1	0	1	1	1	1	7	5
20	1	1	1	0	0	1	1	1	6	1	1	1	0	1	1	1	1	7	1
21	1	1	1	0	1	1	1	1	7	1	1	1	0	1	1	1	1	7	0
22	0	1	0	1	1	1	1	1	6	1	1	1	0	1	1	1	1	7	1
23	1	1	0	0	1	1	1	1	6	0	0	0	0	0	0	0	0	0	-6
																			20

Table 2 Statistics result of score gain between pretest and posttest at 3rd grade in engineering course at Oshima College in the seminar of November 2015.

	1st Common	2nd Common	3rd Navigation	3rd Engine
Hiroshima	0.5952	1.2308	0.6666	0.8947
Oshima	0.875	2.1944	2.6316	1.1111

Table 3 Statistics result of score gain between pretest and posttest at each grade in common, navigation and engineering course at Hiroshima and Oshima College in the seminar of November 2015.

Summary

The content of program has already been edited and published into the textbook entitled “Let's Enjoy Maritime English” (2016). Then it will be introduced to the common curriculum in five NIT maritime colleges (2017). Now, we suggest that the English training combined with the internship program in the Philippines should be affordable for every student in maritime colleges.

In the future, the international internship program in Manila or Cebu areas will be encouraging that maritime college students can put in practice the English training smoothly in the Philippines. It could be expected as one of the countries in Southeast Asia for the international exchange, where is affordable cost and security.

Acknowledgment

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1202

THE FIRST SEMESTER OF THE MEXICAN KOSEN AT THE UNIVERSITY OF GUANAJUATO

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Abstract

The University of Guanajuato offered the Technological High School with an International Profile Program, best known as Mexican Kosen, in August 2015 for the first time. The results of the first semester from the first generation of students are now available. The purpose of this paper is to analyze and show these results as well as to compare them with the results of the General High School Program students in the same institution, referring only to Guanajuato city high school. The reason to compare both programs is because they had the same admission instrument, so all students had the same starting point. As with all new projects or programs, it's very important to take a step back to evaluate every stage of the process. I consider this information as necessary to help determine the direction of the next semesters and to identify the key elements to focus on. I obtained all the information used in this paper from the Integral System of Administrative Information (SIIA by its initials in Spanish) of the University of Guanajuato. I had access to the final grades of the semester of students from both programs, as well as statistical information by program, generation and subject. I found that Mexican Kosen students had good grades as a final result of their first semester, individually and as a generation. Almost 90% of the students had satisfactory grades, and most of them had a result over 80%. Their average results as a generation are higher than those of the General Program students. I also made a comparison by subject, choosing those with similar contents between both programs and the Mexican Kosen students had better results. The findings in this paper show that the obtained results meet the expectations for the first semester of the Mexican Kosen, and students are having better results as a generation than General High School Program students, despite having the same starting conditions. The factors for this difference in results represent the elements to observe in the development of the program.

Keywords: *Mexican Kosen, new program, comparison, results, motivation, first generation*

Introduction

The University of Guanajuato (UG) has a history of 26 years of academic collaboration with Japan. This collaboration has produced agreements with seventeen institutions in Japan so far, including a double degree system for two academic programs at UG. One of the most recent agreements was the creation of a Technological High School Program with an International Profile in the University of Guanajuato, based on the model of Japanese Kosen Colleges, and with the collaboration of the National Institutes of Technology of Nagaoka College, Ibaraki College, Oyama College and Fukushima College.

This new program, best known as Mexican Kosen, was offered for the first time in August, 2015 by the University of Guanajuato. On the first stage of the program, it started in two schools, the Materials Science course at Guanajuato City High School and the Mechatronics course at Salamanca High School. Students at these programs can acquire specialized knowledge on the two offered fields, aiming to be part of the growing manufacturing sector in the state of Guanajuato, mainly Japanese owned industries.

The present paper is an analysis of the results of the first generation at the Guanajuato City High School program, on their first semester. I refer to this school because it is my working place and I had access to the required information. This school offers now two programs, the Technological High School Program (THSP) and the General High School Program (GHSP), which has been operating since 1828. The two programs are very different, but they share two similar aspects, 1) there are four subjects with similar content between both programs on their first level, and 2) they had the same instrument of selection (admission test). Part of the analysis is based on these two similarities, as a point of comparison to better understand the development of the first generation of students at the new program, to evaluate every stage of the process and to determine the direction of the program for the next semesters.

Materials and Methods

All the information used in this paper comes from the Integral System of Administrative Information (SIIA by its initials in Spanish) of the University of Guanajuato. I had access to the final grades of the semester of students from both programs, General and Technological, as well as statistical information by program, generation and subject. All the information from every student at the University of Guanajuato is registered on this online system. I collected the information on final grades for the THSP students, as well as the statistical information of the GHSP students.

As I mentioned on previous lines, there are four subjects at the technological program which can be compared with similar subjects at the general program, according to the contents. *Table 1* shows the similarities and differences of the considered subjects between both programs.

Table 1. Information on subjects with similar content from the General High School Program compared with the first semester of the Technological High School Program at the University of Guanajuato.

	Algebra	Chemistry	Physics	ICT
Name at GHSP	Algebra I	Chemistry I	Physics I	Information and Communication Technologies I
Name at THSP	Algebra I	Chemistry I	Kinematics, Dynamic and Work - Energy	OS and Electronic and Digital Documents
Hours a week at GHSP	5	4	4	3
Hours a week at THSP	3	3	3	3
Level at GHSP	1	2	3	1
Level at THSP	1	1	1	1

The analysis and comparisons presented in this paper are based on these four subjects. The first part of the analysis shows the individual results obtained by each member of the group of the Technological High School Program. The grading system in this school works in a scale from 0 to 10, being 10 the highest possible grade for a student to obtain. The passing grade at UG is 7.0, so a grade equal or above seven is considered satisfactory.

The second part of the analysis focuses on the comparison between both programs at Guanajuato City High School. The comparison is made on the same four subjects mentioned before, considering the Passing Rate and the Average Grade. The Passing Rate is the percentage of students with a satisfactory grade over the total of students with an obtained grade for every subject. The Average Grade is the mathematical average of all the grades obtained by the students for every one of the four considered subjects. Only the numerical grades were included in the average.

It's important to mention that the professors who teach at the new program also work on the general program, so I was able to consider that the methodology and evaluation criteria is also similar between both programs.

Results and Discussion

The first part of the analysis refers to the individual results. *Table 2* shows a summary of the grades obtained by the first generation of the Technological High School Program with an International Profile on their first semester, considering only the four comparison subjects as mentioned earlier.

Table 2. Results obtained by the students of the Technological High School on the semester August – December 2015.

Student	Algebra	Chemistry	Physics	ICT	Average Grade
1	10	9.5	9.5	9.5	9.625
2	10	9.5	9	9.5	9.5
3	10	9	9	9.5	9.375
4	10	8.5	9.5	9	9.25
5	9	9	8	9.5	8.875
6	10	8	8	9	8.75
7	8.5	9	8	9	8.625
8	8	9	8	9	8.5
9	7.5	8.5	8.5	8	8.125
10	7.5	8	7.5	8.5	7.875
11	7	8	7	8	7.5
12	7.5	7.5	7	7.5	7.375
13	7	7.5	6	8	7.125
14	5.5	7.5	6.5	8.5	7
15	4.5	7.5	4.5	7.5	6

The results obtained individually by the students are of a good level. 14 of 15 students (93%) obtained a satisfactory average grade, 12 of 15 students (80%) passed all their subjects at their first attempt, and 9 of 15 students (60%) obtained an average grade above 8.0. These results are considered very satisfactory according to our school standards.

On comparing both programs at Guanajuato City High School, I considered the Passing Rate and the Average Grade by subject. *Table 3* shows the obtained Passing Rate by students of both programs arranged by subject, and the resulting graphic of these percentages is shown on *Figure 1*.

Table 3. Passing Rate by subject of students at Guanajuato City High School, compared between General and Technological Program.

	PR GHSP	PR THSP
ALGEBRA	67.4%	86.7%
CHEMISTRY	75.8%	100%
PHYSICS	63.2%	80.0%
ICT	97.4%	100%

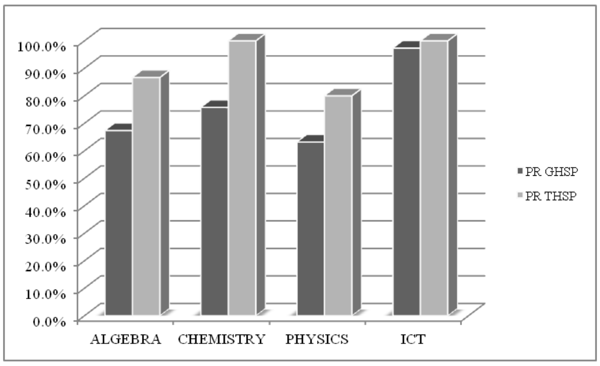

Figure 1. Graphic representation of the Passing Rate by subject of students at Guanajuato City High School, compared between General and Technological Program.

The passing pate of the students at the Technological High School Program is higher than the passing rate of the students at the General Program in all four subjects, as it's shown on the Graphic representation in Figure 1.

The second part of the comparison is based on the average grade calculated by all the obtained grades of students from both programs, by every one of the compared subjects. *Table 4* shows the result of the calculated average by subject and by program.

Table 4. Average Grade by subject of students at Guanajuato City High School, compared between General and Technological Program.

	AG GHSP	AG THSP
ALGEBRA	7.1	8.2
CHEMISTRY	7.5	8.4
PHYSICS	7.2	7.7
ICT	8.3	8.7

These results show that the average grades of the Technological High School Program students are also higher than the General High School Program students, as clearly seen on *Figure 2*. This is observable for all four considered subjects.

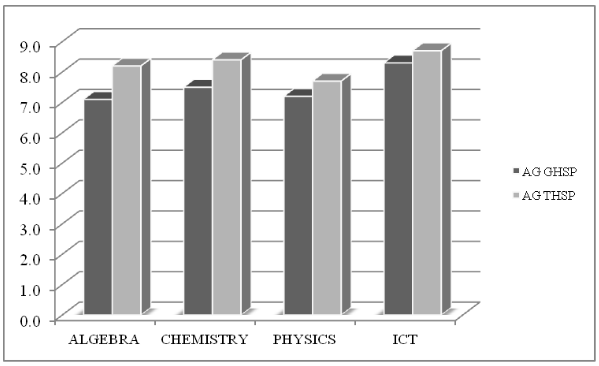

Figure 2. Graphic representation of the Average Grade by subject of students at Guanajuato City High School, compared between General and Technological Program.

Conclusions

The Mexican Kosen is a very important project at the University of Guanajuato. There are a lot of people working to make it a succesful addition to the University Programs, including the international collaboration with the Japanese institutions. The expectations for the fisrt generation of the Technological High School with an International Profile are very high and the results will determine the direction of the program for future generations. The grades obtained by the Guanajuato City students for the past semester are good, and they bring a good prospective to the development of the generation as well as the program.The indivual results are very satisfactory, with very few exceptions and their average results as a generation are higher than those of the General Program students in all four considered subjects, algebra, chemistry, physics and information and communication technologies (ICT). The findings in this paper show that the obtained results meet the expectations for the first semester of the Mexican Kosen, and students are having better results as a generation than General High School Program students, despite having the same starting conditions.

The factors for this difference in results are as important as the results themselves. There wasn't a specific selection method for the admission of the students. They came from the same middle schools as the general program students, took the same test, and study in the same facilities with the same professors. I believe that the main difference in this process is the motivation. The students know that this is a special program, with a high level profile. They know that they're taking subjects of higher levels compared to the general program, and also that their results will translate in better opportunities in the professional and international aspects of their careers. So they are working very hard, and they are directing their efforts according to their goals, developing at a different speed than the General High School program students. This discussion on motivation and attitude should be analyzed particularly and in a deeper level on further research opportunities.

The results obtained by this analysis are encouraging and motivating for all the people involved in the project, and it will be very interesting to witness the future results of this first generation of the Mexican Kosen.

Acknowledgements

I wish to acknowledge the director of Guanajuato City High School, Juana Silvina Galván Rocha, for all the information of the program and her ideas and opinion on the direction of this paper, being also co-author of it. The University of Guanajuato High School System Office for allowing me to get involved on the program and share with me all the information about it. All the people at The University of Guanajuato who make the Integral System of Administrative Information (SIIA) work, not only for this information, but for all the support in every University process.

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1203

DEVELOPMENT AND OPERATION OF ENGINEERING DESIGN EDUCATIONAL PROGRAM COOPERATED WITH LOCAL COMMUNITY

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Abstract

In order to train engineering design ability for the students in advanced course in Tsuruoka college, the unique program has been developed and operated. This program includes three policies; 1) cooperation with the local community type education, 2) grouping by mixing different subject-of-study, 3) training camp activities at off-campus area.

Time schedules of the program is as follows; I) preliminary investigation; investigation about target area and suitable engineering technologies assisting the community (8hrs), II) camp activity in local area; field study, lecture, meeting, etc. 32～48hrs (4～6days), III) group work in campus; continuing manufacturing(26hrs = 2h /weeks ×13weeks), IV) presentation; proposal about their design or products toward the citizens (8hours), V) others; additional activity time(0～6 hrs)

After the preliminary meetings between teaching staffs and official staffs in the local government, main theme was designed. This program have been executed in local area, Sagae city park and Tobishima island in Sakata city in Yamagata prefecture, to tackle the problems peculiar to the areas. Detailed contents were proposed from students by inspection at target area. In Sagae city, for example, the students tried repairing the park bench, and manufacturing the park signboard. In Tobishima island they proposed and manufactured solar cooker and the rocket heater, etc. The debrief session for the citizens about results obtained from this activity was held at "Environmental fair in Tsuruoka" as large environmental event in the city held on Sep. 21, 2014, and Sep. 27, 2015 in the city gymnasium. Students presented in form of poster and exhibiting the manufacture products. By experiencing the program, the students themselves realized the progress especially in motivation to the activity, contribution to local community, and cooperation and communication in group.

The scholastic evaluation for students concerning of this program was judged by the following aspects and using score distribution: 1. evaluation from auditor in presentation, 2. evaluation from the teacher in charge in presentation, 3. resulting report after practice, 4. activity in this practice.

Keywords: *Engineering Design, Local Community, Training Camp, Advanced Corse, Group Activity*

1. Introduction

The industrial technical society has been highly developed in recent years, and its complication, compounding and upgrading, have been increased rapidly. In the educational curriculum "engineering design" is most essential subject of so-called *active learning*. In this subject the students learn how to achieve manufacturing the objects or proposing systems fulfilling social needs by integrating various knowledge and technologies[1]. The program tackles the problems which do not necessarily have a correct one answer, and finds out the realistic solutions. The engineering design ability includes various factors such as problem setting, creativity, integration of various knowledge, communication skills, and teamwork ability, and so on. From 2012 in Tsuruoka college, the new subject named "practical design engineering exercise" has been opened for the students in 1st year of advanced course. This paper describes construction and operation of the new program as a training of engineering design. The scope of this subject includes three policies; 1) Cooperation with local community, 2) Grouping by mixing different subject-of-study, 3) Training camp activities at off-campus area[2, 3].

2. Proposed Program

In order to carry out the design education program effectively, details of those three policies are described as follows:

1) Cooperation with local community; Students recognizes clearly the problems peculiar to the local area, and make effort to draw solutions from various view of points. In the program we tackled the subject in connection with the design of city park in Sagae city and making eco-house in Tobishima island in Sakata city. The activity area and main theme were determined by repeating the arrangement beforehand between the teachers and corresponding local government staffs.

2) Grouping by mixing different subject-of-study; The group comprised of students was composed by mixing of different subject-of-study, i. e., departments of mechanical engineering, electrical and electronic engineering, control and information systems engineering, and chemical and biological engineering(Fig. 1). The aim of such grouping is that the students tackle the problems from various aspects.

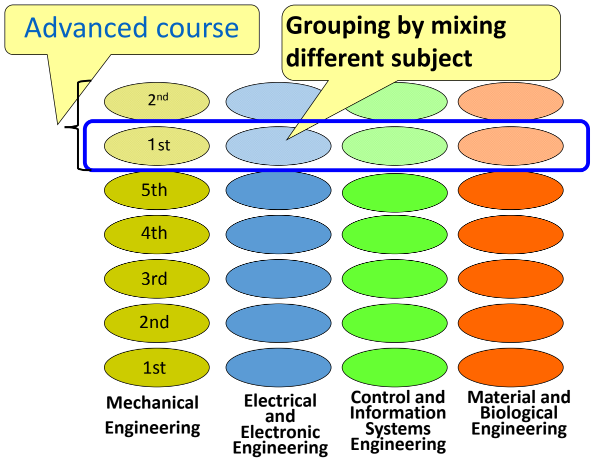

Figure 1 Concept of grouping by mixing different subject.

3) Training camp activities at off-campus area; Training camp was carried out for the students to understand the values of collaboration and the responsibility of the individual in groups. As other purpose, the students can concentrate on activity all day. During training camp, lecture meeting by invited visiting lecturer were also held, in order to offer useful various knowledge to the students.

The operation time of this program consists of 90hours(school hours) and is equivalent to two credits. The time arrangement for this program is shown in Table 1.

The scholastic evaluation for students was judged by the following aspects and score distribution:

1. Evaluation from auditor in presentation 40%
2. Evaluation from the teacher in charge in presentation……... 25%
3. The resulting report after practice 25%
4. Activity in this practice 10%

total 100%

Table 1 Time arranmegent for the program.

Contents	Description	Operation turn
1) preliminary investigation	investigation about target area and suitable engineering technologies	8hrs
2) camp activity at off-campus	field study, lecture, meeting, etc.	32 ～ 48hrs (4～6days)
3) group work in campus	continuing manufacturing	26hrs (2h/weeks ×13weeks)
4) presentation	proposal about their design or products	8hours
5) others	additional activity time	0～6 hrs
total		90hrs

3. Practice of Program

3.1 Sagae City Park Project(2012-2013)

In 2012-2013 we had attempted introducing the program toward the Sagae city (Sagae city park project). The purpose of the project is proposing ideas for the park more to be comfortable one for citizens. As a first of the activity, inspection of the city park by students was performed at the Sagae city park. They searched for what are the deficient points in the park facilities. Also, the students began to clean up in the park and to conduct the maintenance-and-repair volunteer(Fig. 2).

Figure 2 Volunteer activities in the city park.

The purpose of this volunteer activity is to find out clearly the deficient points in the park throughout such activities. There is also the purpose of brewing the atmosphere with which the students of a different affiliation subject of study are each other becoming frank. As results of the inspection, many of the comments about deficient points were proposed, e.g., the map signboard for visitor is not found, the wooden benches have been decayed, etc.

The camp activities were carried out at a training camp site placed side in the city gymnasium. The students held the meeting after returning to the site of a training camp, and designed the plan of activities after today. During the training camp, the visiting lecturers were invited and the lecture meetings were held concerning the engineering design. Each of themes of lectures are listed in Table 2. All of lectures contain very helpful information for constructing the ideas of engineering design, and can lead design solution from various views of points. The contents of activity are listed in Table 3.

Table 2 Contents of activity from respective groups .

group	contents
group 1	Repairing the park bench
group 2	Manufacturing the park signboard
group 3	City stamp rally which used QR Code
group 4	Illuminations in the city using a piezoelectric element
group 5	Cafe establishment of the memorial hall contiguous to a park

For example, details of groups 1 and 2 are as follows:
group 1 The old wood blocks of park bench were changed for new ones(Fig.3a, b). Students purchased the new wood blocks from the store and carried out cutting, filing, coating painting, and making screw holes. In particular, the step of making a screw hole was delayed. Because the position of a screw hole should be correctly located, punching the holes toward perpendicular must be very correctly. Punching was performed by the electric twist drill at the park. However, the accuracy in the perpendicular direction was not enough and the screws were not slightly applied to a flame of benches. Then as redo, new woods were purchased and punching were processed by using the driller in the college. By experiencing such basic manufacturing processes, the students would study the important elements in design education, e. g., importance of accuracy of dimensions, and excellency of processing machines.
group 2 Manufacturing the park signboard was processed by combining thinner timber generated in the park and wood blocks purchased(Fig. 3c).

After the camp activity, the remaining manufacturing were continued after returned buck to the college. The debrief proposal for the citizens about this activity was held in Sagae city hall (Fig. 3d). The city personnel, the citizen, and the media representative audited to the debrief session. The park signboard designed and manufactured was presented to the city and was installed in the city park.

(a)

(b)

(c)

(d)

Figure 3 Products and debrief session about the activities. (a)Wooden benche decayed;; (b)Wooden benche repaired(by group 1); (c)Signboard installed (by group 2); (d)Presentation in Sagae city hall.

3.2 Eco-House in Tobishima Island(2014-2015)

Tobishima is only one of remote manned island in Yamagata Prefecture. The area of an island measures 2.7km^2. Population is about 200 persons. An elderly ratio is about 67%. Although the industries are fishing and sightseeing, the industries should be more activated for sustaining the living in the island. After the preliminary meeting with the city staff, it was recognized that social of the island have required interesting events which can attract tourists from mainland. From the meeting the teaching staff decided as main theme in Tobishima "the making eco-house" which is the energy self-support type engineering designs using the natural power sources peculiar to the island. In the future, this activity would support the island sustaining the people's life even if the life-line is broken by a large scale natural disaster. The site of training camp was kindly offered from city staff to use the gymnasium of elementary and junior high schools in island. At the beginning of the camp the students recognized clearly what kind of engineering design is useful for the residents in the island. Features of environment in Tobishima are warm climate and there are many fine days. Solar energy seems to be utilized. Since there are also much driftwoods on the sea side and thinner timbers in woods, a woody fuel is abundant. Therefore, the handmade solar cooker, the rocket heater by burning drift woods, fresh water generation system from sea water, and so on were proposed from the students.

Table 3 Contents of activity from respective groups.

group	contents
group 1	solar cooker
group 2	the rocket heater using drift woods
group 3	vacuum pump for vacuum preservation of the food
group 4	system of making fresh water and natural salt by distilling sea water by burning drift woods
group 5	system of making fresh water generation by evaporating sea water using direct sunlight

Since public transport in the island was poor, the school car was carried for convenience. The students resided in the gymnasium in the school. Meal was prepared by themselves borrowing the kitchen in the school. During the camp period, the lecture meetings were held at the camp site(Fig. 4 a-c).

(a)

(b)

(c)

Figure 4 Examples of camp activity scenes (a) Cooking for meal; (b) Site in gymnasium of elementary and junior high schools; (c) Lecture meeting in the camp site

For example, details of groups 1 and 2 are as follows:
group1 At beginning of making solar cooker, students recognized that the commercial one is expensive and large weight. Therefore it was turned out that low cost and lightweight cooker would be useful. The students tried to make the solar cooker by using familiar materials such as aluminum foils and the umbrella(Fig. 5). As a result of experiments, they found out that temperatures at the light concentrate point rose to 65℃ while the outside air temperature of 29℃. However, it was not able to reach to more high temperature. In order to attain the further temperature rise, improvements such as extending in area of an umbrella and smoothing of irregularity of the surface of aluminum foils should be needed. In addition, the fixation which can resist a wind is required.

Figure 5 Demonstration of solar cooker manufactured.

group 2 A rocket heater is heating apparatus which burns the combustion gas emitted from burning woods. Combustion gas burns in a hot furnace and generate hot air(Fig. 6). The stack chimney draft was attached so that the combustion gas may not flow backwards. The body of the heater was

(a)

(b)

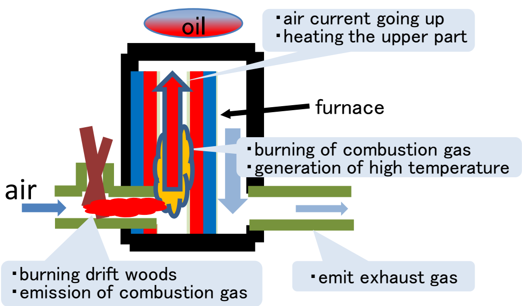

Figure 6 Rocket heater (a) Outside view of heater, (b) Mechanism of heating

manufactured by using the discarded metal container. By burning the driftwoods, the temperatures of oil at the bottom in the pan reached around at 250℃, and the exhaust gas temperature was about at 56℃. It was turn out that a high temperature for cooking or heating can be realized by using this system. In order to improve the durability of the body, it should be made a heat resisting property.

The proposal for the citizens about results obtained from this activity was held at “Environmental fair in Tsuruoka 2014 and 2015” as large environmental event in the city held on September 21, 2014, and September 27, 2015, respectively, in the city gymnasium(Fig. 7). Students presented using the poster and exhibiting the manufacture products.

Figure 7 Proposal in “Environmental fair in Tsuruoka 2014”

After the practice of the program in Tobishima island, the questionnaires to the students were conducted in order to investigate the improvement of a student's consciousness. The self-evaluation, how are the degree of achievement for students in his own consciousness and capability at before and after the program were conducted. Question items are 1. motivation to the activity, 2. contribution to local community, 3. problem solving capability, 4. responsibility, 5. cooperation and communication in group, and 6. confidence. Each of items were evaluated by marking numbers from 1(weak) to 5(strong), and all scores were averaged(Fig. 8)[3,4].

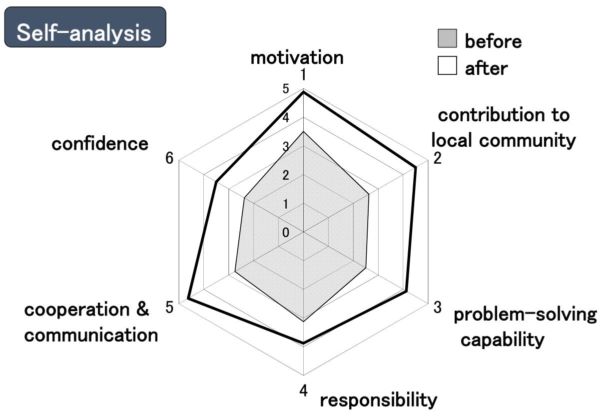

Figure 8 Results of self-analysis by students before and after the program

As shown in the figure, it seems that the students themselves realized the progress in the all items, especially in motivation to the activity, contribution to local community, and cooperation and communication in group. Although completeness of manufacture products was low and there is also much problem, the students realized the fulfillment and responsibility throughout this practice.

3.2 New activities in Tobishima Island (2016)

In 2016 we are trying new theme in Tobishima island. So far, students have been made to do respective theme setting by themselves under the main theme at the beginning of school term. However, since field survey time was short, we were anxious about the degree of achievement of the results which should response to the business solution. Then, in 2016 teaching staff proposed the respective new suitable theme, and made a student can choose the theme. Also here the grouping was composed by mixing of different subject-of-study. The proposed theme is as follows;

1) Development of beach cleaner
2) Producing naturel salt from sea water and its application
3) 3D printer activities
4) Effective removal of a noxious insect (horse fly)

The theme mentioned above would support the local motion trying registration Tobishima into a geopark zone. The rise of opportunity which the local government and resident people cooperate toward the registration is important. Also, understands the nature and culture of the area are important. So that the main theme was set to support for geopark registration. The theme 1 is the manufacturing activities for collecting seashore beach waste and maintaining the beautiful seashore(Fig. 9).

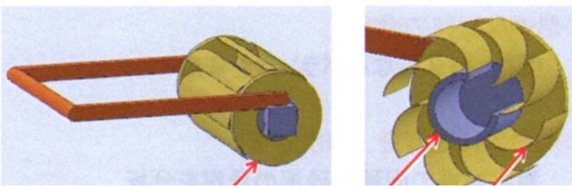

Figure 9 The design figure of a seashore dust cart

The theme 2 is activity for the revival of gastronomic culture which residents have sustained from ancient times. The theme 3 is activity for 3D printer to express topographical information and for Tobishima have familiarity held by many people. The theme 4 is activity for against the horse fly damage to a tourists. The horse fly capture system is being developed. The Results will be reported at elsewhere.

4. Conclusion

Contribution for local type PBL education program for student in advanced course in NCT, Tsuruoka college have been developed and carried out from 2012. This program includes three of unique policies; 1) Cooperation with local community type education, 2) Grouping by mixing different subject-of-study, 3) Training camp activities at off-campus area. Throughout activities, the students realized the fulfillment and responsibility to tackle the engineering problems in local area, which make the students engineer possessing engineering design ability.

Acknowledgments

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A QUANTITATIVE EVALUATION OF LEARNING OUTCOMES AFTER SECOND YEAR OF THEME-BASED CURRICULUM IN HEALTH TECHNOLOGY

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Abstract

A major administrative, government steering and funding reform was implemented in the Finnish Applied Science University system in 2014 and 2015. The change of the funding model implied many revisions in the education programme structures. Helsinki Metropolia University of Applied Sciences (HMUAS) implemented major revisions in our programmes beginning of academic year 2014. Among other things a previously separate programme of Health Technology, was integrated into a much larger programme of Information and Communication Technology as one of its specialisation options. The reform is introduced for background of learning outcome analysis. Programme performance indicators according to the new funding model are retrospectively calculated against the pre-reform student data over four years to establish stabile programme level performance baseline indicators. In particular, we analyse numerically the results of the first year entry cohorts of 2010-2013 during their studies in the old curriculum compared with the theme based integrated approach over two first years of 2014-2016. A cross-comparison of the programmes is presented based on consistently sampled historical data. A longitudinal follow-up of the student cohorts who selected the Health Technology Major in 2015 is traced back to their original entry cohort of 2014 and initial analysis over the two years of sustained good performance is discussed. The realized and significantly improved indicator values were reported. Critical discussion covers some biased and non-biased error sources and the inherent instability of the introduced trigger-level based funding model. Finally some prudent observations on the reliability of our results are discussed, as well as potential directions how the method should be developed in the future are presented.

Keywords: *Curriculum, Health Technology, ICT, Funding model, University reform, Performance, Indicators*

Introduction

Major curricula re-structuring and mergers, including all engineering programmes were implemented in HMUAS at the beginning of academic year 2014. The history and rationale of the reform were discussed in our previous paper (Björn & Soini, 2015). Valmu et. al. (2015) also reported positive learning outcomes after the first year of studies in (HMUAS) Electronics and Electrical Engineering programmes after applying similar principles.

Now two full academic years have passed and our 4-year engineering programmes are mid-way through. This gives an early opportunity to evaluate the results, compared to the earlier curricula, as shown in Figure 1.

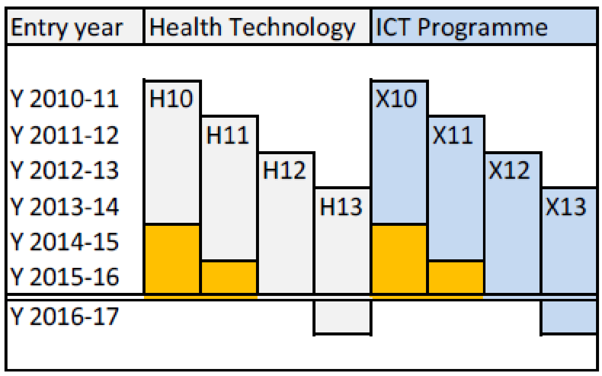

Figure 1: Health Technology and ICT until 2013.

Until the major administrative reform of all UAS's in Finland in 2014, the number and title of engineering programmes was high and largely unregulated. Then many separate engineering programmes we forced to be consolidated to only a few large units, with common student entry. The rationale was to simplify the education system from the applicant point of view and to introduce economics of scale.

In HMUAS we introduced Health Technology in 2008 as a separate entry programme, with a nominal entry of (N=30) students each year. The neighbouring ICT programme was a separate entry and significantly larger. Figure 1 shows the entry years 2010-2013 and their entry groups H10-H13 and X10-X13, respectively.

The figure shows the 4 years of normal study time, followed by until now accrued potential overtime of two years.

Merging of the programmes into a single ICT programme created one student entry point and organisation of ICT related common studies into the first year, shown as ICT14 in Figure 2.

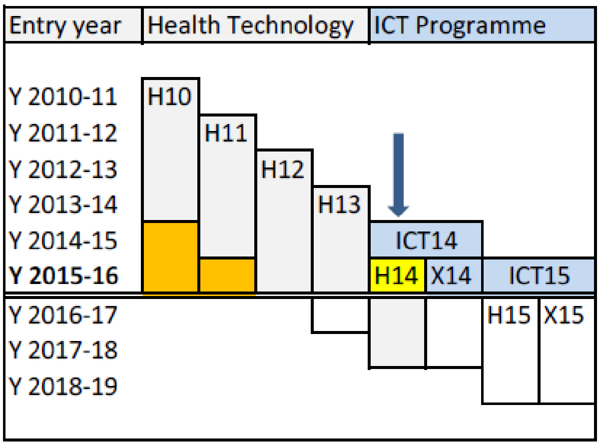

Figure 2: ICT programme merging and reform 2014.

The students would then study same programme and select their Major of interest at the end of the first year. Thus, the Health technology Major is shown as H14 for the second year of studies for academic year 2015-16. The retrospective opportunity is now to evaluate their success during the second year of studies, as well as in principle to trace back their performance also during their first year. There are multiple Majors, and it is out of the scope of this paper to make comparative analysis concerning the first year or between the Majors. Thus they are collectively marked by ICT14 and X14, respectively.

Research Questions

The individual and parallel nature of the two programmes, shown in Figure 1, and the aggregated structure followed after their merger, shown in Figure 2 raise a number of research questions on performance measurement. These include: (1) how to establish comparative performance measures for the pre-reform study groups (Hnn and Xnn) as performance baselines to be referred and to be improved; (2) how to apply the measures during the transition period (ICT14) which affects both programmes with new structure and pedagogical principles; and (3) how to apply these measures consistently on the new Majors again.

This paper is focuses on the H14 studies at the curriculum yearly level as shown in Figure 2. An overall but more detailed structure of the new ICT programme is shown on Figure 3, with length of 240 ECTS (European Credit Transfer System) credit points, equivalent of 4 years or 60 ECTS per year. The second year semester 1 and 2 are equivalently highlighted.

ICT Programme	ECTS	240 Total	
Orientation to ICT		60	
Games and Mobiles	15		
Objects	15		1.Year
Devices	15		
Networks	15		
Foundations of the Major Studies		30	
Physiological Measurement Technology *)			
PMT I	15		
PMT II	15		2. Year
Major Studies			
Customer Oriented Software Applications **)		30	
COSA I	15		
COSA II	15		
Health Technology Devices and Solutions		30	
HTDS I	15		
HTDS II	15		
Innovation Studies		15	
Elective studies		30	
Practical Training		30	
Bachelor's Thesis		15	

Figure 3: Engineering Curriculum Framework in ICT.

The focus of the second research question is to evaluate the second year performance (i.e. first year of the Major in Health Technology, group H14). This group is administratively created independently of the entry group of the students. This allows to sample the students retrospectively from their entry groups, like from the ICT14. Therefore the object of discussion is mainly on gross level of ECTS points earned by the selected group and the resulted average per student.

The most interesting and unstable variable is the number of students who achieve the threshold of 55 ECTS. For comparative purposes this target needs to be expressed as percentage, relative to number of all students; in pre-reform we use entry groups and post-reform we use administrative groups.

A more student learning -oriented parallel paper (Soini & Björn, 2016) describes the learning experience feedback from the first semester of the Health Technology Major (PMT I and PMT II in Figure 3).

Materials and Methods

The research data is sampled from the Health Technology student records of 2010-2013 by entry groups, denoted by H10-H13. The ICT programme is an order of magnitude larger and runs on two campuses. The equivalent entry group data for 2010-2013 by entry groups is denoted by X10-X13. In this historical data and in 2014 entry groups both campuses are identified separately. We sampled the Helsinki campus only, as the same staff of engineering education teach in H-groups to eliminate effect of staff and pedagogy at this point.

The performance evaluation of the groups is possible at semester level. The newer curriculum would enable evaluation by half-semesters; however longitudinal comparison by semester suffices well for our purposes.

Furthermore, the new funding model uses the criteria at individual student level of yearly achieving 55 ECTS or more implying full funding or achieving less implying zero funding. This kind of strong threshold model is applied systematically to all UAS's for them to compete for their relative share of a budgeted amount of funding at national level. This share of total UAS funding is as high as 85 percent of the total. For the comparative goal of being able to show longitudinal comparison of results, the new criteria are applied retrospectively to the pre-reform data at yearly basis. Therefore, the first part of the analysis reflects more of administrative view than pedagogical approach. We also recognize the "unfairness" of applying new criteria to older data, but as the new criteria are to exist in the near future, they are used to establish a baseline measures for improvement.

Establishing Programme Performance Criteria

The performance indicators of the sampled data was then aggregated from student and year levels up to entry group and year level, as shown in Table 1. The 4-year programme is shown in first column. Each student has 5 year time to complete it (Overtime 1) and the UAS can allow one more year (Overtime 2), if appropriate. In addition, a student has an individual right to register as being absent for 4 full semesters, i.e. two years. Therefore, the use of entry years to describe the actual pedagogical performance is inaccurate at student level. The main rationale of using entry group data anyway is that it is descriptive of performance at the system level and it records each student in one category only. This is also the reason of sampling many years of H- and X- data and aggregating them before comparison, to eliminate this variable.

Table 1: Program performance by funding criteria 2014

	H10 (Entry group)				
Study years	N	ECTS	Avg	n(>54)	n/N(%)
1. Year	16	906	56,6	11	68,8
2. Year	16	870	54,4	7	43,8
3. Year	16	871	54,4	9	56,3
4. Year	16	616	38,5	3	18,8
Overtime 1	16	90	5,6	0	0,0
Overtime 2	16	15	0,9	0	0,0

The analysis was carried out to the entry groups shown on Figure 1. An example of the calculated indicators for the first group H10 is shown in Table 1, where N is the administrative number of students, ECTS is the sum of credit points earned by then during the study year, and Avg refers to the average ECTS/N. Fortunately, the Avg's are very close to (the forthcoming) target threshold, indirectly indicating also a good group level performance, i.e. low dropouts and very small number of bad performance. Here we recognize some inconsistency of low N compared to yearly entry; however N and their ECTS are mutually consistent from the study records. Sampling principle is consistent across H and X groups.

The indicator n(>54) is the number of students who reached the limit of 55 ECTS during the year. For comparative purposes it is shown as percentage n/N/%) to allow longitudinal and cross comparison of groups. Unfortunately, this indicator appears to be very sensitive and unstable, showing variations (43,8--68,8 %) with practically same Avg (54,4--55,6 %).

Establishing Programme Performance Baselines

As the yearly results of the n(>54) -indicator vary within the same group due to small N, all four years of the same curricula H10-H13 and X10-X13, are totalled in Table 2 with N per entry year around 100 and 300, respectively. For comparison purposes between the H and X at study programme level we estimate that the indicator is stable enough to allow comparison of administrative performance.

Table 2: Established program performance baselines

	H10-H13 Totals			X10-X13 Totals		
Study years	N	Avg	n/N(%)	N	Avg	n/N(%)
1. Year	101	53,6	57,4	303	43,1	38,3
2. Year	101	51,7	50,5	303	44,8	48,8
3. Year	93	51,1	47,3	303	40,0	39,3
4. Year	68	32,8	16,2	206	26,9	12,6
Overtime 1	43	6,0	0,0	129	12,3	1,6
Overtime 2	16	0,9	0,0	55	6,2	0,0

Perhaps the striking difference is the higher Avg of H-groups around 50 % throughout the main bulk of classroom studies (3 first years), compared to level of somewhat over 40 % in the X-groups. Same kind of level difference can be observed in the n/N(%) -indicator, especially in the first year. Table 1 provides one answer to our research question 1 of establishing performance baselines for evaluating the effects of the reform.

Longitudinal Performance Evaluation

The discussions above have established quantitative performance criteria for programme learning outcomes measurement and they were applied to one cross-comparison of separate programmes. The following research questions are how to evaluate the performance after the groups H and X merged into ICT14 and later split again into H14 and other Majors, denoted as a lump X14. Formulated as above, the issue seems technical. The underlying real challenge is how to maintain the good performance of H-programme? Our paper Björn & Soini (2015) discussed the benefits of strongly integrated curriculum and theme-based active learning. These principles were implemented throughout the new Health Technology curriculum with the initial results in Table 3.

Table 3: Impact of the reform, administrative view

	H10-H13 Totals			H14 Totals		
Study years	N	Avg	n/N(%)	N Adm.	Avg	n/N(%)
1. Year	101	53,6	57,4	40	50,8	72,5
2. Year	101	51,7	50,5	40	55,2	75,0
3. Year	93	51,1	47,3			
4. Year	68	32,8	16,2			
Overtime 1	43	6,0	0,0			
Overtime 2	16	0,9	0,0			

The performance indicators calculated for the second your group H14 are in Table 3 with N(Adm) = 40. The second line is evaluated using the administrative number of the group. This means that the second year Major group was formed based on student selection from both campuses. Students may also be moved between the administrative groups as the new curriculum encourages individual study paths better. This N=40 is the administrative number at the end of the academic year 2015-16. This suggest that for administrative performance, this could be the correct denominator to use, perhaps still use the beginning N of the academic year.

The first year result of H14 is calculated by sampling the student records of the second year group independent of the student's initial campus. The positive result of the new curriculum for the first year is shown as H14 Avg 50,8 ECTS compared to X10-X13 baseline of 43,1 ECTS and significant increase of n/N from 38,3 % to 72,5 %. In plain words this trend nearly doubles the main funding indicator. The impact is only relative at the funding system level, but this seems positive.

The main question of the paper title relates to some more detailed analysis of the second year row of Table 3. The H14 Avg 50,8 ECTS seems to have remained roughly at the same level compared to aggregate of H10-H13 of 53,6 ECTS. Thus we conclude that the joint ICT14 results are significantly better, compared to X10-X13 level of 43,1 ECTS. Further analysis of the X-groups is out of the scope of our paper.

The second year of H14 shows still a slight improvement from 51,3 ECTS to 55,2 ECTS. Obviously, if the normative offering of studies is 60 ECTS, increasing the average becomes increasingly hard. In active learning one teaching group is pedagogically "full" with 30-35 and physically and pedagogically overloaded at around 40 students. The remaining way and the method of improvement is mainly to keep all in performing and to avoid dropouts. We conclude to some extent that the Avg ECTS -indicator seems to approach its upper limit. Here the discussion exits the administrative view and enters the pedagogy.

Finally, the n/N of H14 also shows a slight improvement (75,0 %) compared to the same student group performance in their first year (72,5 %). We conclude we have implemented the good principles also in the Health Technology Major, as the end of the Major is built on the same principles and this was the first implementation on our learning curve. Also, somewhat radical observation is in comparison of this funding indicator to the previous 50,5 %.

Critical View on Trigger-based Funding Stability

Because the treshold-type indicator is very sensitive both on the actual earned credits, but also on the used denominator N, we consider that some further analysis of this variable is necessary. This leads also to some discussion on pedagogy and some more uncontrolled variables as potential sources os biased or non-biased errors. Attempts to eliminate biased errors on N include heuristic methods, such as elimination of students with zero or very low ECTS, from the calculation of cohort N, and thus indirectly eliminating also their ECTS credits (Valmu et. al, 2015).

Because of our detailed follow-up and feedback collection during the second year of studies we recognize the differences of administratine number of students and the actual numbers N(Actuals). Semester 1 was started with N(Adm) = 33 and was added by 7 at the beginning of Semester 2, resulting N(Admin)=40 at the end of the academic year. We used this as a denominator, similar to the entry group size in pre-reform analysia. This number is biased up, so our indicators are prudent. The full set of indicators is again shown in Table 4 top row N(Admin), showing the total earned 2206 ECT credits and 30 students actually reaching the treshold of 55 ECTS. The indicators Avg = ECTS/N and n/N are now prone to possible errors in use of a valid N.

Table 4: Effect of actual attendance, pedagogical view

	H14 (Admin group)				
2. Year	N	ECTS	Avg*)	n(>54)	n/N(%)
N (Admin.)	40	2206	55,2	30	75,0
N (Actuals)					
Semester 1	33	955	28,9		
N (PMT I)	28				
N (PMT II)	28				
Semester 2	36	1251	34,8		
N (Average)	34,5	2206	63,9	30	87,0

Because semester 1 started with actual administrative number of students being 33, we also collected the ECTS by semester. This cohort earned 955 ECTS, giving Avg 28,9 ECTS/semester (or indication of 57,8 ECTS/year). Below this line we recognize that the actual number of students in modules PMT I and PMT II varied and as our case study (Björn & Soini 2016) shows, at the end of semester N(PMT I) and N(PMT II) was 28.

Similarly, in Semester 2 we has actual N=36, and earned credits 1251. Using this we get Avg=34,8 ECTS/semester (or indication of 69,6 ECTS/year). Related to offering of studies 60 ECTS the indicators are biased up. This may be due to students taking some additional courses, some may have their elective studies credited based on earlier studies etc. This would require detailed analysys.

Finally, the N(Average) reflects the average of semesters, most likely to be usable in yearly calculation. Avg* is the 2 * weighted average of semester averages, to give a more prudent indicator of 62,9 ECTS/year. Given the fact that 30 students anyway reached the n(>54) treshold, using N=34,5 we show n/N=87 % compared to 75 % when using the administratine N.

Conclusions and Further Research

The rationale and some main lines of a major curriculum change, including a programme merger was described in the extent necessary to expose the research questions of the paper on a practical level.

The new government funding criteria criteria are based on individual student reaching 55 of normative 60 ECTS credits. The criteria are used to analyse retrospectively two merged programmes over four years before the merger to establish a baseline performance criteria. The criteria were then applied for cross-comparison purposes, but excluding other Majors.

The curricula reform and programme merger were analysed based on formation of the Majors by student selection after their first year. The performance of the Health Technology Major group was analysed over their performance during their second year. The same criteria were applied on their first year in retrospect. Thus the analysis shows the longitudial performance development compared to the old curricula for first two years.

A critical assessment of the trigger-type of criteria are noted, especially their instability due to many uncontrollable variables, as far as any educational institution is concerned. We conclude that the cross-reference and longitudinal analyses using the criteria appear technically feasible, although the indicator comparisons are sensitive to careful sampling and and use of correct group size.

A number of more pedagogically related issues were revealed but not discussed. These could improve the accuracy of the indicators by more dynamically taking into account the actual N at semester, period, or course level. This is however closer to teaching and group dynamics, i.e. pedagogical performance view. It would be interesting to apply the indicators this way based on actial course implementations to assess what we could call a pegagogical performance, or a quantitative view into the learning outcomes.

Our analysis appear to be reasonably valid on system level and in consideration of cross- and longitudinal data. It is likely that we wish to follow up our groups using the established criteria, or perform more cross-references against the other Majors. We feel fortunate to report our excellent performance results and improvements based on the presented criteria. As we all are encouraged to promote increasingly diverse and individual paths of study, it would, however, be prudent to cross-check our indicators yet again using purely administrative, in fact, pedagogically actualised teaching groups to decrease the divergence between our administrative performance and the pedagogical performance with actualized N.

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1205

INTRODUCTION OF ELECTRONIC HANDIWORK TRAINING TO THE SUBJECT "INTRODUCTION OF ELECTRICAL / ELECTRONIC ENGINEERING" FOR THE OTHER DEPARTMENT STUDENTS

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Abstract

In our college, the classes for the introduction to electrical engineering are opened for the 3rd grade students of mechanical engineering course, for the 5th grade students of chemistry and biochemistry course, and for the 5th grade students of civil engineering course. Though these classes are based on lectures mainly, and some simple electronic handiwork trainings are introduced to confirm the principles. In this report, the overview of these classes and the details of handiwork training are introduced.

Keywords: *manufacturing education, other department students, electronic handiwork, exchange of different field, active learning*

Introduction

In our college, the curriculum was revised in 2005 and in 2010. In mechanical engineering course, some subjects about electrical and electronic engineering were changed in 2005. After the revision, the subject "Introduction to Electrical Engineering" was opened in the 3rd grade, the subject "Introduction to Mechanical and Electrical Engineering" was opened in 4th grade, and the subjects "Electirc Circuits" and "Electronic Circuits" were opened in the 5th grade. And, in civil engineering course, the subject "Introduction to electronic engineering" was begun a series of lectures in 2010. On the other hand, in chemistry and biochemistry course, subject about electronic engineering has already opened in the past.

In the initial years after the revision, students of mechanical engineering course have studied about electricity and magnetics in the 2nd grade "Physics" class and "Introduction to Electrical Engineering." To resolve the overlap of studies, the lecture about electricity and magnetics were cut and some simple electronic handiworks were introduced, instead.

On the other hand, in the 4th grade class of civil engineering course, there are no subjects about physics so many students forget the details about electricity.

Based on these backgrounds for each course, some basic principles about electricity are taught commonly and some topics are different for the purpose of the courses. For example, sensing technics using semi-conductor devises for mechatronics are taught in mechanical engineering course, materials of electronic devices are taught mainly in chemistry and biochemistry course, and application of electromagnetic wave and communication technology to surveying such as remote sensing and GPS are taught in civil engineering course.

In chemistry and biochemistry course and civil engineering course, some simple handiwork training is also introduced about common basic things about electronic circuits using breadboard to confirm the principles of the electronic circuits and characteristics of semiconductor devices.

Construction of the subjects

In this section, the items constructing each subject are described.

A) "Introduction to Electrical Engineering" for the 3rd grade students of mechanical engineering course

In this class, students learn about basics of direct current circuit and basics of sensor devices and semiconductor devices such as diode, transistor and operational amplifier, and some basic electronic circuits using them. In the end of this subject, students make the application circuit that operates by sensing of some physical value such as temperature, light, magnetics and force.

The purpose of this class is that the students master how to use semiconductor devices and make simple circuits. In the 4th grade of mechanical engineering course, the ability of realize by electronic circuits to solve some problems for security, ecology, safety, and so on is required in the subject "Engineering Experiments."

B) "Introduction to Electronic Engineering" for the 5th grade students of chemistry and biochemistry course

In this class, students made some systematic circuits using some kinds of sensors such as optical sensor, thermal sensor, supersonic sensor, and condenser microphone. Through the making systems, students learn how to use the sensors and around electronic circuits and devices.

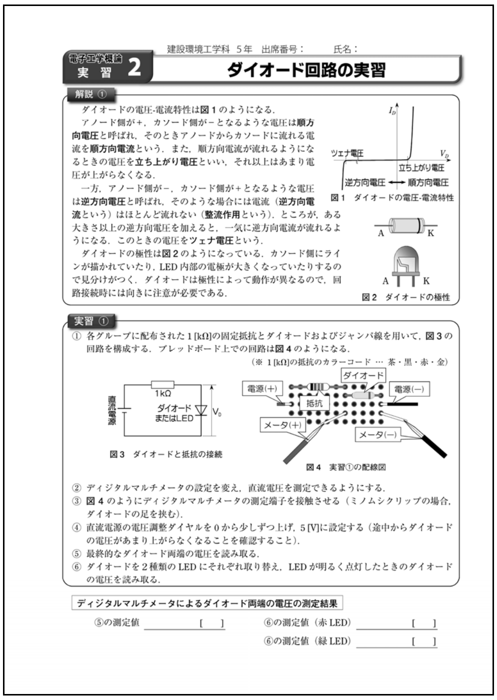
C) "Introduction to Electronic Engineering" for the 5th grade students of civil engineering course

In this class, students learn about basics of direct current circuit and basics of electronics such as model of atom, energy band, and movement of carrier. Also sensor devices and semiconductor devices such as diode and transistor, and some basic electronic circuits using them are taught, too.

In the end of this class, the students learn basics of electromagnetic wave and the application to surveying. The students in this course were learned surveying in the 3rd grade and 4th grade through training and basics of remote sensing and GNSS surveying. However, the detail of them could not be taught by the temporal restriction. So this subject supplies the deficiency.

Methodology

The class hour of these subjects are 100 minutes for each week. For the purpose, to secure the time for trainings and reduce the time for lectures are required. To solve this problem about the time, a lecture sheet is derived to every student. The summery about basic principle relative the training and the method are described in the sheet. In addition, there is the space to record the results of training and experiments. A sample of the sheets is shown in Figure 1.



建設環境工学科 5年 出席番号： 氏名：

電子工学概論 実習 2 ダイオード回路の実習

解説 ①

ダイオードの電圧-電流特性は**図 1** のようになる．

アノード側が＋，カソード側が－となるような電圧は**順方向電圧**と呼ばれ，そのときアノードからカソードに流れる電流を**順方向電流**という．また，順方向電流が流れるようになるときの電圧を**立ち上がり電圧**といい，それ以上はあまり電圧が上がらなくなる．

一方，アノード側が－，カソード側が＋となるような電圧は**逆方向電圧**と呼ばれ，そのような場合には電流（**逆方向電流**という）はほとんど流れない（**整流作用**という）．ところが，ある大きさ以上の逆方向電圧を加えると，一気に逆方向電流が流れるようになる．このときの電圧を**ツェナ電圧**という．

ダイオードの極性は**図 2** のようになっている．カソード側にラインが描かれていたり，LED 内部の電極が大きくなっていたりするので見分けがつく．ダイオードは極性によって動作が異なるので，回路接続時には向きに注意が必要である．

図 1 ダイオードの電圧-電流特性

図 2 ダイオードの極性

実習 ①

① 各グループに配布された 1 [kΩ]の固定抵抗とダイオードおよびジャンパ線を用いて，**図 3** の回路を構成する．ブレッドボード上での回路は**図 4** のようになる．

（※ 1 [kΩ]の抵抗のカラーコード … 茶・黒・赤・金）

図 3 ダイオードと抵抗の接続

図 4 実習①の配線図

② ディジタルマルチメータの設定を変え，直流電圧を測定できるようにする．

③ **図 4** のようにディジタルマルチメータの測定端子を接触させる（ミノムシクリップの場合，ダイオードの足を挟む）．

④ 直流電源の電圧調整ダイヤルを 0 から少しずつ上げ，5 [V]に設定する（途中からダイオードの電圧があまり上がらなくなることを確認すること）．

⑤ 最終的なダイオード両端の電圧を読み取る．

⑥ ダイオードを 2 種類の LED にそれぞれ取り替え，LED が明るく点灯したときのダイオードの電圧を読み取る．

ディジタルマルチメータによるダイオード両端の電圧の測定結果

⑤の測定値 ________ [ ]　⑥の測定値（赤 LED）________ [ ]

⑥の測定値（緑 LED）________ [ ]

Figure 1 A sample of lecture sheet of experiments (for the 5th grade students of civil engineering course)

For the 3rd grade students of mechanical engineering course, a textbook including the lecture sheets of experiments and note space for the class was made. The overview of textbook is shown in Figure 2.

The members of practice group are 2 or 3 students for each group and one table in the laboratory is assigned for each group. The photos of practice in the laboratory are shown in Figure 3. To reduce preparing time, equipment and circuit elements were distributed beforehand. Figure 4 shows the equipment and elements distributed each group.

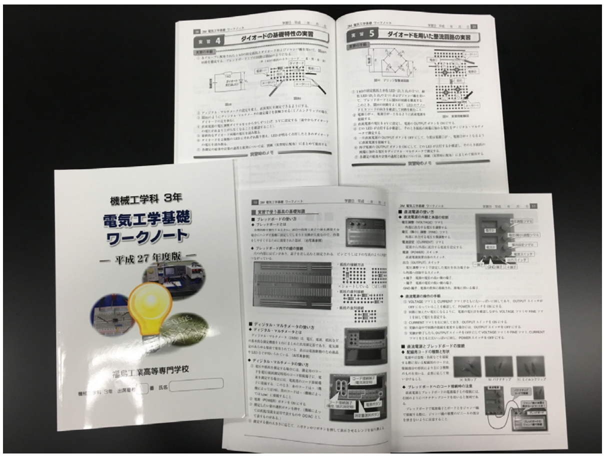


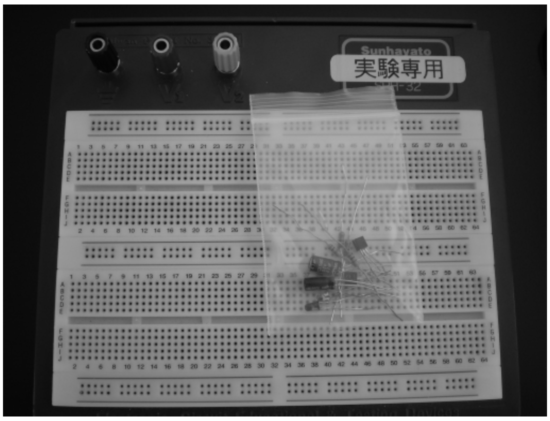
Figure 2 Overview of the textbook for the 3rd grade students of mechanical engineering course students

(a) The state of the whole laboratory

(b) The state of the practice group

Figure 3 Photos of the practice in laboratory

(a) Equipment



(b) Bread board and devices

Figure 4 Photos of distributed things for one group

Discussion of the effect of training

For the 3rd grade students of mechanical engineering course, the learning contents had been not changed since 2010 to 2013. However, the rate of trainings included to the class was different. So the increases of the interest to class of students were whether reflected to the increases of intelligibility are discussed. In our college, the students evaluate the intelligibility of the items that students should understand for each subject by 10 levels. Figure 5 shows the change of the intelligibility for "Introduction to Electrical Engineering" for the 3rd grade students of mechanical engineering course.

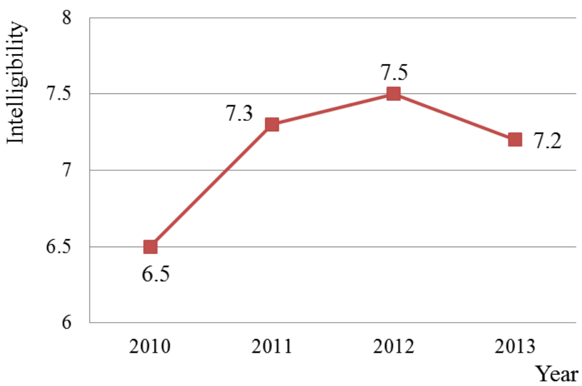


Figure 5 The change of intelligibility of "introduction to electrical engineering" for the 3rd grade students of mechanical engineering course

The intelligibility was increased conspicuously in 2011 when the trainings were introduced. From this result, we consider that the class including the training influence the increase of intelligibility of students of mechanical engineering course for the introduction education of electrical engineering.

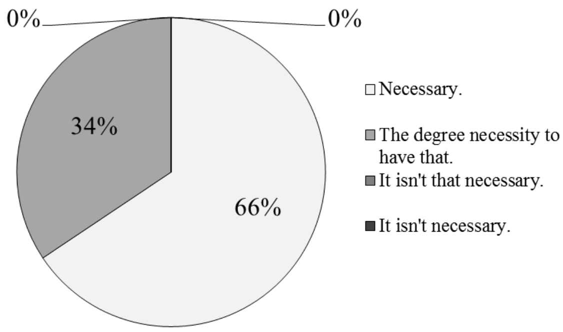
The effect of interest level by the training was evaluated based on the questionnaire to the 5th grade students of civil engineering course in 2015. The questions are as follows.

Q1) The trainings are necessary in the class of "introduction to electronics"?

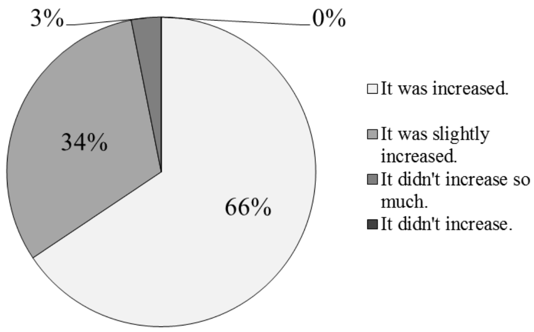
Q2) The intelligibility about electric and electronic circuits was increased by the trainings?

Q3) The interests to electric and electronic engineering was increased by the trainings?

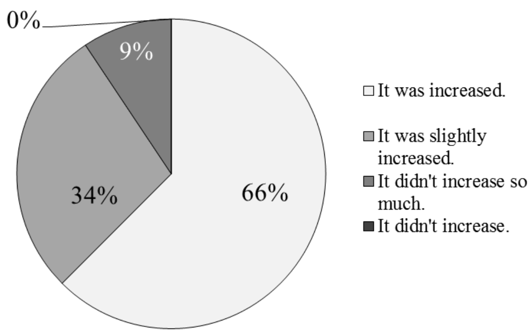
In these questions, students answered in 4 levels. The results of questionnaire are shown in Figure 6.



(a) The result of Q1



(b) The result of Q2



(c) The result of Q3

Figure 6 The results of questionnaire of "introduction to electronics" for the 5th grade students of civil engineering course

In our college, the class evaluation questionnaire is performed in the end of the fiscal year. In this questionnaire, the posture to the student's learning, the will and teacher's class way are being asked. The results of comparison of the score for some items in the questionnaire in 2010 and in 2011 for "introduction to electrical engineering" for the 3rd grade students of mechanical engineering course are shown in Figure 7.

We consider about the posture to the class of the students in the value of this questionnaire. The score increased at both of the item "I took the lesson enthusiastically" and "I worked on a practice and homework aggressively." The reach of the lesson and the level of the question of periodical test are hardly different, so we consider maybe the will to the class of the student and positivism rose by practicing.

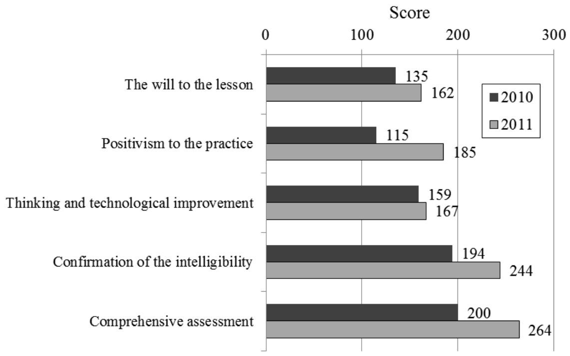


Figure 7 The results of comparison of the score for some items in the questionnaire in 2010 and in 2011 for "introduction to electrical engineering" for the 3rd grade students of mechanical engineering course

Conclusions

In this paper, the introduction of the electronic hadiwork training to the class of basics of electric or electronic engineering and the effects were introduced. The validity was confirmed by the intelligibility of students, the class evaluation questionnaire, and original questionnaire for the training.

The class time of introduced 3 classes are 100 minuite per week, so the lecture and the training must be have the restrictions timewise. For the restrictions, it is necessary to select the class contents carefully and plan for efficiency using prints and slides, etc. accordingly. It is needed to share with physical class and different class about the theoretical explanation and indepth movement of a circuit in the case. In other words, communication between the other class persons in charge and utilization of a network offer a key.

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1206

Application of 3D Technology to Engineering Design Education for Mechanical Design

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Abstract

The progress of three-dimensional technology (3D technology), such as the 3D-CAD and 3D printer, is remarkable. It has become necessary knowledge in the field of mechanical design, so there are a lot of universities or colleges that introduce 3D technology into curriculum and expansion to subject. In our department that authors belong, we introduce 3D technology into some engineering design subjects as practical machine design educations. In this article, we picked up for the two subjects from among these of course, to report. First one is a subject for the design and development of the robot. We have introduced subjects to develop the walking robot using by the 3D-CAD in third to fourth grade of mechanical engineering. In this subject, students learn the basic use of 3D-CAD, and design a walking robot for each team consists of two students. The design specification of developed robot is to implement the movement mechanism by the link mechanism. Then students develop the robot based on their design, and evaluation of developed robot carried out in the contest of the tournament. In addition to the use of the 3D-CAD, that actually develop the robot, so it is possible to learn about the mechanism design. The another one is to design and develop small wind turbine or water turbines by 3D printers. We have introduced an experimental subject in fifth grade of mechanical engineering. After learning the theory of wind or water turbines, students design a wind or water turbines by the 3D-CAD so as to satisfy the specifications. Then modeling in 3D printer and assembling developed wind or water turbines is evaluated by a circulation type water tank or small wind tunnel. By evaluating and consider the work that they have developed on their own, students can learn an important point of the mechanical design. This article reports engineering design education by utilizing 3D technology. With the introduction of 3D technology, we were able to reach up to actually make not only the design. We also considered that there has been an effect of student motivations.

Keywords: *3D Technology, Engineering Design, Robot, Wind Turbine, Water Turbine*

Introduction

The three-dimensional technology (3D technology) represented by 3D-CAD and 3D printers have made remarkable progress. Nowadays, it is now mandatory skill in the field of machine design. So a lot of technical universities or colleges have introduced curriculum of mechanical design utilizing technology 3D technology. In this paper, we report the two cases an application of the 3D technology to engineering design education in Department of Mechanical Engineering, National Institute of Technology, Ichionoseki College that authors belong.

First one is a subject for the design and development of the robot. We have introduced subjects to develop the walking robot using by the 3D-CAD in third to fourth grade of mechanical engineering. And the another one is to design and develop wind turbine or water turbine by 3D printers. Finally, we summarize the education effect of those subjects introduced.

Subject of robot design and development using by 3D-CAD

As the first case of the introduction of the 3D technology for engineering design education, a subject about the design of robot will be explained. This subject is content to develop a self-made robot over a period of 2 years from the third grade to 4 grade. In the third grade, students design a robot by using 3D-CAD to perform sumo competition, also actually do the development based on their design. In followed by fourth grade, students develop the software for autonomous control of robot, which was developed in the third grade. Of these, this paper describes the class in third grade.

In subject of third grade, they do the robot design by two students per team, after learning basic use of 3D-CAD. In the design of robot, the design specifications to the robot satisfies are below.

- Size: 200 [mm] as long and 200 [mm] as width
- Weight: up to 850 [g]
- Movement mechanism and attacking mechanism must be implemented.
- Movement mechanism is implemented by a link mechanism.

Major feature of the design specification is to realize a moving mechanism by a link mechanism. This means that prohibits the movement by the wheel mechanism. Students use the 3D-CAD, to design these mechanisms. Figure 1 shows the actual design example by students. This design example is adopted a Chebyshev link for a movement mechanism. In 3D-CAD software, it has been implemented a mechanism simulation tool. By modelling the mechanism, it is possible to obtain a mechanism motion such as velocity, acceleration. According to the theory of the mechanism, students have been learning in another class. So they will be to design a robot also using this mechanism theory.

After finishing mechanism design, they actually carry out the manufacturing of the robot. Figure 2 shows work of the manufacturing. Robot is made by processing the acrylic plate, an aluminium plate. Students process them in a handy tool such as drilling machine and band saw, and assemble the robot.

Figure 3 shows an appearance of robot developed. This is what has been developed on the basis of the design shown in Figure 2. The production of the robot takes about 12 weeks. Then do the contest of the tournament, evaluate the performance of the robot. At the conclusion of this subject, they make a summary of the one-year effort report by the announcement. Figure 4 and Figure 5 shows contest and presentation.

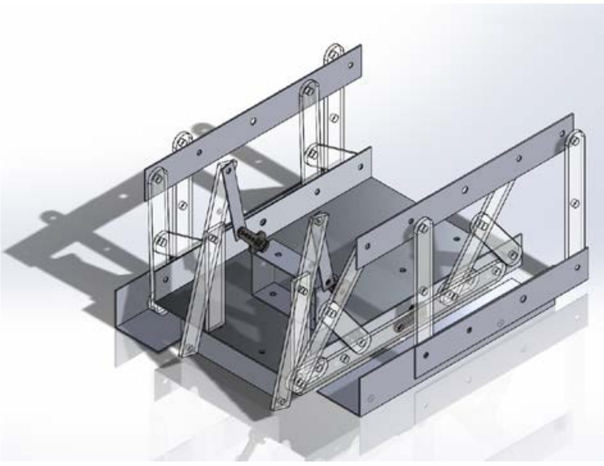
Figure 1 Design example of robot by 3D-CAD

Figure 2 Manufacturing robot by self-hand

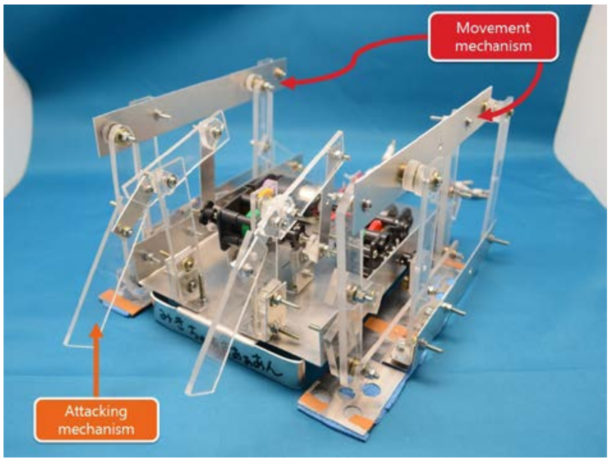

Figure 3 Developed robot based on design Figure 1

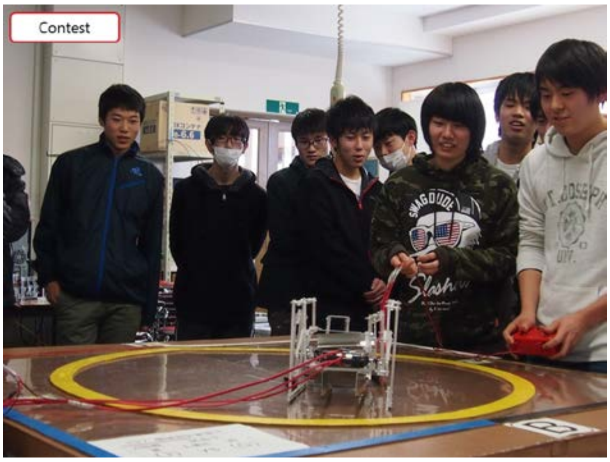

Figure 4 Contest


Figure 5 Presentation about design of developed robot

Subject of wind turbine/water turbine design and development using by 3D printer

From the energy problem in the Great East Japan Earthquake, renewable energy is a lot of attention. While researches about this energy have been actively carried out, but the case incorporating as education curriculum are not many. This is due to that the experimental device is a large scale, or experiment takes a lot of time. On the other hand, it has progressed performance and lowering the price of the 3D printer. In recent years in particular those of small size that corresponds to the personal use is starting out at a low price.

So, as a renewable energy-related engineering design education, authors had introduced the subject to develop and evaluation small wind turbine / water turbine using by 3D technology.

The following shows an outline of the subject. This subject is implemented as one theme of the student experiment for fifth-grade students, it takes seven weeks from a design to evaluation. Basically, it makes up one of the works in one-person student. Students can select either or wind turbine or water turbine, and also what to design a wind turbine or water turbine, it has been left to the student. The design of wind turbine or water turbine is used by the 3D-CAD, which was shaped in a small 3D printer, assemble. 3D-CAD is used to design, and 3D printer is used to building parts. Developed wind turbine and water turbine is evaluated with a small wind tunnel and water tunnel respectively.

As an example a wind turbine that student has actually designed and developed, explaining the flow of the subject. Figure 6 shows 3D model of the spiral Magnus wind turbine designed by student. Spiral Magnus wind turbine has spiral-shaped fins as wings, and lift occurs by rotating this wings (Magnus effect), This is the mechanism by which the wind turbine is rotated.

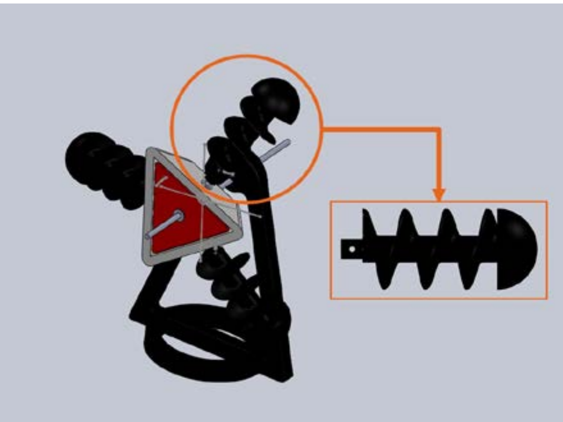

Figure 6 Design of spiral Magnus wind turbine by 3D-CAD

Figure 7 shows the wind turbine after building by 3D printer and assembly. In this subject, UP Plus2 (Delta-Microfacotry) was used to build parts. This is a 3D printer of FDM method by ABS resin, and it is possible to perform building size in 140x140x130 [mm]. Mainly to shape the wing, foundation and so on by this 3D printer, and shaft, bearings is to use the commercially available ones.
‘

Figure 7 Developed spiral Magnus wind turbine

Figure 8 shows the small wind tunnel to evaluate performance of developed wind turbines developed by one of authors. It has a small air channel of the full-length 3.95 [m], and 0.4[kW] fan is mounted. The fan can generate the maximum flow rate 85 [m^3 /min]. The generated wind is send to the observation section via enlarged portion, the rectifying unit, and the narrowed portion. Cross-section of the observation section has become a 210 [mm] x 210 [mm], and to evaluate the performance and put the developed wind turbine in observation section.

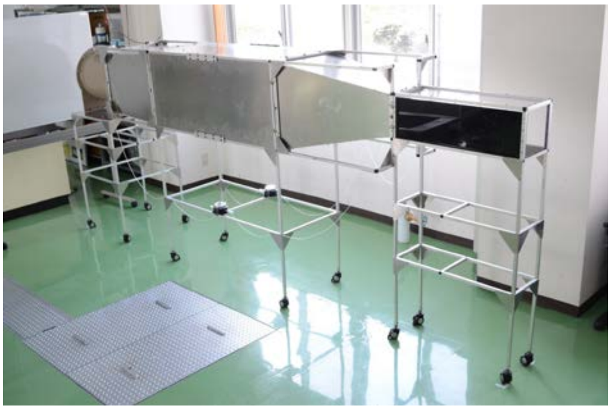

Figure 8 A small wind tunnel for evaluating developed wind turbine.

Table 1 shows the evaluation result of developed wind turbine. To evaluate the performance of the developed wind turbine, the rotational speed of the wind turbine is measured with respect to the flow rate of the fan. It is supposed that the evaluation method of the developed wind turbine is considered by students themselves. The result shows that developed wind turbine do not rotate in small flow rate. And compared with windmill designed by other student, it shows a low number of revolutions at the same flow rate. For the discussion, a summary report of the results of comparing the structure of the actual large Magnus wind turbine.

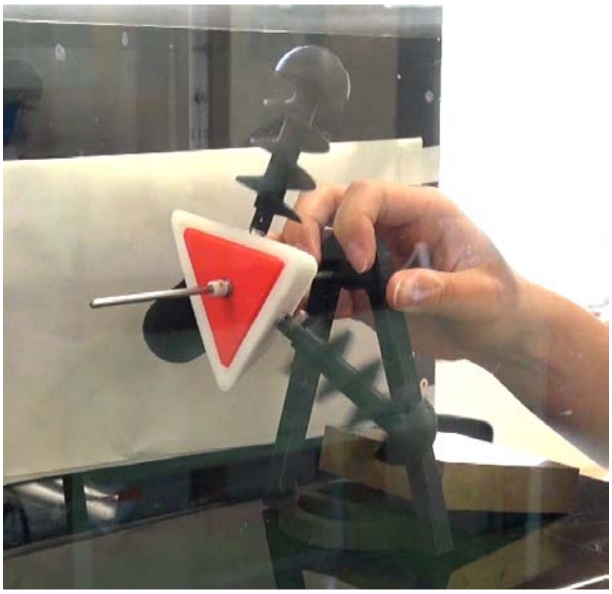

Figure 9 Evaluation of developed wind turbine by small wind tunnel

Table 1 Performance of developed wind turbine

Fan of wind tunnel Flow rate [m/s]	Developed wind turbine Rotational speed [rpm]
6.3	0
7.5	139
8.3	150
9.8	179
10.9	196

Effects of engineering design education by 3D technology

As described above, we reported on two engineering design courses through the introduction of 3D technologies. Here, it is to be mentioned for their educational effects.

On the subject of robot design, the feature is to do all the process in the product development, such as planning, design, production, evaluation, until the presentation. Conventional mechanical design education was only draw to the accompanying drawings. In this way, they do not know whether the machinery and parts designed by work properly. By introducing 3D-CAD design, development efficiency gets increased. Because it enabled the verification of design in 3D-CAD software without prototyping. Thus it was possible to produce a time for developing a robot. In the actual work of robot development, they can reaffirm a lot knowledge about mechanical engineering. We believe that it is the most important point of this subject for students.

The feature of this course is to incorporate the concept of engineering design education in subjects related to renewable energy. Subjects such as fluid dynamics and thermodynamics, which is the basis of renewable energy, it is difficult for students to understand theory or phenomena because it is invisible. By actually designing wind turbine or water turbine, it is believed that can deepen the understanding these theories. Another feature is the introduction of the 3D printer to the course. Manufacturing of fluid machine such as a wind turbine / water wheel are required special processing tools because of its complicated shape. In contrast, 3D printer can perform also easily and quickly build parts with complicated shape. Thus, it is possible to construct a curriculum of mechanical design from design to evaluation.

Common thing in two subjects lies in the fact that we have developing after designing. In the course of the mechanical design, it is an important point than anything that can evaluate their own design. Thus, the subject with 3D-CAD that tend to explain how to use software is varied to the engineering design subject. In addition, since the intended use of the 3D-CAD becomes clear, there was also the effect of student motivation.

Conclusion

In this article, we reported on the engineering design education by utilizing 3D-technology that are carried out in the Ichinoseki College. In the field of mechanical design, 3D technology is becoming essential knowledge, it is important to incorporate this into the educational curriculum. By utilizing 3D technology, it shows that conventional mechanical design education can be changed to engineering design education. Regarding design education that cannot acquire only theory, it is considered that there was a very large effect.

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1207

On a Certain Method of Active Learning in Mathematics Class

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Abstract

My purpose in this paper is to substantiate that my practice for the last eight years in mathematics class is more effective than traditional chalk talk class by means of questionnaires.

This method is based on the thought of "manabiai" advocated by Professor Nishikawa at Joetsu University of Education and is considered as one of active learning.

Especially I try to introduce you to not only knowledge of mathematics but also what students get through this class.

Keywords: *cooperative learning, Course of Study, mathematics education, active learning, questionnaire method*

1. Introduction

In this paper I try to substantiate that my practice for the last eight years is more effective than traditional chalk talk class. Moreover I wish some participants will practice "manabiai" method to their subjects and discuss improving this method in the future.

To begin with, I have been teaching mathematics since 1994 and I continue to seek and improve better practice of teaching in KOSEN. I had ever succeeded in my chalk talk practice for about the first 17 years. But in 2008 I happened to see "manabiai" method in a certain website, and then I had concentrated on investigating it and had been studying it hard.

So in the second term of 2008 academic year I started "manabiai" practice in two classes of the first grader and the second grader respectively. Since then I have practiced it.

I report the result of the last two years among my eight years' practice in this paper.

2. The Typical Scenes in Classes

Quite a few teachers in "KOSEN", which means the whole name of all the colleges of National Institute of Technology, usually teach their subjects by chalk talk method. That is to say, they teach some contents in detail by writing on blackboard or project on screen by projectors, distributing some papers and so on.

But depending on this way there are a lot of problems arisen in class.

I also had been teaching mathematics basically by chalk talk method and had noticed many problems.

Let me introduce some problems here.

First, some students were often sleeping for a short/long time in class.

Second, many students didn't learn what they learn next time in advance and also reviewed what they learned.

Third, some students were doing other things during class, such as reading mangas, writing some reports of other subjects, watching a website by smartphones, and so on.

On top of that, they didn't concern their scores in mid-term or term examinations.

So I wanted to resolve these circumstances for a long time and was looking for some good method of breaking these states.

3. What is "manabiai"?

"Manabiai" is thought to be one method of cooperative learning, but Professor Nishikawa at Joetsu University of Education, who advocated about fifteen to twenty years ago, proclaims that "manabiai" is a thought consisted of three views of education: First, children have their own talents. Second, teachers should prepare students' learning environment to advance their learning. Moreover teaching ought to entrust students. Third, school is the place where students acknowledge that their fellows are indispensable to them for doing their own tasks in various school activities.

Professor Nishikawa says that all the classes based on these three views are called "manabiai" classes. So, "manabiai" class are not limited to specific subjects and almost all subjects seem to be able to be performed.

But I think that there is an orthodox method as "manabiai" or we, practioners of "manabiai" should keep some rules in class.

First, at the first time of the whole classes in a year teachers have to tell why "manabiai" class is needed for students.

Second, teachers should set up problems each time and estimate students' performance, that is, they can get targets which teachers indicate or aim to that day.

Third, teachers allow students to solve problems of that day freely and voluntarily as much time as possible. For attaining this purpose they can leave their own seats and talk with their classmates about solutions.

4. The Next Course of Study

The Ministry of Education, Culture, Sports, Science and technology (MEXT) said that the next Course of Study includes Active Learning. MEXT defines Active Learning as the following in YOUGOSHU in 2012 (the original in Japanese)
: Active Learning is not one-way teaching method like lecture, but a general form of teaching method by which learners can attend classes positively. Active Learning aims to raise the whole talents for learners to adjust, solve and tackle various kinds of problems occurring in our societies in the 21st century.(I paraphrased the original sentenses.)

5. My practice for the last eight years in Kisarazu College

I started this "manabiai" to two classes of the first grader and the second grader in the second term in 2008, and have been practicing until now. And I change "manabiai" class little by little every year by taking into account students' questionnaires' answers.
But the frame of this practice is almost the same in last three years.
In my college a period of time in one class is 90 minutes.
The procedure of my one class is the following
1) Doing mini test (10 minutes), which is concerning about the contents learning until the previous time,
2) Exchanging mini test side by side and marking it by students (about 5 minutes),
3) Explaining brief outline of the content on that day (from 10 to 15minutes),
4) Students' activity (about 60~70minutes),
5) Comment students' activities on that day to promote students' activity next time.

6. Analysis of questionnaires

I mainly attempt to analyze the questionnaires in 2014 and 2015 of the first graders and the second graders. My questionnaires consists of the following ten questions:
1) What do you think about good/bad points in this class?
2) Which one do you like best, "chalk talk class", "manabiai class", "both", "don't know"?
3) Which one do you like best, explaining a brief outline is beneficial for you? YES, NO, Don't Know
4) What percentage do you understand questions in your textbook? 100%, 80%, 60%, less than 40%
5) What do you think of this class as a whole?
6) What do you estimate your own performance in this class?
7) What do you change your views by taking this class?
8) Which way of giving homework do you like in the first term or in the second term? In the first term homework is given every time, while in the second term one is given two times.
9) If you take this class by chalk talk method, what do you imagine your understanding mathematics?
10) Could you please explain this "manabiai" class to younger graders or your parents?

At first I'd like to introduce some students' opinions in Question1.
[Good Points]
1) If I don't understand what I learn, how to solve problems, and so on, I can ask for my fellows about them on the spot.
2) I can deeply learn what I ought to study on that day, tackling problems with my friends.
3) Working on problems with my fellows is fun.
4) I can concentrate and work on problems hardly.
5) Throughout doing "manabiai", I can make some friends.

[Bad Points]
1) Nothing about this class.
2) Talking other things unrelated to maths.
3) After finishing solving problems, some students didn't teach how to solve problems to their classmates.

And so on. Almost all students wrote their own opinions to this question and I'm very happy to be able to get them including criticism to "manabiai".

Question2's results are the following
Tab.1 Comparison between chalk talk and "manabiai" (%)

	Chalk talk	Manabiai	Anything will do	Don't Know
1st grader in 2014	0	77.5	22.5	0
1st grader in 2015	0	66.7	26.2	7.1
2nd grader in 2014 (2classes)	0 & 11.9	52.5 & 42.8	35 & 33.3	12.5 & 11.9
2nd grader in 2015	9.5	52.4	33.3	4.8

This table shows that most students prefer "manabiai" class to chalk talk one.

Question3 's result is the following
Tab.2 Is explaining a brief outline at the beginning of the class is beneficial for you? (%)

	YES	NO	Don't Know
1st 2014	92.5	0	7.5
1st 2015	88.1	2.4	9.5
2nd 2014 (2classes)	92.5 & 97.6	2.5 & 0	5.0 & 2.4
2nd 2015	92.8	0	7.2

This table shows that most students want to be given a brief outline by teacher. So from these two results we validate "manabiai" is more acceptable than chalk talk class.

Question4 's result is the following

Tab.3 Understanding questions in the textbook（%）

	100%	80%	60%	Less than 40%
1st 2014	7.5	60	30	2.5
1st 2015	11.9	47.6	35.7	4.8
2nd 2014 (2classes)	5 & 2.3	50 & 40.5	37.5 & 47.6	7.5 & 9.6
2nd 2015	4.7	54.8	38.1	2.4

This table shows that more than 90% of students understand how to solve questions in their textbook .

In Question5 some students' opinions are the following
[YES]

1) I could ask for my problems which I didn't understand to my classmates and teach problems which are understandable enough to my other fellows.
2) I could teach problems to many classmates.
3) I wanted all my classmates to pass examinations, so I taught problems to them.

[NO]

1) I thought how to solve problems by myself.
2) I can't afford to teach my classmates.
3) I finished problems every time but I didn't teach my classmates.

[Don't Know]

1) I always learned and discussed problems with the same members, so I didn't teach to the other members.
2) I were always taught problems by my classmates.

In Question6 some students' opinions are the following

1) I noticed that to ask for how to solve problems was the fastest way to understand. And I often asked many of my friends for problems which I couldn't solve.
2) I prepared reading the textbook of maths for attending this class, so I could finish solving problems before this class ended.
3) I asked problems my classmates actively throughout this year. Before I experienced "manabiai" class, I left difficult questions in the textbook. But in "manabiai" class I could understand those questions.

In Question7 some students' opinions are the following

1) I could ask my classmates for difficult problems without reserve.
2) To teach problems each other is important for us.
3) I understood difficult problems deeply by teaching them to my fellows.
4) It is a chance to be asked for problems, and then I could understand them better.
5) I recognized that asking problems wasn't a shame.
6) I realized preparing for next time's lesson was good enough to understand it deeply.
7) I made it a rule to read the textbook carefully before attending the class.
8) I endeavored to understand the content within class every time.
9) I could concentrate on solving problems during class.
10) I felt doing mathematics was fun by attending this class.

In Question8 some students' opinions are the following
[First term]

1) I preferred to do homework regularly. On top of that I could review the class regularly.
2) I could remember the content by doing homework regularly.

[Second term]

1) I got down to doing homework according to my plan.
2) Turning in homework two times in the second term is easier than doing it every time.

[Other way]

1) I adjusted both.
2) I didn't have likes and dislikes about how to turn in homework.

Tab.4 Which way do you like?（%）

	First term	Second term	Other way
1st 2014	40	60	0
1st 2015	35.7	54.8	9.5
2nd 2014 (2classes)	52.5 & 33.3	42.5 & 59.5	5 & 7.2
2nd 2015	28.6	66.7	4.7

In Question9 some students' opinions are the following

1) Maybe I didn't try to understand this subject.
2) I thought I understood this subject at the lower level than now.
3) Perhaps I only became a copy machine which took notes every class, so I didn't understand this subject.
4) I didn't think I changed my state of this understanding by "manabiai".
5) Maybe I thought I slept during class, so I wouldn't understand this subject at all.
6) I thought I did understand this subject by halves.

Moreover in 2015 I analyzed the annual questionnaires of the first graders and I got the following result by categorizing the answers. So I noticed that if I taught students in my class by the traditional chalk talk method, almost half of them couldn't understand the contents. Therefore at least it is important to do active learning and especially "manabiai" method is more effective than the traditional chalk talk method, I think.

Tab.5 How do you think the chalk talk method, compared to “manabiai” ?（%）

	May	Jun	Sep	Dec	Feb
Understandable	17.1	9.1	4.5	9.3	9.5
Not Understandable	34.1	47.7	40.9	48.8	52.4
The Same	7.3	9.1	13.6	25.6	7.1
Don’t Know	21.9	18.2	22.7	4.7	7.1
Sleeping	0	0	6.8	0	2.3
Others	19.6	15.9	11.5	11.6	22.6

In Question10 some students’ opinions are the following

1) I think that it is important to ask your classmates your problems. So you should ask your friends the problems actively.
2) I think you can get contents from teaching your fellows the daily problems.
3) I think a courage to say “teach me” is needed.
4) If you wouldn’t teach your classmates after you finished your problems, it owes you one.
5) Doing “manabiai” actively leads your understanding of this subject to you.
6) Asking your classmates difficult problems is not a shame, but a chance to understand them. And also your classmates who tell you them can learn them deeply.
7) In the first several weeks/months you won’t be accustomed to “manabiai”, but you will soon notice good points of “manabiai”. So you can accomplish your score of test with keeping teaching to your friends in mind.
8) The more you discuss problems with your classmates, the more deeply you can understand them.
9) This class is beautiful because there is no sleeping student. Moreover you can understand the content.
10) Studying needs corporation.

6. Results and Discussion

As we see the above results, we can ascertain that “manabiai” class is able to attain the purpose of the next Course of Study.

Looking back to the definition of Active Learning by MEXT, Active Learning is said to be not only a one-way class something like the traditional lecture, but also raising students’ talents including recognitive, social, and ethical capabilities. I think this is the very criterion of Active Learning and to estimate these talents of students is difficult.

I conclude that quite a few opinions of students written on questionnaires will prove this criterion. Concerning social talents, some students were saying that helping my classmates brings to becoming one class. With respect to ethical talent, some students described the value of doing problems with all their classmates.

But of course there are a lot of problems. For instance, I didn’t think I could succeed “manabiai” class for the subjects for the higher graders. The reason I thought is that students’ consciousnesss for the goal of getting credits by all their classmates was decreasing.

Although there are some points to resolve, I will continue to practice “manabiai” and also research for better practice of “manabiai” class.

7. Conclusions

I think “manabiai” is one of the best practices to attain the purpose of Active Learning defined by MEXT. And this method is available for almost all subjects and indifferent to school's form, that is, elementary school, junior high school, high school, or KOSEN.

So I hope “manabiai” will be becoming more familiar in the near future.

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A REPORT OF SUPPLEMENTARY LESSONS IN MATHEMATICS USING UPPER-CLASS STUDENTS AT NIT, KURUME COLLEGE

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Abstract

We carried out three activities: supplementary lessons, open courses and research presentation. Our main purpose is to help our students acquire the skills for learning by themselves and unifying knowledge. Moreover having the upper-class students help us, we expect that they connect these experience to their research and presentation.

The supplementary lessons for the first grade students are divided into two courses, a basic course and an advanced one. In the basic course, the participants are given some problems as easy as ones in textbooks. In the advanced course, given are relatively difficult problems such as entrance examinations. In both courses, the upper-class students played a central role, while we behaved just as facilitators or makers of teaching materials. The results of the questionnaire and the examination given after the supplementary lessons showed that our trial received high evaluation from the participants. In addition, the upper-class students were satisfied with the improvement of their presentation skills and better understanding of what they had already known.

In the open courses held for junior high school students at Kurume College in 2013 and 2014, one of the authors gave an introduction to "knot theory" which is an important field in topology, and had the upper-class students mentioned above to be assistants. The result of the questionnaire showed that the open courses were highly evaluated thanks to the upper-class students' kind guidance for the participants.

After the open courses, the upper-class students shifted to studying subjects concerning knot theory such as tricolorability, the number of p-colorings and the Goeritz invariant. Then, without the help of teachers, they obtained some results and gave a succesful presentation.

It is possible to regard these three activities as a series of active learning. In this paper, we especially take the supplementary lessons with the upper-class students and describe their effort and result precisely.

Keywords: *Mathematics education, Supplementary lesson, Open course, Knot theory, Active learning*

§1. Introduction

In recent years, the bipolarization of the grades of the students has been remarkable in NIT of Kurume College. Moreover it is quite serious that some of the students are likely to lose their motivation to learn. Then we need a new way to learn, so-called *active learning* (see Figure 1).

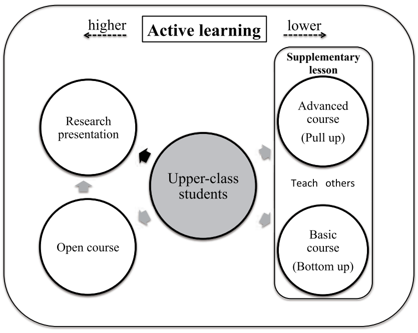
Along the spirit of active learning, the authors carried trial supplementary lessons for students in a part of the departments together with the upper-class students as teaching assistants in 2014. Since our trial were evaluated positively both by the participants and by the teaching assistants, we decided to proceed activities. So, in the next year, we had three activities: supplementary lessons, open courses and research presentations.

Through the supplementary lessons, the participants (the first grade students) are expected to get positive attitude to learn. In addition, in these lessons, the upper-class students behaved like a teacher to explain some fundamental knowledge on blackboard and to check and write some comments on the answer sheets submitted by the participants. The open courses and research presentations are activities in which the upper-class students join. We here note that in these two activities, they learn knot theory since not only it is an interesting field but also it does not require much background information, and there are various materials to learn visually (e.g., Kawauchi & Yanagimoto, 2012; Sakai, Miyaji & Nakabo, 2013). Experiencing these activities, they are supposed to rebuild learning contents which they have already known and obtain a way to teach something to others.

The result of questionnaire told us that our activities were successful for both the first grade students and the upper-class students. Moreover, we had an unexpected result. That is, the participants felt free to ask questions to the upper-class students. On the other hand, the upper-class students were aware of difficulty to make the participants understand.

In this paper we focus on the supplementary lessons for the first grade students held in 2014 to 2015 with the upper-class students as teaching assistants and describe their results.

This paper is organized as follows: Section 1 is the introduction. In Section 2, we explain the structure of supplementary lessons. Section 3 is devoted to the description of a result of them. In Section 4, we review the results of the questionnaire. Finally in Section 5, we describe our conclusion of these activities and the future challenges.



[Figure 1: Conceptual diagram of our work]

§2. The structure of supplementary lessons

As we wrote in the previous section, the bipolarization of the grades of the students has been getting seriously. Then we serve two groups, a basic group and an advanced group, for the supplementary lessons. The participants, the first grade students, can select which groups they attend (we note that not all students in NIT, Kurume College need to participate in the supplementary lessons).

(a) Teaching materials

Teaching materials served to each group with the help of the upper-class students were as follows:

Basic group: Studyaid D.B. ® (a computer software made by Suuken Shuppan),

Advanced group: the original materials and a workbook created by NIT, Suzuka College.

(b) Learning contents

The following is the list of the themes of teaching materials. Its contents and order follow the textbooks which the participants use in the ordinal lecture. In 2014, we just taught item 11 to 15.

1. Calculation of polynomials
2. Quadratic functions
3. Quadratic equations
4. Complex numbers
5. Inequalities
6. Sets and propositions
7. Hi-powered equations
8. Hi-powered inequalities
9. Various functions
10. Exponential functions
11. Logarithmic functions
12. Trigonometric functions
13. Linear programming
14. Quadratic curves
15. Permutations and combinations

(c) Construction

We constructed the supplementary lessons as follows.

- Attending students
Basic group: students who have low or insufficient learning level,
Advanced group: students with high motivation for learning.

- Leader
One teacher and two teaching assistants (the upper-class students) a classroom.

- Time and number of lessons
90 minutes and 5 times in 2014, 90 minutes and 15 times in 2015.

- Contents
We give the attending students the materials above.

- Methods
We repeat the following PDCA cycle to make the attending students fix knowledge and improve their learning level.

Plan: Teachers create teaching materials which reflect the requirement of the participants and the comments from the teaching assistants, in accordance with the progress of the ordinal lecture.
Do: On the blackboard teaching assistants write essential information and they answer students' questions during the lessons.
Check: Teaching assistants correct students' examination papers and explain the points where they often make mistakes in the next lessons.
Action: We review the previous lesson and the correction of examination papers and discuss the next lesson with the teaching assistants.

§3. Some scenes of supplementary lessons

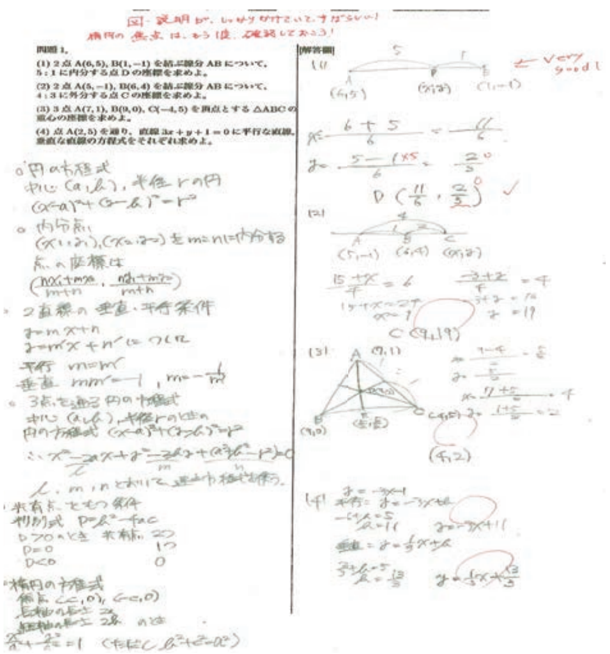
In this section, we review the scenes of supplementary lessons with some photos.

The teaching assistants write some points to solve the problems on the blackboard at the beginning of the lessons. The participants write the points on their answer sheets before solving problems. At the same time, the teaching assistants walk around the participants to answer their questions (see Figure 2). When the participants asked questions, the teaching assistants sometimes used the blackboard to answer them (see Figure 3). Through these activities, the teaching assistants developed their ability to teach mathematical subjects.

[Figure 2]

[Figure 3]

After the lessons, the teaching assistants corrected the mistakes of the sheets which the participants submitted and wrote down some comments. They reported the points that the participants were likely to make a mistake (see Figure 4). We referred to their report to improve the next lessons.



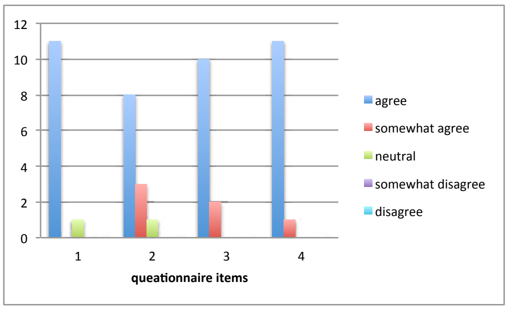
[Figure 4: Correction of examination paper]

§4. Results of the questionnaire

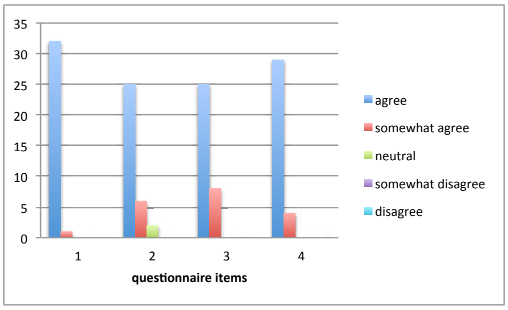
We continued to carry out the questionnaire for the participants whenever the supplementary lessons ended in 2014. Then the following results were obtained (see Table 1 and 2). The similar results were obtained in 2015.

(1) The items of questions and their results

Question 1. Was their explanation easy to understand?
Question 2. Did you feel free to ask them questions?
Question 3. Were their guidance and comments on the exam paper useful?
Question 4. Were you satisfied with this supplementary lesson?



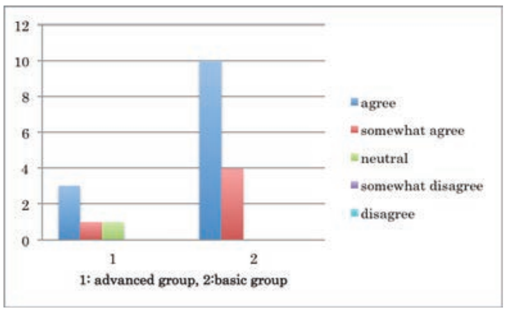
[Table 1: Questionnaire for advanced group]



[Table 2: Questionnaire for basic group]

In addition, one of the authors gave a supplementary lesson for 19 students of department of Electrical and Electronics Engineering *without* teaching assistants at the first half of 2014, and he asked the following questionnaire item 5 to compare with our lessons.

Question 5. Were you satisfied with this supplementary lesson?



[Table 3: Questionnaire about item 5]

(2) Free comments of the participants

Additionally, we asked the students to give free comments about the lessons. The students' free comments are as follows (translated and partially extracted by the authors):

- The upper-class students were very kind and helped my understanding during the lessons.
- The explanations by the upper-class students made me understand mathematics more deeply and I want to take lessons again.
- I found the lessons very beneficial so I want to take them next year too.
- I felt free to ask the upper-class students any question in the lessons. Thank you so much.
- I enjoyed taking lessons and I could understand mathematics deeply.
- The explanation on the blackboad was clear to understand.
- It was good because there was a lot of opportunity to ask questions.
- This lesson gave me a good opportunity to review.
- My understanding was developed by this lesson.
- I got motivated after attending the lesson.
- An advanced lesson made me get more interested in mathematics.

(3) The degree of achievement of lessons

We received extremely high evaluation in question 1 to 4 as is seen in Table 1 and 2. It can be concluded that the preparations for lessons were well and that the instruction of the teaching assistants was educational for each attending student. In particular, as Table 3 shows, supplemental lessons with teaching assistants are far more effective than those without teaching assistants.

The following Table 4 shows the transition of the average of the score in the examinations held for 45 participants.

Departments and average	Electrical and Electronics	Control and Information Systems
Average before lessons	38.5 (class average: 55)	33 (class average: 58)
Average after lessons	45 (class average: 51)	60 (class average:70)

[Table 4: Average of examination for the participants]

(4) Free comments of the teaching assistants

We also had the following comments from the teaching assistants (translated and partially extracted by the authors):

- I could understand mathematics deeply in preparing for the lessons and teaching mathematics to the attending students, in particular in the advanced group.
- I felt fun and difficulty in teaching at this lesson.
- I could review mathematics and obtain teaching method.
- I should have stood in the position of the attending students who are not good at mathematics.

§5. Conclusion and the further problems

The results of the previous section tells us that our supplementary lessons received higher evaluation by not only the first grade students but also the upper-class students than we had expected before these activities. The upper-class students found it both interesting and difficult to teach mathematics clearly. They connected these experiences to higher level active learning such that giving presentation in a meeting. Moreover, we obtained unexpected results. That is, some of the participants became so active to ask questions to teachers and the upper-class students.

As described in the previous section, we obtain that the supplementary lessons by the upper-class students are more effective than ones by teachers (see also Kawashima, Sakai & Matsuda, 2014).

On the other hand, since our materials were not relevant to engineering fields and did not fit the participants with respect to difficulty, we have to research the needs of the participants to make appropriate problems. Besides this, we have to continue these activities to increase the number of the participants and their voices.

Acknowledgements

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DEVELOPING COMMUNICATIVE AND PROACTIVE PRE-PROFESSIONALS THROUGH AUTHENTIC REALS (RICH ENVIRONMENTS FOR ACTIVE LEARNING)

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Abstract

Practitioners face a constant challenge in developing pre-professionals' communicative competence. The challenge is exacerbated by traditional instructional methods that favour inert knowledge acquisition and rote learning. Employers have also remarked that tertiary graduates lack the linguistic productive skills of speaking and writing required of PMETs (Professionals, Managers, Executives and Technicians). Rich environments for active learning (REALs) can address these challenges by promoting intentional learning, situated learning and generative learning activities, all attributes embodied in active learning. The readiness of technology has also transformed a practitioner's ability to create authentic learning activities, by using rich media that can match real-world tasks. Authentic REALs are potentially game-changers as a future prospect for active learning for higher education. The paper therefore, examines the synergistic connection between the learner, task and technology when using REALs to develop pre-professionals' communicative competence. The study uses a case method to illuminate the theory-practice connection of authentic REALs, and strengthen what is already known through existing research. The study looks at the use of REALs in Nanyang Polytechnic's School of Business Management (SBM)'s communication modules, namely Effective Oral Communication and Effective Writing Skills. The study seeks to: 1) Determine the learning design elements integral to embedding REALs in a curriculum through contextual analysis. 2) Develop a conceptual framework for creating REALs to guide future curriculum interventions. Since 2015, about 900 business students have benefitted from REALs. Tutors report greater student engagement levels and higher student motivation levels. The research further validated initial findings by conducting a pre-post effectiveness survey and written test measuring students' receptivity, motivation levels and performance change. REALs impact pre-professionals' communicative competence positively through: 1) Authentic tasks which provide realistic learning experiences 2) Use of rich media within a technology-mediated environment 3) Taking into account students' maturity to scaffold learning. The authentic REALs framework can be distilled into a set of curriculum design principles, applicable to other courses.

Keywords: *business communication, authentic learning, active learning, motivation*

Introduction

Institutes of higher learning, including universities and polytechnics have found that undergraduates' productive linguistic capacities of speaking and writing remain a challenge even today. In Singapore, the challenge goes beyond achieving a functional literacy. It centres upon mastering the required competencies for effective use beyond graduation and in professional settings. Numerous articles and headlines repeatedly state that oral and written communication, known as business communication skills, remain among the most desirable skills employers sought and identified as needing improving (Robles, 2012; Stevens, 2005).

Business communication skills are nearly synonymous with English language proficiency. The closely knitted association is warranted as English remains the lingua franca for business globally. Singapore has always attributed a proficiency in English as having contributed to the island's state economic success and international appeal. In multi-racial and multi-lingual Singapore, it is also the first language for education and governance as it bridges cultures and nationalities (Low and Azirah, 2012). However, the English language as a precursor for business communication skills can be problematic when traditional curricular practices are used to teach business communication. When societies place an importance on meritocratic pursuits, expressed as examination scores, certifications and credentials, learning can be compromised by what Lee (1991) termed as "education for earning, not learning". This can result in an examination culture that promotes rote learning and repetitive drills and practices in the English curriculum. Moreover, numerous studies show that mastering English necessary to build business communication skills requires an autonomous approach where students must engage in independent learning, tackling more challenging tasks (Hurd et al, 2001).

Therefore, there is a need to re-envision what a curriculum for business communication looks like for a pre-professional undertaking higher education. This can better ensure that educational outcomes align with work-based competencies that meet employers' expectations. REALs (rich environments for active learning), as a pedagogical practice, can address these concerns and demands. The potential of REALs are amplified when they are designed with authenticity as the primary principle and mediated by technology. The paper therefore, examines the synergistic connection between the learner, task and technology when using REALs to develop pre-professionals' communicative competence. The aim is to elucidate a framework to guide instructors and practitioners in using REALs to design active and authentic learning activities.

REALs as a Pedagogical Practice

REALs are constructivist in nature. They arose largely as a reaction to traditional educational models that emphasise inert transfer of knowledge and de-contextualised, simplified examples and exercises. Grabinger and Dunlap (1995) define REALs as comprehensive instructional systems that promote learning in authentic contexts and utilise active, collaborative learning and interdisciplinary, generative learning activities. They further emphasise that comprehensiveness referred to the "…importance of placing learning in broad, realistic contexts rather than in decontextualised and compartmentalised contexts" (p. 11). Grabinger and Dunlap (1995) state that REALs are not a delivery technology or a computer-based virtual environment, simulation or hypermedia. REALs must involve a learning community that goes beyond students and instructors to create a learning environment that encompasses the content taught, the delivery technology deployed, the learning tasks attempted and the context used. In short, REALs are information-rich, activity-rich and media-rich environments that promote exploration and collaboration through contextualised content, tasks and learner support. Grabinger and Dunlap (1995) outlined the key attributes and associated key learning strategies of REALs:

A. Student responsibility and initiative: Reciprocal teaching – Students take turns to perform questioning, summarising, clarifying and predicting activities in a shared context.
B. Generative learning activities: Cognitive apprenticeship – Transfers the apprenticeship techniques of observing masters at work to cognitive tasks and make visible the thinking processes required.
C. Authentic learning contexts: Anchored instruction – Instruction is anchored in a realistic event, problem or theme that requires students to solve interconnected sub-problems together.
D. Authentic assessment strategies: Varied techniques that assess across curricula as an integral part of a learning process rather than a periodic quantifiable measure.
E. Co-operative support: Problem-based learning (PBL) – PBL embodies REALs as it involves students working together to solve realistic problems and in that process, raise relevant concepts and principles that are authentic.

Authentic Learning Supported by Technology

While REALs already include an authentic context in its pedagogical model, it is important to highlight the role that authentic learning plays. Authentic learning is a key feature of REALs as it "…focuses on real-world, complex problems and their solutions, using role-playing exercises, problem-based activities, case studies, and participation in virtual communities of practice" (Lombardi, 2007, p. 2). Authentic learning coupled with the use of technology can be particularly effective when the educational goal is to help learners master a skill. The use of technology heightens authenticity and can optimise learning through a plethora of readily available educational technologies. Herrington and Kervin (2007) outline the principles that can translate authentic learning into practice using technology:

A. Authentic context and activities
B. Expert performance
C. Multiple roles and perspectives
D. Reflection
E. Collaboration
F. Articulation (of a culture of practice)
G. Coaching and scaffolding
H. Integrated authentic assessment
I. Professional learning

These guiding principles can be used to create technology-mediated authentic learning tasks within REALs. When technology is used effectively, the end-result is often rich media. Rich media is another key aspect of REALs. The benefits of using authentic learning supported by technology and rich media are numerous. An area to highlight is its capability to develop motivated and active learners. Authentic tasks in REALs are industry-relevant, compared to decontextualised textbook-based exercises. They provide the opportunity to model the actions and behaviours of multiple experts and to collaborate and strategise when solving complex, realistic problems. The active learning environment fosters the development of skill mastery as well as interest for an industry or profession. Technology makes the cited benefits easier to attain and fits better as a mode of instruction for tertiary students who are born digital natives. The multiplier effect that technology brings to REALs has the potential to intimately connect the learner to task and thus, engage in meaningful, relevant learning that leads to skills mastery.

Methodology

The study investigated students' receptivity, motivational levels and performance change after REALs were introduced into Nanyang Polytechnic (NYP)'s School of Business Management (SBM)'s business communication modules, namely Effective Oral Communication and Effective Writing Skills. NYP is an institution of higher learning in Singapore and has more than 15,000 students across seven schools. NYP is categorised as a TVET (technical and vocational education and training) institution and offers diplomas and specialist diplomas for both pre-employment and continuing education learners. The modules, Effective Oral Communication and Effective Writing Skills, are both taken by Year One business students and each is a 60-hour module with two 2-hourly tutorials a week.

REALs are described in this study as case studies on how learning content was transformed to be authentic and active. The exploratory process and implementation are also documented in this pilot study. A quasi-experiment with pre and post questionnaires and a control group was also deployed for three classes (each class has between 21 and 25 students) taking Effective Writing Skills to evaluate the impact of REALs. The experiment was set up with REALs as an intervention and independent variable. Three other classes, which used the traditional curriculum without REALs, acted as control. Three experimental classes were studied because newly developed REALs are first piloted before being introduced to all classes. Care was taken to ensure that the students in both groups had similar educational profiles and the tutors were experienced instructors with at least two years of teaching experience. Effective Writing Skills was chosen as writing skills provided comparatively more objective analysis than presentation skills. The questionnaires utilised a 5-point Likert rating scale and was administered in class. In addition, a post-test in the form of a written exercise was administered to both groups. The written exercise was on business email writing and was scored using a rubric. The aim of conducting questionnaires and a test was to identify the factors as well as evaluate the impact of REALs in optimising learning. The research purpose remains to identify the factors that will deepen understanding and lead to refining current and designing future REALs.

REALs for Business Communication

REALs was introduced into the curricula of NYP's business communication courses in the School of Business Management (SBM) in mid-April, at the start of the first semester in 2015. Since then, more than 900 students collectively have benefitted from REALs. Tutors report higher engagement levels in the classroom and a more sustained follow-through by students seeking to master business communication skills. The transformed tutorials in these courses have yielded initial promising results.

NYP conducts end-of-semester satisfcation surveys where students rate modules by learning goals, content, delivery, assessments and facilities. Both business communication modules achieved better ratings after REALs were introduced. When students were asked to rate the effectiveness of learning materials, there was an improvement of 8.1% (Effective Writing Skills) and 10.6% (Effective Oral Communication) from 2014 Semester Two (prior to the introduction of REALs) compared to 2015 Semester Two, a year after REALs were progressively introduced. The positive trend is also reflected in the overall delivery rating of both modules where there was an improvement of 6.1% (Effective Writing Skills) and 9.1% (Effective Oral Communication) respectively (NYP, 2016).

While the eventual goal is to transform the entire course, REALs were and are introduced gradually into the curriculum. There are several underpinning reasons for this cautious approach. Firstly, REALs took sustantially more time to develop compared to relying on a reference text. Secondly, lecturers and tutors needed time to adjust to the new instructional model and associated authentic learning tasks. Thirdly, it was assessed that a gradual introduction also lowered the risk of rejection, both by instructors and students. Lastly, as education technology was utilised, tutors needed familiarity training and equipment trial runs were also conducted to ensure viability.

For both modules, authentic examples, events and life-like scenarios were already in use prior to REALs. These were the starting points for further exploratory into richer learning environments. The impetus to shift to REALs was clear as there was an expressed need to transform the curriculum and delivery practices to meet growing expectations to produce pre-professionals with strong communicative skills. REALs, as defined earlier, make use of authentic examples, events or cases. However, REALs are more than these. REALs involve anchored instruction in authentic context and must include expert performance. Students go beyond applying learning concepts in narrative cases as they have to make the leap to model decisions and actions based on cognitive apprenticeship techniques. Using Grabinger and Dunlap (1995)'s attributes and learning strategies, both modules were transformed and REALs replaced traditional tutorials for selected topics.

Based on the process used by Russel et al. (2016), the tutorials for both courses were transformed using a three-step process – planning, design and development. SBM follows an outcome-based approach and the main goal is to develop articulate and confident graduates. In aligning learning content and activities to defined outcomes, it was decided that authentic tasks should create complete learning experiences addressing the entire topic and not reinforce a sub-topic or a specific communication strategy. Authentic tasks should also allow for multiple outcomes rather than promote the idea that only a singular model solution exists. Authentic tasks should also connect the significance of the tasks beyond the classroom to emphasise a real-world relevance. Lastly, these tasks should also allow for multiple perspectives from different practitioners where skills are used in context and in actual practice. Learning activities and tasks were also created with inputs, problems and challenges posed by industry practitioners and experts. With these principles guiding the design and development of REALs, it was decided that interactive videos were the optimal delivery technology to achieve the intended outcomes. Table 1 shows the transformed courses.

	Traditional	Transformed
Materials	Workbook PowerPoint	Workbook Interactive Videos Modified Industry & Experts' Content
Structure	Mini-lectures Exercises	Conversations Discussions Presentations Elearning
Activities	Scenarios Exercises	Authentic Tasks Authentic Problems Authentic Examples, Events, Scenarios
Assessment	Presentation Written Test	Presentation Written Test Expert Reviews

Table 1. Transformed Business Communication Tutorials

Two examples of transformed tutorials are described below to demonstrate how REALs were applied in practice. The design of REALs took inspiration from studies that examined how synergies between the learner, technology and task can be seamlessly integrated into the classroom (Herrington et al, 2006).

Course: Effective Writing Skills

Learners: Year One business students are taught professional writing covering the full range of formats and types of messages.

Technology: Three interactive videos where three experts were interviewed were produced. The experts were asked about the type of business writing they did, and to explain the importance and significance of business communication skills at their workplaces. The experts also spoke about situations they faced that required good business writing and to describe what to avoid and what worked well. They then shared a challenge they faced at work and the solutions used. The experts were chosen after taking the students' experience and maturity into account. The experts were also chosen to reflect role models they can emulate for each career stage:

- A recent graduate who spoke on how good writing helped him performed well during his internship.
- A graduate with several years' work experience who shared about how good writing enhanced her ability to engage customers at work.
- A graduate with more than ten years' industry experience who shared about how good writing is necessary for complex situations that require active management.

Task: Students were asked to read about writing principles and strategies prior to class. In class, they were briefed about the learning objectives before participating in REALs featuring the interactive videos. Each interactive video was produced as a series of short clips which had three to five parts, The entire exercise with one interactive video required 60 to 90 mins to complete. Tutors used a stop and pause technique. After watching each video clip, tutors led the class in group discussions. Students delved into the situation each expert faced. They were asked to consider the position of the recipient of the communication and that of colleagues and managers. They then tackled the problem the expert posed. The students had to consider the tone, the culture, the situation and the multiple perspectives when applying the writing principles and techniques they had learnt in class. After student groups proposed their solutions, they watched the expert described how he or she resolved the situation. The tutor then asked each group to revise their solutions, which they then presented their improvements. The session ended with a debrief and reinforcement of effective business writing principles and strategies.

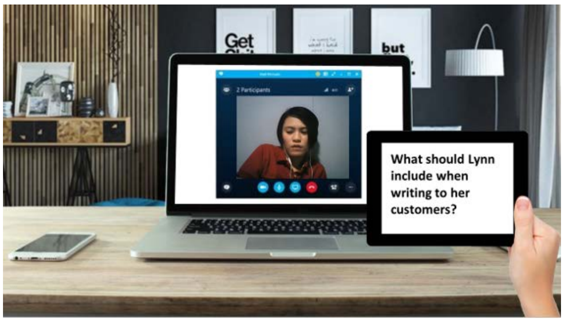

Figure 1. Interactive Video for Business Writing

Course: Effective Oral Communication

Learners: Year One business students learn about presentation skills by working on and delivering informative and persuasive presentations.

Technology: Four interactive videos were produced from two sources. Two were created using TedxYouth videos. Two others featured experts who were invited as guest speakers and were recorded on video as part of a Business Communication eSeminar. The TedxYouth and eSeminar videos were transformed into interactive videos. The experts chosen were excellent presenters who demonstrated the 3Vs of effective presentations, namely, visual, vocal and verbal qualities flawlessly. The intent was to give the students the opportunity to learn about presenting as well as model effective presentation techniques. The experts were a mixture of young and more experienced presenters. This was deliberate as it allowed for intended contrast which would generate different perspectives in how each used their own strengths to deliver a highly effective presentation.

Task: Students watched the interactive videos, which were designed as 45 to 60-min sessions. Tutors used the pause and rewind technique. After watching a part of the video, the tutors asked the class to identify good presentation techniques the experts demonstrated. The video segment was then replayed and paused at appropriate junctions to highlight how the experts structured the presentation and used effective presentation techniques. Students were then asked to predict the reaction of audiences and why the audience reacted as they did to the expert's presentation at critical junctures. The experts also posed a mini-challenge where students worked in groups to resolve. Each group then nominated a volunteer to present the group's solution. The class, led by the tutor, provided constructive feedback for each student presenter. The tutor would end each session with a debrief and reinforce the presentation skills taught in prior classes.

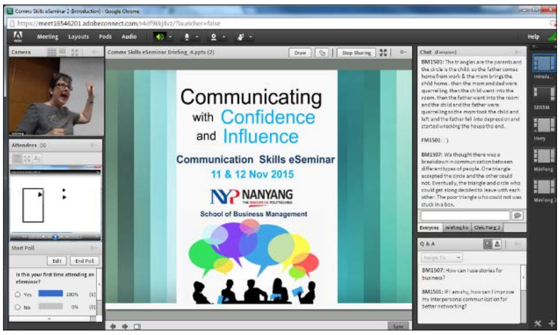

Figure 2. Interactive Video for Presentation Skills created from Business Communication eSeminar

Results and Discussion

Students' receptivity, learning preferences, motivation and interest levels were assessed using a student self-reported survey with a Likert Scale of 1 to 5 (with 5 being strongly agree) at the end of the term.

Two questions asked students to state their self-perceived proficiency in writing and communicating. Seven questions focused on identifying students' learning styles to determine preferences for authentic or traditional learning. Five questions were asked about the students' motivational and interest levels, measured by follow-through actions.

	Control	Pre	Post
	n = 61	n=64	n=67
	Mean	Mean	Mean
Self-Perceived Proficiency	3.16	3.02	3.01
Authentic Learning Preference	3.73	3.57	3.63
Traditional Learning Preference	3.63	3.58	3.52
Motivation and Interest	3.23	3.30	3.42

Table 2. Student Survey Results

In terms of self-perceived proficiency, there was no significant difference between pre and post results. Cassidy & Eachus (2000) explained that students' self-perceived proficiency are formed largely based on prior and current academic test performance. As such, students are more likely to mirror tutor-assessed test scores rather rely on their own judgements. There was also no significant difference between preferences for authentic and traditional learning. The results suggest that students may have entrenched learning preferences that resist new instructional methods. As the survey respondents are first year students, it is possible that they still rely on studying habits developed prior to entering tertiary education. They may also be new to authentic tasks and may require time to develop a preference for such.

There was a significant difference in overall motivational and interest levels, as confirmed by an independent t-test (df=609, -1.964<2.551<1.964). Students were asked if they took more notes, talked about what they learnt with their friends and families and if they took a greater interest in the learning content. This is consistent with studies that report authentic learning enhanced learner motivation (Russell et al., 2016; Duke et al., 2006).

Students were also given a timed test to write a business email. They were given 15 mins to produce a bad news message addressing an authentic situation. Students' written emails were coded for the ability to open using an appropriate tone, to generate relevant points and to close appropriately, with the maximum score being 10 points.

	Control	Post
	n = 68	n=69
	Mean	Mean
Ability to write an appropriate opening	1.59	1.46
Ability to generate relevant points	3.57	4.74
Ability to write a forward-looking close	1.29	1.51
Total	6.85	7.71

Table 3. Writing Test Results

There was a significant difference in the ability to generate relevant points, as confirmed by an independent t-test (df=130, -1.978<2.790<1.978). The ability to open and close appropriately had no significant difference. These findings can be attributed to students having observed multiple experts share a myriad of approaches in resolving real-world problems. Students also benefitted from having actively discussed and collaborated when they had to propose and refine their solutions. Tutors observed a higher level of active participation. Parsons and Ward (2011) explained that the nature of assignments determined students' level of participation. They added students preferred higher-order authentic tasks to easier academic tasks.

Guidelines for Developing REALs

An outcome of this exploratory research is to encapsulate and operationalise our experience developing and implementing REALs into a framework. In linking practice to learning science, the identified characteristics of REALs were encoded into instructional design guidelines. Table 4 shows our resultant REALs framework used, which was based on three key theoretical principles – authentic learning, active learning and technology-mediated learning. The guidelines were developed mainly to assist tutors to distinguish REALs from more fundamental authentic learning tasks.

Levels	Authentic Learning	Active Learning	Technology-mediated learning
Level 1	Examples, Events, Problems	Questioning Discussing Presenting	Projection of Media
Level 2	Role-plays Cases Simulations	Investigating Collaborating Solutioning	Elearning Social media Microworlds
Level 3 REALs	Complex Situations Multiple Linked Scenarios Expert Performance	Modelling Cross-examining Synthesising Reflecting	Interactive videos Immersive environments

Table 4. Operationalised REALs Framework used for NYP SBM's Business Communication Modules

It is important to note that level 3 defined what REALs are. REALs are characterised by complex situations that contextualise learning involving expert performance providing multiple perspectives. They require rich, interactive media within immersive environments to allow for cognitive apprenticeship techniques.

Conclusions

In summary, this study confirms that REALs are beneficial for mastering business communication skills as they positively impact student motivation and communication ability. The key lesson in using REALs as an intervention is that they require the synergistic use of authentic and active learning activities, enhanced by technology, to create a rich environment for optimal learning and skills mastery. The operationalised REALs framework, which emphasises expert performance, used in this study can guide instructional design for other course modules seeking to create comprehensive active learning environments.

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Challenging in PBL Education on the Field of Materials Science

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Abstract

Kosen is a college that educates engineer and researcher to gain deep knowledge to overcoming challenges. However, in today's educational environment, teachers and tutors face variety problems such of globalization and progress of technology that are induced by instantaneous and rapid changes of social environments. Under these conditions, teachers need to have a flexibility in their coaching in order to develop interest and motivation among students. Our college employs a new curriculum style, known as Projective based learning (PBL) system. This style is to be spontaneously learning for students. Therefore they are able to have ability for solving unknown problems. Wisdom and skills in order to solve the problems are necessary. Herein, I described experimental lesson with NMR measurement of unknown sample using PBL methods. From student's comments, this method clarified a useful for problem-solving ability.

Keywords: *PBL education, Active Learning, NMR analysis*

Introduction

Up to now, Kosen education has been conducting in order to bring up technical engineers. Therefore, Alumnae and alumni play an active role as efficient worker in the industrial society. However, shift with change in academic development, educational method need to be changed. Most of the teaching centres, schools, colleges, universities and tuition have their teaching methods based on lectures where instructors would lead the whole learning environment and convey information to students via power point screen or notes written on boards. This teaching strategy would give effects when students are interested and passionate on the learning process or instructors able to give consecutive motivation on their means of teaching. However, with today's student, lecturing does not hold their attention long. Students today have grown up dealing with interactive tools like Internet, computers and smartphones and these gadgets and media allow students to enjoy the real-world problem solving and also give opportunity to express their own views and hear their own voices. Educational life should work the same. A very good example of this is the projective base learning (PBL) engaged in the robotics projects. Students get into group to seek solution to real challenging problems. This process creates a learning community where all participants take responsibility for learning and achieving understanding of concepts by themselves, also deepens the communication skills. With this supportive evidence, implementing PBL in teaching of chemistry has come to action, yet not a major influence in education. In our college, students are allowed to engage in practical tasks which give a complete different learning exposure to chemistry. In fact, they learn better and understand deeper through operating experimental procedures. This paper provides an overview of the findings in our department education system and discusses the consequences of implicating PBL based syllabus on educational development.

Outline of this experimental lesson

Our department of chemistry afford students with complete experience in understanding chemistry by variety of experiments based on biology, physical chemistry and analytic chemistry according to their education grade. Particularly, students of the fourth grade has more intense experimental tasks of 3hours a week. They are offered with opportunities to enhance their knowledge in chemistry through class includes 10 practical themes ; NMR spectroscopy (^{1}H NMR, ^{13}C NMR) measurement, X-ray spectroscopy, density and viscosity against water-alcohol system, measurement of heat of solution for sodium thiosulfate, measurement of boiling point for methanol-benzene system, electromotive force of Daniel-Volta battery, hydrolysis rate of methyl acetate, logic circuit, absorption spectrum and emission spectrum, computer simulations.

授業要目(シラバス)[物質工学科－必修得]

対象学科	物質工学科	担当教員	青木 薫、粳間由幸		
授業科目名	物質工学実験II	科目コード			
学年	4学年	開講学期	通年	単位数	3単位
区分	必修得	授業の形態	実験	単位種類	履修
授業概要	物理化学・無機化学・生物学・機械工学・電気工学に関連する各種の実験を通して、実験計画の立案、データの取得と整理、データの妥当性に関する検討、関連知識・情報の調査を総合的に行う訓練を行う。				
関連する本校の学習教育目標	「複合PRG」:B-1	関連するJABEE学習教育目標	「複合PRG」:d-2		
到達目標	テーマに合致した実験計画の立案、データの取得と整理、データの妥当性に関する検討、関連知識・情報の調査をチームで分担して行うことができる。				
授業の進め方とアドバイス	提示された実験テーマとそのテーマに関する実験を行うための基本的な実験器具等に基づき、計画を立案し実行に移す。調査・研究をチームの構成員が分担して実験を行うこと。 物質工学の基礎を実践に生かすための幅広い知識・技術を習得するために、臨海実習、ものづくり実習を行なう。実験テーマ・実習に関する基礎知識を問う試験を後期期末試験で行う。				
授業内容スケジュール	回数	授業内容			
	前期: (1)下記7テーマについて実験し、レポートを提出する。 ○テーマ1 「NMR測定と解析」 ○テーマ2 「単結晶X線開設測定と解析」 ○テーマ3 「水－アルコール混合系の密度変化と粘度」 ○テーマ4 「チオ硫酸ナトリウムの溶解熱測定」 ○テーマ5 「メタノール・ベンゼン混合系の沸点測定」 ○テーマ6 「ダニエル・ボルタ電池の起電力」 ○テーマ7 「酢酸メチルの加水分解速度」 ○テーマ8 「論理回路」 ○テーマ9 「吸収スペクトルと発光スペクトル」 ○テーマ10 「コンピュータシミュレーション」 (2)臨海実習(広島大学臨海実習施設) 21時間 後期:ものづくり実習 後期期末試験				
教科書	特に定めない				
参考書	後藤廉平編「物理化学実験法」共立出版、小寺明編「物理化学実験法」朝倉書店ほか実験書				
関連教科	物理化学、情報科学I、生物、生化学、機械工学				
基礎知識	化学、無機化学、物理化学、有機化学、生物、生化学、機械工学				
成績の評価方法	総合評価割合		各テーマのレポート:28点。 臨海実習レポート:12点 ものづくり実習レポート:20点 試験は行った実験・実習に対する基礎知識を問う。		
	定期試験	40%			
	レポート	60%			
	演習・小テスト	%			
	その他	%			
		100 %			
備考	オフィスアワー:毎週金曜日16時20分以降				

Figure 1. Syllabus of Experimental lesson (Japanese ver.)

The students are grouped and time is provided for students to do some research on their experiment, in they are assigned to design the own experiential procedures that aim to explain and describe the hypothesis of each task. This enable personalized learning. Participants set their own learning pace and concepts by merging the gap between theory and practice which play a crucial role retaining ideas gained from classroom learning. This journey also imparts high focus on collaboration and valuable discussion among members which increase students' engagement in chemistry Of course, teachers confirm the pre preparation by checking their notes and instructing them the safety alerts before they are allowed to carry out the experiment.

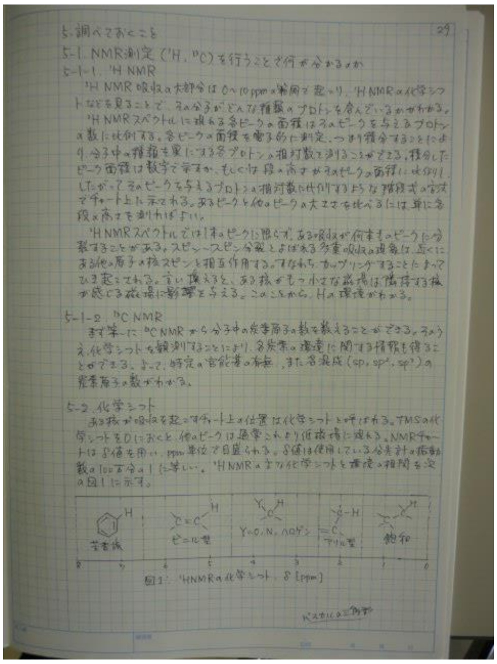

Figure 2. Experimental notebook

Details of this experimental lesson
~ NMR Measurement of Unknown Organic Compounds~

NMR analysis is the most common and powerful tool used nowadays which provides scientists with substance or chemicals information of both stoichiometry and stereometry (Figure 3). Students are provided an unknown sample with known element constituents. The NMR data was measured by students. The data have to analyze until next lesson.

Figure 3. NMR equipment

Teacher taught a meaning chemical shift and split of signals (singlet, doublet and triplet). In the case of ethanol, the chemical composition formula weight is C2H6O1. Firstly Degree of unsaturated (D. U.) was calculated from chemical composition formula weight. D. U. shows a number of unsaturated bond and existence of cyclic structure in the molecule. As a result, a candidate molecular structure were easily obtained (Figure 4). In this case this value show 0; unsaturated bond not involved in the molecule. From this knowledge, students can write two kinds of candidate structures (Figure 4).

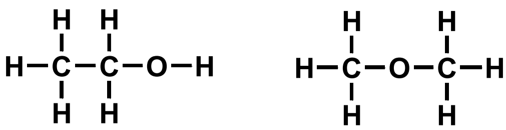

Figure 4. Candidate structure for C2H6O1
Left: ethanol Light: diethyl ether

One out of these compounds determined by ^{1}H NMR and ^{13}C NMR analysis.

Results and Discussion

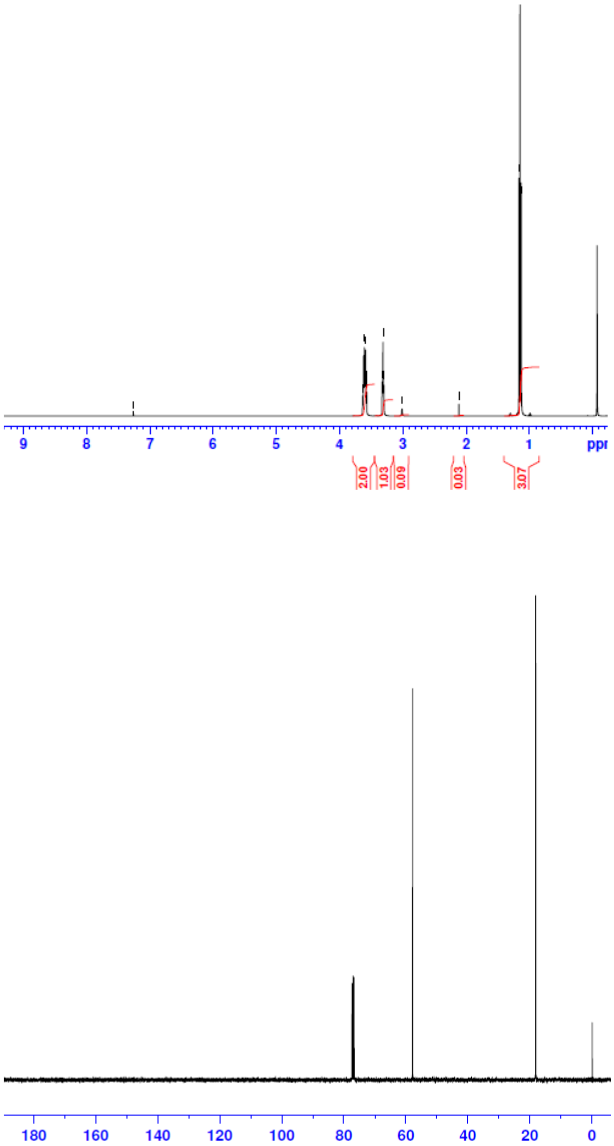

Figure 5. NMR spectra of ^{1}H NMR and ^{13}C NMR

In the case of C2H6O1, it has two candidate structures (Figure 4). On the other hand a molecule has ethyl group and methoxy group. According to ^{1}H NMR data, δ 1.11 ppm indicated triplet signal (3H) and δ 3.57 ppm also indicated quartet signal (2H). And ^{13}C NMR spectrum shows two signals in the chart. As a result, there are two kinds of carbon atoms in the molecule. Finally it has been conclude an unknown sample as ethanol.

By thinking for a candidated structure and analyzing NMR data, students are going to have important skill.
The objective of this lesson is to be having ability for solving problem by discussing their friends.

How do students think about this lesson? I have been interested in student's thought. For some students, this experimental lesson may be pretty hard to write a report. However, a written report is good one. The NMR assignments of unknown samples were also written very well. I carried out the survey about how to proceed the experimental curriculum for the student. The survey includes following listed questions.

1) What grade are you in college?
2) How feel about this experimental curriculum?
3) If you feel good, please fill in your comment.
4) If you feel nothing or no good, please fill in your comment.
5) Please teach me about skills you are learning into the experiment.

These answers are below. The answer for question 2 shows much good feelings. Therefore answers for the question 3 are collecting a lot answers. Mainly answers are to be discussed with the student about not understanding problems and to be understood importance of team work. Answer for the question 4 is not answered. This is meaning that all students feel satisfactory. From the student's comments, they has been discussed with their friends about analysis of NMR data. According to discussion, students have an ability to solve problems for unknown matter and communication skills.

Conclusions

In this lesson, students carried out by discussion with group member a structure analysis of organic compound. As a result, students are able to have ability for solving problem. This ability facilitate solution difficult problem and to create newly technology.

Acknowledgements

I gratefully acknowledge Prof. Takenaka for his valuable suggestion and discussions.

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1211

A STUDY OF INDUSTRIAL COMPANIES' PERSPECTIVE OF BUSINESS ADMINISTRATION GRADUATES

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Abstract

This research study was conducted to investigate the industrial companies' perspective of graduates who had a bachelor's degree in business administration. The main purpose of this study was to develop teaching and learning for students in a business administration program in order to become an employable graduate in industrial companies. The researcher used simple random sampling. The samples of this study were 250 industrial companies located in industrial estates in Bangkok and Eastern areas of Thailand including energy saving and renewable energy industry, textile and apparel, automotive, plastic, mining ceramics and metal base, construction, agriculture and agricultural products, electronics and appliances, metal production machinery and transportation, and services and public utilities. The research instrument was a 5-point rating Likert scale questionnaire. The data were analyzed for their descriptive analysis Percentage, Mean, Standard Deviation using statistics Program and single level Structural Equation Modeling (SEM) analysis.

The result revealed that first of all, industrial companies expected graduates to have ethics and morality. They also needed to have knowledge, cognitive skills, and interpersonal skills and responsibility. Besides, numerical analysis, communication and information technology skills were also required.

Keywords*:* *industrial company, companies' perspective, business administration graduates, industrial sectors, Thailand*

Introduction

Technology Promotion Association (Thai-Japan) (TPA) was founded by the cooperation of Thai and Japanese organizations with the goal of supporting and transferring knowledge and new technologies to Thai personnel. The institute has been developed continuously and created reputation in various aspects such as hosting a conference for technology and management, teaching of foreign languages, being a consultant for many industrial enterprises as well as being a centre that gathers experts from different fields. In order to provide right-quality personnel for Thai industries, Thai-Nichi Institute of Technology (TNI) was founded. TNI aims to produce graduates following the Monozukuri principle so that graduated would be good in both theories and practice. Students need to pass their internship in order to graduate and have more opportunities to get a job after graduation. They would be able to communicate in Japanese and English.

Faculty of Business Administration has played an important role to build quality personnel for industrial companies. The faculty consists of six majors including industrial management, Japanese business administration, business and industrial management, international business management, accountancy, and Japanese human resources management. The goal of the faculty is to build a proficient graduate who is skilful in theories and practice. Japan is one of important investors in many kinds of industries in Thailand. Therefore, all students in the faculty need to learn Japanese every semester. When graduate, they would not only be able to communicate in English, but they would be able to communicate in Japanese as well.

Regarding to the goal of building a right-quality graduate for business and industrial sectors, it is essential to know what quality business and industrial sectors need for their personnel. A research study for this aspect is needed to be done in order for the statute to adapt and develop a curriculum and lessons that are suitable for the needs. Therefore, this study was conducted with the objective to examine industrial companies' perspective of graduates from the Faculty of Business Administration.

Materials and Methods

Participants: Simple random sampling was used to select the samples. The participants were 250 administrators from 250 industrial companies located in Bangkok and Eastern areas of Thailand.

Research Instrument: The research instrument was a 5-point rating Likert scale questionnaire containing three sections: 1) participants' company information; 2) companies' perspective of business administration graduates; and 3) an open-ended question for comments and suggestions.

The questionnaire was adapted and validated by three experts and piloted with 30 industrial companies for its reliability before used with the main study. Cronbach's alpha coefficient was used to analyze the data. Then the revised version contained 71 items including 24 items of knowledge (Kno), 8 items of cognitive skills (Cog), 21 items of numerical analysis, communication and information technology skills (Num), 12 items of ethics and morality (Eth), and 6 items of interpersonal skills and responsibility (Int).

Data Analysis: The data were analyzed using descriptive analysis and single level Structural Equation Modeling (SEM) in order to create a model.

Proposed Model

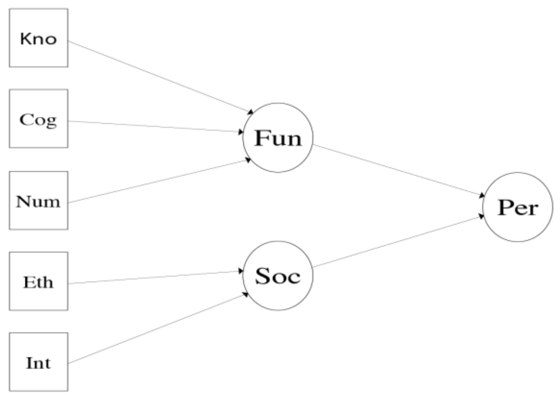

Figure 1: Proposed Model

Results and Discussion

When the participants completed and returned the questionnaire, the data were analysed. The results are reported in this section.

Table 1 demonstrates participants' company information. Most participants were from companies with 301-500 employees (25.6%), the second large group was from companies with 101-300 employees (23.6%) and the third large group was from companies with 100 employees (18.8%).

The departments that participated most were export (12.4%), production control (10.4%), and financial (7.2%), respectively. The smallest group was from the sale department (1.6%).

The three types of industries that participated most were textile and apparel industry (19.2%), energy saving and renewable energy (12.4%), mining ceramics and metal base (10.8%) and metal production machinery and transportation (10.8%).

The participants from companies with 11-20 years of operation (34.4%) were the largest group participated in this study. The second large was companies with 5-10 years of operation (30.4%) and the third large was companies with more than 20 years of operation (20%).

Most companies had authorized capital of 5-50 million baht (30.8%), 51-100 million baht (29.6%), and 101 million baht (22%).

The results from Table 1 illustrate a variety of participants in the present study which would help the institute to gain more confident from the results.

The next table, Table 2, is showing the result of industrial companies' perspective of graduates' qualifications.

Table 1: Participants' Company Information

Participants' Company Information		Numbers of Participants	Percent (%)
No. of employees	100	47	18.8
	101-300	59	23.6
	301-500	64	25.6
	501-1000	43	17.2
	1001 and more	37	14.8
From Department	Research and Development	16	6.4
	Marketing	12	4.8
	Management and Secretary	15	6.0
	Production	15	6.0
	Export	31	12.4
	Credit and Law	13	5.2
	Production Control	26	10.4
	Technical	21	8.4
	Financial	18	7.2
	Accounting	17	6.8
	Manufacture	12	4.8
	Purchasing	7	2.8
	Customer Service	8	3.2
	Products	5	2.0
	Sale	4	1.6
	Human Resource	12	4.8
	Insurance	5	2.0
	Quality Control	13	5.2
Types of Industries	Energy saving and renewable energy	31	12.4
	Textile and apparel	48	19.2
	Automotive	18	7.2
	Plastic	18	7.2
	Mining ceramics and metal base	27	10.8
	Construction	25	10
	Agriculture and agricultural products	12	4.8
	Electronics and appliances	26	10.4
	Metal production machinery and transportation	27	10.8
	Services and public utilities	18	7.2
Years of Operation	Less than 5	38	15.2
	5-10	76	30.4
	11-20	86	34.4
	More than 20	50	20.0
Authorized Capital (baht)	Less than 5 million	44	17.6
	5-50 million	77	30.8
	51-100 million	74	29.6
	101 million	55	22.0

Table 2: Industrial Companies' Perspective of Graduates' Qualifications

Qualifications	N	Mean	Std. Deviation
Ethics and morality (Eth)	250	4.696	.46954
Knowledge (Kno)	250	4.092	.28961
Cognitive skills (Cog)	250	4.236	.45291
Interpersonal skills and responsibility (Int)	250	4.064	.43435
Numerical analysis, communication and information technology Skills (Num)	250	4.648	.47855

From Table 2, morality and ethics is the most important qualification that graduates should have, with the mean of 4.696. The second qualification is numerical analysis, communication and information technology skills with the mean of 4.648. The third important one is cognitive skills with the mean of 4.236.

Using SEM to analyse the data, the result revealed the effect of the five qualifications including knowledge, cognitive skills, numerical analysis, ethics, and interpersonal skills. They were observed variables while industrial companies' perspective was latent variable. Knowledge, cognitive skills, and numerical analysis were defined as fundamental skills (Fun) while ethics and interpersonal skills were defined as social skills (Soc).

Table 3: Statistic Analysis of Structure Equation Modelling for Industrial Companies' Perspective of Business Administration Graduates

Observed variables	Structure Equation Modelling (SEM)			
	Factor loading β	SE	Z	R^2
Fun. skills	0.450	0.101	4.468	0.000**
1. Kno	0.004	0.023	0.190	0.849
2. Cog	0.012	10.007	1.708	0.088
3. Num	-0.041	0.011	-3.809	0.000**
Social skills	0.251	0.078	3.240	0.001**
4. Eth	0.017	0.039	0.436	0.663
5. Int	-0.017	0.057	-0.295	0.768
Chi-square=17.411, df=15, p-0.2949, RMSEA=0.025, CFI=0987, TLI=0.985, SRMR=0.036				

/Z/>1.96 is p< .05, /Z/>2.58 is p< .01

The factor loading of industrial companies' perspective of business administration graduates shows the statistical significance at the level of .01 of both fundamental and social skills. However, the factor loading value of fundamental skills (β=0.450) is higher than the value of social skills (β=0.251).

From Table 3, of five variables, numerical analysis is the only one variable showing the statistical significance at the .01 level. This result could be interpreted that industrial companies expect graduates to have all of those qualifications; however, numerical analysis is the less important one.

For the validity (R^2), the table shows the value of covariance of both observed variables and latent variable. Table 3 also shows that the R^2 values are between 0.00 to 0.0849.

Moreover, the result from SEM analysis using M-plus program confirmed the construct validity of the hypothesis model. The Chi-square statistic x^2 of the hypothesized SEM model was x^2 = 19.210, df = 14 which was a non-significant x^2/df = 1.161 which was less than 2 (p=0.2949) as required for SEM (p > 0.001 and < 2). The model had the good fit with the empirical data regarding the fit indices, CFI = 0.987 and TLI = 0.985 (closing to 1). RMSEA = 0.025 and SRMR = 0.036 (closing to 0). Figure 2 demonstrates the model from SEM analysis.

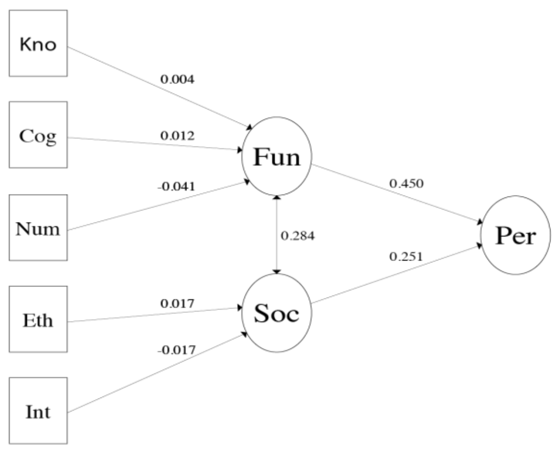

Figure 2: Model of Industrial Companies' Perspective of Business Administration Graduates

From the model created by using SEM analysis, it demonstrates that the five qualifications affect the perspective of industrial companies in Thailand. Fundamental skills and social skills are also related to each other and affect the industrial companies' perspective. The result confirms the proposed model.

Finally, the result from this study revealed that all industrial companies expected business administration graduates to have all five qualifications even though each qualification might not have the same level of requirement. The most required qualification was ethics and morality. The result was the same as previous study conducted by Jaensirisak and Sangsawang (2015), Thanuwarapat (2012), and Sillaparat (2008), which confirmed ethics and morality were the most desirable qualification of graduates. Thanuwarapat (2012) The reason was that when a company hired graduates, their work would relate to many different sections of that company depending on their responsible duties. The duties might relate to insiders and outsiders, important documents, or financial matter. Thus, if employees did not have ethics and morality, it would have serious effects on a company itself and other cooperated companies.

The second important qualification was numerical analysis, communication and information technology skills. It could not be denied that information technology, nowadays, has an enormous effect on the industrial sector. Doing business, fast and accurate numerical analysis was necessary in order to win over other competitors. The fast and effective communication was also playing an important role as shown in a study of Thanuwarapat (2012).

The previous studies (e.g. Buakruen, Sriharun, & Girdtempoom, 2015; Yakhampom, 2014) not only confirmed these two qualifications, but the other three qualifications including knowledge, cognitive skills, and interpersonal skills also were confirmed as important qualifications that any companies expected from the graduates.

Conclusions

In conclusion, from their perspective, industrial companies in Thailand expected graduates to have all five qualifications, and the most important one was ethics and morality. In this study, the result was the overview from different types of industrial companies. Therefore, for the future studies, they could be conducted on some specific types of industries. Then the result could be compared with the result in general and gain more insight of industrial companies' perspective of newly graduates.

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1212

AN EXPERIENCE OF MANUFACTURING GOODS THROUGH PRODUCING WOODEN LATHES

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Abstract

This school was established as a model class of Japanese-style Kosen in October 2014 and Mongolian Kosen was opened in September 2015. In the beginning, 1st grade students learned fundamental exercise of engineering science, and advanced to 2nd grade classes, three course of study by choice and achievement such as machinery engineering, electronical engineering, and electronics and constructional engineering. Fundamental exercise of engineering science has already been reported before[1)].

The authors in charge of machinery engineering class and teach 2nd grade students. Mongolia, however, can be said as an isolated island in the continent and they have little manufacturing machinery. Fortunately enough, wooden material is abundant. We have produced wooden lathes with the help of Japanese instructors and hand crafts/tools and wood cutting machines. In due course of time, we have a plan to introduce manufacturing machinery. So far we would like to deepen understanding of processing whole-wood by lathe machine.

We would like to report 2nd grade students' process and circumstances of creating wooden-lathes.

Keywords: wooden lathes, lathe, wood

1.Introduction

In Japan, manufacturing practice using lathes are usually performed in fundamental exercise of engineering science course. However, in Mongolia, we do not have anything but a desktop drilling machine. We have determined, during 2nd grade, to make lathes which would be used for 1st grade students. Under circumstances where almost no manufacturing machinery exists and is difficult to obtain metal material, we found out that wood material is easy to obtain at inexpensively. After having obtained wood craft machinery such as electrically-powered tools, saws, planes, chisels, etc., we have invited a specialist for wood craft from Japan who taught wood craft practice. We came to a conclusion that making wooden lathes is not a difficult practical application task for 2nd grade students who have already experienced wood craft during 1st grade. After completion of wooden lathes, we plan to put them into actual lathes cutting exercise for 1st grade students.

It is our aim for 2nd grade students, through making wooden lathe to deepen understanding of origin and history, structure, and usage of lathe. We would like to put emphasis on the importance of constructing wooden lathes by students' own hands. We were planning to manufacture early stage hand-powered lathes in its history.

2. Manufacturing Procedure

2.1 Miniature model

In manufacturing wooden lathes, it is our policy for the students to think by themselves, as well as give ideas by referring to schematic diagram of textbooks[2)] and shapes of modern wooden lathes: we reflects students' ideas at present time.

Figure-1 depicts assembled drawing.

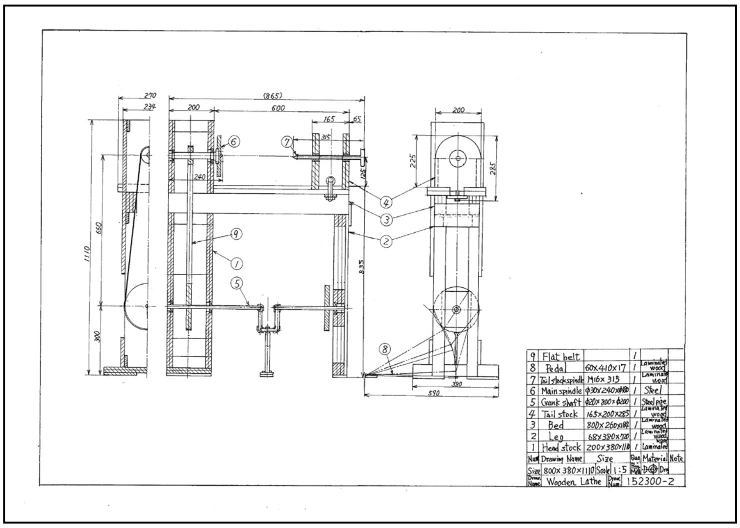

Figure1 assembled drawing of wooden lathe

Actual lathe will be made from plywood of 2m(length) x1m(width), 17mm dimension in thickness. we have decided to make 1/5 scale of miniature lathe. By making a miniature model, we will obtain an image of real lathe, number of parts needed, shape of parts, and procedure of assembly as well as to check correctness of drawing and dimension of parts. The writers instructed students to work coordinating each other and each group is requested to report points or procedure to improve.

We used polystyrene board of 3mm in thickness, while actual lathes plywood of 17mm in thickness will be used. We drew parts shapes on 300mm x 600mm polystyrene board referring to parts drawing lists. After drawing parts shapes, we have cut the polystyrene boards. We then arranged them in order to check and confirm number of parts and dimension. (Figure2)

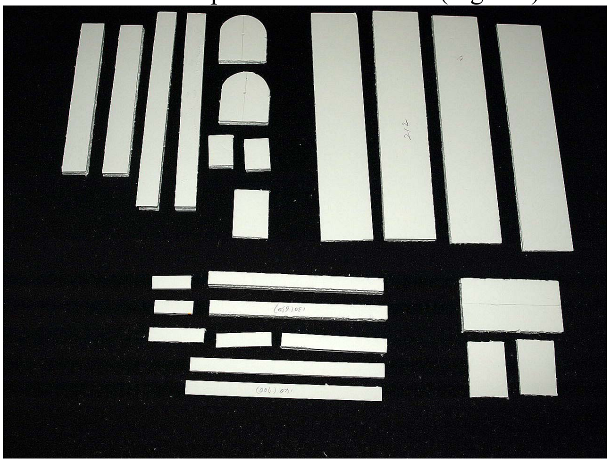

Figure2 number of parts and dimension

After having checked correctness, we put polystyrene parts into ply-boards and glued them together. Figure 3 is a photo of completed miniature lathe.

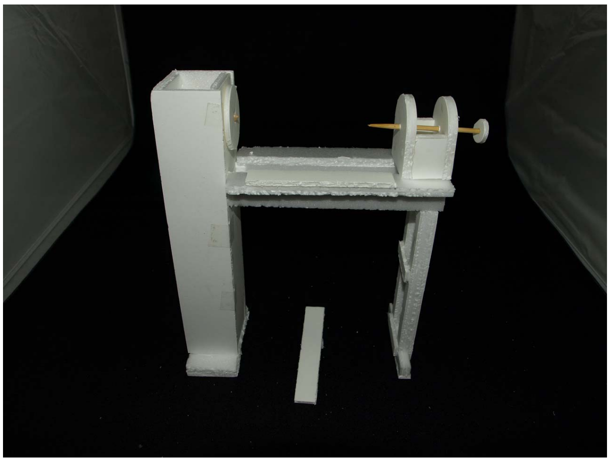

Figure3 a photo of completed miniature lathe

2.2 Wood cutting

In Mongolia, it is rather difficult for us to obtain already cut wood, on the contrary, it is easy to obtain 1m x 2m, 17mm in thickness plywood inexpensively price which are solid in shapes and without conspicuous knots. We measured the plywood with scale, carpenter's square and pencil. (Figure 4) It is recommended to figure out the order to cut the plywood without wasting beforehand. The authors asked students to compare position of outlined parts-shape, and order to cut and efficiency with each other.

Figure4 measuring the plywood with scale, carpenter's square and pencil.

2.3 Cutting into shapes

We start cutting into shapes from the plywood by using electric circular saw. Before using electric circular saw, we conducted safety guidance, which are: plugging into power outlet should be done after having checked the safety around circular saw, plywood to be cut should be fixed by a suitable method, electrical power code should be long enough for whole cutting procedure, electrical circular saw should be held tightly so that the plywood does not move by reaction when turning on the power switch. We roughly cut the plywood into several portion for easy handling. Then, we cut the portioned plywood by using sliding circular saw or saw. (Figure5)

Figure5 cutting into shapes

We cut the plywood into shapes about 5mm to 10mm bigger than the original shape. Figure 6 shows the cut shapes.

Figure6 the cutting shapes

2.4 Gluing parts

Figure 7 shows how to glue parts. We applied wood glue (polyvinyl acetate emulsion adhesive) evenly onto the surface and pile up the parts and then fixed by using C-clamp. Some of these c-clamps were made by 2nd grade students during the welding class. This wooden lathes class is held once a week. Students will know the result of the gluing one week later. Figure 8 shows the glued parts.

Figure7 how to glue parts

Figure8 the glued parts

2.5 Dimension modifying and grooving

As mentioned before, all the parts are cut at 5mm to 10mm bigger than the original dimension with some displacement occurring during the piling procedure. Dimension adjustments were made by sliding circular saw. Left and right symmetrical (bilaterally symmetrical) parts, except too much thick parts, were cut in piles at the same time.

Grooving procedure was conducted by chisel. It is the first time for most of the students to use chisel, however, they soon get accustomed to using it. (Figure 9)

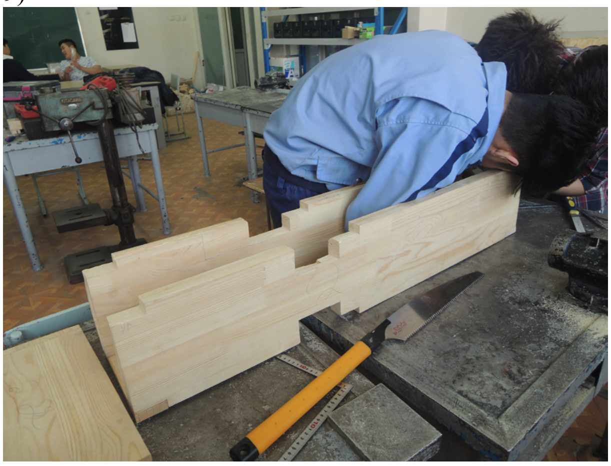

Figure9 the students soon get accustomed to using chisel

2.6 Assembling

Assembling procedures are made in accordance with (1) leg section, (2) spindle section (3) bed section. In the first place, students temporarily assembled the wooden lathe by adjusting horizontal and vertical level using level and then fix them by wood screws. Students faced with the difficulty in adjusting horizontal level of the bed section because floor of the workshop is not precisely horizontal level. We have checked perpendicularity between bed section and spindle section, bed section and legs. Figure 10 shows the finished lathe.

Figure10 the finished lathe

2.7 Manufacturing spindle section

Spindle section cannot be made by wooden parts. With the cooperation of College of Industrial Technology Japan, spindle sections were manufactured in Japan. Figure 11 shows stage car with V-belt are installed to motor.

Figure11 stage car with V-belt are installed to motor

Figure 12 is an assembly drawing of belt driven wooden lathes

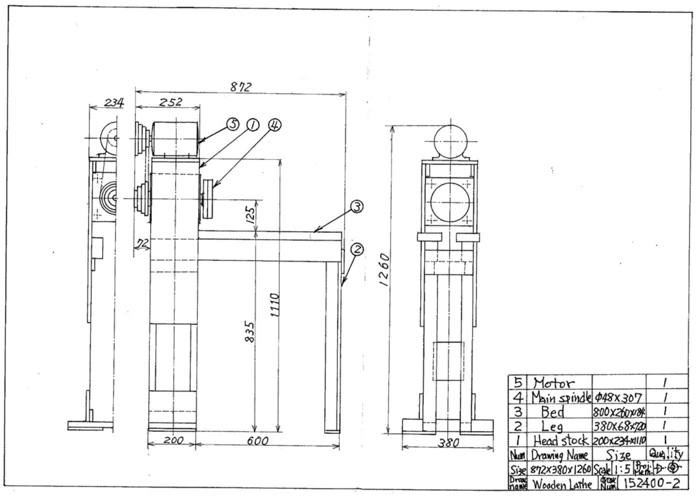

Figure12 an assembly drawing of belt driven wooden lathes

3. Results and consideration

3.1 Progress of work

Table 1 shows all the process from drawings to completion of wooden lathes. Each group consists of five to six students co-operating with each other to manufacture wooden lathes during two-hour-lesson each week. Due to insufficient number of tools and machinery, students faced difficulty in conducting simultaneous processing.
We proceeded manufacture of wooden lathes taking the above facts into consideration.

3.2 Observation and impression

Table1 Manufacturing Process

Schedule	No of lesson	Hours	Details
Lecture	2	4	Origin of lathes, history, construction, usage
Drawing	6	12	Dimension, Parts assembly drawing, assembly drawing
Making miniature lathes	3	6	Making miniature lathes
Discussion	2	4	Completion of miniature lathes and collating with drawings
Part drawing	3	6	Drawing parts' shape on big boards
Cutting into parts	3	6	Cutting into parts from big boards
Gluing parts	3	6	Gluing parts together
Grooving and assembly	4	8	Grooving and assembling parts
Conclusion and observation	1	2	Making reports concerning conclusion and observation
Total	27	54	

Here are summary of students' observation and impression

1) It was easy for me to cut wood boards, finish surface and assemble parts, however, difficult to draw up part's shapes on the wood board. It is quite a bit difficult for me to measure. I am grateful to complete wooden lathes.
2) During the wood processing, I found out that wood boards tend

to break into pieces easily. Dimension of parts we made were slightly different from the original dimension. It is difficult for me to cut wood board by saw. It was fan for me to finish surface of wood board by using sand paper. I am satisfied greatly by having completed wooden lathe.

3) I was not able to proceed teamwork smoothly, for example, read parts drawing incorrectly, glued parts incorrectly. Therefore, we could not finish wooden lathe. I was very disappointed.

4) I understood that precise calculation of parts was essential in manufacturing wooden lathe. Teamwork and good relationship among members are also important. When cutting wood board, I noticed that I need to pay attention to the density of wood board.

5) I now understand the importance of teamwork and safety work.

6) I think I performed a good teamwork in manufacturing wooden lathe. I was able to draw parts' shapes on the board without making mistakes. I think I became prudent in working. I was grateful to be able to complete wooden lathe.

7) I am happy to be able to finish wooden lathe.

8) I am grateful to be able to complete wooden lathe. I feel that I would be able to perform properly in future.

9) This time, we manufactured machinery by ourselves which we used to buy before. We made three sets of wooden lathe. I noticed that it was not good for us to hasten the manufacturing procedure. It is important for us to listen to teachers' guidance well and if needed ask them for the assistance. We failed in making (parts) as we did not listen to teacher's guidance or explanation.

10) At first, we faced many troubles in making a miniature model by polystyrene board, however, we had little failure in manufacturing real size wooden lathe. I realized that we should follow teachers' instruction and if something would happen it is important for us to ask teachers for their assitancce(s).

11) It is a good experience for me to perform teamwork. We were able to complete about 80% of the whole work. We faced with problems in cutting wood parts and gluing process.

12) I was able to think about new idea. I feel I become skillful.

13) I think anything could be done by teamwork. During making wooden lathe work, I felt good, however, slightly frightened.

14) I became skillful and now understood how to use tools.

15) I noticed that it is important for us to perform in good order, precisely and neatly. In teamwork, it is important to perform jobs with responsibility.

16) I noticed that only one mistake would spoil the whole process. It is important for me to perform with paying attention even for trifle procedure

17) If we were to perform a good teamwork we would be able to finish job briefly. We were several hours behind comparing with other teams.

18) We were able to assemble our wooden lathe rigidly than other teams. We made some mistakes, however, we finally stood together and worked hard.

19) We succeeded in manufacturing wooden lathe. Teamwork is important. It is important to realize that I am a member of the team.

20) It is good for me to make a new one and study.

21) I was able to handle wood material. I think I am able to design hereafter.

22) By doing teamwork, I noticed that procedure was able to expedite.

23) It was my first manufacturing goods. It was fun.

24) Teamwork was good. We were able to create new goods. Good experience.

25) It is grateful for me to manufacture lathe for the first time. I noticed that I manufactured a machinery for my own study field. It is wonderful experience for me to study and manufacture machinery by wood.

4. Conclusions

Students gave ideas on wooden lathe and manufactured wooden lathes by themselves. It is the first time for us to make wooden lathes. I feel it is obvious that our project to manufacture wooden lathes are successful taking students' conclusion and impression.

We come to conclude that:

(1) We were able to complete manufacturing wooden lathe from scratch.

(2) We performed the job by team work and we found that group work is essential.

(3) We were able to expedite manufacturing wooden lathes because we first made miniature models before making actual size lathes. Miniature models helped us understand lathes construction details and analyze manufacturing process into several steps.

5. Challenges for the future

While we are not able to manufacture spindle section by students. Figure 13 and 14 show hand-powered lathes designed by students. Manufacturing wooden lathes are a subject for 2nd grade students. For the 3rd graders, we plan to measure tension onto wood-working bits, how much feet and hand power are needed by operators. For this reason, we manufactured motor-powered wooden lathes before manufacturing hand-powered wooden lathes. It is our challenges for the future to manufacture foot-operated lathes as shown Figure-1.

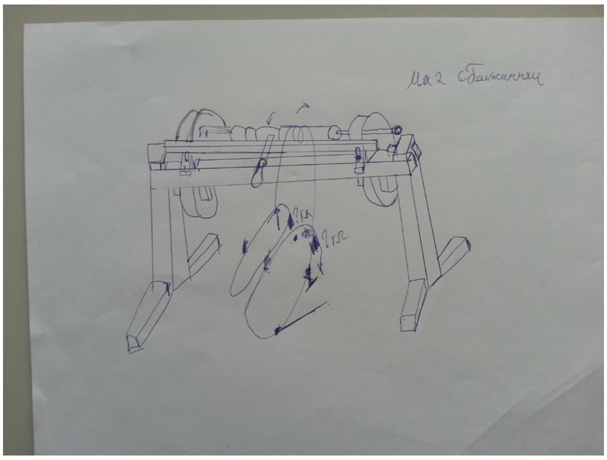

Figure13 hand-powered lathes designed by students (example 1)

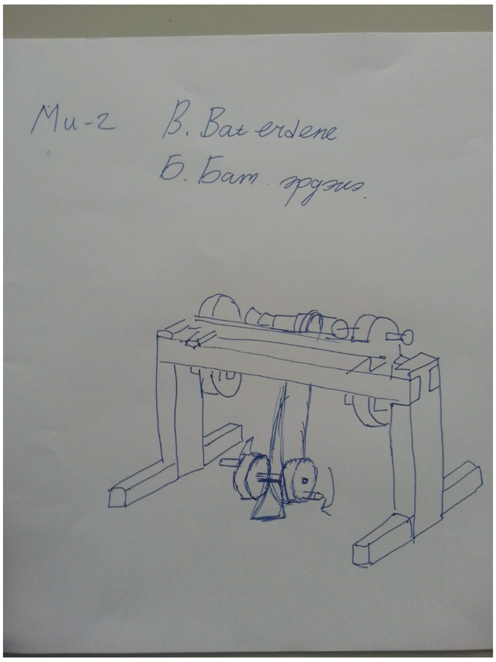

Figure13 hand-powered lethes designed by students (example 2)

6. Gratitude

We would like to express our gratitude for honorly Prefessor Yuji Nakanishi who gave us suggestion in completing this paper.

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DESIGN AND PRODUCTION OF LORENTZ FORCE ROCKETS IN A COURSE FOR THE FIRST YEAR STUDENTS

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Abstract

Since 2009 to 2015 we offered a one year course "Monozukuri-Kiso" to the first year students in National Institute of Technology, Kushiro College. This is, as the name means, an elementary course for design and production. The course is also prepared to help the students in choosing their major field. At the beginning of the second year, the students will choose their major from 5 fields of engineering, those are information one, mechanical, electrical, electronic and architecture. The course consists of 10 subjects covering various aspects of the 5 fields to give the students a little valuable opportunity where they may observe typical features of each of 5 fields. "Design and production of Lorentz force rockets" is one of the subjects from the field of electrical engineering. The rocket is launched by the Lorentz force between the current around the coil which is driven by the external electric power unit and the induced current on the conductor plate attached on the bottom of the rocket. The students are required to achieve three tasks to launch the rocket. First, they are required to make the coil of coated cables. The second task is to make the launch pad of craft papers. And the last, they should fine tune the settings of the rocket and the coil on the launch pad. From these tasks, the students could learn the following. First, they acquire an elementary knowledge about the fundamental laws of the electromagnetism, such as the Lorentz force and the Faraday's law of induction. The second, the students enjoy the fun of designing and producing. The third is to learn the power of high precision tuning. The last, the students see that it is so difficult to use efficiently the electric energy to make mechanical work such that launching rockets. All of them would be valuable experiences to engineers working in every field.

Keywords: *design and production, Lorentz force rocket, first year student, choosing major field, electromagnetism, high precision tuning, electric energy*

1. Introduction

In National Institute of Technology, Kushiro College, the first year students take a one year course "Monozukuri-Kiso". The first purpose of this course is, as its name means, to make the students gain a little experience on design and production. The second purpose is to help the students in choosing their major field. At the beginning of the second year, the students should choose their major field from 5 fields of engineering, those are information one, mechanical, electrical, electronic and architecture.

In "Monozukuri-Kiso", each student takes 10 subjects which cover various aspects of the 5 fields. Each subject would be useful for the students in observing typical features of the field concerned.

"Design and production of Lorentz force rockets" is a subject which is offered from the field of electrical engineering. The rocket is launched by the Lorentz force between the current around the coil, driven by the external electric power unit, and the induced current on the conductor plate attached on the bottom of the rocket.

To launch the rocket, the students should achieve three tasks. The first task is to make the coil of coated cables. From this task, the students acquire some knowledge, at least qualitative, about electromagnetism. This would excite their intellectual curiosities. The second task is to make the launch pad of craft papers. In this task, the students enjoy the fun of designing and producing. A few students propose very unique designs, some of which are well thought-out and have excellent structures. The third task is that in order to launch the rocket higher and longer the students should fine tune the settings of the rocket and the coil on the launch pad. From this experience, they could learn how powerful it is to tune the settings at high degree of accuracy. Here we would like to give one comment. That is, from this subject the students see it is so difficult to use efficiently the electric energy to make mechanical work such that launching rockets.

The organization of this article is as follows. In Sec. 2, we briefly explain the principle of the Lorentz force rocket. In Sec. 3, we give the outline of the subject in some detail. In Sec. 4 we enumerate the results. Sec. 5 and Sec. 6 are devoted to the discussion and the conclusions respectively.

2. Principle of Lorentz Force Rocket

(1) Composition of the System

In Fig.1, we show the composition of the system. The system is composed of two parts. One is the rocket-launcher part, and the other is the electric power unit part.

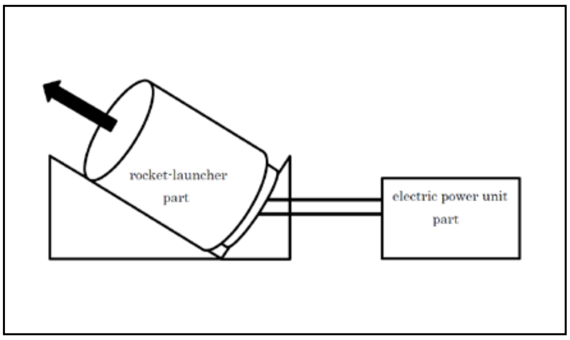

Figure 1 Composition of the system

The rocket-launcher part consists of 3 components. They are the rocket itself, the coil and the launch pad. See Fig. 2.

Figure 2 The rocket-launcher part

As shown in Fig. 3, the coil is attached at the bottom of the rocket.

Figure 3 The coil is attached at the bottom

The electric power unit part is mainly made of 8 capacitors connected in parallel. The capacitance of each capacitor is 10,000 μF , then the total capacitance is 80,000 μF (See Fig. 4).

Figure 4 The electric power unit

(2) Principle of Lorentz force rocket

The Lorentz force rocket is, as its name means, launched by the Lorentz force, which arises between the conductor plate attached at the bottom of the rocket and the coil.

As shown in Fig. 5, when the current is derived to flow around the coil by external electric power unit, the loop current is induced on the conductor plate. It is the consequence of the Faraday's law of induction. The induced current on the conductor plate flows in the opposite direction against the current around the coil, then the repulsive force arises between those currents. By this repulsive force, known as the Lorentz force, the rocket is launched. (There are many text books of electromagnetism. For example, Feynman, Leighton and Sands (1964).)

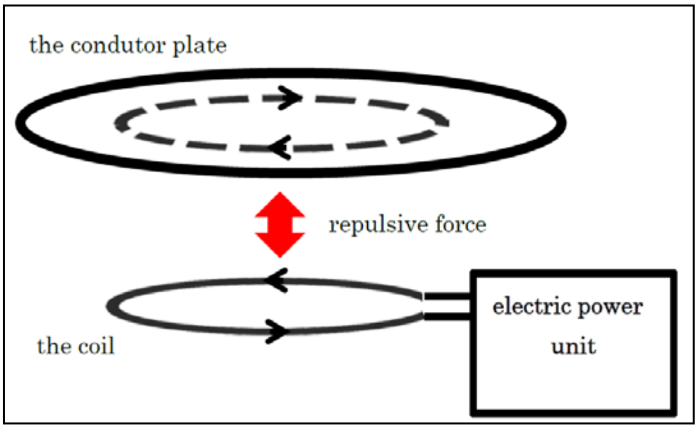

Figure 5 Principle of Lorentz force rocket

3. Outline of Subject

(1) Schedule

The subject is planed to consist of three periods, each of which takes 4 hours.

The first period is mainly devoted to design and making of the coil. The students are strongly promoted to do *trial launch* as many times as possible.

In the second period, the students make the launch pad of craft papers. Designing the launch pad is their home work between the first and the second periods.

At the third period, the distance competition is held. Each student has two chances to launch the rocket. The better of two performances is the record of each student.

(2) Making of coil

In the first period, the students make the coil of coated cables. The length of cable is about 2 meter. The design of the coil almost free, except for one requirement that the coil should have margin of about 20 centimeter on the both ends. This margin is necessary to connect the coil to the electric power unit.

(3) Making of launch pad

The second period is devoted to making the launch pad of craft papers. Because this task takes much of time, designing of the launch pad becomes the homework. The most important point in designing is that the launch pad should have enough strength to withstand the impact of the launching.

4. Results

(1) Making of coil

The styles of coils are roughly separated into two classes. One is a class of one layer style, and the other is a class of two layers.

Though many readers think that two layer coils give higher performance than one layer coils, the difference between performances of each two types is actually small. One of the important key factors affecting the performance is the carefulness of work. The students would find that coils winded carefully, keeping flat and tight, give high performance.

(2) Making of launch pad

One crucial point which influences the performance is the toughness of the base part of launch pads. The students propose various ideas which strengthen the base part of launch pad. Fig. 6 shows one of the most excellent structures among those we found. The structure of tightly stacked multi-layer enables paper crafted bases to have very high rigidity.

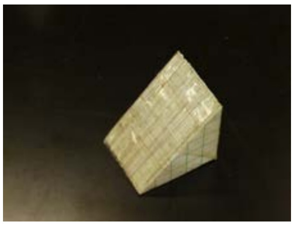

Figure 6 The structure of tightly stacked multi-layer

The task of making launch pad has the largest degrees of freedom in designing in the tasks of the subject. Many impressive and well thought-out works are produced. For example, the work shown in Fig. 7 is designed to enable the launching angle to change in multi-step.

Figure 7 multi-step launching angles

5. Discussion

(1) Making of coil

One of very fruitful harvests obtained from this task is to acquire a little knowledge about electromagnetism. Because the principle of Lorentz force rocket is the same of almost all electric machines, the knowledge would be very useful for the students.

In addition, what is required for improving the performance of the rocket, the carefulness of work, is also the same as those in cases of other electric machines. Therefore, the experience of this task might be valuable lesson.

(2) Making of launch pad

There are various methods to achieve high strength of the base part of the launch pad. The possibilities might be limitless. A few students propose excellent ideas beyond our poor imagination. It is also true in other aspects in designing the launch pad. Many students produce unique, impressive and well thought-out works. This task plays an important role in bringing up the creativity of the students.

(3) Others

In the third period, we show the formula for the electric energy charged in the capacitors, and calculate the electric energy. We also show the kinetic energy utilized to launch the rocket. By comparing both energies, we emphasize how difficult it is to use efficiently the electric energy to make mechanical work, such as launching rockets.

6. Conclusions

Since 2009 to 2015, in National Institute of Technology, Kushiro College, the first year students take a one yaer course "Monozukuri-Kiso". In this cource, each student takes 10 subjects which cover various aspects of the 5 fields. Each subject would be useful for the students in observing typical features of the field concerned.

From the field of electrical engineering, "Design and production of Lorentz force rockets" is offered to the students. Through this subject, the students learn a little knowledge about electromagnetism, enjoy the fun of designing and producing, and obtain a valuable lesson about the carefulness of the work. Also they see how difficult it is to use efficiently the electric energy to make mechanical work.

Acknowledgements

We thank K.Chida for his great effort in starting the subject. We also thank T. Honda and S. Inamori for their collaboration in management of the subject.

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EDUCATIONAL SYSTEM FOR TEACHING MICROWAVE ENGINEERING

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Abstract

This paper describes an educational system developed at the department of Electrical Engineering of the Institute of Technology (IUT A). Basic microwave theory and related concepts are difficult to understand whereas they can be easily illustrated in a laboratory environment. To render the topic comprehensive and attractive for students, an educational system based on a dedicated learning laboratory has been developed at the IUT A. The lab provides computer-aided design (CAD) tools, equipment's for circuits' fabrication and tests/measurements. The lab provides all the facilities to complete a full project including analysis, design, modeling, fabrication, measurement and related applications.

Keywords: *Microwave teaching, hardware project, teaching laboratory, active learning.*

Introduction

One of the main applications of electromagnetics is the design and realization of electronic circuits and systems in the microwave frequency range [1]. Microwave technology has gone through periods of revolutionary changes including coaxial and waveguide structures, hybrid microwave integrated and monolithic circuits [2]. These technological evolutions have changed the tools required by engineers for designing and fabricating microwave circuits. Therefore, the teaching of microwave engineering is fundamental for the students in the specialities of radio and communication [3]-[4]. Many courses in electromagnetic and microwave engineering are considered to be the most difficult in the electrical engineering curriculum as it involves theory of distributed parameter circuits and microwave networks that are full of abstract and complex concepts. Consequently, inappropriate teaching content leads students unable do deeply grasp knowledge, skills and competences in the field. This problem has been found in many universities especially due to the lack of modern educational system for microwave engineering courses.
In this paper, we present an educational system developed at the department of Electrical Engineering of the Institute of Technology. Section II describes the course including organization and contents. The course is illustrated trough a project related to the development of microwave radar for vital sign detection. Section III presents main results and the advantages gained by the students.

Materials and Methods

The all project requires the two-semester sequence for a total volume around 60 hours. Students work in team of 12 students to develop a microwave system that is attractive and that can find viable applications in the modern society [5]. A project example concerns the design, fabrication and experimental validation of microwave radar for detection of vital signs and activity of a human subject at the industrial, scientific and medical (ISM) radio frequency of 2.45 GHz. The organization of the course is discussed below with reference to the content.

A. Specifications of the radar

The project is defined in close relationship with the medical field and involves a doctor as an external partner and consultant. Therefore, the first step of the project is to define the specifications of the system through a meeting between the students, the instructor and the doctor. The main conclusions are given here after.
- The measurement of the respiratory rate is always interesting to detect respiratory diseases especially in a non-contact manner as it saves time for the doctor.
- It is better to perform a back measurement for children.
- The detection of stress is mainly linked to the cardiac frequency. The breathing accelerates after a period of time

- The sensor can be useful to monitor infants and avoid sudden death.
- The system can find applications to awaken people after rapid eye movement (REM) sleep where breathing is faster.
- The system is interesting in geriatric services where it is difficult to manipulate patients.
- It is interesting to develop a communication link between the radar and a laptop or smartphone in order to perform permanent storage or visualize the data in real time.

B. *Experiments with medical sensing techniques*

Conventional techniques for measuring vital signs are studied using the "e-Health Sensor Platform Complete Kit" from LIBELIUM® [6]. It includes a pulse and oxygen in blood sensor (SPO_2), an airflow sensor (breathing), a body temperature sensor, an electrocardiogram sensor (ECG), a glucometer sensor, a galvanic skin response sensor (GSR - sweating), a blood pressure sensor, a patient position sensor (accelerometer) and an electromyography Sensor (EMG) sensor. The sensors are controlled by an Arduino® platform to monitor in real time the state of a patient or to get sensitive data in order to be subsequently analyzed for medical diagnosis.

Fig. 1- e-Health Sensor Platform Complete Kit [6].

This study has mainly two objectives. The first one is to train the students with conventional measuring methods found in medicine. The second objective is to automate the ECG and airflow sensors as reference measurements to be compared with radar measurements.

C. *Lecture on radar techniques*

During this lecture, the students get familiar with radar techniques and microwave circuits. Passive circuits consist of transmission lines, impedance matching circuits, power dividers, couplers and circulators. Active microwave circuits discussed in the course include amplifiers, oscillators, mixers and power detectors. Main topologies of radars and related subcircuits are included. A focus on microwave radar for vital sign detection is proposed. A brief state-of-the art can help the students to situate the project in the general context of microwave engineering. In particular, the first work related to the sensing of physiological movements using microwave radar dates back to the early 1970s [7]. Since then, and abundant literature on the subject has been reported [8]-[10].
In a second part of the lecture, a radar architecture is proposed and described. The solution to build the radar is straightforward and eliminates complicated subcircuits. The simplified block diagram of the radar is illustrated in Fig. 2.

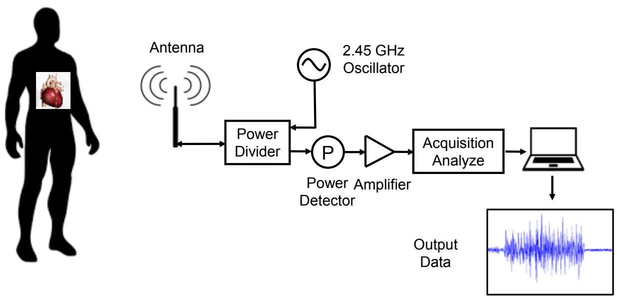


Fig. 2 - Block diagram of the radar system for vital signs detection.

The radar system consists of six subcircuits, i.e., voltage-controlled oscillator (VCO), power divider, antenna, power detector, DC amplifier and a data processing unit for acquisition and analyse. The VCO is used to generate at continuous wave (CW) signal at 2.45 GHz. The system operates in monostatic mode: a single antenna is used to transmit and receive the microwave signals. The implementation proposed avoids the use of bulky and expensive duplexer, such as transmit/receive switch or circulator commonly found in monostatic radar configurations. The power divider separates the emitting wave from the received one. Thereby, the power divider delivers the transmitted signal to the antenna and injects the signal scattered by the target to the power detector. The resulting signal is therefore directly down-converted to DC voltage. A DC high speed instrumentation amplification with gain adjustment stage to match the input requirements of the ADC is used. The DC voltage that is directly proportional to the target motion (breathing and cardiac) is then digitized.

The students are divided into small groups of 2 or 3 students that have to design and fabricate the different circuits of the radar.

D. *Theory and computer-aided tools*

For each part of the project, a write-up was prepared explaining the objective, the theoretical and practical skills needed and providing a set of instructions. The main idea beyond this project is to provide an educational system close to the industry rather than the traditional academic system that separates the mathematical background and experiments. All the

microwave subcircuits are designed with Genesys® that is an accurate and easy-to-use RF and microwave simulation software created for the circuit board and subsystem designer.
In the following, to present a clear picture of the study, we focus on the design of the microwave power detector only. The detection circuit is based on an Agilent Technology HSMS-2850 zero-bias Schottky diode [11]. The circuit of detection comprises a resistive matching network that offers low sensitivity to both temperature and positioning variations of the diode (Fig.3). At the output of the diode, the microwave signal is filtered by means of a surface mount capacitor.

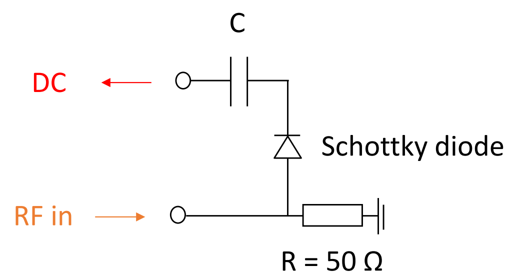
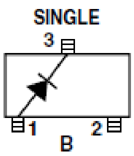
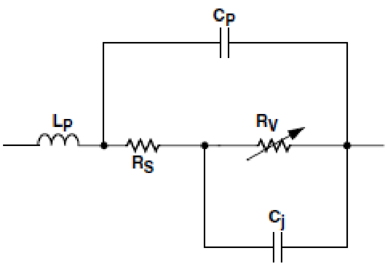


Fig. 3 - Power detector architecture based on a Schottky diode.

The first step is to implement the electrical model of the diode in the CAD environment. All the information are provided on the datasheet of the diode [11] (Fig. 4).



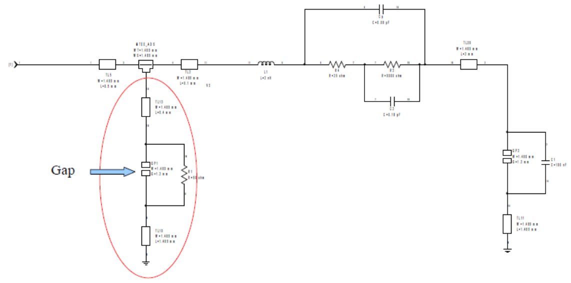
(a)



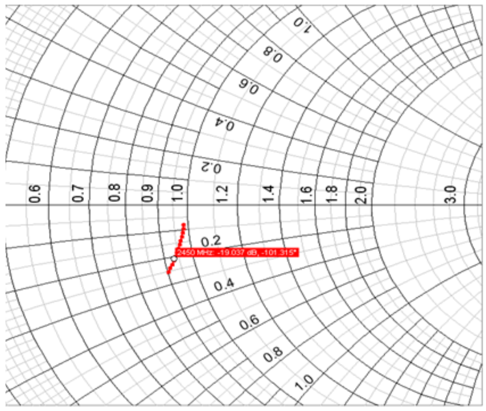
(b)

Fig. 4 – Shottky diode HSMS-2850 from Avago Technologies® [11]. (a) SOT-323 package lead code identification. (b) Equivalent electrical circuit of the Schottky diode with Cp = 0.08 pF, Lp = 2 nH, Cj = 0.18 pF, Rs = 25 Ω and Rv = 9 KΩ.

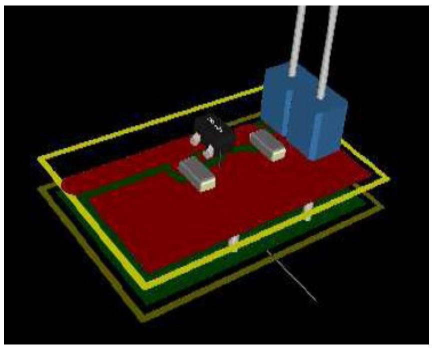
The power detection circuit implemented in the CAD software is given for illustration in Fig. 5. The circuit is designed on hybrid microwave integrated technology using FR4 Epoxy substrate ($\varepsilon = 4.8$) with transmission microstrip line propagation structures in copper (conductivity $\sigma = 5.8 \times 10^7$ S/m) with metallization thickness of 35 µm.



(a)



(b)



(c)

Fig. 5 – Design of the power detector based on the Shottky diode HSMS-2850. (a) Schematic of the power detector. (b) Zoom of the Smith chart showing the reflection coefficient of the power detector. (c) Layout of the power detector.

Fig. 5(a) shows the detection circuit after optimization of both the geometry of the microstrip structures and the values of the lumped elements (R = 50Ω and C = 11 nF). 0805 surface mount devices (SMD) are used. The reflection coefficient of the detector has been simulated using the linear RF circuit simulator of Genesys®. After optimization, the zoom of the Smith chart given in Fig. 5(b) shows a good matching of the detector at the center frequency 2.45 GHz. The corresponding return loss is better than -17 dB. After optimization of the overall structure, the corresponding layout is built [Fig. 5(c)]. The detector is then ready for fabrication.

E. Realization of the radar

All the circuits are realized separately to be tested individually before the integration of the overall system. For laboratory tests, coaxial to microstrip transitions are used for connecting the devices to measuring instruments. Each subcircuit is fabricated by means of rapid printed circuit board (PCB) prototyping. This allows the students to test ideas and easily make changes. The circuit board plotter includes powerful system software for converting layout data into actual printed circuit boards: it takes the data from the design software, edits it for production, breaks it down into individual process steps and guides the user, step-by-step, through the manufacturing process. The lab is equipped with a LPKF® Protomat S62 circuit board plotter (Fig. 6) [12]. Each student received a training course on the equipment. The course consists to learn how to configure and calibrate the plotter, to use the software interface to fabricate the circuit.

Fig. 6 – Circuit board plotter LPKF ProtoMat® S62 [12].

After fabrication of the PCB, the next step consists to solder the surface mount devices and the connector on the PCB. An illustration of the PCB and devices to be soldered is given in Fig. 7.

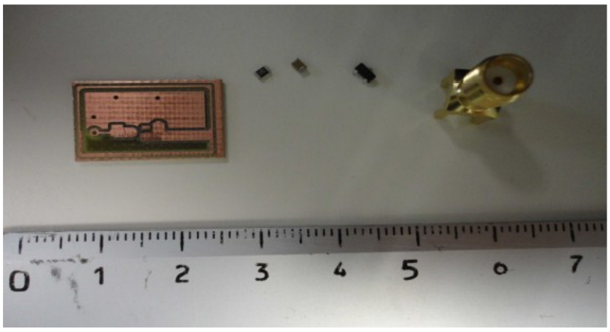


Fig. 7 – Elements of the power detector before soldering.

Dedicated equipment, accessories and products needed for dispensing alloy, placement of surface mount devices and soldering tools have been installed in the laboratory. Fig. 8 gives an illustration of the main resources from 'Circuit Imprimé Français' – CIF® installed in the laboratory [13].

(a)

(b)

(c)

Fig. 8 – CIF® equipment's for devices assembly. (a) Dispenser DOTTY CMS 450.V2 for dosing solder pastes. (b) Pick and place station PRECITEC® manual system for the placement of surface mount devices. (c) Batch reflow oven for prototypes FT05.B forced convection system .

Each subcircuit has been fabricated and tested separately before assembly.

Results and Discussion

The learning laboratory is equipped with all microwave facilities to perform full electrical characterization from DC up to 26 GHz. Students start using the equipment for measurements associated with the project. In particular, the electrical characterization of the power detector concerns the measurement of the reflection coefficient using a vector network analyser.

As expected, the return loss is very close to the simulated value. The second experiment consists to measure the detected voltage as a function of the input microwave power (Fig. 9). To that end, the vector network analyzer is configured as a variable microwave source as illustrated in the inset of Fig. 9.

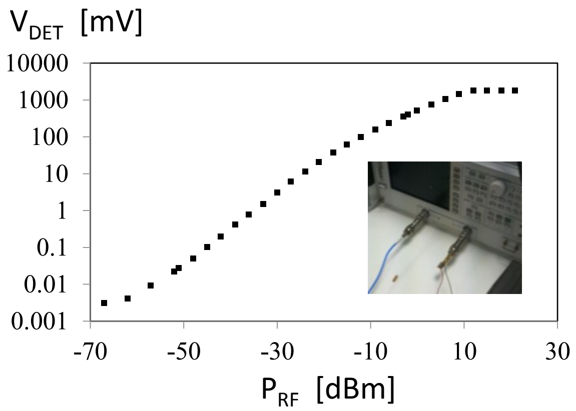


Fig. 9 – Detected voltage as a function of the input microwave power – f = 2.45 GHz.

Each circuit has been characterized. Depending on the measurement performance, optimizations of the initial design are required to meet the specifications. Thus, the CAD software, the circuit board plotter and equipment's for devices assembly are used extensively by the students to gain practical experience. Fig. 10 shows a picture of the final assembly of the radar including DC amplification stage and software resources.

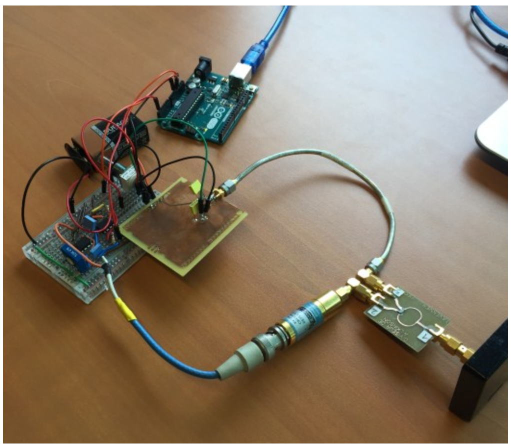


Fig. 10 – Monostatic radar for vital signs detection – f = 2.45 GHz.

The code developed concerns specifically the analysis of the data to extract the breathing and cardiac frequencies. In particular, Fast-Fourier Transform (FFT) algorithm has been successfully implemented in the microcontroller. Furthermore, a communication link between the radar and an Android smartphone has been developed using a simple Zigbee® module plugged on the Arduino® board. Two students have developed the smartphone application as illustrated in Fig. 11.

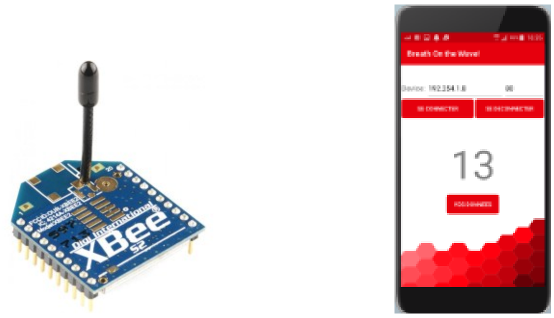


Fig. 11 – Communication link. (a) X-bee module with integrated antenna. (b) Smartphone application for breathing rate measurement.

The main results are (1) basic theory is introduced progressively by the instructor and can be applied directly to simulation/experiment, (2) students make the link easier with skills and trades expected in industry, (3) the project encourages autonomy, students learn how to work in group. The evaluation is based on technical reports, oral presentations and experimental demonstrations with a jury composed of colleagues and external partners.

Conclusions

The motivation, organization and contents of an educational system for teaching microwave engineering have been described. The course proposed is built around a dedicated learning laboratory that merges all the facilities to study, design, fabricate and measure microwave systems. The experience gained from this educational system significantly enhances the student's pedagogic and professional experiences. Students observe practical issues not covered in conventional classroom and gain confidence in their abilities to understand and use microwave concepts for modern applications.

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1304

NOVEL MATERIALS FOR ENGINEERING EXPERIMENTS TO MOTIVATE STUDENTS TO LEARN

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Abstract

This paper describes a novel approach for engineering experiments for third grade students. It was developed with the goal of improving the motivation in low-grade students and was introduced in 2013. The new contents were specifically adapted to the needs of current students. A “Line Tracer” was chosen as the focus of the new engineering experiments and was used to support the learning hardware production and C programming. The students assembled and soldered both the chassis and the motor driver circuit. The chassis comprised a plastic plate, a gearbox, and wheels, all of which are available in commercial stores. The motor driver circuit was included two motor driver ICs, a peripheral interface controller (PIC), and three switches. The students were able to learn the design of an H-bridge circuit. The optical sensor circuit required in a line tracer was made from lower grade materials as compared to those in previous years. The use of cheaper components allowed the students to keep the completed projects. Most students succeeded in assembling the line tracer within three to four weeks. After assembling, to control the line tracers, students had write programs in C. Although the students were given lessons on operating the PIC, they were not provided with algorithms for the line tracer. Two to three weeks were scheduled to complete the programs. Finally, each student’s completed line tracer took part in a time trial in the final week of the course. Most line tracers were able to complete the entire course. Students competed against each other in the time trials both for personal satisfaction and because the result reflected in their evaluation. The time trial provided the students with a sense of responsibility, and most of the students found it engaging. Key factors in student satisfaction with the novel material were that each student completed a line tracer and was able to take it home.

Keywords: *Engineering experiment, Line tracer, Electronic circuit, C language programming, Improvement of learning motivation*

Introduction

The authors introduced new curricula at Department of Electronic Control Engineering in the Institute of Technology, Hiroshima College in 2010, because the needs of students entering the department change year by year. Moreover, some of the experiments used in the engineering course were changed in parallel. Simpler lessons were introduced for freshmen, and expanded lessons were provided for students in the higher grades. Experiments were chosen that were interesting to the students. This helped third grade students to learn better.

A problem encountered by the department was that the students were not motivated by the experiments that formed part of the course material. A survey revealed that some students were dissatisfied with the experiments, which were perceived to be too difficult by these students. When analyzing the results of the experiments conducted by students, the authors concluded that a key reason was that most students in the lower grades were not reading the textbook description of the experiment before the class and were relying solely on the lessons provided while performing the experiments. Conversely, there were many students who expressed interest in the experiments, as most of students enjoyed working with their hands. We concluded that most of the students did not wish to avoid doing the experiments. We, therefore, developed new educational experiments to motivate students to learn better.

Development of the Educational Content

The New Experiments

The goal of the new experiments was to help students to cope up with lessons independently. The working time and perfection level of an experiment depends on a student’s abilities, and we were aware that students become demotivated if they are unable to complete the lesson. Conversely, the difficulty level could not be set as per the abilities of the weaker students, as this would make it too easy for students who prefer a higher level. We therefore selected a line tracer as the new experimental content, as this was not difficult and allowed students to try repeatedly to achieve better results. The line tracer was designed using a peripheral interface controller (PIC) and motor driver IC to simplify the hardware and to shorten the working time without lowering the difficulty level. Each student built one line tracer and wrote a program for the tracer in language C.

The line tracer is used as educational tool for experimental work by the National Institute of Technology, because it comprises several elements that are required for electronic control[1-4]. The goals of these experiments were that every student would be able to understand higher level lessons[1, 2], and that beginners would acquire a basic understanding of electronic control[3,4]. Our new experiments also had the additional feature of providing higher-level students with fulfillment while improving the motivation of intermediate students.

A key goal of most systems of education is that they encourage students to learn independently. In the conventional coursework, students were required to complete four experiments over a three weeks period at three hours per week. In the revised curriculum, the working time of one experiment was extended from three weeks to six weeks, giving students sufficient working time to complete the experiment. We believe that this working time is more reasonable and appropriate. Previous studies[1, 3] suggested that the experiment should be completed within six weeks, as a longer time would have an adverse effect on the experiments.

A design goal was that experiments must be sufficiently attractive to encourage students to learn the engineering basis independently. First, the difficulty level intended to inspire the students' sense of curiosity. A microcomputer was selected for the experiment, giving students experience of using C programming[1-3]. A previous study[2] and our own experience suggested that creating competition among the students is an effective pedagogical technique, encouraging commitment and motivation. We therefore included a time trial as part of the evaluation.

Students were required to build one line tracer, which they took home with them after completion. This provided a sense of fulfillment, as the students were able to show their line tracers to their parents and friends.

Attainment Goals

The attainment goals of the experimental material were as follows.

1. Students will be able to use electronic elements properly and assemble a circuit with these elements.

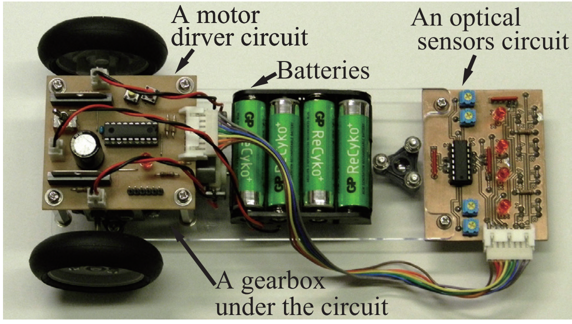

Fig. 1 Line tracer. It has a chassis, wheels, batteries, a motor driver circuit, and an optical sensors circuit.

2. Students will be able to understand methods for controlling a motor using an H-bridge.
3. Students will be able to control the input and output (I/O) ports of a PIC using C.
4. Students will be able to drive DC motors and control the rotation speed using pulse width modulation (PWM).
5. Students will be able to write a program to enable their line tracers to run an entire course.
6. Students will be able to understand the behavior of the line tracer and optimize the program for the better.

Previous experiments also included lessons on a line tracer. However, as this used a commercially supplied Z80 board and motor drivers with stepping motors, it satisfied only goals 3, 5, and 6. Our new experiment included goals 1, 2, and 4. Student attainment of all goals was used as progress evaluation, including a ranked time trial and the production of two experimental reports.

Design of the Line Tracer

The elements required were purchased from a fund collected from our students. This allowed them to keep the line tracer when completed. A key requirement, therefore, was that the line tracer must be designed to have a low price. Figure 1 shows the line tracer designed for the new experiments. It comprised an electronic circuit board for the PIC, an optical sensor board, a chassis, a gearbox, and wheels. The optical sensor board was fabricated by lower grade students. It had four photo reflectors to detect a white line on a course. The authors designed the optical sensor board, whereas the students drew the interconnections using CAD software, assembled the board, and checked the current and voltage of the circuit. The lower grade students undertook this over three weeks.

The PIC and two motor driver ICs were attached to the electronic circuit board. PIC16F1827 (Microchip Technology Inc., Chandler, Arizona, USA) was selected for use in the experiment because easily available and it has a capacity to extend the experiment to a higher level. The program written by the students was transferred to an EEPROM in the PIC through an ICSP connecter. C was used to control the line tracer in the experiment because the students had already learnt this language in an earlier course.

The authors selected a low cost double gearbox (TAMIYA Inc., Shizuoka, Japan) to provide an appropriate rotational frequency, and an H-bridge circuit to control the motors. The H-bridge circuit is often used in robotics as it allows a DC motor to run forwards and backwards. Motor driver IC TA7291 (TOSHIBA, Shibaura, Tokyo, Japan) was selected to reduce the complexity and the working time needed to assemble the electronic circuit. The electronic circuit required a voltage higher than 4.5 volts, because the typical voltage of the DC motor was 3 volts, and the motor driver IC took 1.5 volts from the supplied voltage. Four nickel-hydrogen rechargeable batteries were used in series, generating the 4.8 volts required as the power supply.

The chassis of the line tracer comprised an acrylic plate fabricated within our college.

Overview of the Experiment

The students assembled each element of the line tracer in the first two or three weeks of the six weeks course. We estimated that the students would need two weeks to assemble the hardware, including checking. However, some students proved to have insufficient skill in assembling solid models, even when using commercially available kit. In these cases, students were allowed enough time to assemble the hardware.

Next, the students learned to designate the I/O ports of the PIC and to control the rotation of the motors using C. Control of the PIC was learnt from a textbook, using small step lessons while writing their own program. The students also wrote a program for the time trial. All students took part in the time trial, and the fastest time achieved by each student was recorded.

Figure 2 shows the course for the time trial. The length and width of the course plate were 3,640 mm and 1400 mm, respectively. The course had straight, curves, a lane change, a slalom, and a loop including a crossroad. The course was built from four wooden plates, and was able to be divided into four parts, allowing the order of the course to be changed and different plates to be added.

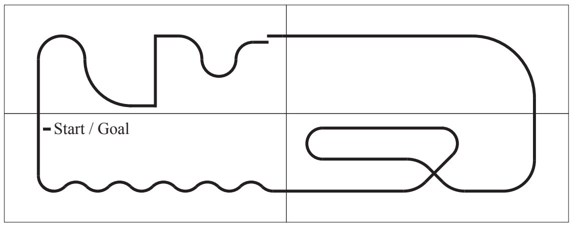

Fig. 2 Course for a time trial. It has a straight, curves, a lane change, a slalom, a loop, and crossroad.

The Experiment

Assembling the Line Tracer

The authors introduced the new experiments for third grade students at the Department of Electronic Control Engineering in the National Institute of Technology, Hiroshima College, staring in 2013. A total of 134 students (including seven female students) have completed the course over three years. Students in each grade were divided into four groups, with about twelve students in a group. Before 2013, students had done various experiments as part of their coursework. In the new approach, twenty-four students built the line tracers. They were broken into separate groups, because of space limitations in the workroom. Each student in a group made the electronic circuit, while students in another group assembled the gearbox, wheels, and the chassis. The electronic and mechanical parts were completed first. However, this took longer than expected, and many students were unable to finish building the line tracer in the two weeks allotted. We concluded that this was due to the students being unable to observe the full assemble process. The next twenty-four students, therefore, were not divided into two groups. Almost all the students in the second group batch completed building the line tracer. We concluded that students benefited from able to track their progress, and from sharing skills with each other. After finishing the build, the students moved to another workroom to write the program.

Programming Lessons

The students learned to write programs though lessons that included the use of LEDs, inputs from switches and sensors, rotating motors, and PWM control. The program, to enable the tracing of a line, was developed in the course of the lessons. Most students completed the lessons within four weeks, and then started to write their own program for the line tracer. Slower students independently sought out the course supervisors to seek permission for extra time to complete the work. This autonomous initiative on the part of the students had never been observed before. Some of the students who had completed the project within the time also came to ask for extended time to improve their performance in the time trial, on their own initiative.

As students were allowed to save their program to their USB storage devices, they were able to extend and to modify their programs when out of college. However, they were not able to compile or transfer the programs. We believe that this helped avoid the problem of students failing to prepare for the experiment.

A Time Trials

The course plates for the time trial were prepared in the fifth and sixth weeks. Trial times were measured in the sixth week, and results were written on a public whiteboard. There was no limit on the number of times that students could compete. As the students began to compare their times with those of other students, they

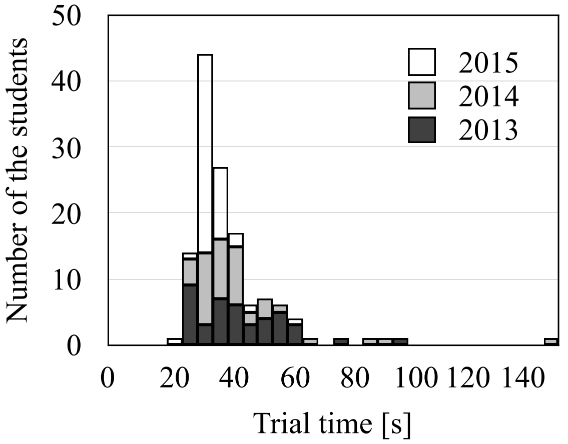

Fig. 3 Histogram of the time trial since 2013. The fastest time was 20.3 seconds, the slowest time was 148.4 seconds, and an average of the time was 41.2 seconds.

repeatedly modified their program to improve their times.

Figure 3 shows a histogram of the time trials conducted since 2013. The fastest time was 20.3 seconds, the slowest time was 148.4 seconds, and the average time was 41.2 seconds. Many students recorded times in the late twenty or early thirty seconds, suggesting that the new course material was not too difficult for the students, and that students competed to improve their performance.

Ninety eight percent of the students completed a trial time over three years. Although the remaining students were well motivated, and worked on their programs until the end of the allotted period, they were unable to complete a trial time. However, even those students who were unable to complete the experiment gain experience using the new course contents.

Evaluations

The students submitted two experimental reports, on the H-bridge and on the programming. Each submitted report contributed ten percent to the evaluation, and an additional point was added for an excellent report. Student attendance and participation in the experiment were also marked. Up to twenty points were added to their score from their rank in the time trial.

Evaluation of Educational Content

Eighty-four students in 2013 and 2014 completed an anonymous questionnaire to investigate their satisfaction with the new experimental material. Figure 4 shows the responses to the following questions, based on five-point Likert scales.

(i) Were you interested in the educational contents?
5 pt: Very interested
4 pt: Interested
3 pt: Neutral
2 pt: Slightly interested
1 pt: Not interested
0 pt: No answer

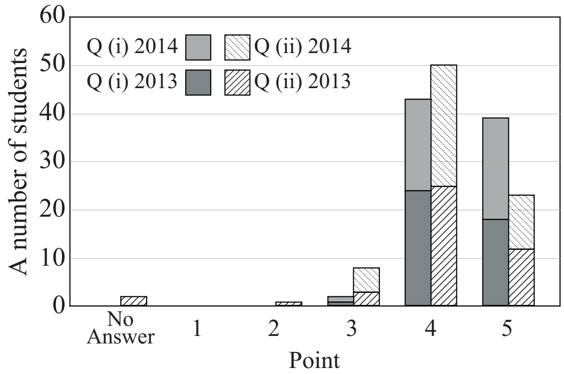

Fig. 4 Evaluations of the experiment from students. An average was 4.40 points for the question (i), and an average was 4.06 points for the question (ii). It suggests that many students evaluated the experiments as good.

The average response to question (i) was 4.40 points, with most students rating the contents more than four. This confirmed that the new material was viewed favorably by the students. Their comments suggested that they had obtained a sense of accomplishment, because their line tracers were able to run the entire course. Many students reported that competing with others for the fastest time had increased their interest.

(ii) Did you gain experience from the experiment?
5 pt: Very good experience
4 pt: Good experience
3 pt: Neutral
2 pt: Lower experience
1 pt: Waste of time
0 pt: No answer

The average response to question (ii) was 4.06 points, confirming that many students recognized that they had acquired skills, techniques, and experiences from the new experiment. The students reported that the contents helped them to understand programming, and that they gained experience in deriving the workflow of the entire project.

Finally, students were asked to compare the new course content with another experimental course run simultaneously by a different professor, in which students worked in groups of four or five to write a program for an inverted pendulum robot with two wheels.

(iii) How did the educational contents of the two courses compare?
5 pt: Very good, it should be continued
4 pt: Better than the other
3 pt: As good as the other
2 pt: Worse than the other
1 pt: Only the other should be offered

The results are shown as Fig. 5. The average evaluation was 4.00 points. Only one student evaluated the new

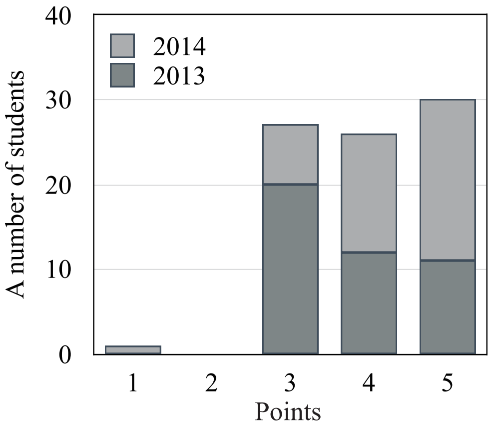

Fig. 5 Evaluations of the experiment compared with another experiment in the same semester. An average was 4.00 points for the question (iii). These answers suggest that they evaluated high the experiment than the other.

contents at one point. The students rated the new experiment more highly than the other experiment. Comments suggested that students rated highly the fact that every student built his/her own line tracer, and were able to let it run the entire course. The comments suggested that not all students completed the lessons in the other experimental course, and that many students did not understand the contents. The goals of the novel approach were to improve the motivation of the students and to allow them to tackle the experiment independently. We consider that these educational goals were achieved based on the results of the questionnaire and observations of the independent activities of the students.

It was also confirmed that almost all students achieved the attainment goals defined above. All students achieved goals 1, 3, and 4, and most students accomplished goal 2 by submitting their report on the hardware. Students whose line tracer succeeded in running the entire course achieved goal 5. Goal 6 was also achieved by students optimizing their programs, and many students were able to write reports on their software that were original, detailed and concrete.

Conclusions

New educational contents were developed to help students work with high motivation on the experimental material. The novel material was introduced in 2013. The experience of the students who used the new materials for conducting an experiment was evaluated by asking them to fill a questionnaire. Students appeared highly motivated to work on the experiment on their own. The results of all evaluations demonstrated that the course contents achieved the attainment goals.

In the future, this material will be used to enable third grade students of our college in their experiments, and the authors will continue to research on the educational benefits.

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1305

REFLECTION JOURNAL: A SEQUENTIAL EXPLORATORY STUDY ON STUDENT COGNITIVE LEARNING DURING THE FILMMAKING PROCESS

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Abstract

Filmmaking students usually take on different roles and work together to make short films. The process is intense, requiring the synthesis of their creative, technical and cognitive know-how. While the films reveal the creativity and technical knowledge of the students, their films do not make transparent the cognitive processes they went through during this creative process. In order to examine first-year Mass Communication (MCM) students' cognitive development while undertaking the filmmaking module 'Location Production', students were tasked to write an 800 to 1000-word individual reflection after their production of a 5-minute short film.

This sequential exploratory mixed methods study analysed the reflection journals to examine the students' thinking and whether the summative use of the journal helped students critically reflect on their learning experiences. Out of 88 students who took the module, 60 reflection journals were examined and 83 students' perceptions of the reflection journal were obtained by a survey.

The qualitative analysis of the journals revealed differences in the quality of reflection between students. Some could critically evaluate their own learning and performances while a few mostly recollected their experiences. For those who could self-evaluate, the self-evaluation process generated internal self-feedback and deepen their learning.

The quantitative survey found that 71% of the students felt that writing the journal has made them learn much more from their filmmaking experiences and 78.3% felt that writing the reflection has provided self-feedback towards their own learning. There were also 3 students who disagreed with the benefits of using the reflection journal.

This small perceived negativity from the survey and the skills gap identified in the analysis warranted future intervention to explain the use of the reflection journals so that all students can effectively reflect and learn from their experiences.

Keywords: *reflection journals, cognitive development, critical reflection, filmmaking*

Introduction

Filmmaking is a complex and collaborative process. Filmmaking students usually take on different roles and work together to make short films. The assessment plan and goals of students tend to focus on the end product - the short films. While the films reveal the creativity and technical knowledge of the students, they do not reveal the cognitive processes students went through during the process of making their films.

In an effort to improve student learning from their filmmaking experiences, Kolb's (1984) experiential learning cycle of reflective observation (RO), abstract conceptualization (AC), active experimentation (AE) and concrete experience (CE) was adopted for teaching the filmmaking module 'Location Production'. The aim is for the students to not simply have the experiences of 'doing' or making a film, but to also reflect, process, think and further understand this process of 'doing' (Fry, Ketteridge and Marshall, 2009).

One way to hone our students' reflective abilities is for them to pen their thoughts and experiences in a reflection journal. Ong (2004) compared 'writing' in the reflection journal to a distillation process that requires students to gather, filter, process, organize, reconstruct and feel the experiences that they have gone through. As a graded assessment, the reflection journal can be structured to guide students to think critically and be more aware of their own learning. These journals as written artefacts also reveal students' thinking (Luidens, 1997) and thus, can serve as a window into the students' minds (Ong, 2004).

Literature Review

Many scholars have encouraged the use of reflection in education (Dewey, 1997; Gustafson and Bennett, 2002; Ong, 2004; Quinton and Smallbone, 2010). Moon (2002) suggested that reflection could enable learners to see their core strengths and weaknesses and acquire a questioning mind. Andrusyszyn and Davie (1997) found that reflection as a deliberate cognitive activity can help learners connect their experiences, thoughts and feelings gained from their learning activities. But the lack of an agreement over its meaning or definition makes the discussion of reflection difficult (Quinton and Smallbone, 2010; Denton, 2011).

Regardless of the different definitions, the fact is - students need to think to reflect. They also need time to reflect - to move through the layers of thinking needed from describing experience to analysing experience to formulating an action plan (Gibbs, 1988). In a way, this also means that the students' reflectivity can be pursued at many different levels (Parkes and Kajder, 2010).

Van Manen (1977) was the first to discuss the different levels, or strata, within reflection. He stratified reflection into three levels, with the first level focusing on practical means, rather than the ends. His second level involved analysing and clarifying experiences and the highest third level included questioning pre-established knowledge, conventions and experiences (Parkes and Kajder, 2010).

Regardless of the number of levels in the different frameworks by different researchers, the different levels always serve as steps to guide the students towards the highest level, which always seems to point the students towards being 'critical' of their own experiences and learning (Van Manen, 1977; Hatton and Smith, 1995; Larrivee, 2008). The construction of these levels into rubrics can help students see their own progress in developing a reflective outlook (Fernsten & Fernsten, 2005). This is crucial as Denton (2011) found that many educators are interested in the study of using reflection to improve learning. Authors such as Parkes and Kajder (2010) in teachers' training and Taylor-Haslip (2010) in nursing education found reflection useful in improving their students' learning. On the same note, this research on the use of reflection journal can help filmmaking students improve their cognitive learning and, at the same time, add literature to the area of film education.

Research Method and Questions

Participants: They were 88 first-year students taking the filmmaking module 'Location Production' in the Diploma in Mass Communication (MCM) program in the School of Film & Media Studies (FMS) at Ngee Ann Polytechnic. Distributed across 6 practical classes - from P101 to P106, most of them were 17-years old and had little or no prior experience in filmmaking.

The students took on different roles, like director, producer, cinematographer, editor and sound to create a 5-minute short film. After completing their films, they had to write an 800 to 1000-word individual reflection, which formed 10% of their final grade. The assignment brief tasked the students to discuss two difficulties that they encountered during the filmmaking process. They had to describe, analyse and evaluate the measures that they took to overcome these difficulties.

Research Design: The sequential exploratory mixed method design was used in this study. Hence, there were two parts to the research.

Qualitative Analysis: 10 journals were chosen from each class randomly. For identification, these journals were assigned a number. E.g., reflection journals from practical class 'P101' were assigned 'A1' to 'A10', for 'P102' - 'B1' to 'B10' and so on. In all, 60 journals were analysed. The analysis studied their thoughts and experiences - how they identified the two difficulties and how did they reach a solution to these difficulties. The analysis also looked for common critical incidents that the students reflected on as well as statements of cognitive thinking that showed higher order thinking. These statements of cognitive thinking could reveal the common themes articulated by students in their journals and address the following research questions:

1) Can first-year students critically reflect on how they overcame the difficulties that they faced during the process of making their films?

2) Can the student filmmakers demonstrate a high level of reflectivity in their reflections?

3) Can the reflection journal as an assessment tool encourage students to evaluate their own learning and thus deepen their learning?

Quantitative Survey: 2 weeks after submitting their journals, 83 students participated in a survey to study their perception on reflection at certain stages of their learning. 5 students were absent during the survey.

The Likert-scale survey consists of 10 questions and is structured to guide students to think chronologically. Some questions were designed to affirm earlier findings in the qualitative analysis. The students would have to indicate whether they strongly agree (SA), agree (A), neutral (N), disagree (D) or strongly disagree (SD) to the questions shown in table 1. The following research questions were addressed by the quantitative survey:

4) Do male and female students perceive the use of the reflection journal differently?

5) Do students performing different roles during the process of production perceive the use of the reflection journal differently?

6) Do students perceive the use of the reflection journal positively?

Results and Discussion - Qualitative Analysis

Three themes emerged from the analysis of the reflection journals.

1) Complex and collaborative nature of filmmaking

All students had no problems identifying difficulties or issues, as the filmmaking process is complex and involves collaboration between participants and creative input. Different groups also encountered difficulties of various degrees, ranging from technical failure and poor planning to cooperation issues and creative argument. The reflection below best described and summed up the complexity and collaborative nature of the filmmaking process. New to filmmaking, sometimes the challenges they faced seemed insurmountable.

> "Despite being able to complete the project on time, the journey was not exactly a walk in the park. Instead, the project was akin to a mountainous range, full of ups and downs with many challenges and difficulties. Some were but small hills with gradual slopes, easy to overcome. Others were steep mountains, requiring patience, perseverance, critical thinking and an open mind to conquer."
> [Student D3]

The analysis revealed that even though the students were freshmen new to filmmaking, they could overcome different challenges that the filmmaking process threw at them by working together. The easier problems were solved individually, e.g. one student used a trolley bag to lug around heavy equipment while another student went online to learn from video tutorials to improve his/her own editing skills. For tough problems or what student D3 termed as ‘steep mountains’, students usually pooled their resources together and dealt with the challenges collaboratively. Overall, the analysis suggested that the first-year students could critically reflect but in varying degrees on how they overcame the difficulties that they faced during the process of making their films.

2) Reflection on Teamwork

There were quite a lot of reflection on the social dimension of teamwork and working well as a team. It was evident that students were aware that filmmaking is a collaborative effort, as seven in ten students cited the importance of teamwork. These students felt that with the help of everyone, the tasks at hand became easier. Using the words of student D5, the word ‘TEAM’ stood for ‘Together Everyone Achieves More”. Some also reflected on how their teammates helped them learn and this appeared to be a significant learning point for them.

> “Conflicts are a big part of any team because of the amount of people working as a team. Each person must realize that his or her idea is not always right. This is the joy of working in groups. You get to learn and grow a lot.” [Student F3]

3) Distinct difference in the quality of reflection

There were distinct differences in the quality of reflection between the students. Some could critically evaluate their performances and project outcomes while a few merely recollected what they had encountered or did while making their films. For students who reflected well, their statements of learning indicated thinking of the higher order from analysis to evaluation. They could draw analogies from their learning and be critical about themselves. In the examples shown below, the students were self-critical and identified their own mistakes and weaknesses. They had reflected and evaluated their own thinking and decided on a change in their mind-sets in order to gain more learning. This self-realization to gain transformative change are indicators that their learning and reflection generate important internal self-feedback that will benefit their future filmmaking endeavours and personal development.

> “The above problem was all stemming from one simple problem that I faced: hubris. I was far too proud and confident in my skills in writing that I did not want to see the errors in the script… I should not be satisfied with my first attempt, as there are always improvements that can be made…” [Student B2]

> “Everyone’s working together and trying to help one another without complaining about their own roles, so what right do I have to be so self-centered and think I was the only one suffering?... I was, only thinking about myself.” [Student E6]

Factors that influence the quality of reflection

The analysis identified three factors that could affect the quality of student reflection. These three factors had also emerged from the different definitions of reflection coined by different researchers (Denton, 2011).

Time: The first factor is time. Gustafson and Bennett (2002) defined reflection as thinking “for an extended time about a set of recent experiences looking for commonalties, differences, and interrelations beyond their superficial elements” (p. 1). Though the amount of time spent on reflecting did not linearly equate to better and more effective reflection, not spending enough time to reflect would be detrimental to the reflective process. Some of the poorly written and edited journals were results of last-minute work and provided the evidence to support this argument that the amount of time spent on reflecting affect the quality of the reflection.

Gustafson and Bennett’s (2002) definition suggested time for a thorough exploration of one’s experiences. This thorough exploration could suggest depth (Denton, 2011). Perhaps the longer students spent thinking about their experiences, the more thorough or deeper their understanding of what they had learnt from those experiences. Denton (2011) suggested that depth refers to “one’s sophistication of understanding and ability to apply knowledge to new problems and environments” (p. 840). Perhaps those students who only recollected what they had encountered did not spend enough time to explore and think deeper into why they had solved their problems in a particular way. They could only think critically about how they had solved their problems. They did not think about their own critical thinking.

Meta-cognition: or thinking about one’s own thinking is the second factor identified. This arose from philosopher John Locke’s (1974) (as cited in Denton, 2011) definition of reflection as “that notice which the mind takes of its own operations”. It meant ‘did the students notice their own thinking’ - who recollected experiences and who critically analysed learning? The analysis showed that the written journals could reveal such students’ thoughts or meta-cognition to the faculty. These thoughts could then serve as evidence from which conclusions could be drawn about a student’s progress (Ong, 2004). In a way, students who merely recollected their experiences explained more about their problem solving while students who went deeper spent more time evaluating what they had learnt from their experiences. This difference in meta-cognition differentiated the quality of the reflection as well.

The analysis revealed two interesting observations on students’ meta-cognition or what Ong (2004) termed as ‘thinking about thinking’. First, students’ thoughts could be guided through the framing of the reflection criteria. The assignment tasked students to reflect on the difficulties they had encountered during the filmmaking process and what they did to overcome the difficulties. This reflection framework generally guided the students towards Van Manen’s (1977) second level of reflection - making students concerned with the analysing and the clarification of their experiences.

Students who merely recollected their experiences remained at the first level. Their reflections explained more of their journeys and less on what they thought about their learning. Focusing the reflection on practical skills also put the students at the first level, unless they had sought further clarification. The question that these students should reflect on was 'why'. Focusing on practical skills also tended to make the reflection less self-evaluative as well.

Students who had critically evaluated their learning would move towards Vanen's third level of reflection - questioning pre-established knowledge, conventions, and experiences (Parkes and Kajder, 2010). Student B2 was a good example when he/she analysed his/her own excessive self-confidence which resulted in mistakes in the script. This realization and transformative change in attitude is the higher order thinking and higher level of reflection that the journal had sought to encourage.

Second, the journals revealed the students' critical thinking used to solve problems that they encountered. In fact, the journals could be used to demonstrate Schön's (1983) 'reflection-in-action'. This is usually called upon when challenges arose during the process of accomplishing the task. The example of how student C3's team as seen below tried to work around the rain was a good example.

> "Nevertheless, no time went to waste as we used the time during the delay to fill up some of the forms required for submission and actors got to analyse their script in more detail. I have learnt that although such situations like bad weather conditions are far beyond my control, I have to make the best out of any situation…" [Student C3]

Student C3's team was reflecting-in-action. They reshaped what they were working on, while they were working on it. They experimented on shooting indoor as a solution to cope with the rain. When their thinking-in-action (Schön, 1983) told them that their sound recording was distorted, they 'reflected' and decided to spend the enforced delay on other productive aspects of the production. They did what Schön (1983) termed as 'reframing' the situation. This 'thinking-in-action' while the students 'reflect-in-action' could be seen in the other journals when the students described how they tackled and resolved their problems. In this way, the reflection journal made student thinking visible.

Reflection-on-action: The third factor that affects the quality of reflection arose from Dewey's (1997) definition of reflection as an "active, persistent and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it, and the further conclusions to which it tends" (p. 6). This seems similar to Schön's (1983) reflection-on-action, "thinking back on what we have done in order to discover how our knowing-in-action may have contributed to an unexpected outcome" (p. 26). In our case, it is whether the students chose the 'small hills' or 'steep mountains' as the critical incidents for discussion.

Students who merely recollected their experiences tended to choose challenges where a solution is readily in sight for discussion, rendering their reflection inactive, non-persistent and with nothing to contemplate about. Thus, the outcome was expected. The student who decided to discuss about the transportation of heavy equipment was a good example.

Students who evaluated their own learning tended to dig deeper and chose challenges that required them to actively and persistently think about and contemplate over. The outcome tended to be more psychological. Student B2's discussion on getting over his/her own ego was a good example.

Overall, the qualitative analysis has shown that the student filmmakers can demonstrate a high level of reflectivity in their reflections. However, not all of them could. Those who could not - did not spend enough time to think about what to reflect on, and did not evaluate what they had learned and changed as a result of the problem-solving process.

The students who could - actively spent their time asking themselves what they had learnt - to try and use reflection to bridge between theory and practice (Schön, 1983) and use reflection to reinforce their experience-meaning connection (Dewey, 1997). This was highlighted in the reflection of Student F3 below:

> "In analyzing my work, I feel that this assignment compelled me to work out of my comfort zone and do extensive research, subsequently building on my practical knowledge." [Student F3]

By writing/focusing on the critical incidents, the students had demonstrated their ability to analyse and evaluate their experiences and connect experience with meaning. If they did not reflect on their experiences, these experiences might remain only as experiences and not become concrete learning points. Thus, the reflection journal has provided a platform for the students to cement their experiences into learning and provided them with opportunities to ask themselves critically 'where was the learning'. This self-evaluation process helped students to deepen learning instead of merely applying their learning.

Results and Discussion - Quantitative Survey

Coefficient alpha was computed to obtain an internal consistency estimate of reliability for the survey. The coefficient alpha was .76, indicating the reliability of the survey to be acceptable.

Independent-samples *t* tests (one for each question) conducted found that male and female students did not perceive the use of the reflection journal differently, except before they joined the course. One-way analyses of variance (one for each question) conducted also found that students performing different roles during the filmmaking process did not perceive the use of the reflection journal differently. This is vital and supports the reflection journal as a valid assessment instrument. This will also mean that though the students performed in different roles or were of different gender, their filmmaking experiences did not contribute to any unequal opportunity for reflection.

Descriptive statistics (one for each question) were conducted to see how the students perceived 'reflection' and the use of the reflection journal. The results are shown in table 1 below.

Table 1: Survey Results - Descriptive Statistics

	SA	A	N	D	SD
Q1 - Before I joined the course, I know how to critically reflect on the experiences I have encountered.					
Frequency	7	44	26	6	-
Valid Percent	8.4	53	31.3	7.2	-
Q2 - Before I start my filmmaking project, I actively think about what I want to write in my reflection journal.					
Frequency	3	19	33	22	6
Valid Percent	3.6	22.9	39.8	26.5	7.2
Q3 - During the filmmaking process, I encountered challenges, which I feel that I can learn from.					
Frequency	41	39	3	-	-
Valid Percent	49.4	47	3.6	-	-
Q4 - The reflection journal allows me to look back at my experiences in dealing with the challenges and learning from them.					
Frequency	26	46	8	3	-
Valid Percent	31.3	55.4	9.6	3.6	-
Q5 - If the reflection journal is not part of my assignment, I am unlikely to reflect on my own experiences in making the film.					
Frequency	7	19	21	29	7
Valid Percent	8.4	22.9	25.3	34.9	8.4
Q6 - I feel that I have critically reflected on my filmmaking experiences while writing my reflection.					
Frequency	19	51	11	2	-
Valid Percent	22.9	61.4	13.3	2.4	-
Q7 - I feel that writing the reflection journal has made me learn much more from my filmmaking experiences.					
Frequency	17	42	21	2	1
Valid Percent	20.5	50.6	25.3	2.4	1.2
Q8 - I feel that writing the reflection journal has provided self-feedback towards my own learning.					
Frequency	17	48	16	1	1
Valid Percent	20.5	57.8	19.3	1.2	1.2
Q9 - Overall, writing the reflection journal has been beneficial towards my learning.					
Frequency	17	50	14	2	-
Valid Percent	20.5	60.2	16.9	2.4	-
Q10 - The reflection journal as an assessment tool should be continued.					
Frequency	14	37	27	3	2
Valid Percent	16.9	44.6	32.5	3.6	2.4

Results from question 2 revealed an interesting note about students' knowledge on reflection. It is actually difficult for students to actively think about what they want to write in their journals before they start on their projects, as there were no experiences to reflect on. The high number of students agreeing and neutral suggested that some students did not know how the journal should work for them. This could offer an explanation to the difference in the quality of the reflection.

Results from question 3 affirmed the finding in the analysis that all students had no problems in identifying issues or difficulties. And together with question 4, the results pointed to a positive perception towards using the reflection journal to document their learning.

For question 5, 31.3% felt that they were unlikely to reflect on their own if the reflection was not part of the assignment, with 25.3% neutral. This meant that more than half (56.6%) had benefitted from reflecting on their experiences with the reflection journal as an assessment. This is important as in question 6, 84.3% of the students felt that they had used the reflection journal to critically reflect on their filmmaking experiences. This suggested that the journals do have value as an assessment for the students to think critically.

Overall, the results showed that students perceived the use of the reflection journal positively. 71.1% felt that writing the journal made them learn much more from their filmmaking experiences (question 7). 78.3% felt that writing the journal provided self-feedback towards their own learning (question 8) and 80.7% felt that writing the journal has been beneficial towards their learning (question 9). This is in line with the findings in the qualitative analysis that the students can critically reflect and writing the journal served as self-feedback for them to deepen their thinking and learning.

However, only 61.5% agreed that the journal should continue as an assessment (question 10). The 6% who disagreed might not like writing or felt that there were better ways to assess them.

The overall survey results showed that most students felt that they could reflect. But there were a few who felt that they could not. This perceived difference in the skills of reflection could have caused the difference in the quality of student reflection found by the qualitative analysis. This has implications to the teaching and learning of the filmmaking module and warrants intervention so that more students can use the reflection journal effectively.

To overcome this perceived difference, more class time can be allocated to teach reflection to bring students to an equal footing. This is congruent with Quinton and Smallbone's (2010) argument that insufficient class time is currently given to reflection. Tutors always find time for the delivery of disciplinary content than for the reflection on learning. Denton (2011) also cautioned against focusing too much on technical interest and neglecting the cultivation of other essential dimensions of human learning, specifically skills related to reflection.

Some students might be quite reflective on their own but curriculum pressure, hectic social life and maybe even part-time employment might have cost them the time to reflect (Quinton and Smallbone, 2010). Time, as discussed earlier, is important for them to have a deeper and thorough exploration of their experiences. Bringing reflection into the learning space as an expectation will thus make the difference. Students need to know that they can all reflect, but that it may not be a habit that some use in a conscious manner (Moon, 2006). But it is a habit worth cultivating.

Conclusion

Learning by doing and reflecting are key strategies used in experiential learning to teach filmmaking. One can say that 'doing' is 'Yang' and 'reflecting' is 'Yin'. This research has showed that reflecting back on their filmmaking journeys helped students internalize their critical thinking used to solve problems while the self-evaluative process helped them think deeper into how they had changed and learnt more about themselves.

While many scholars and researchers encouraged the use of reflection in education (Dewey, 1997; Gustafson and Bennett, 2002; Ong, 2004; Quinton and Smallbone, 2010), not all students are keen nor know how to reflect effectively. The small perceived negativity in the survey and skills gap identified in the analysis warranted future intervention to explain the use of the reflection journals so that all students can effectively reflect and learn from their experiences.

A line in T. S. Eliot's (1943) *The Dry Salvages,* "We had the experience but missed the meaning" reminds us that sometimes the connection between experience and meaning is weak or totally absent (Denton, 2011). We need to reflect to encourage and reinforce this experience-meaning connection (Dewey, 1997). Only then can we truly say that we have understood how we think and how we learn.

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DEVELOPING FUNDAMENTAL COMPETENCIES FOR ACTIVE LEARNING THROUGH HOMEROOM ACTIVITIES

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Abstract

Although many instructors support their lectures with the method of Active Learning, not all attempts have been successful at encouraging students to be creative, persistent, or independent. What seems to be lacking is a discussion on the readiness of students rather than the efficiency of the methods in lectures. Hence, we formulated an approach that would facilitate students' fundamental competencies through homeroom activities. This study aims to discuss the significance of establishing students' basic skills for Active Learning. Our proposed Method for Active-learning Skill Training, or MAST, is based on the concept, "Fundamental Competencies for Working Persons," defined by the Ministry of Economy, Trade and Industry in 2006 as the basic abilities required in working together with various people in the work place and in local communities, which consists of three competencies: (1) Ability to step forward (action), (2) ability to think through (thinking), and (3) ability to work in a team (teamwork). The improvement of fundamental competencies through homeroom activities that incorporate holistic aspect of non-curricular education may stimulate learning motivation to produce proactive students. This study employs three approaches: (1) analysis of self-assessment on Fundamental Competencies for Working Persons, (2) individual supports and understandings recorded in a datebook (action/thinking), (3) improvement of homeroom activities to enhance students' interpersonal skills (teamwork). The realization of these approaches will allow students to improve their fundamental competencies. MAST may not immediately reinforce teaching methods in particular subjects; rather, it will gradually help promote students' intrinsic motivation to be creative and independent. Thus, our capital suggestion is to revitalize lectures aimed at Active Learning. Further research on MAST would clarify the association between homeroom activities and academic achievement.

Keywords: *Active Learning, Fundamental Competencies for Working Persons, homeroom activities, initiative, planning, stress control, teamwork, plan-do-check-act cycle*

Introduction

Concern over the implementation of Active Learning has been growing, and many teachers have been improving their lectures using several strategies, such as group work, pair work, and discussions. However, attempts have not yield unilateral success in terms of effectively encouraging students to be more "active," not only because teachers do not take the appropriate methods but also because the students cannot be creative, persistent, or independent learners. In addition, there are ambiguities in conducting non-curricular activities, such as homeroom activities. Therefore, the main purpose of this work is to discuss how to enhance students' fundamental competencies as basic skills for Active Learning through homeroom activities. We call our strategy MAST, which stands for "Method for Active-learning Skill Training."

MAST is based on the concept, "Fundamental Competencies for Working Persons," which consists of three competencies with 12 competency factors and defines the basic abilities required in working with various people in the workplace and in local communities, set forth by the Ministry of Economy, Trade and Industry in February 2006. In our increasing diversifying society, competencies must be enhanced along with basic scholastic ability for technical knowledge. Homeroom teachers of first- and second-year undergraduate students face problems related to shortage in such competencies.

Although it is difficult for first-year undergraduate students to obtain sufficient competencies to administer their personal and educational lives, homeroom teachers may provide some opportunities for students to train their basic skills for self-administration. Hence, we experimentally introduce a datebook called *Foresight Furikaeri-ryoku koujou (improving the ability to review) Techou*, based on *The 7 Habits of Highly Effective People* by Stephen R. Covey. This datebook allows students to review their daily-lives in the short and long term from the viewpoint of the plan-do-check-action (PDCA) cycle.

In our college, beginning in 2016, first-year students are organized into five classes that consist of different major students so that they can establish relationships beyond their majors and realize interdisciplinary approaches in the future. Emphasis is given to encouraging students to deliver their own opinions, build interpersonal relationships, and control their stress levels. Therefore, we have to enable the socialization of students in each homeroom class.

Our ultimate goal is to produce creative and independent persons with initiative. Thus we stimulate their motivation for learning by improving their fundamental competencies with MAST. This approach is employed in three first-year classes (126 students) in the National College of Technology, Oyama campus beginning in April 2016.

Materials and Methods

MAST is carried out with the following three approaches.

Analysis of *Self-Assessment of Fundamental Competencies for Working Persons*, to clarify the self-awareness of the 126 first-year students

Individual coaching with the datebook, *Foresight Furikaeri-ryoku koujou (improving the ability to review) Techou*, to improve *Ability to step forward (action)* and *Ability to think through (thinking)*

Improvement of homeroom activities to enhance students' interpersonal skills for *Ability to work in a team (teamwork)* with strategies based on *Structured Group Encounter (SGE)* and *Neuro-Cognitive Enhancement Training (N-COGET)*

Results and Discussion

Fundamental Competencies for Students. In July, we carried out a questionnaire, the self-assessment of Fundamental Competencies for Working Persons, in the three first-year classes. The students were asked to evaluate 36 questions using four scales: 4 corresponds to "Strongly agree," 3 to "Agree a little," 2 to "Disagree a little," and 1 to "Strongly disagree." The results are shown in Table 1 and Figure 1.

Table 1 Results of the Self-Assessment of Fundamental Competencies for Working Persons

Three Competencies	12 Competency Factors	Ave.	Dev.
Action	Initiative	2.94	0.545
	Ability to influence	2.99	0.624
	Execution skill	2.95	0.594
Thinking	Ability to detect issues	2.93	0.553
	Planning skill	2.82	0.581
	Creativity	2.87	0.666
Teamwork	Ability to deliver message	2.85	0.569
	Ability to listen closely and carefully	3.18	0.561
	Flexibility	3.16	0.595
	Ability to grasp situations	2.94	0.622
	Ability to apply rules and regulations	3.36	0.516
	Ability to control stress	2.94	0.756

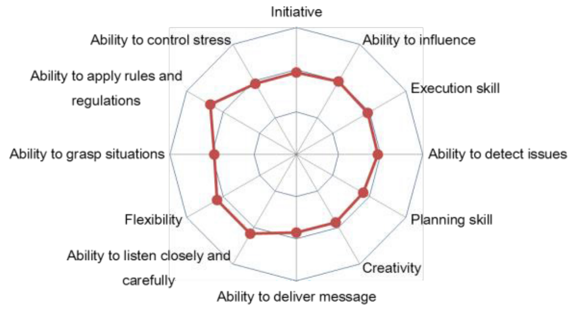

Figure 1 The Rader Chart of 12 Competency Factors

The mean values were high for "Ability to listen closely and carefully," "Flexibility," and "Ability to apply rules and regulations," but low for "Planning skill," "Creativity," and "Ability to deliver message." The detected standard deviations were small for "Initiative," "Ability to detect issues," and "Ability to apply rules and regulations," but remarkably large for "Ability to influence," "Creativity," and "Ability to control stress." Individual differences in "Ability to control stress" were notable: 3% of students marked "1" for all the three questions for this competency factor. The results of "Ability to influence," "Execution skill," "Planning skill," "Ability to grasp situation," and "Creativity" were bimodal or trimodal (Figure 2.). Moreover, many students evaluated these factors significantly low. Individually, those who reported low ratings in this self-assessment tended to rate "Ability to deliver massage" low. This finding indicates the need for teachers to approach them proactively because these students would not take actions even if they have serious problems. In addition, this result has a low correlation with their learning performance in the midterm examinations held in June.

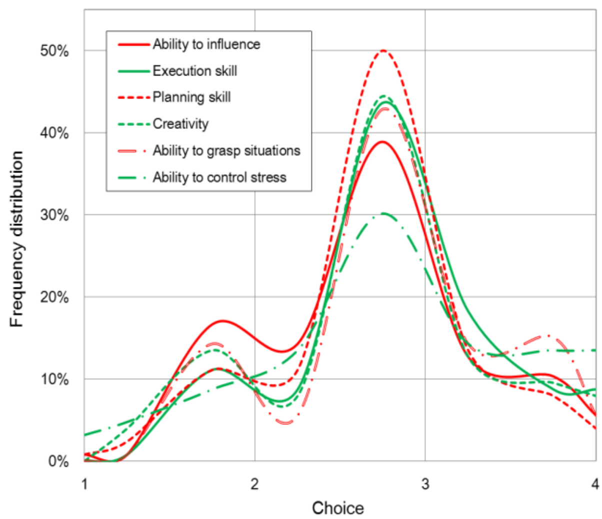

Figure 2 Frequency Distribution of the Extracted Six Competency Factors

There is room for further investigation, given that this assessment was rather subjective; the results may have been influenced by students' personalities. More objective researches and comparative analysis with learning performances or other psychological tests (e.g., the Uchida - Kraepelin psychodiagnostic test) will be needed to realize further support depending on the needs of individuals.

Datebook for 7 Habits of Highly Effective People. In April, five first-year classes were recruited for this attempt, which was assisted by a lecturer from the publishing company that developed the datebook. We inspected their datebooks and offered individual advice necessary.

We encouraged the students to utilize this datebook as a means for compiling their To-Do lists, learning portfolio, and drafts of their reflection on their learning plan for examinations. A number of students mentioned that after using this datebook, they became motivated and able to study systematically (Figure 3).

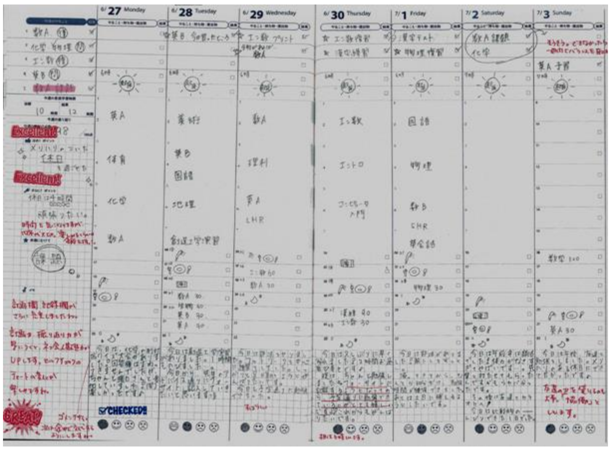

Figure 3 Example of a Weekly Schedule Sections

This datebook has a monthly schedule section. In using these pages, students exercised their ingenuity (Figure 4).

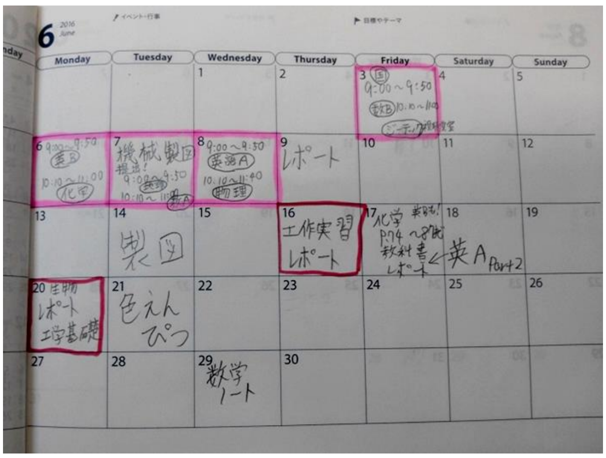

Figure 4 Example of a Monthly Schedule Sections

For a number of teachers who do not have lectures in their Homeroom classes, this datebook can be a valuable tool to communicate with students. The use of this datebook has revealed large differences among individuals, such as whether they can make the most of the many functions in this datebook. We have found that a number of students cannot reflect their habits in the PDCA cycle.

We have begun distributing handouts that make it easier for students to schedule, such as learning plans for examinations. Many students may thus acquire the capability to manage their schedule in their own ways with one datebook in the near future.

Homeroom Activities. After entering college, students have to discuss and determine many topics, such as the division of duties in homerooms, school festival events, and players for ball games. These tasks are often difficult for them when they barely know their peers. Of course, such a situation can be reframed as valuable opportunities to train the competency of "Teamwork." Instructors can promote arguments, discussions, or conversations, with appropriate support. Figure 5 shows one of the handouts designed to help the activities, particularly when discussions reach a standstill.

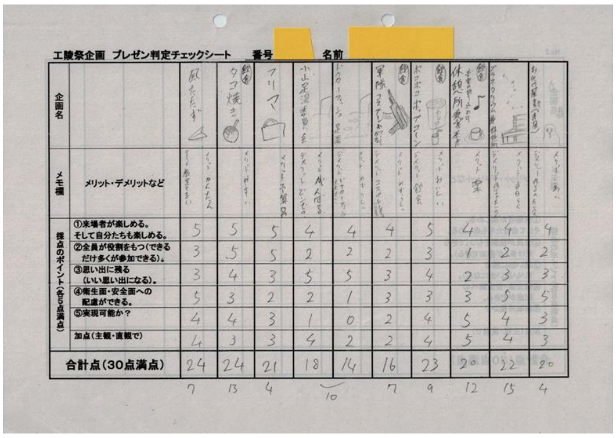

Figure 5 Example of A Handout for the School Festival Presentation

The handout is based on published resources; similar handouts are published in many books and easy-to-use materials, such as SGE. However, it is necessary to revise the activities or handouts and adapt them to the occasion and targeted students.

Although these strategies promote active arguments or discussions, students may not able to relate with others. Therefore, we are currently interested in adapting N-COGET, which helps reinforce cognitive function. This module may be useful in training students' *Ability to work in a team (teamwork)*.

Conclusion

The results of the Self-Assessment of Fundamental Competencies for Working Person partially substantiated our hypothesis on our failure experiences in Active Learning or non-curricular education. Individual coaching with a datebook and the improvement of homeroom activities have produced notable achievements to enhance the three fundamental competencies, as the homeroom activities incorporate the holistic aspects of non-curricular education. However, further investigations and approaches are needed. Presently, our school counselors are interviewing all first-year students, mainly based on the results of the Uchida-Kraepelin psychodiagnostic test.

This tool would be a great help to our analysis of our approach and to improving strategy to facilitate students' development.

MAST does not promise immediate results in reinforcing teaching methods in particular subjects. It aims to help gradually promote students' intrinsic motivation to be creative and independent learners. Consequently, our capital suggestion is to revitalize lectures aimed at Active Learning. Further research on MAST would clarify the association between homeroom activities and academic achievement.

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1307

Problem-based learning with a large-sized handout for effective group work facilitation

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Abstract

In recent years, a student needs to learn not only specific skills in the specific fields but also generic skills such as problem solving, critical thinking, and communication, which are essential to adapt a recent complex social organization. To learn such skills, active learning is one of the best instructional approaches. In the active learning, problem-based learning (PBL) has been frequently used in the world. While PBL can develop several generic skills through student activities, the necessity of facilitation ability as PBL teacher makes things difficult. In order to resolve the problem, this study attempted to introduce a large-sized handout (LSH) to "Production Design Engineering Practice", which is PBL-based class (once per week in first semester) for 1st grade students of Advanced Engineering School (20–21 years old) in National Institute of Technology, Kitakyushu College. Because the LSH describes facilitative information (just simple template) on the larger sized paper (>A3 sized paper) as distinct from blank paper, we can easily use the LSH for any PBLs, and expect the promoting of students leaning process. Therefore, utilization of the LSH enables to facilitate student group work with only larger sized papers and a simple template, and the LSH results can be used for presentation directly. In the PBL-based class, we grouped 8 teams (4–5 students per team) from 39 students of 3 courses (Control Engineering Advanced Course, Production Engineering Advanced Course, and Materials Science & Chemical Engineering Advanced Course). The teams included members from at least 2 fields of experts to keep diversity. We prepared problem solving scenarios as: 1) the students are employees in Kitakyushu technology company capitalized at $10,000, 2) the students team need to design new projects for the company, and 3) project concepts are assistive technology, environment, or disaster prevention. Using LSHs for PBL-based class, we could decrease our facilitation time, and students actively attempted to resolve the problem using LSHs' guide and direction. Although the class has not been finished, we could observe the LSH effects for the students in the PBL-based class because of their excellent processes, achievements, and abilities development.

Keywords: *Problem-based learning, Active learning, large-sized handout, Group work, facilitation*

Introduction

Based on rapid globalization and technological advancement of today's world, novel student's skills are required in our society, which are called as generic skills. Assessment & Teaching of 21th Century Skills (AT21CS) project defined the skills into four categories as ways of thinking (*i.e*. problem-solving and creativity), tools for working (information and communication technology literacy), ways of working (communication and collaboration), and ways of living in the world (*i.e* citizenship and personal/social responsibility) (AT21CS, http://www.atc21s.org). To accomplish development of such skills, "active learning" is one of the best instructional approaches, which provides learning environments with positive encouragement and close interaction between students and teachers in several ways (Prince, 2004). In the active learning, problem-based learning (PBL) has been frequently applied to group works for their problem-solving abilities improvement (Hmelo-Silver, 2004). While the several benefits for students can be observed, the necessity of facilitation ability as PBL teachers and students in the team makes cautious to perform PBL-based class (Hmelo-Silver, 2004; Hmelo-Silver & Howard, 2015).

To support the facilitation skills of PBL reachers, we prepared a large-sized handout (LSH), which describes facilitative information (just simple template) on the larger sized paper (>A3 sized paper) (Aburatani *et al*., 2016). Besides, the previous study reported that LSH enabled to support our facilitation of class, promote the students learning processes, and produce presentation document on the LSH directly.

In this study, we introduced the LSH to "Production Design Engineering Practice", which is PBL-based class in National Institute of Technology, Kitakyushu College. In doing so, we attempted to develop students' abilities such as problem-solving, communication, and learning process. And, we evaluated the LSH effects to the students in the PBL-based class from the viewpoints of their processes, achievements, and abilities development. In this study, we report the PBL achievement and evaluation results by interim presentation of the class.

Materials and Methods or pedagogy

Large-sized handout (LSH)

A1-seized LSHs were prepared in every class, which describes facilitative information for students group work. The LSH format was prepared according to Aburatani *et al*. (2016) (Figure 1). In most of the class, students performed presentation using LSHs products directly.

Production Design Engineering Practice

Production Design Engineering Practice class is performed (once per week in first semester) for 1st grade students of Advanced Engineering School (20–21 years old). In the class, we grouped 8 teams (4–5 students per team) from 39 students of 3 courses (Control Engineering Advanced Course, Production Engineering Advanced Course, and Materials Science & Chemical Engineering Advanced Course). The teams included members from at least 2 fields of experts to keep diversity. We prepared problem solving scenarios as: 1) the students are employees in Kitakyushu technology company capitalized at $10,000, 2) the students team need to design new projects for the company, and 3) project concepts are assistive technology, environment, or disaster prevention. Students attempted to plan their innovative idea using LSHs in every class. The class outline of this study is shown in Table 1. At the 6th class and extra time, students prepared the documents for interim presentation, and presented at 7th class for 10 minutes (with 10 minutes question time).

Questionnaires for evaluation of students development

We provided the 3 questionnaires to students at interim presentation of the class (7th class). In order to evaluate the students development and LSHs effectiveness, we performed the 9 questions for self-evaluations and groups-members-evaluation (Figure 2A). Besides to 9 questions, we prepared the free space to write the students' arguments. The questionnaires were prepared based on generic skills definition and "model core curriculum in National Institute of Technology" (National Institute of Technology, 2012). In addition to generic skills questionnaires, students and class teachers also evaluated their presentation and achievement using different types questionnaires (Figure 2B and 2C).

Data analysis

Raw questionnaires data was analysed using scatter plots correlation test using interim presentation data (project and presentation) by students and PBL teachers and average of 9 generic skills evaluation by self- and groups-members-evaluation. For scatter plot correlation

Table 1. Outline of the class contents

Class	PBL class contents	mins
1th	Brain storming and presentation of students' projects using LSHs	90
2th	Project planning and presentation	90
3th	Concept mapping of the project	90
4th	Continuation of project concept mapping and presentation	90
5th	Business planning	90
6th	Preparation of presentation documents	90+extra time
7th	Interim presentation	180

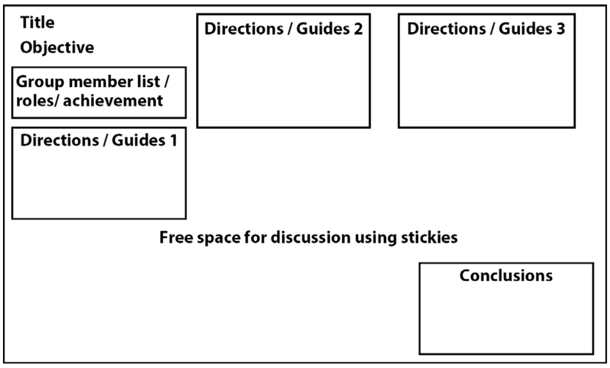

Figure 1. The format of large sized-handout (LSH) in this study.

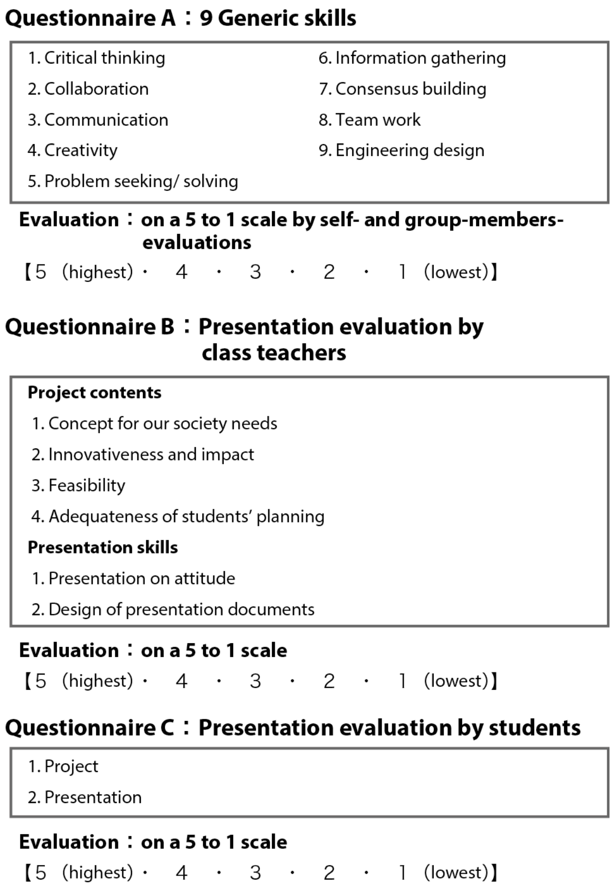

Figure 2. Questionnaires for students and class teachers. (A) For generic skills evaluations of students, (B) Presentation evaluation by class teachers, and (C) Presentation evaluation by students.

test, we used average value as PBL teachers evaluations data of the interim presentation. Welch's t-test was performed using 9 generic skills evaluation between self- and groups-members-evaluation.

Results and Discussion

The Production Design Engineering Practice class was performed for 1st grade students of Advanced Engineering School in National Institute of Technology, Kitakyushu College. Despite the facilitators (class teacher) performed few minutes simple facilitation in 90 minutes class, the students actively attempted to resolve the problems written on the LSHs in every class (Figure 3). PBL teachers encouraged and interacted during the class. The business planning types of 8 teams shows in Table 2. The 8 teams planned 4 disaster prevention projects, 2 environmental projects, and 2 assistive technological projects.

At the interim presentation, each team presented using power points for 20 minutes in front of 8 PBL teachers. And, students and PBL teachers evaluated their presentation and project contents using the questionnaires B and C of figure 2. Based on the correlation tests between students and PBL teachers, project and presentation evaluations are strongly correlated because of R^2 values (> 0.8), suggesting that

Figure 3. Students' achievement using LSH. This LSH shows the result of project concept mapping.

Table 2. The lists of students team in the class

Team	No. of students	No. of women	Project planning types
1	5	3	disaster prevention
2	5	0	disaster prevention
3	5	0	Environment
4	5	0	Environment
5	5	0	disaster prevention
6	5	0	Assistive Technology
7	5	0	disaster prevention
8	4	0	Assistive Technology

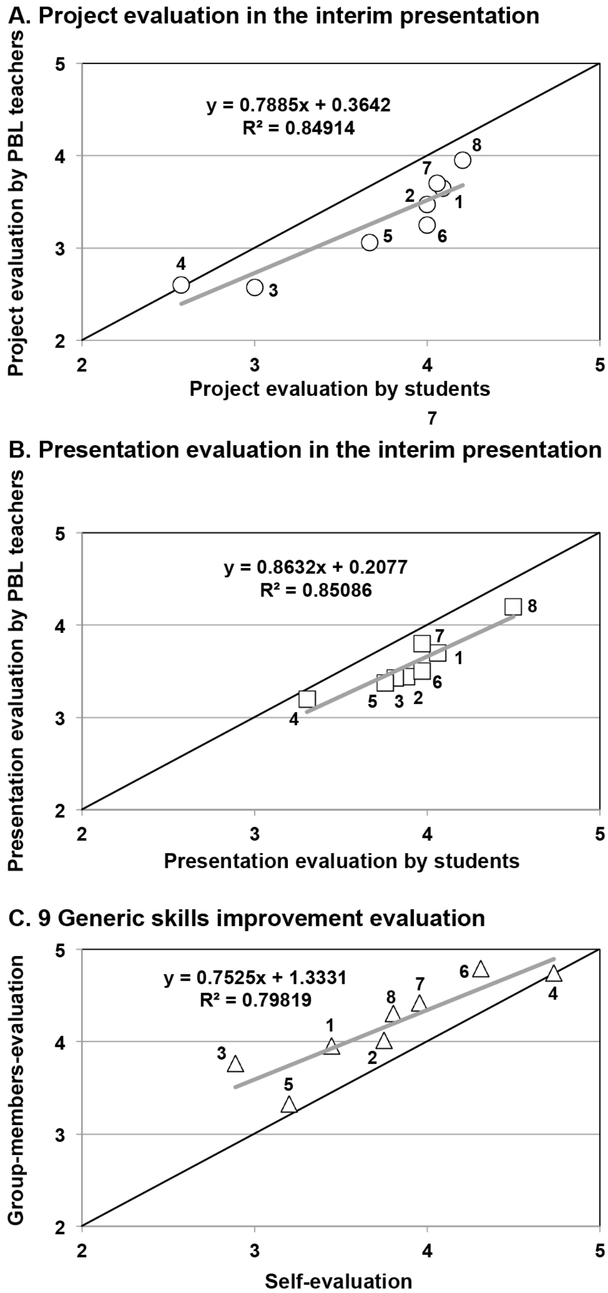

Figure 4. Correlation tests based on scatter plots of questionaries.
(A) Project evaluation in the interim presentation, (B) Presentation evaluation, and (C) 9 generic skills improvement evaluation. Numbers in the figures show each team.

students can seriously evaluate each other (Figure 4A and 4B). On the other hand, PBL teachers evaluations were relatively lower than students'. Thus PBL teachers strictly evaluate students presentation compared with students according to teachers' knowledge, major, and experiment. While the correlation between self- and group-members-evaluations of generic skills indicated that students lowly evaluated themselves, this scatter plots also strongly correlated (questionnaire A). Therefore, students may recognize themselves

Table 3. Average values of 9 generic skills evaluation

	Q1		Q2		Q3		Q4		Q5		Q6		Q7		Q8		Q9	
Team	**S***	**T****	**S**	**T**	**S**	**T**	**S**	**T**	**S**	**T**	**S**	**T**	**S**	**T**	**S**	**T**	**S**	**T**
1	3.6	3.7	3.4	4.2	3.6	3.9	2.8	3.8	3.6	4.0	3.6	4.0	3.6	4.0	3.8	4.0	3.0	4.0
2	3.8	3.7	3.8	4.2	3.8	3.9	3.0	3.6	4.0	4.1	4.3	4.2	3.5	3.9	4.0	4.4	3.8	4.1
3	2.8	3.7	2.8	3.8	2.8	4.0	2.6	3.7	2.8	3.9	3.2	3.8	2.8	3.7	3.2	3.7	3.0	3.8
4	4.8	4.9	4.6	4.7	4.6	4.5	4.8	5.0	5.0	4.8	4.4	4.5	4.6	4.7	4.8	4.7	5.0	5.0
5	3.4	3.5	3.4	3.2	3.0	3.3	3.2	3.5	3.8	3.2	3.0	3.6	2.4	3.2	3.0	3.2	3.6	3.4
6	4.6	4.9	4.4	4.9	3.8	4.7	4.2	4.8	4.4	4.8	4.0	4.9	4.4	4.6	4.4	4.9	4.6	4.8
7	4.0	4.4	4.2	4.5	4.0	4.5	3.6	4.4	3.8	4.3	4.0	4.5	4.0	4.3	4.2	4.8	3.8	4.3
8	4.3	4.3	4.3	4.7	4.0	4.6	3.3	4.2	3.8	4.0	3.3	4.3	3.5	4.3	4.5	4.5	3.5	4.0
ALL	3.9	4.1	3.8	4.2	3.7	4.1	3.4	4.1	3.9	4.1	3.7	4.2	3.6	4.1	4.0	4.2	3.8	4.2

*S: Self evaluation
*T: Third party (group members) evaluation
Q1–9: 1. critical thinking, 2. collaboration, 3. communication, 4. creativity, 5. problem seeking/ solving, 6. information gathering, 7. consensus building, 8. team work, 9. engineering design

objectively, whose ability is one of the important skills because it enables to overcome a hurdle of their life (Garrison and Akyol, 2013).

Table 3 shows the results of 9 generic skills improvements questionnaires according to Figure 2C. Based on Welch's t-test using raw data of Table 3, Q2 collaboration, Q3 communication, Q4 creativity, Q6 information gathering, Q7 consensus building, and Q9 engineering design were statistically different between self-evaluation and group-members-evaluation ($p < 0.05$, $n > 35$). Besides to the Welch's t-test, average values of 9 generic skills evaluations by group members were higher than self-evaluation (Table 3). A previous study reported that the LSH use might facilitate creativity ability compared with blank paper use for group work (Aburatani et al., 2016). Although this study has no candidate control such as blank paper in previous study, their creativities could be improved because of higher value (4.1) by group members evaluation. Moreover, all group-members-evaluation of generic skills are higher than 4.0. Therefore, in respect of metacognition, we should make effort to assimilate their abilities improvements between self- and group-members-evaluation.

Conclusions

In this study, we attempted to use LSH into PBL-based class, and evaluated students' generic skills improvements. Despite the class has not been finished in this semester, the students felt their achievements of the class, and positively performed project planning using LSHs. In addition to students feeling, PBL teachers have realized facilitation possibility of LSH formats. Continuously, we will evaluate the LSH effects to the students in the PBL-based class from the viewpoints of their processes, achievements, and abilities development.

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1308

The Teaching of Technical English for NIT Students as Future Global Engineers

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Abstract

In this paper, we are going to discuss the teaching of technical English for NIT students as future global engineers. Our three main points are as follows (I) ~ (III):

(I) The fundamental principles of technical English are defined as "3Cs (=Correct, Clear, Concise)". To put it into practical teaching, we need to investigate the actual conditions of English users.

(II) As a factual investigation, we held a technical English seminar for a selected local company. Eventually, the problem is whether or not English teachers can understand their graduates' working environments and what kind of English is used there.

The teaching of technical English should allow students to seek their own identity as an engineer, and also help to promote their career enhancement through English study based on the actual case study.

(III) In conclusion, we constructed a model of the teaching of technical English for NIT students.

Notice that this paper is a part of achievements supported by a National Institute of Technology subsidy for research of 2015 -18.

Keywords: *English Technical Writing Test, Training Global Engineers, Regional Activity, English Language Teaching, Career Enhancement*

Introduction

Generally speaking, despite the prevalence in Japan of "practical English" indispensable to global engineers, it seems rather difficult for teachers of NIT to encourage their students to understand the importance of English study. Actually, many NIT students do not entirely believe in a considerable advantage of having a good command of English. As a reason, they cannot imagine how technical English could be used in their future workplace. It can be said that "a serious gap" between teachers and students exactly exists here. Accordingly, we should illuminate how important the teaching of technical English is. Our three main points in this paper are as follows (I) ~ (III):

(I) As a definition of technical English, considering Pearsall (1975), "Japan Society for Technical Communication (=JSTC)" defines the fundamental principles of technical English as "3Cs (=Correct, Clear, Concise)". To put it into practical teaching, we need to investigate the actual conditions of English users.

(II) As a factual investigation, we held a technical English seminar for a selected local company. Interestingly, we found out that a basic sentence pattern such as "S+V+C (O)" would be most required in their workplace. Eventually, the problem is whether or not English teachers can understand working environment and basically similar English use there. They have to do the actual case study of student's place of employment. Hence the teaching of technical English can allow students to seek their own identity as an engineer, and also help to promote their career enhancement through English study based on the actual case study.

(III) In conclusion, we constructed a model of the teaching of technical English for NIT. For the practical teaching of technical English, English teachers are certainly required to understand and cooperate closely with teachers of technical education as well as engineers at local firms. Therefore, the illiberal dichotomy between the humanities and science course should be transcended.

Upon these three essential points, firstly, we would like to set the background of this study roughly through the past research.

The Background of This Study

As we have already mentioned, the importance of English has been widely prevailed among the people in Japan. Apart from its judgement, the teaching of English has an important role and variety in Japanese educational system. In this much enthusiasm, the notion of "practical English" tends to be regarded as very important. In the case of NIT, "English for specific purposes (=ESP)" can be its equivalent. As teaching staff committed to the teaching of English for the students majoring in engineering, we need to define what kind of English our NIT students need to learn.

We have already considered what kind of curriculum can be regarded as a suitable one for teaching English at national institutes of technology. An improvement of English education as a project had been conducted for two years (2012-4 academic year) at the advanced course of National Institutes of Technology, Fukui campus. In this project, firstly, we tried to set TOEIC® as the most important target.

In this study, our students were encouraged to get an average score (400 points) of TOEIC®, although it was not enough to meet the demand by students themselves. Even if we taught them that TOEIC® was foremost "practical" for their future, they could not or would not fully understand it as their merits. That was why we set another target for the students. As a different approach to teaching English suitable for global engineers, teaching presentation in technical English had been introduced as a compulsory curriculum of the subject "Current English". In other words, we faced much difficulty to define "technical English" itself through teaching English at advanced course at NIT in this study. That was because we have also tried to show mainly how we designed a new subject "Technical English for Global Engineers" through this project.

As a first step in this study, we examined what kind of technical English needed to be taught through the introduction of "English Technical Writing Test (=ETWT)" into our curriculum. In the next chapter, we would like to analyse ETWT.

"English Technical Writing Test (=ETWT)"

In this chapter, as most qualified materials for a teaching of technical English, we introduce "English Technical Writing Test (=ETWT)" widely held in Japan. Kyono (2010) explains about ETWT as follows:

(ETWT is) provided by the Japan society of Technical Communication and emphasizes the importance of the active skills, mainly focusing on what skills should be taught in the future and how to develop these skills. This paper also stresses the necessity of learning rhetoric-related skills, concept of the 3Cs (Correct, Clear, and Concise) as a means to develop technical writing skills for engineers. (Kyono 2010:18)

At first, we give an outline of ETWT. There are five levels in ETWT; "Grade 1st", "Grade 2nd", "Pre-Grade 2nd", "Grade 3rd", and "Grade 4th". Generally speaking, The levels of "Grade 1st" and "Grade 2nd" normally require those examinees to have the actual business experience. We could suggest that those two grades are rather difficult for NIT students. As a result, many acquisitors of Grade 1st and Grade 2nd intend to be necessarily limited to actual engineers or patent translators. Therefore, NIT students, normally, and high school to undergraduate level: 15-20 years old, majoring engineering are strongly encouraged to obtain Grade 3rd, and Grade 4th. Some of the questions of those are shown as follows:

As the name "English Technical Writing Test" itself means, the question pattern of ETWT is simple and fundamental such as technical term translation or word understandings. All the questions of "Pre-Grade 2nd", "Grade 3rd", and "Grade 4th" have to be answered on the mark sheet. We can say ETWT is especially useful for the writing and reading of technical English. Some of the questions of ETWT are shown as follows (I)~(VI):

(I) Translation into Japanese
There is no known useful formula that sets apart all of the prime numbers. . . . The first result in that direction is the prime number theorem, proven at the end of the 19th century, which says that the probability that a given, randomly chosen number n is a prime is inversely proportional to its number of digits, or to the logarithm of n. (105th Exam, Grade 1st, November 15th 2015)

(II) Sentence Combination (i)+(ii)
(i) Higashijima Island is the only known home to the incredibly rare Bryan's shearwater.
(ii) This is a bird that until recently was feared to be extinct. (104th Exam, Grade 2nd, July 25th 2015)

(III) Paraphrasing (i)=(ii)
(i) Thre robot is capable of placing the parts precisely at the right places on the table.
(ii) The robot is capable of (*one word) the parts precisely on the table. (105th Exam, Grade Pre 2nd, November 15th 2015)

(IV) Composition
If (1. stops 2. of 3. operating, 4. devices 5. these 6. you 7. any) should think about replacing them all.
(105th Exam, Grade 3rd, November 15th 2015)

(V) Word choice
You can lose control of the car (1. how 2. if 3. unless) you press the accelerator hard.
(105th Exam, Grade 4th, November 15th 2015)

As some notable characteristics of Grade 3rd and Grade 4th examinations, it is very important for the examinees to acquire essential technical terms. We show some of the terms used for the questions of Grade 3rd and Grade 4th (105th Exam, November 15th 2015) as follows (VI):

(VI, i) Grade 3rd (translation into Japanese)
refine, irreversible, secrete, disintegrate, covert

(VI, ii) Grade 4th (translation into Japanese)
harden, odor, alloy, width, axis

Here we acknowledge that writing English clearly, correctly and concisely is foremost important in the preparation of ETWT and this would be effective for teaching of technical English. Pearsall (1975) maintains that "Technical Writing may be defined as the presentation in written form of technical and scientific information with clarity and precision on a level suitable to the intended audience". We can define ETWT as a concrete gate for the learners of technical English.

As to the question patterns for Grade 3rd and Grade 4th, a large vocabulary of technical terms is essentially needed. In other words, different from other English proficiency tests, NIT students need to imagine the actual work place in which such terms could be regarded to use. Learning technical English means to nurture the so-called engineering mind. This can be said a great contribution through English teaching for training global engineers. TOEIC®

To promote NIT students' self-study, under the support by the Japan society of Technical Communication, we made the list of the essential English sentences for NIT students (I) as digital version last March and uploaded on our college HP. Everyone can access it worldwide. It consists of 100 sentences and covers the Grade 3rd and Grade 4th. We are planning to upload the next version as the list (II) until next March.

Certainly, ETWT is one of the best learning materials for NIT students, but more importantly, we need to encourage NIT students to study technical English at the daily level. To many NIT students, it seems that learning English is understood not as the continuous, but special levels. We need to eliminate the so-called "Englishphobia" or the allergy for English. To do so, it is essential for NIT students to get used to English in their daily campus life.

Next, we report how we tried to construct the global atmosphere at our college campus. We promote this through the facilities named "English Café". Our another intention is to inspire students' motivation, and tutor them for ETWT through this system

"English Café" at NIT

Promoting students' self-study, we opened the facilities named "English Café at NIT, Fukui campus (=EC)" in April 2015. EC is intended to give any students the opportunities to be familiar with English study and to ease their "Englishphobia", or hesitation and reluctance in using English and to feel confident to use English as much as possible.

We planned to offer the special educational programmes as follows (I) ~ (IV)

(I) English conversation class (1 hour) was regularly held once in a week, and a native speaker as a facilitator was invited to the classes.

(II) A special lecture was held in Autumn, and an associated professor at Tohoku university was invited as a special lecturer. He gave a 1.5 hours lecture about the introduction to the comparative cultural study between Japan and Canada.

(III) Special preparation classes for ETWT were held during the summer vacation and just before the examination day of ETWT in January.

As to the above programmes (I)~(III), any students can participate the programme freely

Joining EC was completely separated from the usual English classes as compulsory subjects. In each class, about 10 students constantly joined, and seemed to enjoy EC. As a result, this gave great effects on the teaching of technical English. As below, we show the brochure on the programme (Figure 1).

Figure 1 A brochure on the programme

(IV) For the staff as well as students, we planned to hold a technical writing seminar. This aimed to prompt them to write their thesis in English, and help to join in an international conference.

A technical translator was invited as a special lecture. The programme consisted of two parts; two 1.5 hours lectures. Those lectures focused on the principles "3Cs (=Correct, Clear, Concise)" in writing technical English, and gave many examples of the actual errors collected by the special lecturer.

12 teachers and technical assistants participated in this seminar. We show an example of the responses to the questionnaire from staff as below (Figure 2).

The questionnaire was a descriptive one, and reading the participants' comments, we understood that this kind of lecture was urgently needed by researchers majoring in engineering. They understand the importance of technical English as well as the so-called practical English (TOEIC®). Here we should admit the balance between the two kinds of approaches: technical and practical ones.

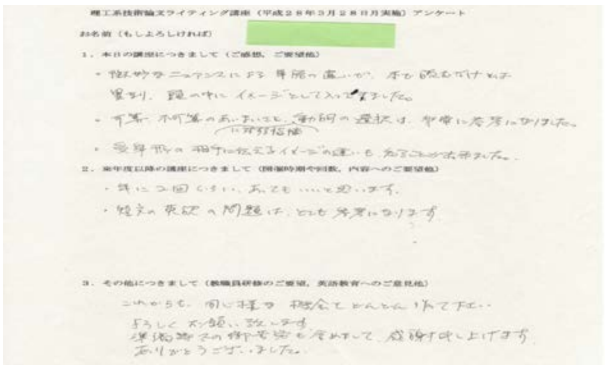


Figure 2 An Example of the Responses to the Questionnaire (From staff).

In this chapter, we demonstrated how we tried to give NIT students the opportunity to get used to English in their daily campus life. As a next step, we thought out that students should need to have an actual experience of using English in the atmosphere of collaborating with other universities and local companies. Beginning in the learning ETWT, NIT students gradually expanded their learning community within their own campus to the outside of the campus. This style of learning can be classified as an active learning method.

In the next chapter, we focus on an instance of career education for NIT students as future global engineers, and seek the possibility of teaching technical English.

A Career Education Programme through Teaching English

As a good example of practical English programme, we would like to illustrate an instance of career education for NIT students as future global engineers. We published a research paper about this programme in *ISATE 2015 Proceedings*. We would like to explain the outline of the programme by extracting some parts from the paper. Although the quotations would be too long, we are sure to need the outline once again in this paper as follows:

By collaborating between the institutions of higher education in Fukui prefecture, a two-day seminar named "Fukui Kigyogaku (=A Study of Globalization and Locality in Fukui Enterprises)" for NIT's and universities' students was held in 2014 and 2015. This seminar was presented by "The Division of Promoting the Development of Universities and Private Institutions of Learning at Fukui Prefectural Government (Fukui government)", and academics from those higher institutions as a team arranged the whole programme. It can be defined as career education. We deal with how this seminar was planned and held last September.

"Fukui Kigyogaku" was characterized by the following:

(I) This programme was aimed at offering each participant the opportunity to think about globalization as a member of local community. In short, they were able to realize the important relationships between globalization and locality. In fact, through this seminar, the participants tried to cultivate not only their global mind but also their senses of locality. Therefore, we would like to maintain that a global perspective should be attained through a local one in career education.

(II) This programme was organized by the joint staff of NIT and universities in Fukui prefecture, Fukui government, Junior Chamber International Fukui and so forth. Therefore, this can be a suitable example of Regional Activity at NIT.

(III) This programme mainly consisted of the two parts: some lectures including group discussions planned by a few leading local enterprises and English lectures. The head author of this paper was responsible for a plan of the English lectures, and also served as one of the chief coordinators.

As a result, all participants from NIT had a suitable opportunity for learning what is needed for global engineers by desirable interactions with the others from different universities. The results of a questionnaire to the participants proved this programme was able to yield educational benefits as an introduction of active learning.

Notice that this programme was a part of achievements supported by a government subsidy for aiding scientific research of 2013-2016.

Considering the training of NIT students as future global engineers, it is no doubt that basic communication skills are foremost required of them.

Generally speaking, English language education can be regarded as a major role in it. However, the collaboration between the training of global engineers and English education can be difficult to design. As one of the main reasons, we can say many students easily tend to jump to the conclusion that the poorer their English ability is, the worse their aptitude for global engineer is. Needless to say, teachers should have them feel secure about their ability, and design the suitable educational curriculum for the students.

Based on career education, we mainly discussed the design of an English teaching programme in a career seminar for NIT students as future global engineers

Setting "career education" as important, we sought a suitable educational programme.

At first, for generalizing the notion of globalization, we picked up some NIT graduates' opinions about ideal global engineers. They expressed their ideas about the ideal image of global engineers in the book. We summarize the common opinions among them as the following (I) ~ (III):

(I) English should be regarded as an essential and important skill for global engineers.

(II) English as communication skills needed in the globalized world should be centred in English language teaching.

(III) Teaching English for global engineers must be taught mainly through a school curriculum, and so English teachers should have responsibility for it.

By developing these opinions, we shaped the notion of the English teaching programme for "Fukui Kigyogaku (= A of Globalization and Locality in Fukui Enterprises)". In short, after considering the requisite English for this programme, we decided that "Fukui Kigyogaku" should motivate the participants to realize English as important skills in the globalized world for improving their career prospects. This met the object of the programme. Here, it can be said that the collaboration of career education and teaching English could be rather suitable for the training of global engineers.

This kind of educational and career programme would become effective to NIT students if we aptly plan to make a collaboration of English study, career guidance, and PBL on the basis of regional activity. As a result, "Fukui Kigyogaku" helped to promote the teaching of technical English.

Figure 3 was a brochure delivered for the recruit of "Fukui Kigyogaku 2014".

Figure 3　A brochure on the programme

As a final instance, we would like to show a practice of planning technical English programme at a regional company.

Technical English Seminar at a Local Company

Next, we focus on regional activity, and seek the possibility of teaching technical English through regional activity.

We also consider how a teaching staff of liberal arts at "National Institute of Technology (=NCT)" should practice "the educational and research contribution to the local community (=Local Contribution)"

So far, we have shown three instances (I) ~ (III) as follows:

(I) a course for NIT students preparing for taking ETWT in Practical English Proficiency

(II) planning a two-day seminar for NCT and university students in Fukui prefecture

(III) "English café": constructing an atmosphere of daily English use

Through the practice, we would like to maintain that a global perspective should be attained through a local one in career education at NCT. The process was as follows (I)~(V):

(I) After consulting with staff belonging to the department, and some local companies, we chose one company for the model case.

(II) Some main reasons why we chose the company were (i) ~ (iv) as follows:
(i) There were only a few graduates who work for the company.
(ii) The chosen company was very much interested in recruiting NIT students.
(iii) The company is classified as a manufacturing industry, and manufacture precise parts and as such.
(iv) The company ("Fukui Byora") is a local based one, and has many foreign branches.

(III) As the next step, we ask the company to offer an example of document in English usually circuited among the International branches.

(IV) We asked a full-time lecturer at JSTC to be the lecturer of this programme.

(V) This programme consisted of two parts (90 mins x 2) and 30 employees joined this programme.

A questionnaire to the participants about the programme was conducted and the results were shared among the staff.

This questionnaire asked a few discriptive simple questions mainly about the actual correlation between their workplace and the use of technical English. We present a part of text book (Figure 4) and some of the responses to the questionnaire (Figure 5) as below.

A part of the results of this questionnaire was summarized as follows (I) ~ (V):

(I) 20 of all the participants were conscious of the connection between their workplace and English. In short, many participants thought that studying English should be needed for them in this case.

(II) Around half of all complaint their English curriculum which they took in their high school or university years. That is why we must admit that the serious gap certainly exists. This could lead to "Englishphobia".

(III) Judging from their image of ideal English curriculum, there would be a variety. Some wrote that practical conversation training would be desperately needed, and on the contrary, others mentioned that writing would be very essential to their workplace. To them, as a basis, English is "a skill", so we have to think the balance is very important.

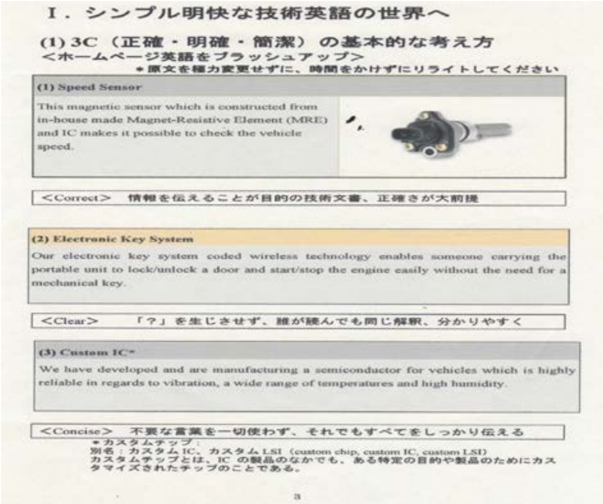
(IV) From the document uesd in the company, we found out that a basic sentence pattern such as "S+V+C (O)" would be most required in their workplace.

(V) 20 people of all (30 people) thought that technical English would be essential in their workplace.

As a result, although social demand for English education has a variey, we need especially focus on technical English and English conversation as the participants' demand. As to regional activity, these two aspects should be regarded as teaching materials.

In spite of the pervail of the communicative English, what we can say is to teach to write correct English so that a extent of grammar teaching should be needed. For example, Koike (2010) points out this stand through nationwide cunducts. This is also regarded as essential in the fundamental principles of technical English as

"3Cs (=Correct, Clear, Concise)". Here, we can point out the improtance of technical English teaching.



I．シンプル明快な技術英語の世界へ

(1) 3C（正確・明確・簡潔）の基本的な考え方
＜ホームページ英語をブラッシュアップ＞
＊原文を極力変更せずに、時間をかけずにリライトしてください

(1) Speed Sensor
This magnetic sensor which is constructed from in-house made Magnet-Resistive Element (MRE) and IC makes it possible to check the vehicle speed.

<Correct> 情報を伝えることが目的の技術文書、正確さが大前提

(2) Electronic Key System
Our electronic key system coded wireless technology enables someone carrying the portable unit to lock/unlock a door and start/stop the engine easily without the need for a mechanical key.

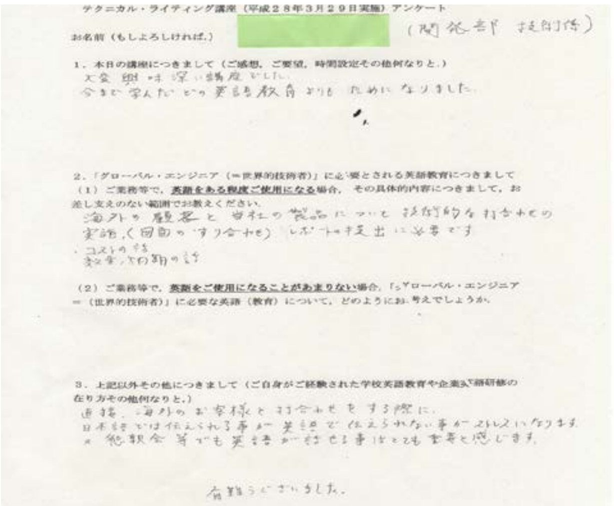
<Clear> 「？」を生じさせず、誰が読んでも同じ解釈、分かりやすく

(3) Custom IC*
We have developed and are manufacturing a semiconductor for vehicles which is highly reliable in regards to vibration, a wide range of temperatures and high humidity.

<Concise> 不要な言葉を一切使わず、それでもすべてをしっかり伝える

＊カスタムチップ：
別名：カスタムIC、カスタムLSI（custom chip, custom IC, custom LSI）
カスタムチップとは、ICの製品のなかでも、ある特定の目的や製品のためにカスタマイズされたチップのことである。

Figure 4 A Part of the Textbook



テクニカル・ライティング講座（平成２８年３月２９日実施）アンケート

お名前（もしよろしければ。）[redacted]

1．本日の講座につきまして（ご感想、ご要望、時間設定その他何なりと。）
大変興味深い講座でした。
今まで学んだどの英語教育よりもためになりました。

2．「グローバル・エンジニア（＝世界的技術者）」に必要とされる英語教育につきまして
（1）ご業務等で、英語をある程度ご使用になる場合、その具体的内容につきまして、お差し支えのない範囲でお教えください。

（2）ご業務等で、英語をご使用になることがあまりない場合、「グローバル・エンジニア＝（世界的技術者）」に必要な英語（教育）について、どのようにお考えでしょうか。

3．上記以外その他につきまして（ご自身がご経験された学校英語教育や企業内研修の在り方その他何なりと。）

有難うございました。

Figure 5 An Example of the the Questionnaire

Further Study of the Teaching of Technical English

Finally, we can summarize the main four important points for promoting further study of the teaching of technical English as follows (I)~(II):

(I) Helpful support by graduates of NIT should be included so that students can be much more conscious of the career pass through English education. As further study, we need to try to make an educational programme for technical English lectured by graduates of NIT.

(II) Training global engineers doesn't merely mean English teaching. Nevertheless, it can be said that English teaching should play an essential role of global education, so the motivation for English learning with technical English needs to be set for NIT students. The teaching of technical English can connect between NIT and regional companies. In short, global education can be defined as "glocal (=global+local)" education".

Conclusion

As a conclusion, we would like to confirm the outline of this paper.

In this paper we reported the main five achievements as follows (I) ~ (V):

(I) "English Technical Writing Test (=ETWT)": to encourage NIT students to study technical English.

(II) "English Cafe": to promote the autonomous learning by a construction of global atmosphere for the daily use of English

(III) "Fukui kigyogaku": to introduce new type of career education programme for NIT students to learn autonomously and concretely how and where technical English is generally uesd

(IV) To plan and offer an educational programme for technical English to local company and the staff at NIT.

(V) Through the above (I) ~ (IV), NIT students can concretely imagine how English learning could be useful in their future.

Acknowledgement

We should like to record our thanks to Mr FUJII Masahiro, a secretary-general at the Japan society of Technical Communication (JSTC), and all the participants for Technical English seminar at Fukui Byora Co., Ltd., and all the staff involved in the plan of "Fukui Kigyogaku.

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Connecting STEM education and Japanese skills: The result from data mining of registration system's data, approaches to increase Japanese competency for IT students

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Abstract

According to official statistics from the Japanese Chamber of Commerce, Bangkok(JCC), Thailand's figure of Japanese corporation's membership equals 1,615 companies last year and becomes 1,715 companies in 2016. (100 companies increased) and the data from Thailand's board of investment also supported that Japan is the top foreign-investor for more than 10 consecutive years, aligns with JETRO's information that Thailand still has a good infrastructure, technical skills, quality of engineers, supporting industries and transparency of investment-related law.

Thus, cultivating students with Japanese competencies is a major requirement to serve Thailand-Japan business. as mentioned before.

The purposes of this study are

1. Using data mining to discover knowledge for developing a study plan of Japanese language connecting with Science, Technology, Engineering and Mathematic (STEM) education.

2. Using discovered knowledge to increase Japanese language competency for Information Technology (IT) students at TNI.

The research also used the partial correlation to discover patterns of course planning that reflect to students' academic performance and Japanese proficiency. Based on our applied techniques we found that

1. The left and right brain dominance theory affected IT students' academic achievement in Japanese learning.

2. The finding result implies that we need to reorder the study sequence of STEM and Japanese courses to balance between Japanese and STEM courses for better academic performance.

Finally, this research provides the faculty with a new method from research to strategic planning for set up an appropriate program plan and tools according to discover knowledge and it also gives the opportunity of the future educational planning.

Keywords: *Data mining, Japanese language competency, STEM education, Information Technology student, study plan, academic performance*

Introduction

Thai-Nichi Institute of Technology (TNI) is the only university in Thailand that requires all undergraduate students to learn Japanese language for at least 5 courses as shown in table 1.

Table 1: Five courses of Japanese language at TNI

Course Code	Course name	Year of Study
ENL-101	English for Communication 1	1
ENL-102	English for Communication 2	1
ENL-201	English for Communication 3	2
JPN-101	Business Japanese 1	1
JPN-102	Business Japanese 2	1
JPN-201	Business Japanese 3	2
JPN-202	Business Japanese 4	2
JPN-301	Business Japanese 5	3

At first year, Japanese language and Information technology course are the new experiences for freshly at TNI. These programs might take a great effect to TNI's IT student for academic result. Supporting this evidences from previous study of TNI's registration data (Chertchom, 2016) shows that the average GPA (Grade point Average) of IT students is just 2.84. (GPA 4.0 scale)

Kosit Tiptiempong (2016), the lecturer at Tokyo University of Foreign Studies wrote in the article that Japanese people does not study Japanese language but they study kokugo. (国語 ; kokugo) which they call national language. He stated that Japanese language that foreign student study is just for communication, while Japanese learn a culture of their nation for understanding their lineage and to be live in their own society. Thus, the way of getting deeply understanding for Japanese language of foreign student may be not align with the core value of Japanese language.

In addition, from a study by Aungtrakul (2009) for studying of Japanese education problems at University in Northern Thailand, she found the problems as listed in table 2.

Table 2: Problems of Japanese education at University in Northern Thailand

Problems	Level of problem
1. The teaching and learning for Thai student is difficult due to unequal basis of Japanese language.	High
2. Not enough class activity due to a lot of contents.	High
3. Too many students in class result in class practicing	High

While TNI's IT students have to study Japanese during at the first and the second year, a STEM course is also new to them at the same period of learning that use different skill in learning (Nielsen et.al, 2013)

Table 3: Sample of STEM Courses for TNI's IT students

Science Course Name	Technology Course Name	Engineering Course Name	Mathematics Course Name
- Science and Technology	- IS Project Management - Business Software Project Management - CRM - ERP - SCM - MRP - BPM - IT Audit and Control	-OO Programing -OO Programing Lab - Data Structure and Algorithm - Analysis Modeling and Design	-Business Mathematics -Discrete Mathematics -Mathematics1 -Mathematics2 - Math for Computing

Align with the evidences from previous study of TNI's registration data as mentioned earlier (Chertchom, 2016) that the average GPA (Grade point Average) of IT students is 2.84 and most of IT students fall into the average GPA with lower than 2.00 and between 2.00 and 2.50 as shown in figure 2.

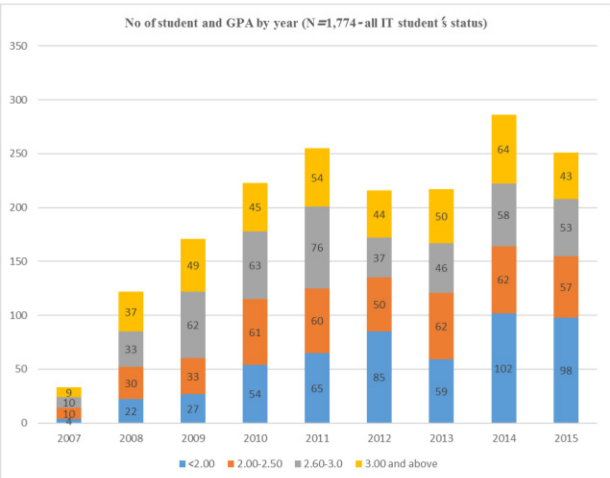

Figure 1: Number of student and GPA by year (N=1,774- all IT student's status)

In addition, the average GPA of Japanese, Science, Technology, Engineering and Mathematics courses are 2.88, 2.85, 2.83, 2.76 and 2.56 respectively as shown in table 4.

Table 4: Descriptive Statistics for Average GPA

	Mean	Std.Deviation	N
GPA	**2.87**	**0.48011**	**353**
AVG.Japanese	2.88	0.66941	353
AVG.Science	2.85	0.79335	353
AVG.Technology	2.83	0.43779	353
AVG.Engineering	2.76	0.58512	353
AVG.Mathematics	2.56	0.72275	353

Thus, this research uses data mining with association technique to discover knowledge for developing a study plan of Japanese language connecting with Science, Technology, Engineering and Mathematic (STEM) education and also used the partial correlation to identify a relationship reflecting to students' academic performance.

Related Materials and Methods

Japanese versus Thai language structure

There are very significant differences between Japanese and Thai, particularly in sentence structure. (Japan Foundation, 2016) The Japanese writing uses three main scripts: Kanji (characters of Chinese origin), Hiragana (a syllabary*) and Katakana (a syllabary) while Thai language contains all the information of sentence in the written form to let people work out tones, emphasis, short/long vowels.

Thai is a tonal language, while Japanese has 5, pure vowel sounds that may be short or long. In all these aspects Japanese is different from Thai Language.

Moreover, at TNI, students have to study Japanese languages for 5 courses at the first and the second year and this courses are new to most of TNI students. In order to develop better curriculum and sequence of study program, researchers used the past records of Japanese language's grade in computation model for understanding the interaction between it and STEM courses.

STEM Courses

STEM education is believed to be a new way of construction of courses that will used to drive students to be a problem-based thinker. STEM consists of the four disciplines subjects which are science, technology, engineering, and mathematics. According to U.S. Immigration and Customs Enforcement (STEM Designated Degree Programs, 2016), they classified course and degree that are STEM disciplines for example; Information Technology, Computer Programming/Programmer, General, Web Page, Digital/Multimedia and Information Resources Design, Computer Graphics, Computer Systems Networking and Telecommunications, Information Technology Project Management, Web/Multimedia Management and Webmaster etc. Thus, in this paper, researched categorized STEM course at TNI for faculty of information technology as following in table 5.

Table 5: STEM-Designated Course Program List

Engineering = 16 courses	
BIS-103	OO Programing
BIS-104	OO Programing Lab
BIS-107	Data Structure and Algorithm
INT-101	Intro to Programming
INT-102	Intro to Programming Lab
INT-103	OO Programming
NT-104	OO Programming Lab
INT-105	Internet Technology
INT-106	Computer Structure
INT-201	Computer Network
INT-202	Computer Network Lab
INT-204	System Analysis and Design
INT-301	Database
INT-302	Database Lab
INT-303	Software Engineering
ITM-502	Analysis Modeling and Design
Mathematics = 10 courses	
BIS-101	Business Mathematics
BIS-102	Discrete Mathematics
BIS-203	Financial Accounting
ITM-501	Statistic and Research methodology
MSC-107	Mathematics1
MSC-108	Mathematics2
MSC-126	Math for IT
MSC-127	Math for MT
MSC-201	Math for Computing
MSC-202	Statistics and Probability
Science = 1 course	
MSC-112	Science and Technology
Technology = 101 courses	
BIS-105	Introduction to IS
BIS-106	Computer System and Organization
BIS-202	Web Service Technology
BIS-301	IS Project Management
BIS-305	Business Software Project Management
BIS-401	CRM
BIS-402	ERP
BIS-403	SCM
BIS-404	MRP
BIS-405	BPM
BIS-406	IT Audit and Control
BIS-407	IT Innovation and New Technology
BIS-408	IT Consultancy
BIS-416	Special topics in BIS 1
BIS-417	Special topics in BIS 2
BIS-418	Special topics in BIT 1
BIS-419	Special topics in BIT 2
ITE-201	Computer System Admin
ITE-202	Web Services Technology
ITE-203	Web Services Technology Lab
ITE-204	Computer Network and Communication System 2
ITE-205	Computer Network and Communication System 2 Lab
ITE-301	Web Design and Development
ITE-302	Web Design and Development Lab
ITE-303	Information Technology Center Management
ITE-304	MIS
ITE-305	Software project Management
ITE-306	Multimedia Technology
ITE-307	IT Seminar
ITE-308	E-Commerce
ITE-309	Multimedia Technology
ITE-401	CRM
ITE-402	ERP
ITE-403	SCM
ITE-404	MRP
ITE-405	Computer Simulation in Business
ITE-406	GIS
ITE-407	Network System Security
ITE-408	Network Design
ITE-409	Advance Topic in DMS
ITE-410	Data WH & Mining
ITE-411	KM
ITE-412	Computer Animation
ITE-413	Mobile Apps Development
ITE-414	Computer Graphic Design
ITE-415	Game Development
ITE-416	Special Topic in IT1
ITE-417	Special Topic in IT2
ITE-418	Data Structure and Algorithm
ITE-419	OS
ITE-420	Fundamental of Wireless Communication
ITE-421	Network System Security
ITE-422	Network Design
ITE-423	Computer Animation
ITE-1,258	Computer Graphic Design
ITM-503	Information System Project Management
ITM-504	Computer Network Technology
ITM-505	IT Seminar
ITM-616	Data and Information Management
ITM-617	IS Strategic planning
ITM-618	KMS
ITM-619	E-Business Technology and Development
ITM-624	Image and Video Processing
ITM-626	Modern multimedia Technology
ITM-636	Web Based App and Internet Programming
ITM-671	Advance Topic in IT
ITM-672	Advance Topic in IT2
ITM-673	Oversea IT Seminar
MTE-101	Principle of MT
MTE-102	MT Practiced
MTE-103	Introduction to OO Programming
MTE-104	Introduction to OO Programming Lab
MTE-105	Fundamental of MT Programming
MTE-301	MT Communication
MTE-302	Digital Signal Processing
MTE-303	Human Computer Interaction
MTE-306	MT
MTE-401	Advance programming for MT and Animation
MTE-402	AI for Game Design
MTE-403	3D Game Development
MTE-410	Advance Computer Animation
MTE-411	3D Animation and Special Effect
MTE-412	Computer Animation
MTE-413	Media Art
MTE-414	Computer Graphic Design
MTE-415	Game Development
MTE-416	Mobile Apps Development
MTE-417	Multimedia Design for Advertisement
MTE-418	Virtual Reality
MTE-419	Digital Video Editing
MTE-420	Digital Video Processing
MTE-421	MT Retrieval
MTE-422	Pattern Recognition
MTE-423	Data Compression
MTE-1,258	MT Applications
MTE-425	Storage Media Technology and Design
MTE-426	MT Design and Authoring
MTE-431	Computer Vision for MT
MTE-432	Digital Image
MTE-433	Special topic in MT 1
MTE-434	Special topic in MT 2

In this study, researchers collected GPA of each course as shown in table 5 for analytic.

Brain functions and The left and right brain dominance theory

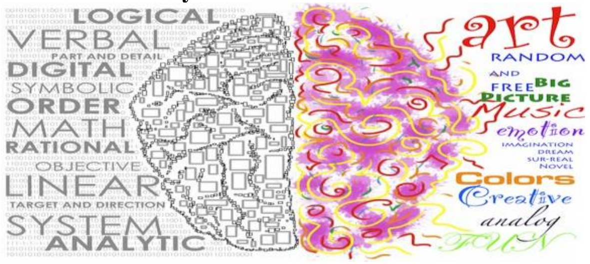

Figure 2 right-brain and left-brain personality traits (EarthSky, 2013)

Nielsen et al., (2013) makes this distinction that individuals have 'right-brain and left-brain' (figure 2) which are responsible for different manners of thinking or cognitive style. From the study, they found that a "left-brained" typically associated with logical thinking, analysis, and accuracy and "right-brained" with aesthetics, feeling, and creativity.

In particular, learning language is associated with using right brain much more than left brain. On the other hand, learning STEM uses left brain for thinking, analysis rather than feeling and creativity.

Thus, in this paper, researchers tried to see the relationship of Japanese language and STEM based on this theory to see how we develop IT students to use a proper "right-brained" to increase their Japanese skill.

Relationship modelling with the partial correlation

Scholars apply multiple the partial correlation models for data analysis. One of benefits of the partial correlation is, for instance, it is used to identify the interconnection between two variables while controlling for a third variable. The researchers apply this technique to find the unique variance between two factors while eliminating the variance from a control variable. In addition, some paper uses it for observing a control variable how it impacts to the results. Moreover, we use more than 1 control variables in model. (Yang and Wang, 2011; Jung and Chang, 2016).

Using data mining with classification technique to analyse data.

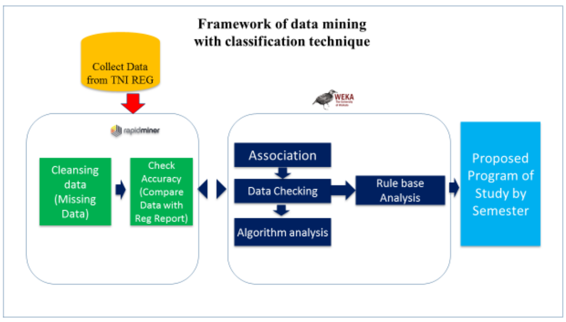

Figure 3 Framework of data mining with Association Rule Learning

The first steps of this paper (figure 3) present a task of retrieving data from TNI registration system. The second task is to organize data for example cleansing and checking of accuracy to transform data that was collected in forms other than numbers, and turned into quantitative data for analysis by using Rapid Miner tool.
Then, after processing of data validation to ensuring that a study's data are clean, correct and computable, we used WEKA for data mining with classification technique to analyse data.

Association Rule Learning

Association rule learning (Romero et al., 2008) was applied to determine the relationship of the data. This research used the Association Rule Learning for analyzing and predicting the GPA's pattern between Japanese score and STEM's courses score to finding all possible association rule that each rule is a binary partitioning of a frequent item set. This paper used Apriori Algorithm for finding meaningful patterns of Japanese language and STEM's GPA result. The sample of Apriori Algorithm is illustrated in the diagram below.

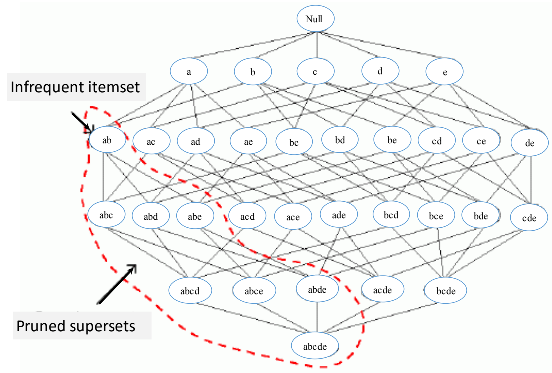

Figure 4: An example of the Apriori Algorithm.(Parallel Data Mining, 2016)

From the results of this algorithm Analysis, we will use it to develop a study plan of Japanese language connecting with Science, Technology, Engineering and Mathematic (STEM) education.

Research Methodology

Design of Framework

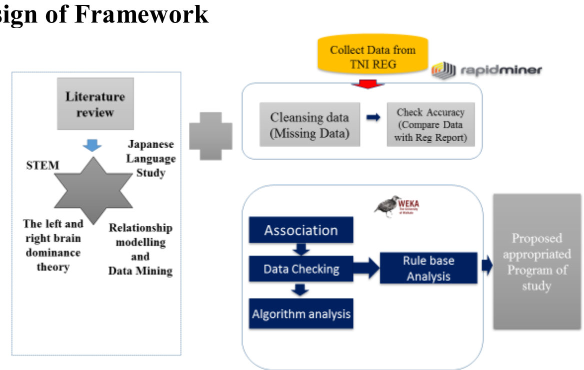

Figure 5: Framework of research construction (By Author)

The framework of research (figure 5) started from a curiosity from my previous study that why TNI's IT student graduated with low grade average. Thus, the first step of this paper started from obtaining data from registration system.

In these framework, the interaction between STEM and Japanese and the related factors such as brain function and sequence of study program are indicated to see an influence among them.

The second step, we used descriptive and inferential statistics tools to analyze basic data and relationship to understanding information of this academic performance by observing interaction between Japanese and STEM's courses.

The third used more tool to deeply find association of studying courses such as the partial correlation and data mining technique. (Kalaitzopoulos et al., 2016)

Fourth, this paper proposes strategic planning for set up an appropriate program plan and tools according to discover knowledge and it also gives the opportunity of the future educational planning.

Data collection

The registration data was obtained from department of academic affair of Thai-Nichi Institute of Technology from year 2007-2015. In this study, we only focused on graduated IT student's data and the total sampling of students in the study was 1,258 rows. We use Microsoft Excel and Microsoft Access to organize the data and Rapid Miner with WEKA for analytic and for data mining process.

Measurement

The analysis of data in this study is adapted from the five steps of academic analytics (Campbell et.al, 2016 . (As shown in Figure 6) to turn data into information, and information into insight for develop a strategic plan to improve a studying program.

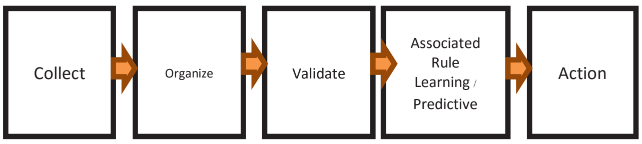

Figure 6: Analytic process flow (by author)

In addition, the extraction of data also used inferential statistics (using SPSS) that is a partial correlation analysis to analyse.

Results and Discussion

Table 6: The partial correlation analysis between Japanese language and STEM Courses.

The Patial Correlations				
	df = 1,250	Average GPA Japanese Laguage	Significance (2-tailed)	**Control Variables**
J	Average GPA Japanese Laguage	1		
S	Average GPA Science Course	**0.07**	0.013	Average GPA of (Engineering,Technology and Mathematics)
T	Average GPA Technology Course	**0.209**	0	Average GPA of (Science,Engineering and Mathematics)
E	Average GPA Engineering Course	**0.187**	0	Average GPA of (Science,Technology and Mathematics)
M	Average GPA Mathematics Course	**0.023**	0.423	Average GPA of (Science,Technology and Engineering)

Output from table 6 is for seeing the relationship between "Japanese language" and "STEM Courses" while controlling variables were shown in the last column of table. From this table we can predict how strength of a relationship between Japanese language and those variables. The third column of the table 6 represents the bivariate correlation between "Japanese language" and "STEM Courses", r = .070, p = .013, r = .209, p = .000, r = .187, p = .000 and r = .023, p = .423 respectively. While statistically significance value is lower than a p-value of 5%, it means that correlation value can explain the result.

It obviously determines that the degree of relationship between them are weak related. In addition, while controlling for a third variable (Omitting the effect of other variables), there is no sign in change due to third variables. Thus, we can imply that if the change in Japanese language's GPA is not accompanied by a change in the well of learning STEM courses. It is interesting to note that although the type of relationship between them are not negative relationship, it can say that there may use different skill in learning. In summary, this paper used additional data mining tool to discover in more deeply to see other association among them.

Table 7: Result of data mining (Association Rule Learning using Apriori algorithm by WEKA)

		Association Rule Learning - Apriori									
Rules	No.	**Japanese**	Science	**Technology**	Engineering	Mathematics	**GPAX**		Conf.	%	
1	302	**Fair**		Fair	Fair		Fair	301	1	0.09	
2	284		Fair	Fair	Fair		Fair	282	0.99	0.08	
3	284			Fair	Fair	Fair	Fair	278	0.98	0.08	
4	371	**Fair**		Fair			Fair	371	0.98	0.11	
5	516			Fair	Fair		Fair	503	0.97	0.15	**0.92**
6	379		Fair	Fair			Fair	366	0.97	0.11	
7	335			Fair		Fair	Fair	335	0.96	0.10	
8	365	**Fair**			Fair		Fair	368	0.95	0.11	
9	331		Fair		Fair		Fair	331	0.95	0.10	
10	**270**	**Good**	**Good**	**Good**			**Good**	**256**	**0.95**	0.08	
	3,437									1.00	

	GPAX	
Good	>=	3.00
Fair	2.00	2.99
Low	0.00	1.99

From table 7, Apriori, the association rule mining algorithm was applied to process of determining the frequency of occurrence for characteristics of TNI's IT students. There are 3,437 transactions and 10 items in the data set. 92% of students fall into a rule no. 1 to no. 9 while only 8% of students was doing well for current curriculum.

Conclusions

In this study, the partial correlation was used to examine how Japanese language learning was associated with STEM courses, after controlling for related factors. A bivariate analysis showed that STEM courses have a weak correlated with Japanese language. In addition, the Association Rule Learning using Apriori algorithm simultaneously was applied for an analysis. It revealed more information than what bivariate analysis could yield, the results showed that only 8% of students is successful with current TNI's IT curriculum for studying 5 Japanese courses in the first and second year, which is very low rate. From information we found, all cases are students who have good GPA for all subjects.

Specifically, taking credit loads in Japanese courses with STEM courses in the first and second year, leads to unsatisfied academic performance at last. Thus, a connection in the left brain could be associated with a completely novel neural computation of the right brain. It may be an indicator of the content of the two networks given known differences in function of the respective left- and right-brain.

Finally, the analysis confirmed that a new studying plan may be adjusted to increase Japanese competency and also STEM courses as shown in table 8.

Table 8**:** Proposed New Study Plan for TNI's IT students

Year of Study	Group Course
1	Semester I: Basic STEM Semester II: Basic STEM
Summer	**English I**
1	Semester II: Basic STEM
2	Semester I: TE
Summer	**English II**
2	Semester II: TE, English III
3	Semester I: TE, **Japanese 1, 2** Semester II: TE, **Japanese 4, 5**
Summer	**(Japanese 3)**
3	Semester II: TE, **Japanese 4, 5**
4	Semester I: TE, **Language Courses(Japanese- advanced course)**

As a further work, we would like to see the result again after university changes the order of studying and analyze what happen if Japanese language may be studied in the third or fourth year after students get in touch with STEM course in the first and second year.

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THE ROLE OF FORM-FOCUSED INSTRUCTION AND INDIVIDUAL DIFFERENCES IN THE DEVELOPMENT OF FOREIGN LANGUAGE PRONUNCIATION

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Abstract

The study presents an acoustic phonetics analysis, attempting to examine the difficulty in the acquisition of weak forms by Japanese adolescent learners of EFL at a technical college level. Weak forms are also discussed from a pedagogical perspective indicating its substantial role in the *Form-Focused Instruction* (FFI). The rationale for the study originates from just twenty years of experience in teaching EFL to engineering-major students, and an ongoing interest in the effects of instruction on the development of foreign language pronunciation. Japanese has traditionally been classified as a syllable- or mora-timed language, whereas languages classified as stress-timed, like English, are known to reduce their vowels to the extent of phonological neutralisation in unstressed syllables. This poses a stumbling-block for learners from many language backgrounds, who tend to transfer their native language phonological habits to foreign language pronunciation. Because of these systematic differences, Japanese EFL learners find it difficult to reduce vowels in unstressed syllables in English, which might often lead to communication break-downs. This study deliberately explores the significant possibility that learners will be able to work together toward eliminating their pronunciation errors in a positive classroom setting, as suggested in Abe (2015a).

Keywords: *FFI, pronunciation, weak forms*

Introduction

The paper offers further findings from the *Form-Focused Instruction* (FFI) given to engineering-major students during regularly scheduled classes taught by the author at a college located in northern Japan. FFI is defined as 'any instructional activity which aims at drawing learners' attention to language form, where "form" stands for grammatical structures, lexical items, phonological features, and even sociolinguistic and pragmatic features of language' (De Graaff & Housen, 2009, p. 736). The last two decades have witnessed a growing body of research in the effectiveness of instruction on second language (L2) development from the perspectives of FFI (Doughty, 2003; De Graaf & Housen, 2009; Long & Robinson, 1998). This line of inquiry has led to continuous modification of FFI, increasing its positive effects on L2 classroom instruction in the Japanese context and yielding strong support for the hypothesis that a timely combination of form-focused and communication-oriented instruction is necessary for successful L2 development (e.g. Muranoi, 1996).

In the meantime, however, L2 pronunciation instruction has not kept pace with the insights gleaned from the development of FFI. The rationale for the study stems from the question of whether the FFI is unambiguously effective in L2 pronunciation instruction (Abe, 2015a). FFI has generally been categorized into two types, namely (a) *focus on forms* (plural; FonFs), involving explicit types of FFI, and (b) *focus on form* (singular; FonF), involving both implicit and explicit types of FFI. The distinction, *implicit* and *explicit* type of FFI, is demonstrated with several attributes in Housen and Pierrard (2005): Implicit FFI '*attracts* attention to target form, is delivered *spontaneously* (e.g. in an otherwise communication-oriented activity), is unobtrusive (minimal interruption of communication of meaning), presents target forms in context, makes no use of metalanguage, and encourages free use of target form' (p. 10, italics in the original), whilst Explicit FFI '*directs* attention to target forms, is *predetermined* and *planned* (e.g. as the main focus and goal of a teaching activity), is obtrusive (interruption of communication of meaning), presents target forms in isolation, uses metalinguistic terminology (e.g. rule explanation), involves controlled practice of target form' (p. 10, italics in the original).

The treatment in the experimental group (EG) focused on the phonetic form, encouraging learners to observe the target feature and discovering the rule under their own initiative, and in the production session, the participants were expected to use the target pronunciation in *focus-on-form* (FonF) practice, whilst the control group (CG) followed a traditional *forms-focused* instruction (FonFs) in two sessions of perception and production. Meanwhile, the present paper further examines both qualitative and quantitative modifications of vocalic elements in the acoustic data of the weak forms, attempting to describe the difficulty to reduce vowels in unstressed syllables in EFL.

Weak Forms in Foreign Language Pronunciation

The acquisition of English weak forms has posed difficulty to non-native speakers of English for long in perception and production. Cruttenden (2008: 308) states "If listening to native speakers, they should be aware of the types of assimilation and elision which have been described above; otherwise, they will find it difficult to understand much of ordinary colloquial English. This knowledge is particularly important because a second language is often learned on a basis of isolated word forms; in the speech of the native, however, the outline of these words will frequently be modified as has been seen". The L2 English weak forms have been examined from pedagogical perspectives, yielding positive effects of instruction in the formal setting (Bogacka, Scwartz, Zydorowicz, Polezynska-Fiser, Orzechowska, 2006; Gómez Lacabex, García Lecumberri, Cooke, 2009; Gómez Lacabex & García Lecumberri, 2010; Nowacka, 2011; Gutiérrez & Moroy, 2003; Porzuczek, 2010). Nonetheless, to the best of the author's knowledge, few studies have examined the question why adolescent learners' production ability has hardly exhibited marked progress in the productive performance unlike university students. The insufficient attainment in production could be due to the degree of difficulty according to the type of weak form vowel. After an investigation of their research on connected speech modifications in English, i.e. *linking*, *flapping*, *vowel reduction* and *consonant cluster simplification*, Anderson-Hsieh, Riney, and Koehler (1994) reported that 'while the HP group approximated the performance of the NS group in several categories, the IP group often lagged far behind' (p. 31), where HP and IP stand for high-proficiency and intermediate-proficiency respectively, and NS is an abbreviation of *native speaker*. Anderson-Hsieh et al. (1994) further argued:

> An analysis of the forms used by the HP and IP groups showed that both groups reduced their vowels mainly in the definite and indefinite articles. They rarely reduced vowels in words such as *you* or *to* or in unstressed syllables in words such as *request*. This failure to reduce vowels may arise at least in part from native language transfer, since Japanese vowels retain their pure quality and are never centralized as they are in English. (pp. 45-46)

Thus, the following research questions have been formulated:

(1) Do instructed learning and exposure to foreign language pronunciation under FFI contribute to the increase in durational differences between stressed and unstressed vowels?

(2) Can vowel qualities in unstressed syllables be reduced as a result of instructed learning and exposure to L2?

Form-Focused Instruction: EG vs CG

The treatment for both EG and CG has been previously reported in Abe (2015b), thus just a brief survey is provided below. This study was conducted during a regularly scheduled class taught by the author at a college located in northern Japan. The number of participants were 30 in the EG and 31 in the CG. The EG and the CG participated in a quasi-experiment, in which the classroom experiment was conducted over a period of three weeks and consisted of a pre-test, treatment sessions, and a post-test. The pre-test took place in week 1, prior to the perception and production treatment sessions, which consisted of four class hours in week 2, in both groups. Then, in week 3, the participants took the post-test.

The perception instruction for the EG followed both explicit and implicit FFI, encouraging learners to observe a certain target feature and discover the underlying rule on their own initiative. In the production sessions, the instruction of the EG shifted to implicit FFI, based on the premise that not only input but also output-promoting tasks play a critical role in L2 learning experiences. Corrective feedback (CF) and free production activities resulting in output of the target forms during such instruction can enable learners to modify their knowledge in meaningful communicative activities. In this way, it was assumed that phonetic negotiation of form (CF) would help participants to discover rules governing the use of weak forms or to gain declarative knowledge of weak forms more successfully than merely presenting the target forms even with an explicit explanation ,

For the CG, the perception sessions, like those for the EG, were devoted to explicitly presenting the target forms in context, as well as asking participants to identify the target forms in prepared dialogues, with the aim of helping them to comprehend the target weak forms. In doing so, the author played a crucial role in explicitly informing participants of the rules underlying the target prosodic features. This helped them gain declarative knowledge of weak forms by means of FonFs or a synthetic approach (Wilkins, 1976), in which sequenced and fragmented items are presented to learners in a stepwise manner. The lesson ended with a pair reading-aloud activity in which the participants were asked to pay particular attention to what they had learned in order to reflect it in their reading.

The production test consisted of recording of two subtests: reading a passage and a picture description task. The samples were digitally recorded and saved as an audio file on a PC computer at 22 kHz with 16-bit resolution using Olympus Sonority Plus for Editors, LS-11. A spectrographic analysis was undertaken by means of *Praat* (Boersma & Weenink, 2011).

Results and Discussion

This finding seems to correlate with the previous scholarship: unlike university students, adolescent learners might be able to perceive weak forms after instruction. Thus far, learners' production ability has hardly exhibited marked progress in the performance (Bogacka et al., 2006; Gómez Lacabex & García Lecumberri, 2010; Gutiérrez & Moroy, 2003). The findings of Anderson-Hsieh et al. (1994) and the result of production of this study might support the assumption that the pronunciation of weak forms in *to* [tə] is a demanding modification in L2 vowel reduction. Another challenging reduction for learners concerns the competence of the timing control of weak and full vowel contrast.

To examine this issue, an acoustic analysis of the weak and full vowels of a randomly selected 20 participants was conducted (n=10 from the EG and CG respectively), and participants' data were compared with that of the instructor, who is at approximately advanced level, at the post-test stage. According to Rojczyk and Porzuczek (2012), who extensively reviewed the past 50 years of L2 vowel reduction research, 'unstressed vowels were roughly half the duration of the stressed vowel…' (p. 210). As in the following Table, the duration of participants' EG and CG varied in the range of 70 ms and 250 ms for both weak and full (stressed) vowels, which did not indicate a marked difference between weak and full stressed vowels. In other words, while the instructor exhibited approximately half duration for the full vowel, for instance, 68 ms in weak forms and 135 ms in full vowels in Reading, and 30 ms in weak forms and 80 ms in full vowels in Dialogue, the participants in the EG and CG rarely demonstrated the weak and full vowel contrast in production either during the post-test, or the pre-test. However, the between-group comparisons for weak forms in the post-test, deploying a Mann-Whitney test, at least revealed a significant main effect of instruction with a large effect size at the level of $p<.049$, $r=.62$ in the Reading and $p<.03$, $r=.68$ in the Dialogue.

Table
Mean Duration of Weak Forms and Full Vowels of the EG and the CG

	PRE		POST	
	Weak	Full	Weak	Full
Reading EG	111	140	130	160
CG	130	160	171	180
Instructor			68	135
P	0.17	0.7	0.049	0.186
Dialogue EG	120	130	154	70
CG	130	120	250	110
Instructor			30	80
P	0.57	0.34	0.03	0.006

'The phenomenon of vowel reduction in unstressed syllables appears to be composed of both durational and qualitative factors that cooperate in signalling unstressed vowels.' (Rojczyk and Porzuczek, 2012: p. 210) Thus, the data gathered by the present study might suggest that the cognitive and linguistic competence of Japanese adolescent learners, whose English level is generally around CEFR A, might not be able to pronounce accurate weak forms from the developmental perspective; that is, it is not simply that they have had insufficient time and effort to practice the weak forms.

Meanwhile, despite the acknowledged benefits of FFI demonstrated by L2 research in the past decade, the second problem regarding the adequacy of FFI still remains. The cognitive and interactional model of L2 acquisition, upon which FFI is based, assumes that learners are willing to engage in communicative activities and that, in so doing, teachers encourage them to accelerate the acquisition process over a short-term period, which is not always the case. According to MacIntyre, Clement, Dorney, and Noels (1998), learners often risked losing communicative competence because of L2 anxiety or worry, for instance, by thinking '*I might lose face when I make a mistake in the class*', and thus barely moving beyond a rudimentary communication level. Baran-Lucarz (2014) reported that the higher the level of anxiety about L2 pronunciation, the less eager the learners are to engage in oral communication tasks in their foreign language classroom or outside of it. Thus, it seems pertinent to suggest that the attainment of L2 pronunciation in FFI might be affected by learner variables, with a range of cognitive, affective, and social factors, which have unfortunately been neglected in the mainstream FFI and L2 pronunciation research until now. This will help us develop pedagogical intervention for FFI, so that more learners could actively get involved in the output-promoting task and thus achieve higher attainment in foreign language pronunciation (Abe, forthcoming).

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LIVING PLACES AS LEARNING SPACES AND STUDENT OUTCOMES: THE TRANSNATIONAL STUDIES EXPERIENCE

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Abstract

Temasek Polytechnic's (TP) policy of developing its students' TransCultural Mindset is an integral component of its Desired Graduate Profile (DGP, 2014), aligned with a Global Citizen's DNA and Singapore's SkillsFuture initiative.

In response to this, TP's Centre for TransCultural Studies (CTS) developed a 45-hour Transnational Studies (TNS) module.

Given the potential of using living places as learning spaces in enhancing the TransCultural mindset of learners, TP introduced a 2-week residential stay as a mandatory out of classroom learning experience component of the TNS module.

The aim of this qualitative study was to generate theory regarding how students undergoing the TNS module 'dealt with' their 2-week mandatory residential learning space experience. Ball's (1994) policy trajectory model was selected to frame the broad parameters of the study. The central guiding question and a series of sub-guiding questions based on the principles of symbolic interactionism were used for gathering data.

Data was gathered from more than 700 students undergoing their residential learning space experience through semi-structured interviews and documents. Grounded Theory approaches were used in data analysis.

The substantive theory generated from the study was that the students, in 'dealing with' their residential learning space experience, went through three phases: culture shock phase; challenge and confront phase; and, change and transform phase. In the culture shock phase, students encountered various challenges living together with similar and 'other cultures'. In the challenge and confront phase students explored initiatives to 'deal with the challenges'. In the third change and transform phase, students realised their personal transformation resulting from the use of explored initiatives successfully. These three phases, while reported in the study as distinctively separate, were actually interrelated and not mutually exclusive of each other.

The study provides fresh insights into transforming living places as learning spaces that 'frame interactive behavior, and impact on social interactions critical to student engagement and learning' (Harrison and Dourish, 1996). It also provides insights into how 'the physical learning environment is an influential element in the complex and highly contextualised nature of learning, characterised by dynamics and interactions between the learner, teacher, content … (OECD, 2013).

Keywords: *Living places, learning spaces, residential stay, TransCultural mindset, Global Citizens.*

Introduction

Temasek Polytechnic's (TP) policy of developing its students' TransCultural Mindset is an integral component of its Desired Graduate Profile (DGP, 2014) aligned with a Global Citizen's DNA and Singapore's SkillsFuture initiative.

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Institutionally, TP's Desired Graduate Profile (DGP, 2014) spells out TransCultural Skills as a key exit outcome to be realised through two in-process outcomes: firstly, students should be able to firstly recognise and respect cultural diversity which includes national, ethnic, and workplace diversity; and secondly, demonstrate ability to interact and communicate appropriately in diverse cultural settings, whether in Singapore or abroad.

These outcomes align with one of the key qualities expected of a Global Citizen, who ‘respects and values diversity” (Oxfam, Canada). Hunter (2004) highlights that “having an open mind while actively seeking to understand cultural norms and expectations of others, plus leveraging this gained knowledge to interact, communicate and work effectively outside of one’s own environment” is essential to being and becoming a Global Citizen.

Nationally, in Singapore, there has been several initiatives both by government agencies, educational institutions as well as community–based agencies to foster the embracing of diversity, cross-cultural communication skills, and appreciation of other cultures with whom Singaporeans need to interact with socially and professionally given the cosmopolitan make-up of our population. SkillsFuture is a national movement to enable all Singaporeans to develop to their fullest potential throughout life. At a national level, SkillsFuture will play an important part in charting Singapore's next phase of development towards an advanced economy and inclusive society (http://www.skillsfuture.sg/).

Methodology

The OECD Centre for Educational Research and Innovation defines learning environments as “an organizational form that covers the particular learning arrangements for a group of learners in context over time, in which the learning taking place is an integral part” (OECD, 2013).

The learning environment of the students who are enrolled in this course comprise:

a) Physical learning spaces comprising lecture theatre and classrooms where they engage in formal learning via face to face lectures and tutorials;
b) cyber learning space where they engage in online self-assessment and learning;
c) out of classroom learning space - the residential living apartments where they engage in living with others as a social community with all its diversities and working on out of classroom activities e.g. international buffet preparation; group project work;

This study focuses on the students’ perspectives of how they ‘dealt with’ their experience living and learning in the residential learning space.

The key elements and the relationships which form the “pedagogical core” of this learning space, (OECD, 2013) are:

a) **the learners** - students living and learning with one another in their respective apartments during the scheduled 2-week mandatory residential stay as well as follow-up tutorial sessions.
b) **the content** – involves students applying what they have learnt in their Transnational Studies module lectures and tutorials, namely Trompenaars-Hampden Turner’s 7-Dimensions of Culture model living and working together in apartment project groups to complete the assigned project while in residence. The intention was to deepen student’s understanding of cross cultural differences needed to operate more effectively in multicultural contexts both personally and professionally.
c) **the educators** – tutors who facilitate face to face learning of content during lectures and tutorials
d) **the resources** – students’ transnational studies lecture and tutorial notes and activities, students and target country Intercultural Assessment Profiles (IAP), students’ research on target countries assigned for each project group, project briefs and intermittent consultations provided by teaching team and most importantly each project group’s residential space.

Current literature review available internationally focussing on connections between learning places in schools and student outcomes (Temple, 2007; Blackmore, et. al, 2010), reveal that most research on learning places focus on the design phase, rather than on the later phases or on the people that use the space – practitioners and learners. There also seems to be limited literature available on possible conceptual frameworks that could be effectively applied to understand the lived experiences from students’ perspectives on how they deal with their residential stay experience.

The study reported here therefore utilised Ball’s (1994) policy trajectory model. This model comprises the context of influence (where interest groups struggle over construction of policy discourses), the context of policy text production (where texts represent policy, although they may contain inconsistencies and contradictions), and the context of practice (where policy is subjected to interpretation and re-creation by key stakeholders).

The study focused in particular on the third context within the policy trajectory model, namely, the context of practice to generate theory regarding how TP students undergoing the TNS module ‘dealt with’ their 2-week mandatory residential learning place experience.

The particular notion of ‘context’, which is a key feature in qualitative research resulted in the study being situated within the natural learning environments (O'Donoghue, 2007).

The non-linear nature of Ball's comprehensive policy model calls for a qualitative approach to research and tends towards the descriptive rather than the numerical.

The particular qualitative approach deemed appropriate for the study reported here is that based on interpretivism. Proponents of the interpretivist viewpoint share the goal of understanding the complex world of lived experience from the point of view of those who live it (Schwandt, 1994, pp. 118-37).

The symbolic interactionist perspective within the interpretivist paradigm chosen to underpin this research enabled me to capture the students' perspectives regarding their lived experiences in the residential space and the learning that came out of it.

Empirical data was gathered from more than 700 students involved in 'dealing with' their 2-week residential learning space experience through their reflection-in-residence posters which had prompt questions to be completed throughout the duration of their two-week stay, and reflection documents used for their debrief sessions which had prompt questions at the end of the course. Grounded Theory approaches were used in data analysis.

Results and Discussion

The central theory generated in this study is that in 'dealing with' their residential learning space experience, students went through three phases: culture shock phase; challenge and confront phase; and, change and transform phase.

In the first culture shock phase, students reported experiencing culture shock due to two key challenges: firstly, challenges arising from differences in value orientations despite being of the same ethnic group, and secondly, challenges arising from differences living together with 'other cultures'. We define culture shock in this context as the feeling of disorientation experienced by someone when they are suddenly subjected to an unfamiliar culture, way of life, or set of attitudes causing them confusion, anxiety, and disenchantment especially without adequate preparation.

The first challenge that gave rise to 'culture shock' as articulated by students was that of recognizing that despite their largely ethnic similarity they had completely different value orientations. Students explained this by using The Seven Dimensions of Culture Model – one of the most recognized cultural theory model co-created by Trompenaars and Hampden-Turner (1997) which they had been taught during their course of study in this module.

Regarding culture shock arising from differences in value orientations, students attributed the greatest culture shock to differences they experienced in the following 5 dimensions: Individualism-Communitarianism orientation (preference of cultures to work individually or in groups); Time especially sequential-synchronic orientation (preferences in how cultures organize time); specific–diffuse orientation (preferences of how cultures prefer to communicate); neutral–affective orientation (preferences as to how cultures prefer to manage their emotions) and finally universalism-particularism oriented (preferences of cultures regarding how they value rules vis-à-vis relationships).

Regarding culture shock caused by Individualism-Communitarianism, communitarianism oriented participants who had experienced the benefits of working in teams commented that 'it was unbelievable that many of our room-mates just did not want to work in teams especially when it came to our project work' (22). On the other hand, individualism oriented students responded that 'it is more unproductive to work in groups when I could do my part quickly' (35); 'I do not see how working in groups will work because at the end of the day, after all the discussion, I still have to do my part!'(76).

Regarding culture shock caused by Time dimension, the sequentially oriented students responded that 'there was just too much to be completed within such a short span of time – sometimes I just had no time to sleep by the time I completed each of the tasks set' (83); some students also articulated that 'the key challenge was that our group did not keep to their word of doing their project at the allocated time' (64). On the other hand those who were synchronically oriented tried to juggle the many tasks but realized that as one students expressed 'although I am a multi-tasker, I realized that I still needed to prioritise and stay focused and not get distracted by the freedom I experienced living in the apartments.'(117); while another student commented that 'time has always been a factor that caused me to miss out on the fun that was happening in the apartments' (275).

Regarding the culture shock caused by Specific-Diffuse orientation, students attributed it mainly to the way they communicated with one another. The specific oriented students often mentioned that they 'spoke their mind about what they felt about issues when they had a conflict' (549); however, several students also reported that they were seen to be 'insensitive' (622); 'blunt' (107); and at times perceived to be even 'rude' (276) and 'uncooperative' (413). The diffuse oriented participants on the other hand expressed their difficulty in 'saying what they had in their mind without hurting the others apartment mates'(633); or 'keeping silent'(715) till it came to a point where they 'could not tolerate the matter' (516).

Regarding the culture shock caused by neutral – affective orientation, the neutral oriented students attributed the challenge to their inability to express their feelings of 'anger' (28) 'frustration' (57) and 'disappointment' (76) with their apartment mates regarding their 'non-sharing of household chores' (90) and 'not delivering work on time' (32); 'not following duty roster schedules' (85). Further one student articulated that 'I am not very expressive when it comes to emotions. I also take time to get comfortable and only when I get comfortable and trust them do I really share my feelings and thoughts' (94). They were also shocked by their affective room-mates 'openly laughing, shouting, screaming' (623) when they were happy/unhappy with any matter. One student commented that 'one of my apartment mates was very affective. So we would have a lot of weird moments during our stay as she was very expressive and we did not know how to react or respond to her' (292). The affective oriented students on the other hand, expressed that 'I wished that my room-mates would be more open with their feelings' (54) and 'show us how exactly they feel' (89) about certain apartment matters. They also felt that 'we had to often guess what they were thinking' (76) or 'what is going on in my apartment mates' mind'(16). Many found it a 'struggle to break the ice' (32) or even 'socialize and live with people who are not affective like me' (70).

Regarding the culture shock caused by the universalism–particularism orientation, the universalism oriented students felt that 'it was unfair that because of some of their apartment mates who disregarded the apartment stay rules, the whole apartment had to be bear the burden of the punishment' (58). The particularism oriented students on the other hand articulated as one participant indicated 'I am not used to such curfew or rules at home. My parents never question me or punish me when I am home late; so it was very challenging for me to follow the rules'(47); another indicated that 'coming home by 10.30 curfew was tough as I usually come home very late'(472). Others reported that ' …had lots of conflicts and disagreement when setting up and following the rules'(547). 'The universalists amongst us forced us and stressed us to do work and finish it according to the agreed time. We ended up doing more work and less play' (486). Another articulated that 'the universalists always stick to the deadlines for project – they are very inflexible' (622).

Regarding culture shock arising from differences living together with 'other cultures', students attributed these to three factors: firstly differences in cultural practices; differences in dietary preferences; and lack of confidence interacting with other cultures.

Regarding culture shock arising from different cultural practices, students reported that they were shocked to see some of their 'Christian friends spending time reading the Bible' (39; 76) and 'praying for things to be better' (96); others reported that they were shocked that 'one of our roommates who was a Muslim, often would get up and go to pray despite being in a conversation with the rest of the roommates' (119); 'in fact I was shocked and surprised that there were strict rules to how he should pray and pray five times a day…I was not used to this at all and it came as a shock to me.' (202). Further, one student also commented that 'one of my apartment mates dresses in her 'tudung' (head dress) throughout the day but when at night we were all together, she does not use it. It was indeed a shock to me and my other apartment mates when we first saw her without her 'head cover' – like she was a totally different person (187). Yet another apartment mate commented that 'Although she explained to us that she has to follow the strict dress code due to her religion, I am still trying to understand her culture and her cultural attire' (267).

Regarding culture shock arising from cultural dietary preference and practices, participants reported experiencing shock due to the realization that 'that my Muslim room-mate cannot eat non-halal food' (517); while another student commented that 'I did not realize that my Buddhist and Indian apartment mates that I was living with could not eat meat and beef respectively (682); it was a real shock to me that they were so strict with their diet' (673). Yet another of our roommates was 'vegetarian' although she was Chinese but she was not a Buddhist; while another roommate was 'Hindu and not vegetarian' (538). Yet another commented that 'I thought only all Indians were vegetarians – so this came as a real shock to me as we had to be very careful what we cook now' (538; 540).

Regarding culture shock arising from their lack of confidence levels interacting with other cultures, students reported that they 'really did not know how to interact with another culture as I never had any friends from another culture' (74); 'I was afraid to offend them so kept conversations to a minimum and kept to only small talk' (97). Equally students of e.g. the Malay culture who were in residential stay during their fasting month reported that one of the challenge they faced was 'waking up at 6.30 am for morning prayers to break fast while my room-mates were still sleeping. I felt as if I was disturbing them' (436).

The above responses from students clearly indicate that much of the culture shock arises out of they coming into contact with people who are different for the first time especially in close living quarters, their limited interaction with other cultures and their reliance on their own cultural lens to make assumptions about others different from them. When they came across behaviours and attitudes that are different from theirs, it disorientated them, leading to culture shock. It also resulted in students going through feelings of anxiety, disenchantment and frustration in this stage.

In the second challenge and confront phase students seemed to have gone through a process of responding to the challenges through questioning of their own and other's values as well as taking steps to confront the challenges by exploring initiatives to ‘deal with the challenges’. Two key themes emerged from the findings in this phase: firstly the use of a range of life skills and secondly the use of initiatives to develop their cultural awareness to make things work in their respective apartments.

Regarding the use of a range of life skills, students articulated that after about three to four days they began ‘to realise and recognise that the differences are here to stay’ and that ‘it is something we need to do something about especially if we are going to stay two weeks’ (50). Students also reported that ‘not doing anything was not going to help as we had to work together to do the international buffet, group project and worse still peer assessment’ (259). One student commented that the ‘stalemate situation was not getting us anywhere; we were also losing time to complete our projects’ (373); while another mentioned that ‘we just could not continue the way we are – if we do, in the end all our grades will be affected’ (422). Yet others commented that ‘it was really no fun being in the apartment when we just did not want to do anything with one another because of our differences. Holding on staunchly to our own preferences was not getting us anywhere. So I decided that we need to break this ice’ (93).

Hence their questioning of the ‘stalemate’ situation, presence of strong motivational factors such as assessment, personal discomfort, and/or personal motivations to make things work for the better, encouraged students to begin to confront the challenges they were facing and explore ways to ‘deal with the situation’ (56).

Amongst the range of life skills used by students, several reported that they resorted to ‘confront the situation’ (24) through having ‘an open dialogue with our apartment mates (44). One student reported that their group ‘decided to have dinner together and have an informal discussion on our state of affairs in the apartment and explore how to make things better’ (88). Others reported ‘having regular chit chat sessions to find out more about each others’ preferences (258); yet others ‘decided to work as a team’ (437); ‘adapting to each others’ needs (567); ‘taking greater responsibility for myself as well as my apartment mates’(636); ‘communicate more clearly with each other, especially with my diffuse apartment mates’ (72); and ‘ respect the rules of the residential stay’ for the benefit of my whole group’(498).

Several students reported that they decided ‘drawing up a duty roster’(39); ‘help out each other to do housework’ (172) and ‘learn from one another how to cook different meals’ (42); ‘keep my belongings in the room in order and not be so messy as I always am so that I don’t cause my roommate any headache’ (93). Others indicated that they decided to ‘organise and share project tasks’ (269) and ‘plan as a team to complete tasks when pressed for time’ (71).

Yet others reported that they decided to ‘adapt’ and/or ‘compromise’ to ‘solve the common problems faced on a day to day basis’ (86); ‘give and take a little here and there’(478). As one student put it ‘it does pay to be a little flexible for everyone’s happiness’ (496).

Others reported that they ‘learnt to be independent’ and ‘began to take care of myself, my belongings’(596) and ‘to look out for our roommates especially when they needed help, especially if they were ill’ (140). ‘Sometimes when I am back late, I buy back food for my roommates for the night as we always get hungry’ (67).

Students also articulated ‘they learnt how to communicate with one another, to prevent misunderstandings’ (61) as it ‘really helped to discuss with my apartment mates’ (275).

Others commented that they ‘actually began to sweep the floor (22); wash the toilet which I have never done in my life as my mum was always there to do all this for me’ (329). It is this process many ‘began to appreciate my parents and helper who mainly did all the household chores’ (60). Students also reported experiencing ‘budgeting and shopping for basic necessities’ (41) and in the process managing their limited finances for the two weeks stay. Some students reported that ‘planning and buying things for the international buffet given the shoestring budget really forced us to learn about budgeting to run our house’ (104; 716;62;47).

Regarding initiatives to develop their cultural awareness, students reported that they explored ‘adapting to the needs of the different cultures they had to live with (37); living with each other respectfully by embracing differences for example respecting my apartment mate’s need to eat only halal food’ (59); coming to terms with the fact that not everyone is like me especially if they are of a different culture, race or religion’ (296). Students also reported that they ‘realised the importance of keeping an open mind’ and ‘not to assume or not to form my own opinions without understanding’ (333) to deal with the cultural challenges they faced.

Several students also reported on the increased levels of confidence in interacting with different cultures, races, and students with different religious affiliations after adopting an ‘open-mind’ (59) and ‘take an interest in getting to know their apartment mates who are Malays and Indians better’(433). One student reported that the more she learnt about different cultures, the more she realised ‘how ignorant I was’ (723) but when ‘I actually got to know them, I realised that we are similar in so many ways, despite differences in our race and religions’ (678).

From the above responses, we can see the development of a range of life skills as well as the development of initiatives that enhanced students’ cultural awareness. These arose as students challenged their standpoints and took initiatives to confront their challenges living in close proximity in the apartments, to work together socially and professionally.

In the third change and transform phase students realised their personal transformation resulting from their use of explored initiatives successfully. Two themes emerged from the findings: firstly, realisation of personal transformations relating to their life skills and secondly, realisations of personal transformations relating to their cultural awareness.

Regarding realisation of personal transformations relating to their life skills, students articulated that ‘through this residential stay, I have learnt to be more independent’ (79). ‘I used to get very upset at home when things don’t go my way; this residential stay has made me realise the importance of considering and caring for others; and not to withdraw or fight to get my way but to solve problems with resilience’ (683). Others reported that it pays to be ‘adaptable to others needs – there is never only one way to do things or solve problems which I had always believed in’ (59); another indicated ‘My mom always scolded me for being so irresponsible – but this residential stay has really taught me the meaning of taking responsibility for myself’ (681).

Regarding realisation of personal transformations relating to their cultural awareness skills, students reported the following: appreciation of cultural diversity (45), importance of cross-cultural friendship building (90), greater awareness of other cultures (38); interest in learning about other cultures (164); living in harmony (80); resilience in coming to terms with culture shock (70); applying their learning of the 7-D framework to understand other cultures better (529), and the ‘mindset that every culture is different’(716).

It is clear from the students’ responses that ‘the physical learning environment is an influential element in the complex and highly contextualised nature of learning, characterised by dynamics and interactions between the learner, teacher, content, …’ (OECD, 2013). It facilitated students’ coming face to face with diversity, motivating them to challenge and confront their culture shock which in turn set in motion a process of personal transformations in the students’ mindsets.

Conclusions

The study reported here provides fresh insights into transforming living places as learning places that ‘frame interactive behavior, and impact on social interactions critical to student engagement and learning’ (Harrison and Dourish, 1996). It is clear that purposeful use of living places as learning spaces with clearly articulated curriculum, student roles, structured to maximise social and professional engagement opportunities via suitable projects for students do lead to desirable student learning outcomes.

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USING *ONDOKU-DOJYO* TRAINING SUPPORT TO PROMOTE ENGLISH LANGUAGE SELF-MONITORING

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Abstract

This study investigates whether English Language pronunciation training support improved novice Japanese English as second language students' self-monitoring skills to learn English self-monitoring skills and learning aptitude. Reading English aloud from GlobalVoiceCall2 (GVC2), a pronunciation training software developed by HOYA, this four-year research project examines the changes in each participant's self-monitoring awareness of their oral reading. This study aims to establish a training system that promotes proactive after-school self-learning.

Keywords: *language support, English, oral reading, self-monitoring, autonomy*

Introduction

In the first year of this research, the first term was used to develop a new English language training after school support called Ondoku-Dojyo. Thereafter, participants were recruited, and the software was loaded onto the nominated school's computer system. Ten second-year students lagging behind in terms of their English grades were selected for the research and were trained in Ondoku-Dojyo. The training was held 24 times from Monday to Friday after school for 45 minutes, October to November 2105, just prior to the school year's third examination week.

It was expected that the training would improve participants' grade on the English test in the third examination period. However, the results revealed that the training did not have a strong positive effect on the grade. An aptitude test conducted in November 2015 indicated that their learning attitude compared with the results from the same aptitude test in June 2015.

This study analyses why the learning support at the first Ondoku-Dojyo had no or little effect and elucidates those aspects of Ondoku-Dojyo that may have caused the disappointing results. These findings summarize the first-year's Ondoku-Dojyo training and propose the developments needed for the next training period.

Ondoku-Dojyo

Ondoku-Dojyo is an after-school training system that develops English language oral reading skills using GVC2, a pronunciation training software developed by HOYA. The first *Ondoku-Dojyo* was held in 2015 was held at the first language laboratory of the National Institute of Technology (Figure 1), Hakodate College from 16:30 to 17:15, Monday to Friday, over 24 sessions from October 1 to November 20 2015. Participants were recruited from students identified as having difficulty in a Communication English Ⅱ, class taught by the first author. Ten students voluntarily participated in *Ondoku-Dojyo* after school as preparation for the third examination, at which they practiced reading an English textbook out loud using GVC2. All participants gave permission for their personal data to be used in this study.

Figure1 First language laboratory entrance with the sign for *Ondoku-Dojyo*

Figure 2 A student's training using *GVC2*

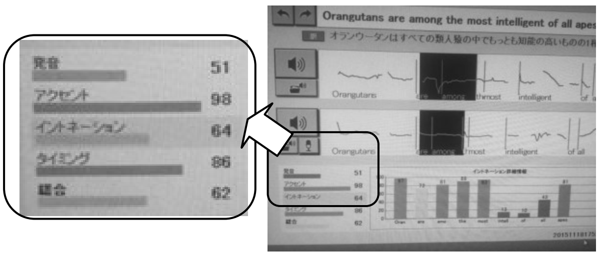
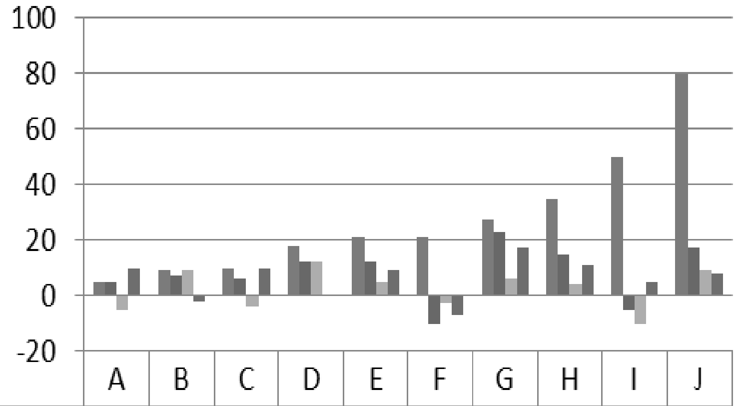


Figure 3 The GVC2 indicator and the numerical evaluations

The learning objective of the *Ondoku-Dojyo* program was to gain the skills necessary to be able to correctly and fluently read out loud eight pages of an English textbook, which covered material for the third examination. It was explained to the participants that correct and fluent oral reading would promote their comprehension skills which would assist them in gaining a better grade in the third examination. Participants sat at individual desks, and after listening to



	A	B	C	D	E	F	G	H	I	J
participating rate(%)	5	9	10	18	21	21	27	35	50	80
grade difference between the second and the third examination (0-100)	5	7	6	12	12	-10	23	15	-5	17
paper test difference(0-60)	-5	9	-4	12	5	-3	6	4	-10	9
practical exam difference(0-40)	10	-2	10	0	9	-7	17	11	5	8

Figure 5 Participation rate of 10 participants and the English grade differences between the second and third examinations

the model English, they recorded their oral reading in chunks on a computer (Figure 2). The recording was numerically evaluated immediately after the recording: if participants received a total score higher than 50 (Figure 3), they moved on to the next chunk. Ondoku-Dojyo was explained to all ten participants and eight voluntarily participated in Ondoku-Dojyo on the fifth day. The participants appeared to enjoy reading orally using the GVC2 with all giving positive feedback on the GVC2 and the Ondoku-Dojyo support system at the completion of the training. However, over the 24 sessions, the participation rate gradually decreased from the fifth day. Figure 5 illustrates the participation rate of the 10 participants and their English test grade differences between the second and the third examination. Over the four week Ondoku-Dojyo training period, one participant came to the after school training only once (Figure.5 Participant A) and two participants (Figure. 5 Participant I and Participant J) participated in 50 % of the classes. None of the participants completed the eight English text pages over the training period. Participant H completed four pages, and the other nine students did not get beyond three pages. Although Participant I, with 50 % participation rate, had a lower grade in the examination, Participants D, E, G, and H who all had lower participation rates, all improved grades. Therefore, as the effect of the Ondoku-Dojyo intervention was not apparent, the first experiment was deemed a failure

Analysis of the Failure of the first *Ondoku-Dojyo*

(1) Learning Aptitude of the Ten Participants

The learning aptitudes of the Ten *Ondoku-Dojyo* participants' were examined twice using the Academic Adjustment Inventory (AAI), first in June (after the first examination) and then in November 2015 (before the third examination) with other classmates. None of the 10 participants showed any improvement in learning motivation between the first and second AAI (Figure 6).

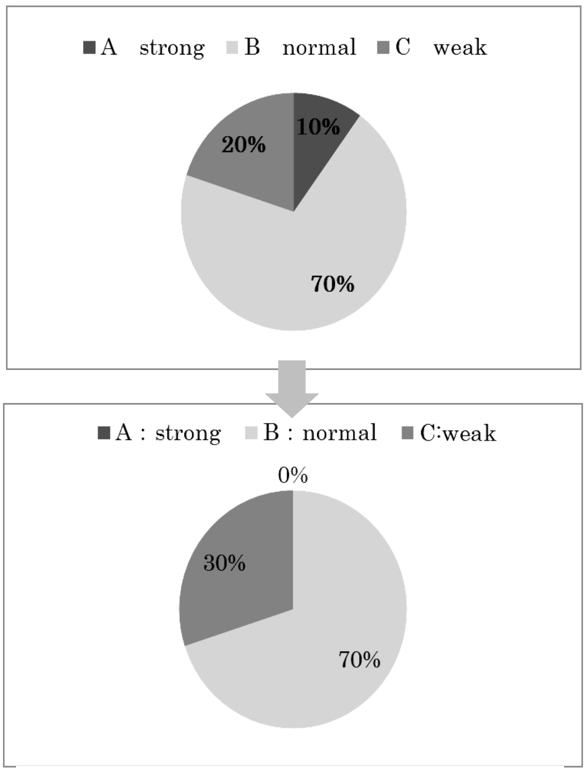


Figure 6 Changes in *Ondoku-Dojyo* participants' learning motivation between June and November 2015

However, 10 students of the 200 second-year students, ranked in the top 5% for English including the *Ondoku-Dojyo* participants, had normal or strong learning motivation in June, which had strengthened by November (Figure 7).

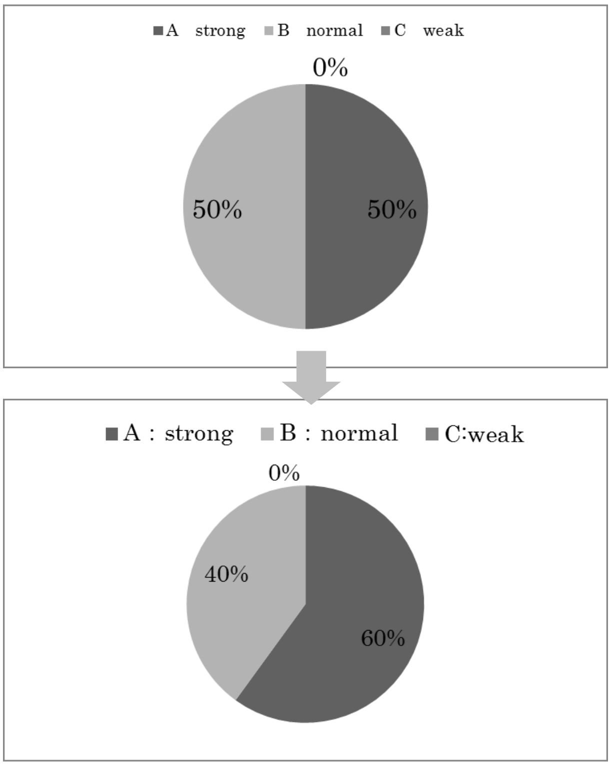


Figure 7 Changes in learning motivation for the10 top 5% students between June and November 2015

In the AAI conducted in November, the 11 factors that contributed to learning were evaluated on scale from one to five: ① learning motivation, ② time management, ③ class participation, ④ note taking/textbook comprehension, ⑤ memorization skills, ⑥examination taking skills, ⑦learning environment at school, ⑧learning environment at home, ⑨persistent application, ⑩self-control, ⑪meta-cognition. Table 1 indicates the comparison between the average scores for the two groups: the 10 *Ondoku-Dojyo* participants and the 10 top 5% English students. Comparatively, the 10 *Ondoku-Dojyo* participants were weak in ⑨ persistent application (2.9), ④ note taking and reading comprehension (2.8), ⑧ learning environment at home (2.7) and ⑩ self-control (2.7) because the scores were less than 3 in the 1 to 5 range. Further, compared with the top achievers, the average for the *Ondoku-Dojyo* participants was lower than 1.0 for the five factors: ① learning motivation, ④ note taking and reading comprehension, ⑥ examination taking skills, ⑦ learning environment at school, and ⑧ learning environment at home. Therefore, the *Ondoku-Dojyo* participants did not have a good learning environment at school or at home, low persistent application, were not good at taking notes or reading, had a low learning motivation, and were unable to manage examinations.

(2) Set-Up for *Ondoku-Dojyo*

In 2015, *Ondoku-Dojyo* was held at the first language laboratory on the third floor. The location was near the students' classroom and the experimental laboratories. The session times were from 16:30 to 17:15 after school, which often overlapped with students' experimental activities and make-up examinations for other classes. This lower accessibility may be one cause for the poor participation rates.

Table1 Comparison between the average scores for the two groups for the learning factors (1—5) contributing to the learning examined in the AAI

Groups of 10 / Learning Factors	(1)Average of top5% achievers	(2)Average of *Ondoku-Dojyo* participants	Difference (1)−(2)
① learning motivation	4.5	3.3	$\boxed{1.2}$
② time management	4.1	3.3	0.8
③ class participation	4.4	3.4	1.0
④ note taking /reading comprehension	4.1	$\boxed{2.8}$	$\boxed{1.3}$
⑤ memorization skills	4.1	3.1	1.0
⑥ examination taking skills	4.6	3.3	$\boxed{1.3}$
⑦ learning environment at school	4.2	3.1	$\boxed{1.1}$
⑧ learning environment at home	3.8	$\boxed{2.7}$	$\boxed{1.1}$
⑨ persistent application	3.8	$\boxed{2.9}$	0.9
⑩ self-control	3.7	$\boxed{2.7}$	1.0
⑪ meta-cognition	4.5	3.7	0.8

(3) Relevance of the *Ondoku-Dojyo* Learning Process

The learning objective of *Ondoku-Dojyo* was to develop the ability to correctly and fluently read eight pages of the English language textbook that covered the materials tested in the third examination. The first author explained to the participants that correct and fluent oral reading would develop English language comprehension skills, which would assist them gain better grades in the third examination. Basically, *Ondoku-Dojyo* was a self-learning process in which participants were required to 1) monitor the model, 2) record their attempt, 3) analyzed the GVC2 evaluation, 4) reflect on the differences between the model and the self-recording, and repeat 1) to 4) until a total score of 50 or more was achieved. Taking the advice of the GVC2 developers, in early days of the program, the total score was set as 60. However, the *Ondoku-Dojyo* participants were unable to achieve a score of 50 even after 100 attempts. Therefore, the desired score was lowered from 60 to 55 and then to 50 within the first three days. The lowered total score made the participants feel that their progress was poor, making them lose their initial motivation.

Observation of the participants revealed that they often started recording without fully listening to the model. After struggling with the GVC2 about 10 times, they began to compare their English with the model by analyzing the diagrams on the monitor or monitoring the sounds. Therefore, they did not follow the expected learning process, as they spent little time monitoring the model English or their own oral performances. Through the observation, it became apparent that *Ondoku-Dojyo* held in 2015 did not give sufficiently detailed directions to allow the participants to fully understand the importance of monitoring skills for better oral reading. Furthermore, it did not provide a step-by-step learning process that led to the acquisition of better monitoring skills.

Participant J, who had the highest participation rate at 80%, did 100s of oral readings from the English textbook during *Ondoku-Dojyo.* However, his low test scores indicated that he conducted *kara-yomi, or* reading aloud without comprehension. Participant J's low examination results suggested that *Ondoku-Dojyo* should have instructions to eliminate *kara-yomi* by prompting them to make conscious efforts to better comprehend the material and expand their vocabulary.

(4) *Ondoku-Dojyo* Learning Style

The first language laboratory is a specific classroom for English language learning in which each student uses the computer at a fixed seat. For convenience, participants were required to use the same seat in *Ondoku-Dojyo* as in their regular English classes. Therefore, participants were scattered throughout the room, isolating them from others, and reducing the collaborative learning atmosphere. The first author circulated in the room, observed the participants, gave advice and encouraged the English performances by analyzing the figures on the screen. At the end of each *Ondoku-Dojyo* session, each participant was required to show their day's results. If there were several participants, they formed pairs and monitored each other's oral reading or tried to guess the total GVC2 scores. However, the 10 participants became from four different classes, so they did not know each other. Therefore, when participants were required to peer evaluate, they lacked confidence. After four weeks, there were only one or two regular *Ondoku-Dojyo* participants. From this analysis, it was speculated that participants were uncomfortable with the learning style of *Ondoku-Dojyo.*

(5) *Ondoku-Dojyo* Surveys

At the end of 2015, 18 students, including the 10 participants from *Ondoku-Dojyo* who failed in the final English examination, were given survey conducted by the second author on the learning support provided by NIT, Hakodate College (Table 2). From the answers to Items 3 and 4, it can be seen that four participants considered *Ondoku-Dojyo* to be helpful and six thought that it was not helpful in preparing them for the English language examinations. Participant J commented, "Although I did hundreds of recordings, I could not remember the English from the textbook well. I should have written the English by hand many times for memorization." Reflecting on this comment, it could be surmised that while *Ondoku-Dojyo* gave practice in reading English aloud, it did not encourage content retention. At this point, we realized that *Ondoku-Dojyo* lacked a reflection phase that would allow the participants and instructor to discuss what had been learned and what had or had not been achieved.

Results and Discussions

For *Ondoku-Dojyo* to be an effective after-school learning support, several factors needed to be included to facilitate active student participation. According to Sato (2014)[3], oral reading can be effective in increasing the English competence of lower-ranked students. However, Shoto (2015)[6] indicated that the value of oral reading in a teacher's mind is often different from that of the student'. Therefore, as Ishihara(2002) [1] established, teachers should demonstrate the effectiveness of English oral reading for memorization.

Table 2 Survey on NIT Hakodate Learning Support and *Ondoku-Dojyo*

<table>
<tr><td colspan="6">☆Choose the best answer to describe your condition or impression</td></tr>
<tr><td>1. What do you think of the final examination? (18 respondents)</td><td>① No good (9)</td><td>② Not so good (3)</td><td>③nothing to think of(5)</td><td>④Good (1)</td><td>⑤Very good (0)</td></tr>
<tr><td>2. Describe your efforts on the final exam. (18 respondents)</td><td>① No study (2)</td><td>②Not study enough (6)</td><td>③ Studied some (6)</td><td>④ Studied hard (3)</td><td>⑤ Studied very hard (1)</td></tr>
<tr><td>3. Did Ondoku-Dojyo help your learning? (10 respondents)</td><td>①No help (0)</td><td>② Not so helpful (2)</td><td>③So so (4)</td><td>④ helpful (4)</td><td>⑤ Very helpful (0)</td></tr>
<tr><td colspan="6">4. Describe the reasons for the above in your words(10 respondents)
<u>①-②</u>: "English was not flashbacked in the test. Hand writing would be more helpful for memorization."
<u>④-⑤</u>: "I feel my English pronunciation has improved very much." "GVC" enhanced my English skills." "I was able to remember English sentences within a short time." "I was able to distinguish native English and Japanese English." "Through many trials to reach the target score, I was able to memorize the word order and spelling of an English sentence." "I answered test questions with what I learned through GVC2."</td></tr>
</table>

5. How was your feeling after the final exam? (18 respondents)	① very bad (0)	②bad (2)	③stable (9)	④good (7)	⑤very good (0)
6. After the final exam, did you change your learning attitude (18 respondents)	① not at all (0)	② not so much (4)	③same as before (8)	④changed some (6)	⑤changed a lot (0)
7. Free comments on *Ondoku-Dojyo* and NIT Hakodate learning supports after class. "I prefer memorizing by writing rather than by *Ondoku-Dojyo.*" "I need handouts for the makeup tests." "I prefer studying in a compartment rather than in a large classroom." "I want to learn within a small group." "I like *Ondoku-Dojyo* as it is new." " I don't remember new words easily." "At *Ondoku-Dojyo,* I noticed weak points in my English pronunciation and was able to brush up my English pronunciation skills with the training." "I can't get motivated to study at home after school, so it is good for me to be forced to study after class at school."					

Table 3 Ishihara's (2002) survey to educate students (first author's translation)

	When reading English aloud, you are	always conscious of	sometimes conscious of	little conscious of	never conscious of
①	reading each word naturally and correctly	1	2	3	4
	reading with natural intonation	1	2	3	4
②	reading carefully by meaningful chunk	1	2	3	4
	reading while comprehending meaning	1	2	3	4
③	reading by recognizing grammar	1	2	3	4
	reading to memorize English	1	2	3	4
	reading as fast as possible	1	2	3	4
④	reading not by distinguishing each word but by keeping English prosody in sentence	1	2	3	4

＊(①)-(④)were added by the first author

This is because students do not actively read aloud even though they know it may be useful for their English language learning. Ishihara (2002) noted that positive activities were needed to make students aware of the effectiveness and the meaningfulness of oral reading in improving English competence. Table 3 is an English translation by the first author of the survey used by Ishihara(2002) to educate students on effective oral reading. Kadota (2012)[2] categorized oral reading functions into four steps: ① oral reading to associate sounds with letters, ② oral reading for comprehension, ③ oral reading to internalize vocabulary and grammar, and ④ oral reading to make others comprehend the meaning. Categorizing the eight items in Table 3 (Additional numbering of ①—④by the first author), Ishihara's(2002) items cover all four functions and is well-designed as an oral reading learning procedure.

The next *Ondoku-Dojyo* plans to introduce Ishihara's(2002) educational oral reading concept by combining Kadota's (2012) four functions for oral reading with a rubric evaluation (Stevens and Levi, 2013)[4], which should promote student' autonomy toward oral reading and self-and peer monitoring skills to improve their learning skills (Table 4).

Sugie (2011)[5] suggested organizing problem-solving-oriented groups to promote autonomous study by activating group dynamics. In the next *Ondoku-Dojyo,* the learning support needs to ensure that the time and location are suitable and that participants develop a

Table 4 *Ondoku-Dojyo* rubric evaluation plan

Learning Goal	Excellent	Good	Not required
Student records English by chunks on GVC2	50 or more on pronunci-ation	40 to 49 on pronunci-ation	less than 40 on pronunci-ation
Student reads aloud by chunk to Ss or T and translates into Japanese	Translate 80% or more into correct Japanese	Translate 60 to 70% into correct Japanese	Translate no more than 60% into Japanese
Student writes down English after moni-toring.	Recite English correctly 80% or more.	Recite English correctly between 60 to 70 %.	Recite English no more than 60%.
Student recites sentence by maintain-ing English prosody.	To recite 80% or more of the total prosody.	To recite 60 to 70 % of the total	To recite no more than 60% of the total.

collaborative learning community.

Conclusion

This study analyzed why the learning support in the first *Ondoku-Dojyo* was unsuccessful. Furthermore, it discussed the findings with the aim of improving the following year's *Ondoku-Dojyo.*

Acknowledgements
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Additional Statement
This research was approved as making adequate provisions for the safety and privacy of participants by the Life Ethics Committee of NIT, Hakodate Collage.

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1402

ENGLISH AWARENESS IMPROVEMENT BY A VISIT TO SINGAPORE INCLUDING THE EXCHANGE OF THE SP STUDENTS

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Abstract

Recently, the ability for English conversation for engineer is increasingly required by globalization. After all the best method to improve ability for English conversation is really to practice more conversation with the foreigner speaking English. For five years from 2011, our students of the department of mechanical engineering in Sasebo College have been visiting Singapore for school trip. 40 fourth year students had good opportunity to have the interchange with the student of Singapore Polytechnic(SP) and visit the Japanese companies in Singapore. In addition, from 2015, approximately 10 SP students have been visiting our college. Then, our students had more good opportunity and their awareness for English is increasing more. In particular, the exchange program with SP is effective. When our students visit SP, SP is preparing the manufacturing competition with our students. Our students experience technical English conversation with SP students from the program. When SP students visit our college, our students make the posters such as introductions of school or Sasebo city or Japan, and explain it in English. Furthermore, some of our students try to explain their research too. Therefore, this program is the good opportunity to practice English. After students participated in this program, their feeling of resistance to English decreased and their awareness for English increased. As a result, four students did one year study abroad for English. After studying abroad, they give a briefing session to the lower-grade students of our department. Then the lower-grade students increased their interest of abroad more and some students want to go abroad. It follows that awareness improvement for English of the student increases by providing opportunities to interact with a foreigner as in this program to enable an engineer to work abroad in future.

Keywords: *English Awareness, Visiting Singapore, Exchange Program with Singapore Polytechnic, Studying Abroad*

Introduction

The fourth year students of our department have participated in a school trip for one week. We had gone to Nagoya or Tokyo in Japan before, but we changed to a foreign country from 2008 and went to China first. The visit to China was the good experience in knowing the foreign countries. However, there were problems in China such as an earthquake or the disease occurred, and as for the most important problem, the language is not English. Therefore we changed the visit from China to Singapore from 2011. Table 1 shows the destination for our school trips. During the visit to Singapore, our students participated in the interchange with Singapore Polytechnics(SP) students, visiting companies or shopping. The next step is SP students are visiting our college from 2015, and interchange with many of our students. This program is the good opportunity to practice English for our students. After students participated in this program, their feeling of resistance to English decreased and their awareness for English increased. As a result, four students did one year study abroad for English recently.

Table 1 Destination for school trip

Year	Country
～2007	Japan
2008～2010	China
2011～	Singapore

1. Visiting Singapore

The fourth year students of our department have visited Singapore from 2011 for a school trip. Table 2 shows a schedule of the trip. First day, our students visit Singapore Polytechnics. Singapore Polytechnics provide lab facilities & campus tour, and is preparing the manufacturing competition with our students. Our students experience technical English conversation with SP students from the program(1). Figure 1 shows the appearances of visiting Singapore Polytechnics. Our students have many chances to communicate with Singapore Polytechnics students.

Second day, our students visit two factories which are Japanese companies. Figure 2 shows the appearances of the factories. Some Japanese engineers who graduated from National Institute of Technology like our students are working in both companies. They show their activity to our students. Since they graduated from National Institute of Technology, our students understand that

Table 2 Schedule of Singapore trip

day	Contents
1st	Visiting Singapore Polytechnichs ・Lab facilites & campus tour ・Engineering activities
2nd	Visiting two campanies
3rd	Sightseeing or shopping (free time)

they also have many opportunities to work abroad after their graduation.

Third day, our students have free time, and go sightseeing or shopping. They try to get on a train or buy something using their own English ability. Our students know immediately whether they can communicate in their English.

Figure 3 shows the results of the trip questionnaires of 2015. The number of students is 42. Level 3 is a normal evaluation and level 5 is very high, level 1 is very low. Question① indicates that most of students had a good impression toward Singapore. And from Question②～④, visiting Singapore Polytechnics or companies were also good impression. From Question⑤, however, many students found that own command of English was insufficient. And from Question⑥, they felt the need of

(a) Singapore Polytechnics

(b) Campus tour

(c) Engineering activity

Figure 1 Visiting Singapore Polytechnics

(a) Company A

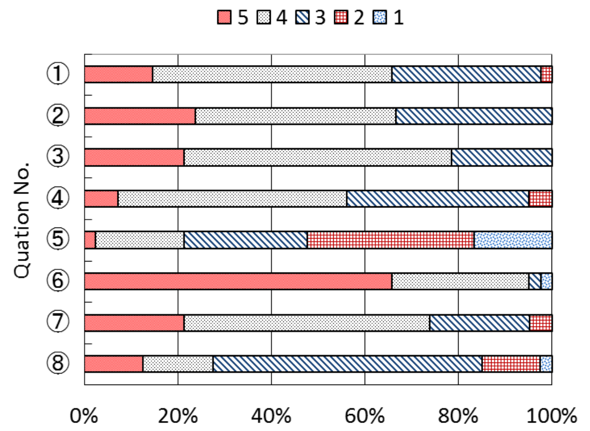
(b) Company A

(c) Company B

Figure 2 Visiting Companies in Singapore .

the command of English strongly. That is, students found that they have to study English more hard, vocabulary, grammar, listening, communication, pronunciation, etc. From Question⑦, this trip was a good opportunity to change their thinking for English. They understood that English was important and necessary for an engineer now, and the English conversation is not possible by only learning of the English grammar. Since they want to become able to speak English freely, some students want to study abroad. Question⑧ is about the image for working abroad. Recently, many engineers are working abroad. Many of our students also will work abroad. In this trip, they seem to understand about working abroad.

Figure 4 shows the evaluation of the trip by visiting



Q①: Impression of Singapore
Q②: How was the visit of the Singapore Polytechnics?
Q③: How was the visit of MAKINO (company)?
Q④: How was the visit of DAIICHI-SEIKO (company)?
Q⑤: Did you have confidence toward own command of English?
Q⑥: Did you feel the need of the command of English?
Q⑦: In this trip, did the way of thinking for your English change?
Q⑧: How was the image for working abroad?

Figure 3 Trip questionnaires of 2015

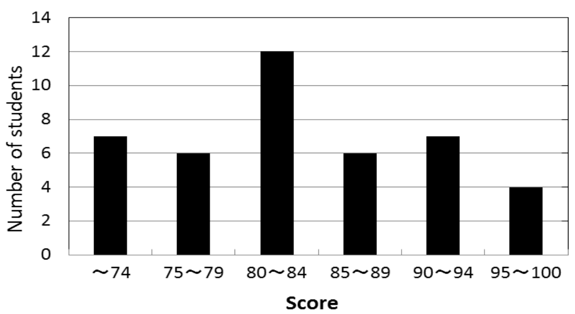


Figure 4 Evaluation of the trip

students. Students were asked to give an overall score for the school trip. It is a histogram of one hundred perfect score. It indicates that most of students evaluated greater than 80 points. That is, this trip is very useful for increasing their awareness for English and most of students felt satisfied about the school trip.

2. Singapore Polytechnics Students Coming to Japan

Approximately 10 students of Singapore Polytechnics have been visiting our college from 2015. Table 3 shows a schedule of their visit. First & fourth days, they visit our college and have an exchange meeting with our students. Our students make some posters such as introductions of school or Sasebo city or Japan, and explain to SP students in English[(2)]. Our advanced students also have the time to explain their research. Furthermore, our fourth grade students who are going to visit SP three month later interchange with them finally. As a result, when our students visit SP, SP students also host our students. Indeed, some our students trade an e-mail with SP students.

Third day, we provide a short trip to Nagasaki where is historical place. SP students learn about atomic bomb and shipbuilding in there. Second & fifth days, SP students have the time to see some nice sightseeing spots in Sasebo. Figure 5 shows the appearances of Singapore Polytechnics Students Coming to Sasebo.

In this way, this program is a good opportunity to communicate with foreign people in English without visiting abroad for our students. And SP students also have wonderful time in Sasebo. Therefore many SP students who belong to several departments hope to visit Sasebo.

3. Studying Abroad

In this way, this program is the good opportunity to practice English. After students participated in this program, their feeling of resistance to English decreased and their awareness for English increased. And some

Table 3 Schedule of SP trip in Sasebo

day	Contents
1st	Visiting Sasebo NIT ・Meeting with the principal ・Visiting Dormitory ・Interaction with Sasebo students
2nd	Sightseeing (Visiting Huis Ten Bosch)
3rd	Visiting Nagasaki City ・Peace Park (Atomic Bomb Hypocenter, Atomic Bomb Museum) ・Industrial & Factory Visit
4th	Visiting Sasebo NIT ・Engineering activities ・Lab facilites & campus tour
5th	Sightseeing or shopping (free time)

students want to improve their English abroad. As a result, so far four students did one year study abroad for English recently. Table 4 shows the list of the study abroad students. They look for studying abroad by oneself and experience one-year studying abroad by an own effort. After studying abroad, they give a briefing session to the lower-grade students of our department. Figure 6 shows the appearances of the briefing session of the study abroad experience. Then the lower-grade students increase their interest of abroad more and some students want to go abroad.

It follows that awareness improvement for English of the student increases by providing opportunities to interact with a foreigner as in this program to enable an engineer to work abroad in future.

(a) Poster session by students of English course

(b) Poster session by advanced students

(c) Interchanging with 4th grade students

Figure 5 Singapore Polytechnics Students Coming to Japan

Table 4 List of the study abroad students

Yesr	Country
2012	America
2015	America
	Australia
2016	Canada

(a) UK

(b) USA & Australia

Figure 6 Briefing session of the study abroad experience

4. Conclusions

For five years from 2011, our students of the department of mechanical engineering in Sasebo College have been visiting Singapore for school trip. 40 fourth year students had good opportunity to have the interchange with the student of Singapore Polytechnic and visit the Japanese companies in Singapore. From 2015, approximately 10 SP students have been visiting our college. Then, our students had more good opportunity and their awareness for English is increasing more. After students participated in this program, their feeling of resistance to English decreased and their awareness for English increased. As a result, four students did one year study abroad for English.

It follows that awareness improvement for English of the student increases by providing opportunities to interact with a foreigner as in this program to enable an engineer to work abroad in future.

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1404

SPATIAL PEACE: THE ULTIMATE GOAL OF LIVING NON-EXISTENT EXPERIENCES IN AN EDUCATIONAL CONTEXT IN MEXICO

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Abstract

Last year we confirmed that there's a bond between the decline of the human relationships and the impoverishment of the human space experience. That link was stablished as the main subject or raw material for a group of artistic practices that were called *Art of the human space experience*. This year we want to share a different perspective, one that complements our original proposal and in which a beneficial human relationship matches an enriched practice of the human space. We refer to the way in which inclusivity feeds one of the most enhancing experiences we can face, spatial peace, a concept related to that of spatial justice set forth by Edward Soja. The couple of pieces of art presented in ISATE 2016 differ from those shown before in the mindful use of a dissimilar strategy, but also in the purpose of the new artworks: to encourage a reflection on spatial peace.

The methodology followed to reach the aim was the artistic process conceived by Luis Racionero. However, since it was particularly hard to record the series' footprint on the participants, we combined Racionero's qualitative approach with some quantitative tools. This led us toward a more accurate result. Now we could have a better idea of how many people were involved and how many of them reflected, as well as the way that they are willing to contribute to build spatial peace experiences though their everyday actions as citizens and professionals.

The proposed non-existent experiences differ between themselves in the fact that they depart from diverse ideas, and share that they end at a common result: some of the community members participated and many of them pondered and expressed their engagement to build more human surroundings. The two works of art have definitely had a positive impact on our school population by helping some of its members be aware of how we can live together even if we are different. We would, without a doubt, recommend replicating these experiences in other contexts so that we can get closer to spatial peace every day.

Keywords: *peace, space, experience, art, Mexico.*

Introduction

This writing is structured in four sections. The first one is Materials and Methods or pedagogy, in which a retrospective of what we presented last year in ISATE is done and a viewpoint that complements our previous research is mentioned. Some notions that were essential to develop the works of art that we produced this year are included, such as Soja's "spatial justice" and Webel and Galtung's "peace". Also, this year's pieces are introduced and their objective is stated. The concepts and precedents (Tiravanija and Reyes) that inspired each composition, as well as the human and material resources that contributed to each creation are described. To conclude, the conditions required for this idea to succeed are mentioned and the "artistic process" as a methodology is described.

The second section is called results and discussion. In it the number of the school community members that visited each work of art is revealed, as well as the impact that each *oeuvre* had, considering the pondering that was fulfilled. Besides, the fact that some people achieved deeper thinking is noted and some photographs are provided to illustrate our proposal. Finally, a fragment of a significant article for the research is comprised.

The third section of this text is titled conclusions. An overview of the project shows it as a successful effort to generate deliberation on people, especially on our students. Lastly, new initiatives are convened to approach justice, and ultimately, peace.

Materials and Methods or pedagogy

In 2015, we identified a number of pieces of art that share a common trait: they show the artist's concern about a link between human bonds and the practice of the spaces that we inhabit. We brought them together and called their production *Art of the human space experience*. However, as our research continued, we found out that we have focused on just one facet of this group or artworks. Another viewpoint is missing, a more optimistic one that highlights how improved human bonds are related to an enhanced practice of the spaces we live in. This time we would like to emphasize, particularly, how inclusivity is related to spatial peace experiences.

Following this spirit, we approached the concept of spatial justice. American geographer Edward Soja (2010) conceived this term to refer to "…what arises from the enforcement of a critic spatial vision that is commonly known as social justice"[1], understanding social justice as the equal distribution of what is necessary to the growth of an individual in a community. He also uses this expression to indicate the rapport that exists between the spatiality of justice and human rights. But how is justice related to peace? Justice is needed to achieve peace. In fact, Charles Webel and Johan Galtung (2007) defined peace as "…a linchpin of social harmony, economic equity and political justice…""…peace denotes the simultaneous presence of many desirable states of mind and society, such as harmony, justice, equity…"[2] From this angle, the ultimate goal of all of our actions, no matter what discipline we belong to, should be peace. This is why, even if the term "spatial peace" hasn't been set yet, the objective of our work is focused not only in raising awareness on spatial justice, but also on spatial peace.

For the 2016 edition of ISATE, we are happy to share two art pieces: *Vaccination campaign against classism* and *Mixed*, both planned and executed this year. They are very different from the ones shown the last year because their intention, as we explained, changed, just as the strategy we used this time, especially because we decided to explore a more hopeful side of our research. As you will see, both works of art illustrate a whole new attitude as the planning, production and result assessment were always kept constructive.

When involving people of any economic status, beneficial human relationships happen. These links are associated to spatial inclusion as a kind of enriched practice of the human space. This fact guided us toward the creation of *Vaccination campaign against classism*. As a style reference to produce this artwork we must mention Pedro Reyes' *Sanatorium* (2012). In this piece, the Mexican artist presents a temporary clinic in which he offers some treatments to cure urban illnesses such as stress, loneliness and over-stimulation. Visiting Reyes' *Sanatorium* begins with the check-in as a patient and it continues with an interview. The visitor is diagnosed and is given an appointment to experience at least three of the sixteen therapies that are available. The treatments are new versions of Fluxus'[3] actions and include Gestalt[4] psychology exercises, warm up exercises used in drama, conflict solving techniques, trust-building games, corporate counselling, psychodrama[5] and hypnosis. It is important to underline that the check-in form that is filled out by each participant at *Sanatorium* clearly reveals that neither the therapies nor the therapists are real, and this gives each one the freedom to believe or not. The experience that Reyes suggests to the visitor has a transforming nature because it encourages him/her to reflect about the way he/she perceives his/her surroundings. Three elements were borrowed from Reyes' *Sanatorium*: fiction, as a main feature of the piece; the connection of the *oeuvre* with the health (in our composition, as described in the next lines, classism is understood as an illness); and the intention to achieve the visitors' analysis about how we see the context we live in.

To translate the previous information into shapes we exaggerated the presence of classism by imagining that it was a sickness. We proposed a spatial intervention that actually happens with a certain periodicity in our country: vaccination campaigns. *Vaccination campaign against classism* consisted on the location of three fake vaccination posts in the main square of our school during one day. The three of them were devoted to administer vaccinations against classism. To model this intervention we used (written and spoken) words and volumes (furniture). Twelve students collaborated in the project by placing furniture where needed, setting signs and identification cards, administrating placebos, distributing informative and vaccination cards, and also asking the attendants to register. Some material resources were also needed. A campaign identification ad was set and the next items were located in each station: a registration table, 2 chairs, 2 lab coats, a cooler, an eyedropper, a placebo container, an identification card for the art work, a station identification card, informative cards, fake vaccination cards, a clipboard, registration forms and pens. It is essential to mention that all the participants were informed that the campaign and all of its components were a simulation.

Moreover, when relating with people of any gender, improved human bonds take place. These nexuses are

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[2] Webel, C. & Galtung, J. (2007). *Handbook of peace and conflict* (pp.5-6). New York: Routledge.

[3] "…Dick Higgins, Bob Watts, Al Hansen, Geoorge Macunias, Jackson MacLow, Richard Maxfield, Yoko Ono, La Monte Young and Alison Knowles presented very different performances at the Café A Gogo, Larry Poon0s Epitome Café, Yoko Ono's Chambers Street loft and the uptown Gallery A/G, all of which came under the general name of Fluxus, a term coined in 1961 by Macunias as the title for an anthology of work by many of these artists." Retreived from Goldberg, RoseLee (2001). *Performance Art. From Futurism to the Present* (p. 132). Singapore: Thames and Hudson.

[4] The study of perception and behavior from the standpoint of an individual's response to configurational wholes with stress on the uniformity of psychological and physiological events and rejection of analysis into discrete events of stimulus, percept, and response. Retrieved from http://www.merriam-webster.com/dictionary/Gestalt%20psychology

[5] An extemporized dramatization designed to afford catharsis and social relearning for one or more of the participants from whose life history the plot is abstracted. Retrieved from http://www.merriam-webster.com/dictionary/psychodrama

related to spatial inclusion too, as a kind of an enhanced practice of the spaces we share. A remarkable example of this positive approach is *Soup/No soup* (2012) by Rirkrit Tiravanija. In this relational art piece, the Thai artist offered soup for free to all of the exhibition spectators, who became participants of a common experience in which the human bonds that were made stood out as the most important creation elements. Following this idea, we planned and implemented a second intervention of art called *Mixed*. In this point it is important to mention that all the toilets of our school are separated, nowadays, by gender. Our proposal was to allow students, professors and administrative staff members of any gender to use any toilet (in one of the two sections of our school) during three days. There are four modules of toilets in the section that we chose.

The shapes that we used were (written) words and volumes (furniture). These components were combined in a simple and clear language, according to our time and having as a reference Tiravanija's *oeuvre*. The human resources that collaborated were fifteen students who were in charge of placing furniture, setting identification cards and signage, distributing informative cards as well as inviting the attendants to write some information on the registration clipboard. The material resources that we used at each of the four toilet modules were a registration table, a clipboard, an identification card of the art piece, mixed toilets signage, informative cards, registration forms and pens. None of the participants, except for the professors who were notified in advance, were informed about the mixed toilets to get more natural results.

Concerning the conditions for the artworks to take place, no special considerations were required for *Vaccination campaign against* classism. On the other hand, *Mixed* needed all of the urinals to be cancelled during the days it was working, so that any student could be exposed toward the other users, independently of their gender.

The methodology that was followed to develop this research and art project was the "artistic process" set by Spanish writer Luis Racionero (1986), which has four steps. In the first one, called "reality", the artist takes some phenomena from reality and brings them together, respecting a current style (if he/she wishes to broaden that style) or proposing a metaphor thought by him/herself (if he/she is the creator of a new style). In the second step, named "shapes", the artist selects some information and converts it into shapes, intensifying at the same time some details of reality. He/she translates thoughts in matter and looks for structures that must be able to communicate what he/she has understood in an expanded way. The shapes that are used can encompass a very wide range, such as words, lines, colours, sounds, volumes or even movements. The third step, "the artwork", must generate a deliberation by the spectator, while the last step, "the spectator", perceives the art piece, internalizes it and does an analysis that can be similar or different than the one that the artist had reached. Finally, the observer compares that pondering to reality and approaches to it in a mood triggered by the work of art to verify if he/she remarks something new and unknown in everyday settings.

The artistic profile of *Vaccination campaign against classism* and *Mixed*, and experience as a subject, demanded this research to follow a qualitative methodology in which a description of the unique space experience by each participant was presented. However, the amount of visitors and the extended schedule in which the toilets were functioning led us to include quantitative tools. We used, therefore, a combined methodology that could allow us to know how many people visited the toilets and their characteristics, but also to know if the piece achieved its ultimate objective: to generate critical thinking about inclusivity as a beneficial human relationship and how it matches and spatial peace as an enriched practice of the human space.

Results and Discussion

After examining the information gathered in the registration forms, some of the results that we found are the ones mentioned in this section. *Vaccination campaign against classism* was visited by 192 school community members, according to the data on the registration clipboard, which represents around 12% of the whole school population. When they were asked "do you considered it is fair or unfair to accept people from any class at any station?" 185 participants indicated that vaccination posts for people of any class were either fair or unfair. Any choice implies that a decision was made, which means that around 97% of the visitors pondered. We also asked people "what class do you belong to? 52 considered themselves to belong to the upper class, 96 to the middle class and 37 to the lower class. When we combined the results of both questions we got a hint of the way our school community thinks. We found that the opinions for and against class-free vaccination stations are balanced among the upper class people and unbalanced among the lower class people. In other words, 43.7% of the upper class people thought it was fair, while 56.3% thought it was unfair. 16.7% of the lower class people thought it was fair, while 83.3% thought it was unfair. Another fact that we discovered was that even if a high percentage of the school community rejects classism, there is a worrisome 25% who think that people from diverse classes should not share the same spaces.

Figure 1. One of the collaborators administrating the fake vaccine to a participant.

Figure 2. Students filling out a registration form.

Figure 3. One of the professors visiting *Vaccination campaign against classism*.

Figure 4. A collaborator administrating the fake vaccine to an attendant.

Some of the most important results of *Mixed* were that it was visited by 235 people (including students, professors and administrative staff members), which represents around 15% of the total population of our school. 94 of them were men, 134 were women, 2 were transgender and 5 did not specify their gender. 213 participants marked the mixed toilets as a fair or unfair space. Once again, either choice implies decision making, which means the majority of the visitors (around 91%) reflected. From those 213 visitors, 123 (around 58%) agreed that people of diverse genders should share the same space, 60 of them were women and 63 were men. It was interesting to find that the exact same number of women (60) didn't agree about the mixed toilets and that only 24 men were against.

In both artworks another question was made: "what could you do as a citizen and as a professional to help building more fair and peaceful surroundings?" Since the answers had a very wide scope, they were not included in this writing. Mentioning it is significant however, because even if not all participants answered, it definitely guided a deeper thinking process on some of them.

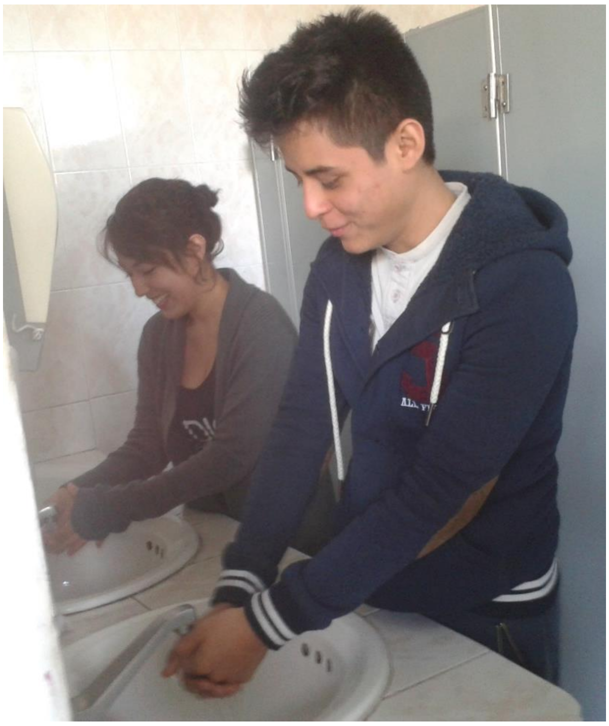

Figure 1. Students washing their hands in a mixed toilet.

Figure 2. Students participating in *Mixed*.

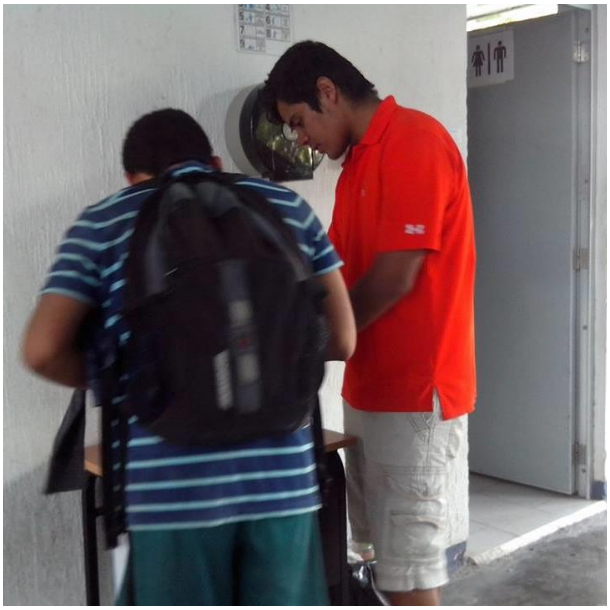

Figure 3. Students filling out a registration form. In the background, the signage that identified the mixed toilets.

A few days after presenting *Mixed*, the New York Times published the article "U.S. directs public schools to allow transgender access to restrooms". It was relevant to find it as an indicator of what is happening in the international context in what concerns to spaciatial justice and thus, peace, related to gender. A fragment of this text says "The Obama administration is planning to issue a sweeping directive telling every public school district in the country to allow transgender students to use the bathrooms that match their gender identity. A letter to school districts will go out Friday, adding to a highly charged debate over transgender rights in the middle of the administration's legal fight with North Carolina over the issue. The declaration — signed by Justice and Education department officials — will describe what schools should do to ensure that none of their students are discriminated against. It does not have the force of law, but it contains an implicit threat: Schools that do not abide by the Obama administration's interpretation of the law could face lawsuits or a loss of federal aid."[6]

[6]Hirschfeld Davis, J. & Apuzzo, M. (2016) *U.S. directs public schools to allow transgender access to restrooms.* Retrieved from http://www.nytimes.com/2016/05/13/us/politics/obama-administration-to-issue-decree-on-transgender-access-to-school-restrooms.html?_r=0

Signs outside a restroom at Santee High School in Los Angeles. Mark Ralston/Agence France-Presse — Getty Images

Figure 4. Screenshot of the front page of the article about mixed toilets published by the New York Times this year.

Conclusions

Vaccination campaign against classism and *Mixed* were a couple of attempts made from art that encouraged people, mainly our students, at elaborating thoughts on the experiences we have in human spaces. They also inspired all of us to promote inclusion as an improved human bond, as well as to support the building of spatial peace experiences as citizens and from our own professional profile.

According to the outcomes shown in the Results and Discussion section, our proposal was successful, but it was an effort that is not enough. We need to repeat it in unlike disciplines and in diverse contexts so that change can occur. Peace has never been easy to achieve, but we always have the chance to make the difference. Any help to accomplish justice from a class, gender, race or religion perspective is a step on our way to reach peace. When we get our students to realize this, another step, a bigger one, is taken.

Acknowledgements

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TEACHING AND LEARNING RESSOURCES DEVELOPED FOR THE FRENCH DIGITAL UNIVERSITIES - A NEW CHALLEGE FOR TEACHERS AND LEARNERS

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Abstract

The present communication addresses the question of the evolution of teaching contents in the technical and engineering fields for the Bachelor and Master degrees in the French Universities by developing active learning training approaches. In order to propose to students new attractive and useful ressources for training and learning, three projects of digital ressources were recently developed. The general idea of the created ressources is to give free elements to teachers and trainers, who can directly re-use them in their presentations or for their teaching supports. The provided courses can also be used in self-learning. The projects were realized by integrating videos, self-assessment tools or practical case studies realized by involving students from the Lille 1 University and from other partner universities from Nortehrn France. The digital resources were then used and tested with success in several courses, especially in the "eco-design innovative products" vocational Bachelor at the Lille 1 University. The present article has a double objective; the first one is to describe the elements which guided the instructional design that contributed to the improvement of students performance and attitude in training and learning; the second objective of the paper is to illustrate and discuss significant future challenges permitting to other educators to learn and adapt their teachnig ressources from our experience.

Keywords: *active learning, training, learning, digital ressources, student centered education, engineering.*

Introduction

During the last decades, numerous authors underlined the need for changes in pedagogical approaches, especially in engineering science, by promoting the active learning. This approach is essentially based on meaningful and collaborative learning, case studies or problem solving and critical thinking. Active learning was developed to provide opportunites for learners to think critically about content through a range of activities that help them to prepare themselves for the challenges of professional situations involving problem solving. The startpoint is given by findings such those of Huba and Freed (2000) who underlined that those that are learning the most in a classroom are the professors. Following the same authors the professors reserved for themselves conditions promoting learning: actively seeking new information, organizing it in a meaningful way, and having the chance to explain it to others. In this context the usual lecture format of the majority of the courses presents many challenges to both teaching and learning. Even if a traditional lecture course allows an efficient presentation for a large body of content to a large number of students, this "one-way transmission of knowledge" often faces superficial learning and do not stimulate students motivation. The principal consequence of this model is that a part of the students completing their education do not possess skills that are important for their future integration and work in companies. It is then obvious that new forms of instruction must be find, by placing the students at the center of instruction, in order to allow them to become independent and critical thinkers.

The mechanical Engineering Department of the Lille 1 University developed the P2NT-GM project (active pedagogy based on digital ressources and new technologies in mechanical engineering) which is based on the creation of new digital ressources and on the construction of a technological innovative platform.

In this paper are presented the three digital ressources realized between 2011 and 2014 in the framework of the previously cited project. The question of the evolution of the pedagogical content is equally adressed, because these evolutions aim to propose good quality case studies or courses for the concerned students. Several aspects related to this approach are illustrated by presenting some pedagogical experiments conducted in this period with a group of students of the "eco-design innovative products" vocational licence proposed at the Lille 1 University, France.

An educational approach based on active learning and the use of digital ressources

Active Learning based pedagogical approaches. It is actually convenient to define the Active Learning as anything that students can do to learn and train themselves except taking notes and passive listening of an instructor's lecture. A lot of research works proved that this approach improves students' understanding and retention of information and can be very effective in developing higher order cognitive skills such as critical thinking and problem. However, restructuring a course by using elements of active learning can sometimes seem overwhelming for faculty with extensive time commitments in other realms and little or no formal training in pedagogy. In addition, adapting the content and the structure of a teachning ressource with respect to the actual standards and regulations or by centering the treated case studies and the lectures content with respect to the industrial requests and reality are tasks which complicate a lot the preparation work and which request a lot of time for the research to recovering correct and usefull information to be used in the teachning activities (especially lectures and demonstrative works). The next section presents the active learning approach developed at the Mechanical Engineering department of the Lille 1 University .

The P2NT-GMP educational project

Context and usefulness. Several reasons pushed the pedagogical team of the Mechanical Engineering department of the Lille 1 University to develop the P2NT-GM project, which is centered on an active pedagogy, based itself on the use of digital ressources and innovative new equipments in the field of mechanical engineering. We recall among these reasons the students motivation and attitude or the miss of time and specific tools (for trainers) dedicated to the development of digital ressources. Given the previous reasons and the willingness of the team to help students in improving the success of their education, it was decided to act on two distinct plans : on one side, create an innovative technological platform (financed mostly with our own ressources) and on the other side realize new training and learning digital ressources by taking advantage of the technical and financial support provided by two French foundations working in the engieering respectively the environmental fields. Note however that the development of these ressources is not enough to improve the quality and the content of our lectures and ressources, this is why it was equally decided to capitalize and to valorize our experience by increasing the number of exchanges with our industrial, educational and institutional partners, in order to get the best feedback possible which can be used for a continous improvement of our practices and tools.

The technological platform. The mechanical engineering department develops since many years a technological platform dedicated to the innovative technical equipments. In this framework the University financed the acquisition of innovative technical equipments and devices such a 3D measurement device and scanner, fab lab equipments and 3D printers, industrial vision cameras and devices, foundry fournace or computer numeric control machines. Note that a big majority of these equipments are in free acces for students.

The digital ressources. Linking the technical and digital ressources (existing ones or to develop in the future) is on the other hand an excellent mean favoritizing student succes and which allow them to train themselves thanks to the use of pedagogical ressources with high level of educational interactivity. We naturally decided then to take advantage of the opportunities provided by the support offered by two foundations (digital universities) and we participated to several call proposals. Three of the proposed projects were approved, this offered to us the opportunity to put in practice our ideas and to develop new digital courses. The design of these digital ressources will be presented in the next sections.

The French digital universities UNIT and UVED. The development and the promotion of active-learning pedagogy is facilitateded and supported in France since many years by the 7 digital universities working under the guardianship of the French Ministry of Education. Two of these digital Universities develop activities in the environmental and engineering fields : the digital University of Engineering and Technology (UNIT) respectively the Digital University of the Environment and Sustainability (UVED). These foundations provide support for faculty committed for implementing active-learning strategies in their courses by proposing training opportunities and by furnishing example teaching ressources and materials readily available.

Objectives. The availability of digital ressources and the training for the use of innovative tools are factors strongly contributing to the development of autonomy of students in the acquisition of knowledge. The educational level of interactivity of the created ressources must be strong; we decided then to realise ressources of expository type, with an important use of communication tools with the learner (forum, chat, etc) and a strong presence of exercices, multiple choice questionnaires, case studies and other activities centered especially on the problem based apprenticeship or similar to the serious game activities. Our choice focused then on realizing numerical ressources of the form of educational grains designed by abording several fields of engineering sciences.

The realisation method. The project based approach and the problem based methods (see Barret and Moore, 2011) are inductive unusual methodologies of learning . It was then decided to arrange the tools already realised or to come under the form of educational grains of two kinds :

- sequential, where the information is detailed in one grain
- parallel, under the form of worksheets associated to elements giving the "theoretical" information attached to the methodology and the practical information declining its application to the case study.

The grains are imbricated and more other theoretical or practical tools were added : links to other courses, videos, examples of results, etc. The scope is to provide a set of ressources conceived under the form of toolboxes or libraries. These boxes are opeed by the learner one by one to learn, to self-evaluate or to acquire new knowledge and information. The more he will advance the more he will enter in the methodology details in order to find the right tool/information. The interest of the proposed structure is the fact that information will be very quickly find. The teacher's role and contribution are essentally situated at the case study level and in the project approach. He is the one who will help the learner to address the good questions, who will encourage him in opening one or another box, to make new researches. The main goal is to bring the learner to an important autonomy level, to help him in the acquirement of the method, and to push him in developing criticism with respect to the collected data or to the obtained results.

Structure of the project. The project is therefore inscribed in an active learning pedagogy and it is divided in three axis. The first one consists in pourchasing of new technical innovative means, completed by the realisation of user guides and /or technical worksheets allowing to the learner to self-train. The second action concerns the development of new digital ressources and educational kits allowing to other trainers to adapt the proposed ressources with respet to their needs and practices. Finally, the valuation and the capitalization of the acquired experience and of the developed tools are done by the redaction of a "feedback guide" and by presenting the developed approach at several events : congresses, symposiums, (e.g. Gruescu, 2014 and Gruescu et al., 2014).

Target audience. The digital ressources we developed have for target students of licence level (L1, L2, L3) or master (M1, M2). The content was adapted with respect to the public and indications are given to learners in order to guide them to use the information associated to their competences and knowledge. Initial, continuing and apprenticeship training as well can be trained by using the realised ressources, since the trainers have in possession an educational kit.

The 3PM - EFAU project for the UNIT digital university

We describe here the development and the implementation of an instructional design that focused on bringing multiple forms of active-learning and student-centered pedagogies into a traditionally lecture-based introductory engineering course dedcated to mechanical manufacturing. This course restructuring was motivated by several perceived deficiencies which are common to traditional lecture-based introductory courses. The most pronounced concerns were poor student involvement and attitude, feelings that were shared by several faculty involved in the course presentation. Both written or numeric responses on course evaluations indicated in the past that students were not satisfied with it and they did not recognized equally the usefulness of the course content to their education and future needs in professional work. For example, very often the students qualified that the lectures and the course materials were boring. In addition, they recognized being more concerned with their test scores than with gaining a thorough understanding of the course material. Poor student attitudes were reflected by limited participation in class, poor attendance and almost unexisting individual instructor–student interactions.

Study design and course description. The course restructuring we describe here pertains to the lecture and tutorial classes of a two-semester course that typically enrolls arround 100 students anually. This course was taught in a standard lecture format in the previous years and redesigned to emphasize active learning and student-centered pedagogy. It proposes a set of activities that aim a progressive simulation ofthe learner, which is close to industrial reality thanks to which he or she will acquire and improve the technological skills useful in the organisation and methods department. He will be able especially to know the different production processes, their caracteristics and application fields. He wil equally use his knowhow to define a production process and to integrate in the production analysis the quality, cost and delai constraints, in order to improve the productivity.

This digital ressource (http://www.analyse-fabrication.univ-lille1.fr/co/001_MOG_web.html) is positionned as an application field of the organisation and methods department in a production workshop. Structured in 4 main parts, it is composed of theoretical presentations, videos, exercices and multiple choice questionnaires. It concerns students from higher and vocational education in initial or continuous training. Any other vocational training can equally be done with the help of this tool. Finally the Master students or engineering students can use it for quick upgrading of their knowledges. Concerning the teachnig public this module concern all kind of teachning categories developing their activities in echanical engineering field. Since it was conceived under the form of educational grains it can be exploited in totality or partially. Project activities can also be proposed to students on the basis of this module, sice self-evaluation is possible thanks to the solved case studies or to the divers applications proposed under the exercice forms at the end of each chapter. We finally emphasize the remarkable work which was done in order to complete the ressource with videos of high technical quality and which were realized based on realistic screenwritting.

The improvements in the course redesign. The first point to emphasize in the redesign of the course is the *reorder of the course content.* The presentation of the course was reordered in four main chapters and enriched in order to teach specific content within the context of broad conceptual themes. For example, a new lecture dedicated to the materials used for the machining tools production was integrated, it was designed to serve as an intellectual bridge between materials science and machining by chip removing. The *active learning and the group problem solving* were introduced in several lectures. Students work now organized in small groups, each case study needs several minutes of discussion in order to correctly state the adressed problem. During this period, the instructor would move from group to group in the classroom to monitor student progress and offer suggestions to the groups that are encountering difficulties. Finally, note that we adopted several additional strategies to create a more *student-centered* learning environment. Every lecture includes a set of learning goals made explicit to students in the lecture

PowerPoint slides. The exam are labeled with the corresponding learning goals, in order to emphasize the alignment with assessment. A set of vocabulary terms was also included in the ressource to help the students focus on important concepts. As part of the course revision, and based by the use of a moodle platform, we modified the assessment plan to include weekly quizzes.

The ACV Bat and ECOPem projects for the UVED digital university

The Digital University of the Environment and Sustainability (UVED) promotes, accredits and supports numerical ressouces projects related to environment or to sustainability. It has a similar organisation to the UNIT foundation and it's precisely in this framework that we had the opportunity to develop two new projects, one dedicated to learning of the Life Cycle Assessment methodology and the second one presenting the eco design approach. The choice for choosing these topics is given on the recent and future industrial evolutions (from the technical, economical and lawful points of view) as well as the normalisation of the LCA (Life Cycle Assessment) and ecodesign methodologies, which are factors contributing to the development of eco-design abilities for students integrating the technical sector in the Bachelor's and Master's degrees. Then, the question of an evolution of the pedagogical content of these degrees is asked. It was choosed to focus first on using problem-based learning because these activities tend to be more succinct and less open-ended than case-based studies. Thus it was easier to integrate problem-based activities into our previously established lecture organization by developing the ACV Bat project.

The ACV Bat virtual course (Introduction to the Life Cycle Assessment) constitutes a common basis of work of teachers from three differents universities. The main goal of the project was to test if its possible to realize a digital ressource useful for students in different specialities (mechanical, energetics and textile fieds) and for research and development departments in order to acquire abilities in eco-design or LCA methodology application using a Problem-Based Learning (PBL) approach. The interest of this course is also to present the LCA methodology by using real examples, contrary to many trainings which just present a specific software tutorial. The general idea is to give free elements to teachers and trainers, who can directly re-use them in their presentations or teachings supports. It can also be appropriated by self-learning. Given the fact that the treated methodology use compex tools and databases the teams which are involved in such an approach must have multidisciplinary abilities and knowledge. This requirement has led to serious modifications of the pedagogical course and methods, particularly in Bachelor's and Master's degrees, and to the creation of new special fields and cursus. In France, this necessity was identified few years ago by Puyou and Teulon (2006) respectively Schiesser et al. (2010). Let us finally notice that several international standards define the principles and the methodology of life cyle assessment methodology (the ISO 14000 cycle) and this fact was a very important constraint in the design and realisation of the ACV Bat ressource.

Course description. The course was built to be not only the methodological core of the LCA approach (see Figure 1), but also as an application to the building sector. Then it becomes possible to apply the methodology to other industrial sectors without any particular difficulty.

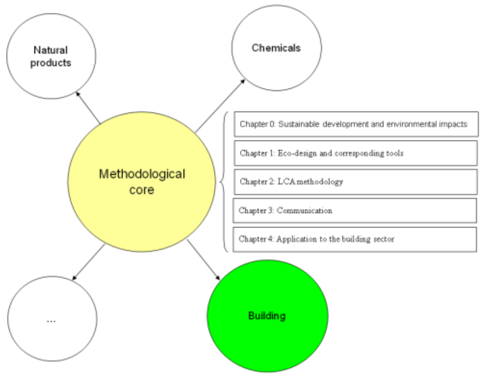

Figure 1. The structure of the ACVBAT ressource (http://www.acvbat.univ-valenciennes.fr/accueil/co/acvbat_010_accueil.html)

Inside the resource, the learner will find different elements such as videos presenting LCA applications, different examples, tests to validate the acquired level of knowledge. Throughout the entire course different case studies are presented, especially the case of a interior door. Another case study is completely done and presented, it was partly realized by students coordinated by the authors and the results have been rendered in a graphical tool called the ACVBAT radar (Figure 2). This tool helps the user to validate his or her approach, and can be properly used as a powerful communication tool allowing to understand the meaning of the course by only making 4 or 5 mouse clicks.

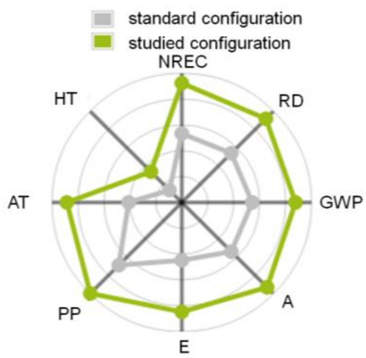

Figure 2. The corresponding ACVBAT radar

It must be emphasized that ACVBAT is not only a classical course for students in universities, but also a free-access numerical resource which can be used by everybody in a professional context (eco-design for example) or for self-training. This resource has been used with a certain success in a few cursus, especially in the "eco-design innovative products" vocational licence at the Lille 1 University, France (see the following section) and at the high school of engineering ENSIAME, Valenciennes University, France.

The ECOPEM virtual course. Entitled "eco design and environmental study of energy greedy products : application to a household appliance product" the ECOPEM digital ressource has as main goal to ensure to the learners the ownership of a simple methodology permitting to identify the main materials used in household appliances as well as the appropriation of the basic principle and the considerations to account in ecodesign. It is equally proposed to the learner to use the life cycle assessment methodology (LCA) to evaluate the environmental footprint of the most common household appliances. This step needs the ownship of knowledges from several technical fields : the LCA methodology, the energy, the design methods and the materials science. Contrarily to ACV Bat, ECOPEM is builded as a toolbox (see Figure 3) in which the learner can freely search the informations needed for the apprenticeship. This information is available under the form of folders containing each different chapters (worksheets) which are independent and can be accessed separately. The ressource can then be unwounded linearly but also sequentially according to the wishes of the learner, to the educational method used by a trainer or with respect to the learner's skills and followed objectives.

The LCA methodology is applied to a concrete case study, which facilitates the learning and which also allows to use a specific tool called "coffee-break" (see Menet, 2014).

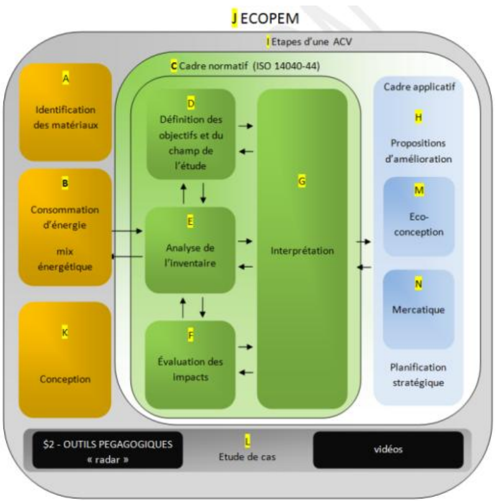

Figure 3. The structure of the ECOPEM ressource (http://www.ecopem.univ-valenciennes. fr/)

Discussion and training experiments

Discussion about the 3PM-EFAU digital ressource. A traditional lecture format in a large classroom presents several disadvantages, as it was already emphasized in the previous sections. There is reason to believe that this deficit diminishes learning outcomes and may contribute to the loss of some of our most talented students, especially at the introductory level. The primary goal of the courses restructuring was to improve student attitudes, motivated by the hypothesis that improved attitudes would lead to improved learning outcomes. It was then observed that incorporating active-learning and student-centered pedagogy into the instructional design of our educational approach also lead to increased student attitude and performance. The courses redesign had another unanticipated benefit: it improved not only the students' attitude toward the course but also the professor's morale and enthusiasm. Machining by chip removing has been for a long time a problematic course for our department because of the deficiencies such superficial learning, poor student attitudes or suboptimal performance. As a consequence, educators or instructors often losed enthusiasm for teaching this course after a few years. It is obvious actually that the interactive pedagogy (based on active learning) and the positive student reactions made this a much more exciting and rewarding course to teach. The changes we implemented also have had an impact at the departmental level. Based in part on the positive student reactions to interactive and student-centered pedagogy in the mechanical engineering courses, other collleagues seriously thing about implementing the use of digital ressources in their courses. Since the same author taught the course before and after redesigning, the main outcomes of the new approach are that student attitudes and performance increased in response to the instructional design that we implemented.

Pedagogical and training experiments

Beyond the “self-training” of designers in companies, another question is to train students or auditors to this methodology. This section deals with some experiments which have been developed in two Nortern France Universities via the numerical course ACVBAT. We recall that this course proposes an academic presentation of the LCA methodology, and describes several case studies applied to the building sector. The examples are treated using a free software called Bilan-Produit ® which was developed by the French National Energy and Environment Agency (ADEME).

The general idea was to use a non-conventional approach which is in any way the one which will be discovered in the companies and in the organisations by the students or the auditors as soon as they will start their professional careers. This method is called the Problem-based Learning (PBL) and is described in many works (e.g. Barret and Moore, 2011). This pedagogical method is more interesting for students and auditors because it directly deals with real cases. Besides, the student is no longer a “listener” but becomes an actor of the methodology, which permits him to acquire knowledge and abilities more quickly and more durably. This method also deals with “organisational learning” given the proposed interactions between the working groups and given the time constraints that each team has to face.

The vocational bachelor's degree in industrial production, speciality "eco-design of innovative products"

The students trained in this bachelor's degree dedicated to eco-design are privileged holders of an eco-designed approach, in position to disseminate and implement in practice its innovative concepts and principles. They are trained to acquire technical, scientific and organisational skills required by companies to implement the eco-design in their practices. Within the company, they will be in charge of improving the products performances : energy consumption, optimal recycling, etc. by seeking solutions that lowers the environmental impact. More than 40 % of their courses are provided by industrial or institutional partners. Integrated in the LMD scheme (Licence-Master-Doctorate) this training is composed of 11 modules, totalizing 480 hours of training, spread over two academic semesters and worth 60 ECTS (European Credits Transfer System). The tutored-project and all the courses related to materials-science are realized by integrating the "learning by doing" concept during almost 200 hours of activities. We recall here the example of the materials identification procedure used in evolutionary design (see Gruescu, 2014). The main outcome of this project is respectively the evolutionary design. By accounting the market needs, design requirements are formulated. The scope is to design an energy-greedy household product and it's packaging by increasing the performance, by decreasing the costs and by considering its environmental footprint. The need of process and materials data is underlined in this context, especially with respect to their environmental footprint. The design constraints are the shape, the manufacturing, the cost and the eco-impact. Several practical case-studies are considered, they allow to students discovering new concepts such the design for the environment, the design for sustainability and to perform energy balances for the embodied energy, for the process energy and for the end of life potential. In addtion to the increased interest of the students for the proposed approach it worths noting that the obtained results were used for the development of the so called ECO-PEM project (for the UVED University).

The institutional context

The redesigned or newly intrduced courses that we implemented in the framework of active learning required significant time investment and consequent financial support. Given the encountered problems it worth capitalizing and valorizing the acquired experience and the realized digital ressources in order to allow to other colleagues to benefit of our advances and to use at our turn their eventual feedback. Attendance at national and international workshops or symposia, can naturally provide significant background theory and training. It was also possible to organize some regional meetings with colleagues form other universities, these occasions were as well opportunities to improve our practices and experience. These symposiums were particularly useful in providing the opportunity to discuss specific details of course redesign with individuals highly experienced in implementing active-learning and student-centered pedagogical approaches.

Conclusions

Active learning is a key aspect of the education which can be applied to any learning environment from online to standard lectures or as a blend of these. The Mechanical Engineering department of the Lille 1 University works since several years in implementing this approach in its educational system. The creation of a technological platform dedicated to innovative technical equipments and the reorganisation of existing courses (or the introduction of new ones) are the main initiatives to be emphasized in this context. The new digital ressources were realized with the support of two digital Universities, this allowed the reorganization of some courses by using active learning and by centering education on students. A good feedback and more positive results in students evaluation illustrate how changing the instructional design of a course, without wholesale changes to course content, can lead to improved student attitudes and performance.

With respect to the use of the Problem-Based Learning methodology in the development of the ressources it was shown that this approach permits in all the cases to train students, auditors, or designers in place. Besides, the results in terms of the appropriation of the subject are better than those which could have been obtained using conventional pedagogical methods. Sometimes, these approaches lead to creativity, innovation, or scientific results. This pedagogical approach has been applied to mechanical manufacturing, eco-design and Life Cycle Assessment courses but it is clear that the aplication field is not at all limited.

In summary, we developed and implemented an instructional design that focused on incorporating active-learning and student-centered pedagogy in courses which where previously traditional lecture-based teachnig activities. These changes led to sustainable improvements in student attitudes and performance. The course reorganization we described provides not only a model for revision of an individual course but can also be a catalyst for institutional reforms. Note finally that the force of this project lies not only in the interest of the aborded themes but equally in its regional and national recogition.

Acknowledgements

The author gratefully acknowledge the UNIT and UVED Foundations (the French Digital University of Engineering and Technology respectively the Digital University of the Environment and Sustainability (UVED) for the financial support which leaded to the realisation of the ACV Bat, ECOPem and 3PM-EFAU digital ressources. The author equally acknowledge the co-authors of the previously cited digital courses as well as the support teams for their contributions to the redaction and the technical realisation of ressources.

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STUDY ON THE EFFECT OF HOMEWORK GIVEN BEFORE ENROLMENT TO THE DEPARTMENT OF ELECTRONICS & CONTROL ENGINEERING IN TSUYAMA COLLEGE

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Abstract

This paper describes the verification result and discussion on the effect of a homework given before enrolment to the department of electronics & control engineering in National Institute of Technology, Tsuyama College. Our department has provided freshmen with the homework, in which students investigate the things wondered scientifically in their surroundings, before enrolment in order to foster a positive and spontaneous way of learning contrary to a taught and passive education for more than seven years. The educational effect, however, had not been verified. Therefore an investigation has started since five years before by means of a questionnaire survey. As a result, following conclusion was obtained: (1) From the questionnaire survey to students, it was found that they regarded the homework as helpful and they has recommended the homework to their junior, further many of them have determined their theme by themselves, and the theme are roughly divided two categories; science like "why sky is blue", and the technology like the principle of LEDs. In addition, the method of survey on their theme has been changing from book and experiment to internet search. (2) From the questionnaire survey to teachers, it was found that the submitted works were useful for making conversation in a group advisory class especially at a beginning of the new term. (3) After the presentation on the homework in the homeroom class in the first year, it was found that the mutual evaluation of the students are consistent well with that of each other. It has been suggested that the homework is a kind of problem discovery and problem-solving education, further in a sense it could be an e-learning since students tend to utilize Internet as their survey tool. The tendency of increasing in the use of web survey is agreed well with the increase of personal computer and smartphone penetration rate in junior high school students.

Keywords: *homework, active-learning, e-learning, problem-finding, solution-finding*

Introduction

Learning before admission has been generally given to the students before enrolling to a high school from a junior high school. The information on the learning has been exchanged at a pearls of wisdom in Japanese YAHOO [1] and similar web site [2]. Further the preparation before enrolling high school are shown in a home page managed by a cram school [3] as following,

・The pre-study of high school textbooks and the review of junior high school texts are recommended for freshmen to high school, since high level characteristic textbooks depending on the course or department are used and the proceeding speed is fast in high school.

・The homework given at the explanatory meeting are usually workbooks for reviewing junior high school study, then confirmation tests will be conducted after enrolment.

・The pre-study of principle three subjects; Mathematics, Japanese and English, are recommended for the students in general course if the textbooks are obtained.

In our college, home works of the three subjects have been given to the students so that the fundamental understanding in the contents learned in their junior high school is achieved utilizing the period after announcement of successful applicants, and the confirmation tests have been carried out after their entrance.

The other hand, there are no entrance examination to university at eighteen years old in our national college of technology unlike normal high schools, we discussed on the home work which is helpful to make students have an interest in science and technology, and to make students find and solve their own challenges in addition to the above three subjects. As a result, the following three works were proposed.

・Homework A: Investigation on the theme in which students are interested regarding scientific things.

・Homework B: Investigation on the topics in which students are interested on the home page of our college.

・Homework C: Idea memo showing the device or improvement on the surrounding goods.

The verification of those challenges, however, have not been discussed systematically although no problem have been recognized by a series of questioners. Therefore, in the present study the effect and the further study on the home works before admission in our department were discussed by analysing the series of questioners to the students and teachers.

Contents and Implementation status

Contents of the homework before admission

Our department of electric and controlling engineering has given the three kinds of home works A, B, C as mentioned above although all works were not given in every fiscal year. The backgrounds and contents will be explained below. The enrolee are classified into two groups. One is a group of admission students by recommendation which result is published in the end of December, the other is a group of admission students by achievement test in February. The above mentioned home works A, B, C have been given to both groups of students, and the C has been given only to the students by achievement test.

Homework A

The purpose of this work is to expect that the students find a problem then solve it by themselves. Concretely speaking, it is a homework that students investigate what they are interested in or wondered in their surroundings by means of the use of library, the Internet, experiment and/or prototyping by themselves, then summarize in a report. However it may be difficult for the students in the age of fifteen years old to perform the homework, therefore a book "The wonder in our surroundings" has been introduced as a reference to help the students to set up their theme or to learn the way of investigation. In the book, the themes in which adults are interested as well as students are shown, for example, "The rustic wonders found at sea, mountain and sky", "The rustic questionnaires found in machinery and equipment". The book is relatively cheap and easily obtained in library.

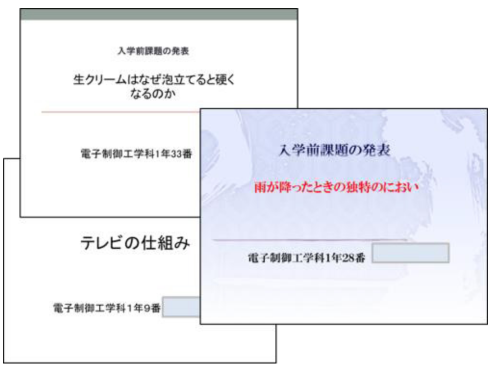


Fig.1 Some of the examples of the homework A prepared for presentation in their home room class.

After the entrance to our department, the freshmen prepare a power point for presentation in the class of home room for one month, then they give presentation including their self-introduction in around June or July. Some of the power points are shown in Fig.1 as an example.

Homework B

This work aims at the smooth transition for the students from junior high school to our college, although the admission students have basically understood the admission policy of our college. The students investigate and understand well on the learning, school life, organization facilities and dormitory and so on, of our college and department by looking our homepage. This work is not to expect such high level of achievement as the home work A and B, but to make students become familiar with our college. The topics actually have been reported were on the activity of sports clubs, subjects and dormitory and so on.

Homework C

As mentioned above, as the homework C is an idea sheet imposed on the admission students by recommendation, the submitted reports were handed out only to their tutors for individualized teaching so that the students are not identified as the admission students by the recommendation or by achievement test, and the reports were not used for any open investigation nor guidance. However, in fiscal years of 2011 and 2012, our college had joined a project related to intellectual properties organized by Japan Patent Office, therefore some survey results by questionnaire to the individual students are remaining. In the homework, an "Idea sheet" is given out to each student as shown in Fig. 2. As the examples a few examples are shown in the format, "A novel idea that the detection and informing system of the difficulty in breathing of baby by lying flat especially face downward" which has already applied to a patent by a student in the national institute of technology, and an idea "Equipment for creating patterns like a character of cartoon by punching out a dried laver seaweed, then the patterned dried laver seaweed are placed on a rice in lunch box ". Some students have proposed more than ten ideas, although each student usually submits one idea. The present homework C is a placement to the first step to the proposal of patent or improvement (Kaizen) contrasting to the homework A which is a first step to a study or research, since the main work in homework A is to survey a little novel things by themselves, and the homework C is to device or give an idea by themselves.

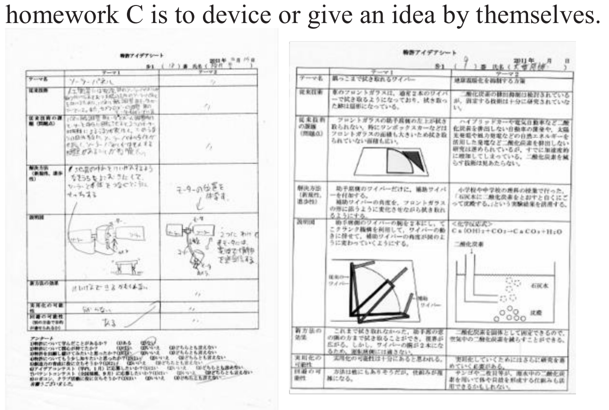


Fig.2 Some of the examples of the homework C showing novel idea in the format.

Result of Questionnaires

Questionnaire to the students

Homework A

The items in the questionnaire are the following nine items. The result in fiscal 2011, 2012 and 2015 which are remained in details are shown in Fig. 3.

(1)How the theme was determined?

The students who determined their theme by themselves were the largest number of 15% to 58%, and the students who had a guidance from their friends or the member of their family were the second largest number of 4% to 40%, suggesting that the majority found and determined their theme by themselves. Therefore it has been confirmed that the initial purpose we expected was achieved.

(2)What extent it took the period of?

The majority of students took three to ten days to finish this homework A. However the ratio decreased from 40%, 31% to 24% gradually, then the students who took one to three days or less increased 54%, 46% to 69%.

(3)How many hours was taken?

The largest number of students took 1 to 10 hours to complete, but the students who took 1 to 1 hours increased. The reason has suggested that the way of surveying has been changing from book to the Internet, resulting in shortening the preparation time for the reports.

(4)What was used for the reference?

As mentioned in the above (3), the way of surveying has been changing. The ownership rate in personal computer or smart phone of junior high school students has being increased rapidly, therefore it has been suggested that such social phenomena influenced heavily on the method for obtaining information using the Internet.

(5)Was the observation, experiment or manufacturing carried out for the homework?

The students who conducted the observation, experiment or manufacturing by themselves tends to decreased as shown in (3). The reason is also suggested that the information to the investigation can be easily obtained visually and virtually in short periods through the Internet without observation, keeping the high quality of their reports. However the further study will be required to discuss the educational effects of the Internet.

(6)Was the student's view described?

The most students answered that they could write down their opinion or idea, it is suggested that the expected effect by the authors was obtained. When the result is interrupted in good faith, and is also added to the previous result, it could be possible to understand that the time enough long to summarize their opinion was appropriated owing to the Internet by obtaining large information in short periods.

(7)Was the homework useful for the students?

The most the students answered that the homework was useful, and the ratio of the favoured students tends to increase as shown in (7). Thanks to the result of this questionnaire, this homework has continued conducting. In fiscal 2015, although the questionnaire consisted of five questions was different a little from the above questions were also summarized as follows;

・Good, Understood, Interested and Impressed: 50%

・Hoped further or another investigation: 21%

(8)Should the homework be given to their junior?

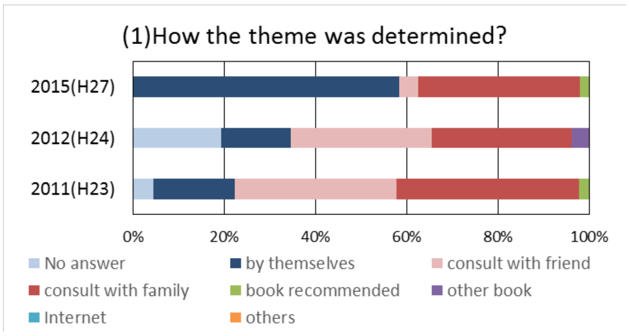
The answer which the content of the homework needs to be changed was small ratio of 16%, 0% and 0% in 2011, 2012 and 2015 respectively, suggesting that the support from students has been obtained very well.

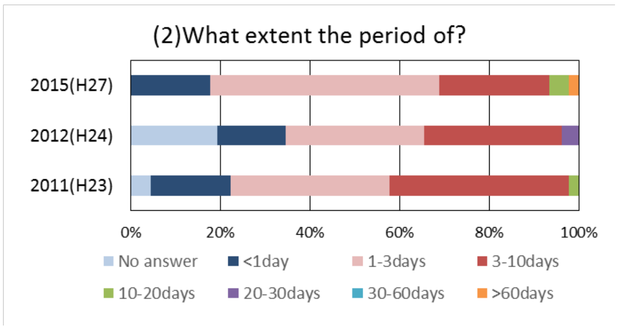
(9)Is the quantity of the homework appropriate?

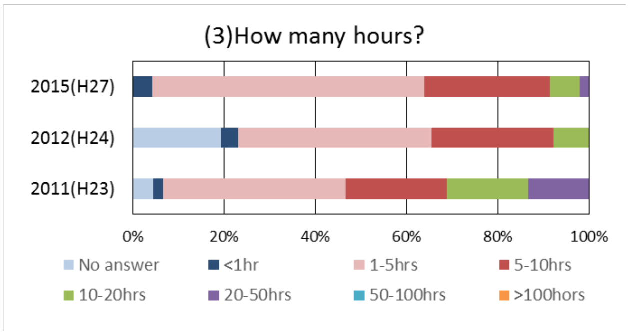
Regarding the quantity, the answer was roughly good, but in fiscal 2015 the large number of students answered that it is better to reduce the quantity. The home works on Mathematics and English are also given, further generally it has been a mentally pressurised society. The verification and discussion is required with regard to the quantity considering the effect of homework.

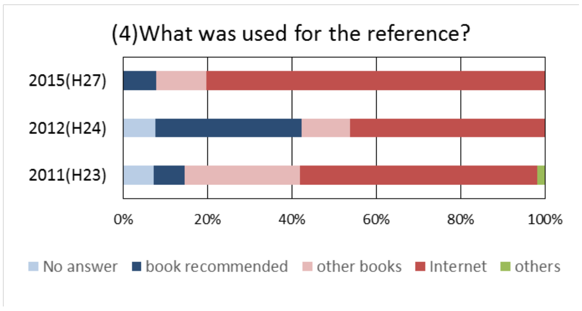
(10) Will the report be better, if the students do the homework A after presentation (3-6 months later)

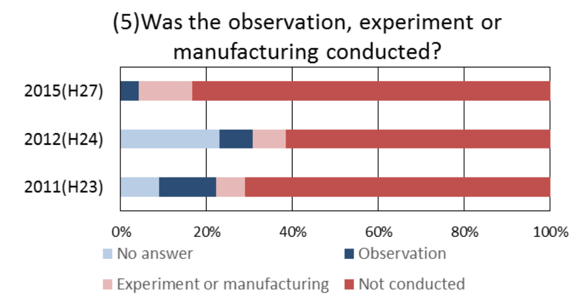
It was found that the students think their report could be better if they write it again indicating the educational effect we expected, and it is the author's pleasure.

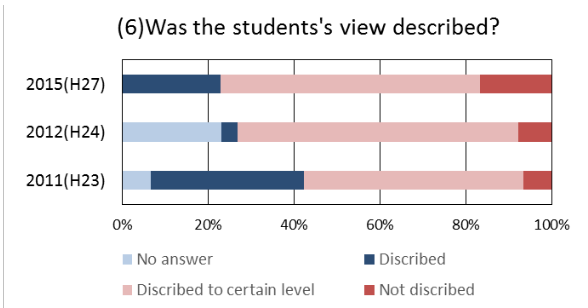


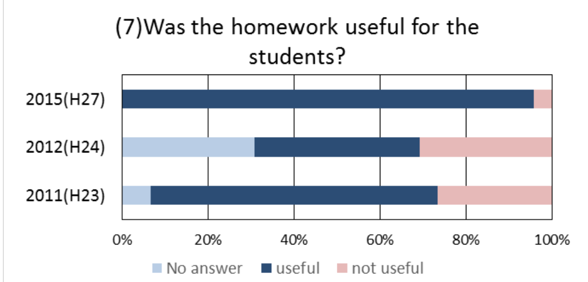


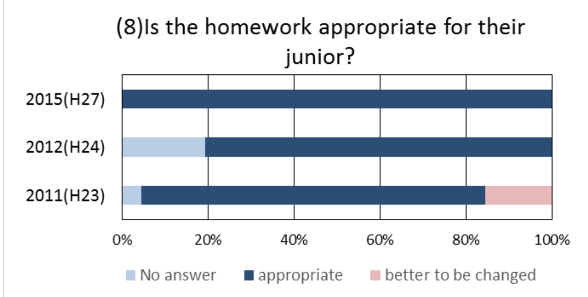


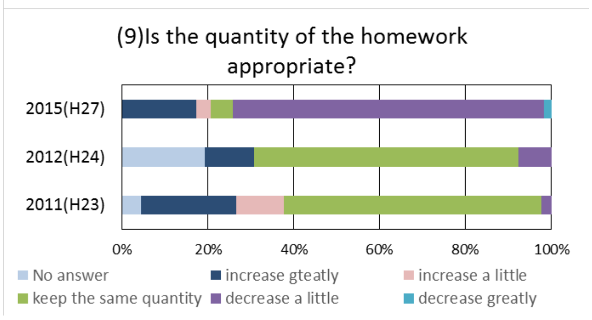












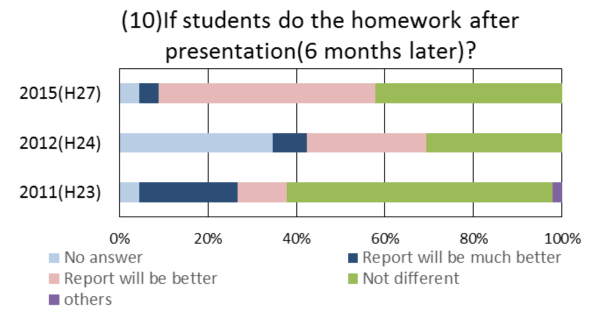
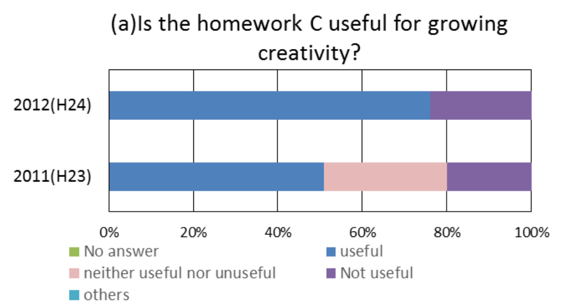


Fig.3 The result of questionnaire regarding the homework A, in which the students find a problem then solve it by themselves

Homework C

As above mentioned, although there are only questionnaire data for two years, the answer showing "Helpful for growing the creativity" was 51% to 76%, and the answers showing "Got to be interested in patent" was 44% to 62%. Therefore it was found that the students supported the effect on the development of creativity. However, "Got to be interested in patent was 44% to 62%", "Not interested in patent was 22% to 29%" which was not overwhelming majority. Therefore it has been suggested that homework A has highly effect to motivate the student than homework C, probably due to the unfamiliarity and difficulty for fifteen years old students. However it should be noted that some students were motivated to propose many excellent ideas, so the motive on the problem discovering and solution proposing was given to the students.



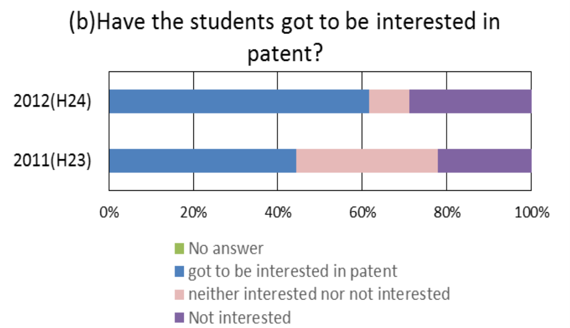


Fig.4 The result of questionnaire regarding the homework C, idea sheet.

Questionnaire to the teachers

Homework A

Questionnaire to the teachers was conducted on homework A after the fiscal year of 2015. The result are shown below.

(1)Is the homework, in which students find their theme and investigate by themselves, appropriate to prepare for the specialized subject?

It was found that the most of the teachers regarded this homework as "appropriate" or "neither appropriate nor not appropriate", probably because there are no hard evidence to show the educational effect of the project except for the result of questionnaire to the students supporting the homework as shown in Fig.3. Further there are one comment on this question, mentioning that the fundamental subjects like mathematics and English are more important in fifteen years old than the homework A to understand specialized subjects. The other hand, there are one comment addressing that the anxiety before entrance to the new college would be eliminated to manage to the homework rather than tackling with the difficult and not interested in mathematics and English in which memorization is required.

(2)Is the homework useful for the teachers?

It was found that the most of teachers evaluated this homework as useful, because such information containing the interest of student and understandable their characteristic in early period after entrance is helpful to discuss in group advisory class and in individual consultation. It is suggested that the contact of teachers to students becomes easier by using this system, which is important to obtain good practice mentioned in a literature [4].

Conclusions

Our department has provided freshmen with the homework, in which students investigate the things wondered scientifically in their surroundings, before enrolment in order to foster a positive and spontaneous way of learning. As a result of questionnaire survey, following conclusion was obtained: (1) From the questionnaire survey to students, it was found that they regarded the homework as helpful and they has recommended the homework to their junior, further many of them have determined their theme by themselves, and the theme are roughly divided two categories; science like "why sky is blue", and the technology like the principle of LEDs. In addition, the method of survey on their theme has been changing from book and experiment to internet search. (2) From the questionnaire survey to teachers, it was found that the submitted works were useful for making conversation in a group advisory class especially at a beginning of the new term.

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Educational Training Program for Electromagnetic Field Simulation

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Abstract

In this program, 2-D FDTD source code was introduced with references for beginners so that a progressive series of simulations including model creation, source code modification, compilation, results output on display while introducing some of the specific analysis cases such as wire and reflector antenna, waveguide, diffraction, scattering, shielding, and cavity could be experienced. With this, it has become possible to introduce specialized content at the same level of researchers of about 20 years ago to the current lab's student experiments level. In the future, this educational training will lead to the development of a free electromagnetic field and wave simulator that is suitable for practical use.

Keywords: *CEM, FDTD, educational, microwave, simulation*

Introduction

For electromagnetic engineers, it is most effective to incorporate a triple combination of theoretical analysis, measurement, and electromagnetic field simulation in a given electromagnetic field problem. At higher educational institutions, training excellent professional technicians during early stages is an important task. So systematizing these problem based approaches and providing efficient learning content are indispensable. In the case of electromagnetic field simulations, commercially available electromagnetic field simulators that can be said to be industry standard are used. Although, these simulators are highly functional including 3-D CAD applications with easy-to-use GUI's, efficient computation algorithms, and colorful display outputs of the results, the internal source code is completely proprietary and has been obscured by a veil like that of a black box. So we are still left with a problem. For example, simulator beginner users who are not familiar with the specific simulation principles may commit grave errors through inappropriate condition settings. To solve this problem, it is valid for students to learn about the inter-workings of the electromagnetic simulator by modifying the source code for themselves. In the field of the electromagnetic field simulation, it is known that three major numerical methods are used to solve Maxwell's equations, Finite Difference Time Domain method (FDTD) [1][2], Finite Element Method (FEM) [3][4], and method of moment (MOM) [5][6]. Of these three major methods, some knowledge of the first-order approximation of the Taylor series expansion, whichi is taught at the undergraduate level, is required to unerstand the FDTD method. However, in the case of the FEM or MOM, advanced knowledge of variational method, the weighted residual method, and the integral equation method are required to understand. So, it can be said that the FDTD is an appropriate simulation technique for beginners.

Theory

In electromagnetic problems, the governing equations are the well-known Maxwell's equation set as shown in Eq. (1). In this equation set, the first equation shows Ampere's law in differential form not including the conduction current density J [A/m^2] and the second equation shows Faraday's law in differential form.

$$\begin{cases} \nabla \times \vec{H} = \dfrac{\partial \vec{D}}{\partial t} \\ \nabla \times \vec{E} = -\dfrac{\partial \vec{B}}{\partial t} \end{cases} \tag{1}$$

For the sake of simplicity in a theoretical explanation of the FDTD method, the following description is limited to the case of one-dimension (1-D) and is source free in free space. Extension into 2-D and 3-D space is straightforward. For a plane wave propagating in the z-axis and polarized in the x direction, Eq. (1) becomes a set of simplified partial differential equations composed of only two field components, the electric field E_x and the magnetic field H_y as follows.

$$\begin{cases} \dfrac{\partial E_x}{\partial t} = -\dfrac{1}{\varepsilon_0}\dfrac{\partial H_y}{\partial z} \\ \dfrac{\partial H_y}{\partial t} = -\dfrac{1}{\mu_0}\dfrac{\partial E_x}{\partial z} \end{cases} \tag{2}$$

where ε_0 and μ_0 are the permitivity or permiability in a vacuum. t is the time and z is the spacial axis. The following constitutional relationships are used.

$$\begin{cases} D = \varepsilon_0 E \\ B = \mu_0 H \end{cases} \tag{3}$$

Dielectric or magnetic materials are taken into account by substituting their medium-specific dielectric constant ε or magnetic constant μ instead of ε_0 or μ_0 . An ideal electric conductor is expressed by forcing to zero, the electric field at its surface and inside the conductor. Frequency dispersion medium, anisotropic media, and left-handed medium are outside the scope of this study.

Derivation of the differential equation: In the FDTD method, Eq. (2) is directly discretized using a first - order approximation of a Taylor series expansion. Here, the special feature is that the electric and magnetic fields are shifted by a half step in both the time and spatial axis. This is called as Yee lattice [7].

$$\begin{cases} \dfrac{E_x^{\,n}(k)-E_x^{\,n-1}(k)}{\Delta t} \\ = -\dfrac{1}{\varepsilon_0}\dfrac{H_y^{\,n-1/2}(k+1/2)-H_y^{\,n-1/2}(k-1/2)}{\Delta z} \\ \dfrac{H_y^{\,n+1/2}(k+1/2)-H_y^{\,n-1/2}(k+1/2)}{\Delta t} \\ = -\dfrac{1}{\mu_0}\dfrac{E_x^{\,n}(k+1)-E_x^{\,n}(k)}{\Delta z} \end{cases} \tag{4}$$

Here, n is the number of the time step, k is the number of the space position on the z axis, Δt is the small time width, Δz is the division mesh size in the z axis. Then the electromagnetic fields are calculated at all points on the discreteized meshes in a given time step using Eq. (3). In general, Δz is determined less than $\lambda/20$, where λ is the wavelength, so that the nature of the wave can be observed. Δt is selected so as to satisfy the Courant-Friedrichs-Lewy (CFL) stability condition. From Eq. (4), the electric field E_x at time step n and position k, and the magnetic field at time step n+1/2, and position k+1/2 are derived as follows.

$$\begin{cases} E_x^{\,n}(k) = E_x^{\,n-1}(k) \\ -\dfrac{\Delta t}{\varepsilon_0 \Delta z}\left[H_y^{\,n-1/2}(k+1/2)-H_y^{\,n-1/2}(k-1/2)\right] \\ H_y^{\,n+1/2}(k+1/2) = H_y^{\,n-1/2}(k+1/2) \\ -\dfrac{\Delta t}{\mu_0 \Delta z}\left[E_x^{\,n}(k+1)-E_x^{\,n}(k)\right] \end{cases} \tag{5}$$

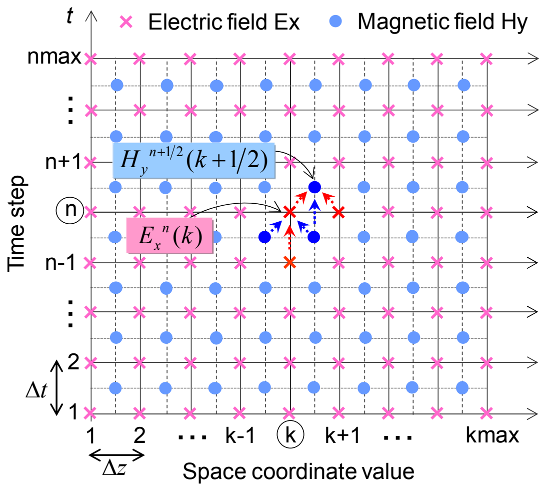

Fig. 1 Calculation procedure of the 1-D differential equation in time and space. The vertical axis shows the time step and transverse axis shows the space discretization. The pink exes represent the electric field E_x and the blue dots represent the magnetic field H_y.

A schematic view of the calculation of the 1-D partial differential equation in time and space is shown on Fig. 1. In this figure, the electric field $E_x^{\,n}(k)$ and the magnetic field $H_y^{\,n+1/2}(k+1/2)$ are focused on. From Eq. (5) the electric field $E_x^{\,n}(k)$ is calculated using the electric field at the same position of one step before $E_x^{\,n-1}(k)$ and the magnetic fields at both sides of a half-step before $H_y^{\,n-1/2}(k+1/2)$ and $H_y^{\,n-1/2}(k-1/2)$. And the magnetic field at $H_y^{\,n+1/2}(k+1/2)$ is calculated using the magnetic field at the same position of one step before $H_y^{\,n-1/2}(k+1/2)$ and the electric fields at both sides of a half-step before $E_x^{\,n}(k+1)$ and $E_x^{\,n}(k)$.

Absorbing boundary condition: However, it requires a magnetic field outside the analysis space that does not exist in the simulation when calculating the electric field on the boundary at k = 1 and $k_{\max}$, Therefore, Eq. (5) can not be used in the calculation of the edge of the analysis space. There are two ways to avoid this problem, one is the use of the analytical one way wave equation [8], another is to place a virtual wave absorption material called a Perfectly Matched Layer (PML) [9]. In this program the latter method was adopted. Details are omitted here.

Source condition: As wave source excitations, there are the conduction current J, magnetic current M, electric field E, magnetic field H and, a combination of these. The conduction current J is equivalent to the magnetic field surrounding it from Ampere's law. And the magnetic current M is equivalent to the electric field surrounding it from Faraday's law. In other words, inputting the conduction current changes the magnetic field around it, and inputting the magnetic current changes electric field around it. In this program, the conduction current excitation is adopted by adding the current term $\vec{J}$ to the right hand of Eq. (1). The differential expression is made by adding $J_x^{\,n-1/2}(k)$ to Eq. (5) as follows.

$$\begin{aligned} E_x^{\,n}(k) &= E_x^{\,n-1}(k) \\ &-\frac{\Delta t}{\varepsilon_0 \Delta z}\left[H_y^{\,n-1/2}(k+1/2)-H_y^{\,n-1/2}(k-1/2)\right] \\ &-\frac{\Delta t}{\varepsilon_0} J_x^{\,n-1/2}(k) \end{aligned} \tag{6}$$

Description of the source code

In this program, the entire source code is composed of nine files written in the F90 programming language. An overview of the source code list is shown in Table 1. The following is a brief description of each file.

1. ``fdtd_alloc_lib_2dtm.f90" is called the module file. In this file, common variables (global variables), physical constants, are defined together using a run-time allocation array. So to speak, this file plays the role of the library or the header.

2. ``main_2dtm.f90" is called main file. In this file, the entire flow chart is written to determine the reading order of the program blocks. So to speak, this file has the role of the entire blueprint.

3. ``lattice_time_2dtm.f90" is called the mesh size and time step setting file. In this file, the size of the

entire analysis space, mesh size, and the computation step time are determined. The total amount of memory required for the analysis and the total iteration calculation time is determined.

4. ``media_coeff_2dtm.f90" is called the medium file. In this file, the geometry and the material constant of the medium, dielectric constant, magnetic permeability, and conductivity are defined. With this, setting of the spacial coordinate information with regard to the medium is defined. This file has an equivalent role to CAD if this text data information is visualized on a graphic display.

5. ``eh_field_2dtm.f90" is called the field calculation file. In this file, the differential equation of the Maxwell's equations is described. So to speak, it is the core of the FDTD calculation.

6. ``eh_pml_wg_2dtm.f90" is called the Perfectly Matched Layer (PML) file. It has the role of arranging the virtual electromagnetic wave absorbing material at the edge of the analysis space so that the spurious reflection is not generated by the edge of the analysis space. The electromagnetic field sent to this PML file is absorbed but decays exponentially.

7. ``source_2dtm.f90" is called the wave source file. In this file, the input conditions of the electromagnetic field is determined. Speaking of the closed planar circuit problem, it crresponds to voltage source or current source.

8. ``output_field_2dtm.f90" is referred to as the field output file. It performs data output for display visualization of the calculated results of the electric and magnetic fields at every point on the mesh.

9. ``output_tdd_2dtm.f90" is referred to as the time-series output file. It makes the transient response data output of the electromagnetic field. A DFT or FFT can be applied to the time-series data for frequency spectrum analysis.

Table 1. Overview of the source code files. File name and its main role is descripted as follows.

File name	Main role
fdtd_alloc_lib_2dtm.f90	Common variables (global variables), physical constants, the definition of the array
main_2dtm.f90	The entire flow chart
lattice_time_2dtm.f90	The size of the analysis space, mesh size, and configuration of calculation step time
media_coeff_2dtm.f90	Medium of shape and material constant (permittivity, permeability, conductivity) and the definition of coordinates
eh_field_2dtm.f90	Difference formula of Maxwell's equations
eh_pml_wg_2dtm.f90	Absorbing boundary condition
source_2dtm.f90	Input (sine-wave, pulse) Definition
output_field_2dtm.f90	Electromagnetic field space distribution output
output_tdd_2dtm.f90	Electromagnetic field transient response output

The Source codes listed in Table 1 are further divided into several subroutines depending on its internal processing block. For example, the eh_field_2dtm.f90 file is composed of three subroutines listed on the eighth to tenth lines in Table 2. The first subroutine ``init_eh_filed_2dtm'' has the role of array initialization. The second subroutine ``e_field_2dtm'' has the role of electric field calculation. The third subroutine ``h_field_2dtm'' has the role of magnetic field calculation. The division method of these files or subroutines is up to the discretion of the coding designer.

Table 2. Details of the source code. Some source code files have several inner subroutines.

File name	Inner classification
fdtd_alloc_lib_2dtm.f90	module fdtd_lib_2dtm
main_2dtm.f90	program main_2dtm
lattice_time_2dtm.f90	subroutine lattice_time_2dtm
media_coeff_2dtm.f90	subroutine media_coeff_2dtm subroutine modeling_2dtm subroutine circular_media
eh_field_2dtm.f90	subroutine init_eh_field_2dtm subroutine e_field_2dtm subroutine h_field_2dtm
eh_pml_wg_2dtm.f90	subroutine init_eh_pml_wg_2dtm subroutine e_pml_wg_2dtm subroutine ey_pml_calc subroutine ez_pml_calc subroutine h_pml_wg_2dtm subroutine h_pml_calc
source_2dtm.f90	subroutine j_source_2dtm
output_field_2dtm.f90	subroutine output_field_2dtm subroutine slice_yz
output_tdd_2dtm.f90	subroutine output_tdd_2dtm subroutine tdd_ey subroutine tdd_hx

Analysis example

In this program, a Luneberg lens antenna was selected for an analysis example [10]. This antenna is composed of a plurality of concentric dielectric layers. This antenna can be used as a multi-beam antenna because a focal point is formed on the opposite side of the incident plane wave. An analytical model is shown in Fig. 2. There are seven concentric dielectric layers in the center of the analytical space surrounded by the PML absorbing boundary. The current sheet source is input from the left side of the analytical space.

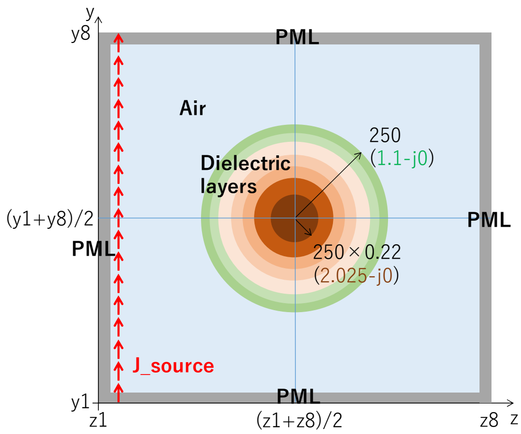

Fig. 2 Schematic view of analytial model of the Luneberg lens antenna.

The maximum radius of the outermost dielectric is 250 mm having the dielectric constant 1.1-*j*0 and minimum radius of the innermost dielectric is 250x0.22 mm having a dielectric constant 2.025-*j*0. In this figure, the variables y1, y8, z1, and z8 represent the edge of the analytical space for typical reference points. The total physical size is about 700 by 700 mm and 2 mm square mesh is used. The total mesh size of the analytical space is a 350 by 350 excluding the PML layer. The analysis frequency is 2.45 GHz (λ_0=122.45 mm). These initial conditions are described in the subroutine ``lattice_time_2dtm'' listed in Table 3 and subroutine ``source_2dtm'' listed in Table 4.

Confirmation of the input data: An example of the source code for creating the material is listed in Table 5. In the source code, the electric and magnetic constants are defined first in the upper half, then their geometric shapes and space coordinate variables are defined in the lower half. In this case, a new shape input subroutine called, ``circular media'' is prepared for modelling a circular material using the coordinates of the center of the circle and its radius. A confirmation screen shot of the entered medium shapes is shown in Fig. 3. This contour data is generated in the subroutine, ``modelling_2dtm''. The free Linux based graph drawing software called, "gnuplot" was used to visualize the output data. In this figure, zero level means free space and one to eight level represents the different dielectric constants. Then the validity of the input model can be confirmed though the PML layer and the current source is not displayed on this figure. It is very important to confirm the input text data through visualization to detect any unwanted mistakes. Users can create any shape by modifying this file. If another shape is input, geometrical shape subroutines such as linear, planar, rectangular, triangular, and parabolic are prepared. Boolean operations are also possible with any combination of these subroutines.

Table 3. A script example for lattice size, time step, and sinusoidal frequency condition. The variable ncpml means the number of meshes in the PML.

```
subroutine lattice_time_2dtm
!****** lattice widths ******
dl=2.0d-3
dy=dl
dz=dl
!****** number of cells in pml (ncpml) ******
ncpml=8  ! number of cell in pml
tcpml=ncpml*dl  ! thickness of pml
!****** sinusoidal frequency  ******
freq=2.45d9      ! Hz
```

Table 4. A script example for current source conditions.

```
subroutine j_source_2dtm
 do j=yi(1),yi(8)-1   ! for z propagation
 k=zi(2)+2
     id=id_ey(j,k)
        ey(j,k)=ey(j,k) &
                -(dt/eps(id))/(1+(sig(id)*dt/(2.0d0*eps(id)))) &
                *(-2.0d0)/sqrt(mu0/eps0)/dz &        ! J [A/m2]
                *dsin(2.0d0*pi*freq*(time-dt/2.0d0))
end do
```

Table 5. A script example for material conditions.

```
subroutine media_coeff_2dtm
! ****** material constants ******
  ! id=0 vacume
  eps(0)=eps0
  sig(0)=0.0d0
  mu(0)=mu0

  ! id=1 pec or pmc

  ! id=2 is dielectric media
  eps(2)=eps0*(1.1d0)
  sig(2)=omega*(eps(2)*0.0d0)
  mu(2)=mu0*(0.0d0)

  ! id=3 is dielectric media
  eps(3)=eps0*(1.25d0)
  sig(3)=omega*(eps(2)*0.0d0)
  mu(3)=mu0*(0.0d0)

  . . . (media 4 to media 7 are omitted for simplicity.)

 ! id=8 is dielectric media
  eps(8)=eps0*(2.025d0)
  sig(8)=omega*(eps(2)*0.0d0)
  mu(8)=mu0*(0.0d0)

!****** coordinates and geometric shape ******
 ! circular media 2
  jcent=nint((yi(1)+yi(8))/2.0)
  kcent=nint((zi(1)+zi(8))/2.0)
  radius=250.0d-3
  call circular_media_2

  ! circular media 3
  jcent=nint((yi(1)+yi(8))/2.0)
  kcent=nint((zi(1)+zi(8))/2.0)
  radius=250.0d-3*0.92
  call circular_media_3

  . . . (media 4 to media 7 are omitted for simplicity.)

  ! circular media 8
  jcent=nint((yi(1)+yi(8))/2.0)
  kcent=nint((zi(1)+zi(8))/2.0)
  radius=250.0d-3*0.22
  call circular_media_8
```

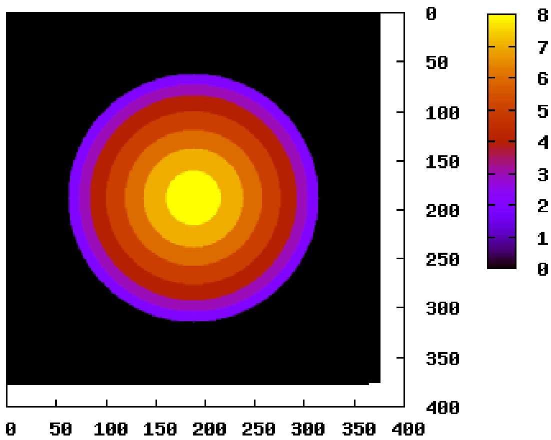

Fig. 3 Confirmation screen shot of the medium shapes created by the text-based input.

Program Execution

First, users have to download all the sample source files into the working folder. Then they will modify the subroutine ``lattice_time_2dtm'' listed in Table 3 and subroutine ``source_2dtm'' listed in Table 4 and subroutine ``media_coeff_2dtm'' listed in Table 5 if necessary. The commands for executing the procedure are listed in Table 6. In this program, the Linux based gfortran is used as the compiler. The ``-c'' option means the compilation of the module file and creating an object file having the same name. Then, the objectfile and all other source files are linked. Finally, the ``a.out'' executable file is created in the same folder. The program can be stopped at any time if Ctrl^c is pressed while the program is running.

Table 6. Commands for execution in the Linux terminal. ``$'' represents the command prompt.

```
$ gfortran –c fdtd_alloc_lib_2dtm.f90

$ gfortran fdtd_alloc_lib_2dtm.o main_2dtm.f90
lattice_time_2dtm.f90 media_coeff_2dtm.f90
eh_field_2dtm.f90 eh_pml_wg_2dtm.f90 source_2dtm.f90
output_field_2dtm.f90 output_tdd.f90

$ ./a.out

$ Ctrl^c
```

How to confirm the results

Figure 4 shows a visualization example of the absolute electric field distribution at a steady state of the Luneberg lens antenna. The strength of the electric field is colored from 0 to 3 V/m when the input electric field level is 1 V/m. A focal point constructed by interference can be observed at the opposite side of the input plane wave having a size of about half of a wavelength. Some of the concentric circlar layers can be observed. These field distribution data files are created in the subroutines ``output_field_2dtm'' and ``slice_yz''. Then, they are visualized using the graph drawing software to make a confirmation of the input data. A gnuplot script example is shown in Table 7 for animating the field distribution. An animation is started if this script file is loaded in the gnuplot terminal. A succeeding GIF animation file can be created if the graphic manupulation software GIMP is used.

It is a significant feature of the FDTD method that users can observe the change of the field distribution from a transient state to a steady state. Then it can have a high educational effectiveness for observing invisible electromagnetic phenomena like reflection, transmission, diffraction, scattering, radiation, and absorption of the wave. It is difficult to obtain these transient features in the case of a frequency domain simulation method like FEM or MOM.

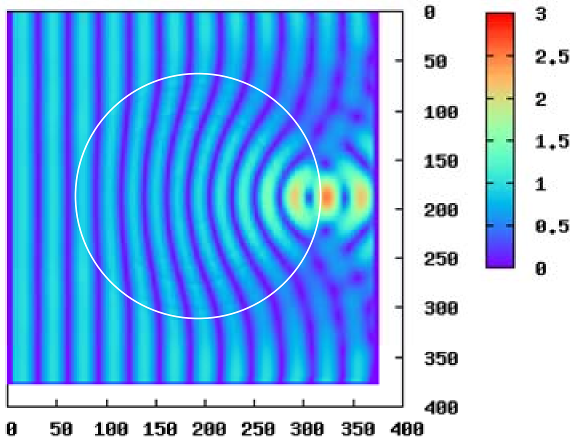

Fig. 4. Visualization example of the absolute electric field distribution at steady state of the Luneberg lens antenna. The focal point can be observed on the right side having a size of half of a wavelength.

Table 7. Script image for visualizing the animated field distribution for gnuplot.

```
set parametric
set pm
set palette rgbformulae 33,13,10   # for rainbow-colored
set size ratio 1.0
unset surface
unset contour
set cntrparam levels 40
set view 0, 90
set cbrange [0:3]
set zero 0
splot 'field_yz0001' u 1:2:6 w l
pause 1.0 'Step : 1'
splot 'field_yz0002' u 1:2:6 w l
pause 1.0 'Step : 2'
splot 'field_yz0003' u 1:2:6 w l
pause 1.0 'Step : 3'
. . .
```

Another simulation examples

Several simulation examples using this program are shown in Figure 5 and Figure 6. In Figure 5, the top left shows a reflection pattern of a parabolic antenna and the top right shows a horn antenna in receiving mode. A focal point is observed on the right side of each pattern. And the bottom left shows a quarter wavelength monopole type wireless handset in transmitting mode. A cylindrical wave radiation pattern and its directivity can be observed. The bottom right shows a microwave oven. Multi-resonant modes can be observed in the cavity. In Figure 6, the top left shows the diffraction from a large aperture. A large wraparound can be observed. The top right shows the diffraction from a large aperture relative to its wavelength in higher frequency. The wraparound is small compared with low frequency cases. The bottom left and bottom right show the interference pattern generated by two small holes relative to its wavelength in low and high frequency cases.

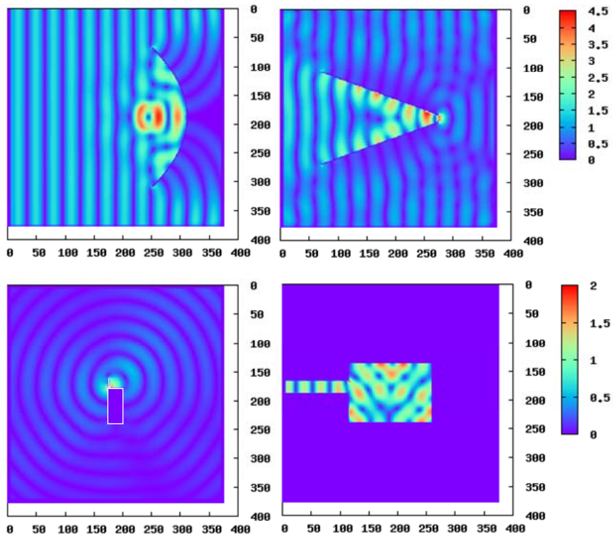

Fig. 5. Simulated examples of reflector antenna, horn antenna, mobile terminal, and resonator .

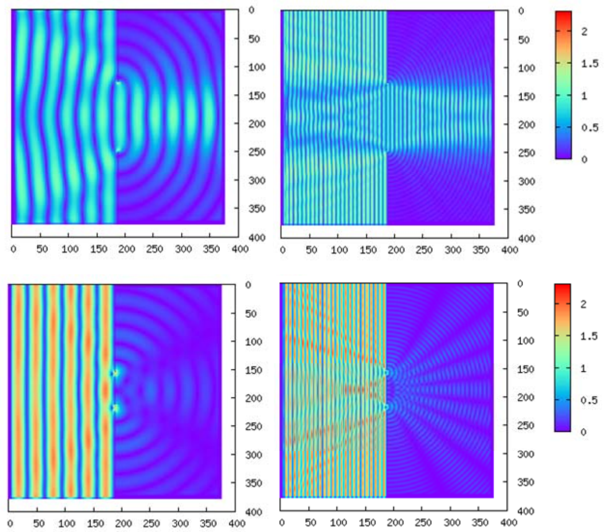

Fig. 6 Simulated examples of diffraction and interference by different types of apertures .

Conclusions

In this program, 2-D FDTD source code was introduced with references for beginners so that a series of simulation exercises including model creation, source code modification, compilation, results output on display while introducing some of the specific analysis cases such as wire and reflector antenna, waveguide, diffraction, scattering, shielding, cavity could be experienced. The significant feature of the FDTD method is that users can observe the change of the field distribution from a transient state to a steady state. With this, it has become possible to introduce specialized content that had been done at the level of researchers about 20 years ago to the current lab student's experimental level with only some low cost Linux PCs. It has a high educational effectiveness for students because invisible electromagnetic phenomena like reflection, transmission, diffraction, scattering, radiation, and absorption of the wave can be visualized using computer simulation.

In the future, this educational training package will lead to the development of a free full featured electromagnetic field and wave simulator that is suitable for practical use in 3-D problems.

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Practice of Active Learning by Role-play of Start-up Companies

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Abstract

Education of practical and creative engineers who are active in a wide field, and innovative evolution of monozukuri (advanced manufacturing technology) are becoming important in recent years. In this paper, we report on the practical information processing education by group work that was likened to the start-up companies. Technical problems given to the students is the development of an android app. One team is formed from 3-5 peoples, respectively. Some roles such as leader, developer, presenter and designer are given for each member of the team. After the team organization they should work on the determination the concept, development, interim report and a presentation. Lecturer should be a mentor to support the students. In addition, lecturer give an instruction that to be aware of the start-up companies to students. This seems to be the effect of increasing the motivation of students.

We adopt the MIT App Inventor 2 as App development environment. In general, because of constraints of the course curriculum, it is difficult to allocate sufficient time for application development. However visual programming provided by this development environment enable the development of a short period of time. We also discussed ideathon. Ideathon is a hands-on format of the seminar, and participants of each team consider brainstormed ideas along with a theme and combine them into better idea. We adopted the logic tree method as a way to organize a lot of ideas that has been issued by the brainstorming.

It is difficult to assess activities of each student in PBL-style classwork. We have defined a rubric for self-assessment of learning outcomes in this lesson by visualization of learning outcomes based on Bloom's taxonomy. We consider the ideas proposed by students and android apps developed by them and the self-evaluation of goals and objectives.

Keywords: *Active Learning, Problem Based Learning, Ideathon, App Inventor, Android App*

Introduction

According to the changes in the industrial structure and the society, the importance of information processing education is increasing. The one of the faculties which required for future ICT engineers is the ability to create new ICT services by themselves. In order to respond to this challenge, Kitakyushu College has performed reorganization in 2015. 5 departments have been consolidated into one department of creative engineering and five new courses have been established. ICT professional education is carried out in the Information System course. Here, we describe the initiatives of "Exercises of Information Processing", which is one of the subject of the Information System Course. Fifth grade students take this subject.

This subject was designed along the guidelines which has been established by NIT (National Institute of Technology, KOSEN Headquarter). We have introduced the practical use of ICT and LMS, group discussion group work, presentation and PBL into the subject as methods of active learning.

MIT App Inventor 2

App Inventor is a software to develop an android-compatible application software. It is an epoch-making concept that app can be created by simply combining. The number of users is increasing with focus on educational use.Figure 1 shows screenshots of design interface for the app.

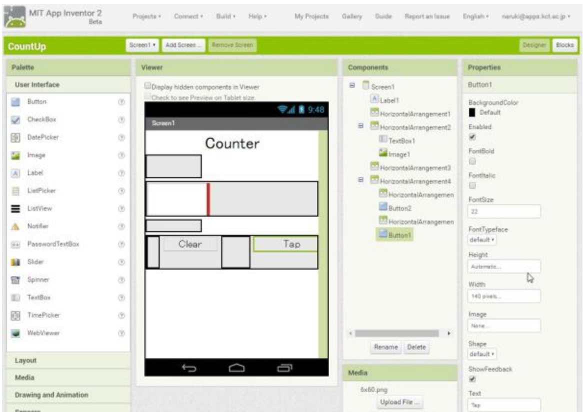

Figure 1. Design of apps interface

Figure 2. Visual programming using blocks

Figure 2 shows screenshots of block mode for programming.

Textbook

Most of the students who attend this classwork are not experienced android application development. They have not learned Java language yet, to say nothing of experience of App Inventor or Android Studio. It can be said that they have learned only the C language, therefore, textbook selection is important. We have selected a textbook which is plain and suitable for self-study. This textbook shows development process of 5 basic apps and 5 advanced apps. Figure 3 shows the contents of these apps.

A. 5 Basic Apps
A1. App to make a call by tapping the screen
A2. Counter app
A3. Pelmanism app
A4. English word learning app
A5. Browser app

B. 5 Advanced Apps
B1. App using an acceleration sensor
B2. App to calculate complex expressions
B3. App to save the data in the cloud
B4. App that slide show the image on the Web
B5. Customization of Google StreetView

Figure 3 Apps those creation procedure is described in the textbook

Connection method of development for the PC and the smartphone and distribution method of the application has been explained in textbooks, it can be said to be suitable for students' self-study. We describe the development of the first three apps until the third classwork, we confirmed all the students have the capability to create these 3 apps.

Subject and Curriculum

We describe the subject in detail. "Excercise of Information Processing" is carried out once per week, tuition of 90 minutes. It is carried out over a period of 15 weeks in the first term. This course of the students are required to learn on a voluntary basis, even outside of classwork time (3 hours per week a total of 45 hours).

Table 1. Schedule of this classwork.

Week	Contents
1	Explanation of the syllabus, Orientation
2	Development Environment
3	Creating a Simple App
4	Team forming, Discussion
5	Ideathon
6 13	Writing a proposal, App development Interim report, Preparation for presentation
14	Presentation, Evaluation of the application, Tuition questionnaire
15	Reflection, Tuition questionnaire

Table 1 shows schedule of this classwork. The purpose of this lesson is to experience the process of application development, project management, planning, development, and presentation. Table 1 shows the schedule of classwork.

Team Forming

We carried out team forming in the fourth classwork. 1 team will be up to five from three. First, 10 students apply for the leader of each team. Leader gathers the necessary human resources who have a ability of programs, presentations, proposals, graphics and scenarios. Further, in order to get to feel the atmosphere of the start-up company, job titles such as CEO (Chief Executive Officer,) CTO (Chief Technology Officer) and CMO (Chief Marketing Officer) are also explained.

In order to get working on app development actively , we provide them direction which is as following. "*Let's imagine. You guys will set up a small start-up companies from now. On the basis of the new ideas, please to develop an app that is required for many users.*"

Ideathon

We carried out ideathon in the fifth classwork. Ideathon is a coined word that combined the "Idea" and "Marathon". Ideathon is a hands-on format of the seminar, and participants of each team consider brainstormed ideas along with a theme and combine them into better idea. Participants will be able to obtain a large sense of accomplishment in proportion to the time, because they concentrate on examining the idea in a short period of time. The theme of ideathon is "App that you want to use". Table 2 shows the time tables of this ideathon. It was carried out in the order of explanation, brainstorming, organizing ideas and presentation. A sufficient amount of simili paper, color pen and post-it has been provided to each team. Whiteboard, tablet, projector can also be available.

Brainstorming is a technique to expect the induction of chain reaction and ideas of mutual crossing by ideas provided from a group member. We explain to students the principles of the ideathon such as "Not critique the ideas of others", "novel and wild ideas are welcome", and "anyway quantity than quality is the important".

Table 2. Time table of ideathon

Explanation of the ideathon	10 minutes
Brainstorming	30 minutes
Organize ideas	30 minutes
Presentation	30 minutes

Figure 3 shows two principles and four rules of brainstorming.

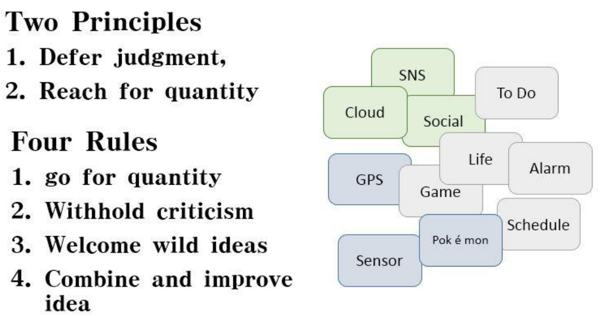

Figure 3. Two principles and four rules of brainstorming

There is a need to organize a lot of ideas. We adopted the logic tree method as a way to organize a lot of ideas that has been issued by the brainstorming.

Figure 4. An image of concept of logic tree

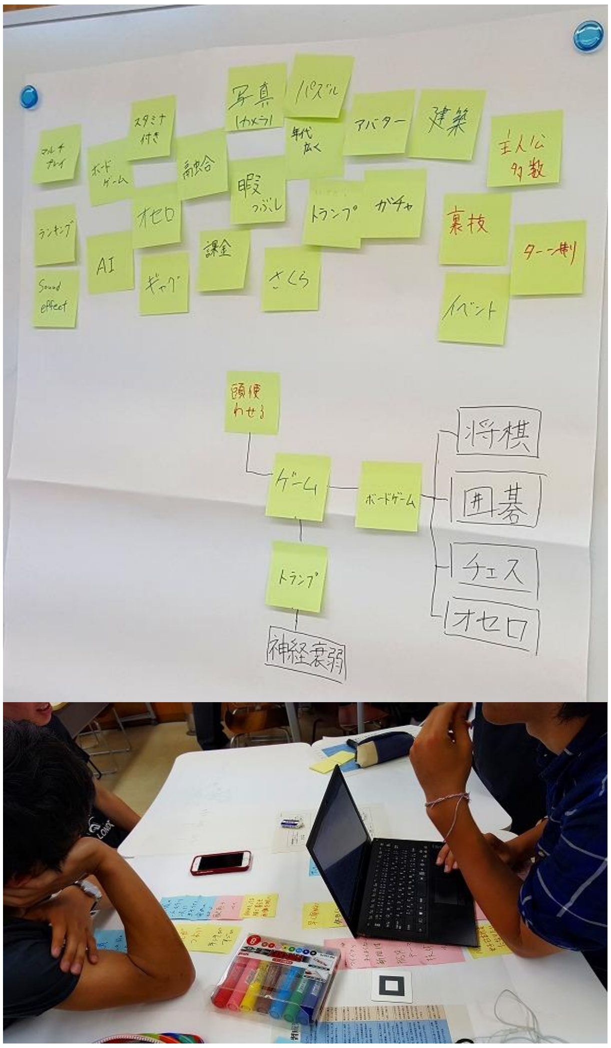

Figure 5. Photos of Ideathon

Figure 4 shows an image of concept of logic tree. Figure 5 shows scenes of Ideathon.

Learning Objectives Based on Bloom's Taxonomy

NIT clarified the learning objectives that should be accomplished from ideal technologist that society demands. NIT define attained level for students based on the Student Outcomes by ABET and the UK-Spec by UK Engineering Council In order to ensure international standards. This attained level in order to develop practical engineers for society and industry, are defined as 6 levels that are Knowledge and memory, Understanding, Application, Analysis, Evaluation and Creation.

At the level 1 (Knowledge and Memory), students can recognize and recall the relevant knowledge). At the level 2 (Understanding), they can understand the meaning of important concepts and methods. And they also should take advantage of if necessary (to interpret, to illustrate, to summarize, to guess, to compare) in this level. At the level 3 (Application), they can apply the knowledge, theory and information in specific cases in order to solve issues. At the level 4 (Analysis), they can analyze complex issues by summarizing the issues, and finding a structure. At the level 5 (Evaluation), they are able to evaluate and determine problem based on the standards and norms (adjustment, discovery, observation, verification, criticism and judgment). At the level 6 (Creation), they can assemble new elements in order to constitute a whole, or re-organize (production, planning and design and product). Figure 1 shows dimension of cognitive processes by Bloom's Taxonomy. Students up to fifth grade should achieve the level 3, and advanced course students needs to achieve the level 4 at least generally.

Results and Discussion

Here we will discuss app student team has created. Table 3 shows the list of android application developed by each team.

Table 3. The list of android apps developed by them

Team	Category	Features and Notes
1	ToDo	Focusing on the priority of the task
2	Alarm	Prevention overslept using location information
3	Game of Tag	Location information
4	Quiz (Game)	Learning support app test
5	Novel Game	School-themed novel game
6	ToDo	Simple Interface
7	Novel Game	School-themed novel game
8	Schedule manage	Simple Interface
9	Vocabulary learning	virtual creatures assists learning and keep motivation.
10	Board Game	Simple board game collection

Figure 6,7,8,9,10,11 shows screenshots of apps by Team 1,2,3,5,9,10 respectively.

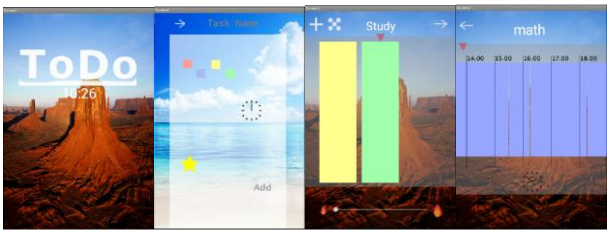

Figure 6. Screen shots of ToDo app by Team 1

Figure 7. Screen shots of alarm app by Team2

Figure 8. Screen shots of novel game app by Team 3


Figure 9. Screen shots of novel game app by Team 5

Figure 10. Screen shots of novel game app by Team 9

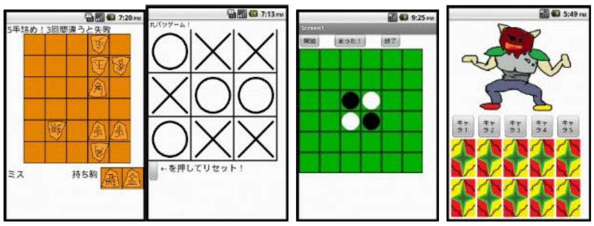
Figure 11. Screen shots of novel game app by Team 10

To Do app that allows customization of the priority, alarm apps to prevent overslept using location information, high-quality school-themed novel game and so on, 10 apps based on the students' idea of were developed. Especially vocabulary learning app that virtual creature assist to keep users' motivation of the user, its ideas and quality are excellent.

Visualization of Learning Outcomes

It is difficult to assess activities of each student in PBL-style classwork. We have defined a rubric for self-assessment of learning outcomes in this lesson by visualization of learning outcomes based on Bloom's taxonomy.

Table 4. Rubric assessment sheet

	Lv1	Lv2	Lv3	Lv4	Lv5	Lv6
A. Independence	A1	A2	A3	A4	A5	A6
B. Responsibility	B1	B2	B3	B4	B5	B6
C. Logical thinking	C1	C2	C3	C4	C5	C6
D. Identify topics	D1	D2	D3	D4	D5	D6
E. Teamwork	E1	E2	E3	E4	E5	E6
F. Leadership	F1	F2	F3	F4	F5	F6
G. Communication	G1	G2	G3	G4	G5	G6
H. Consensus Building	H1	H2	H3	H4	H5	H6

Table 5. Result of Rubric assessment sheet (%)

	Lv1	Lv2	Lv3	Lv4	Lv5	Lv6	N. A.
A	2.564	10.256	25.641	25.641	20.513	15.385	0.000
B	2.564	5.128	25.641	35.897	20.513	10.256	0.000
C	2.564	10.256	35.897	23.077	23.077	5.128	0.000
D	2.564	17.949	17.949	33.333	20.513	7.692	0.000
E	2.564	10.256	25.641	38.462	20.513	2.564	0.000
F	5.128	10.256	41.026	23.077	12.821	7.692	0.000
G	5.128	0.000	23.077	43.590	20.513	5.128	2.564
H	2.564	2.564	30.769	41.026	15.385	5.128	2.564

Question A "Independence"
In the application development by the team, please answer about your level stage of the "independence".

A1. know that you have to think on your own and work by yourself
A2. can show your solutions to team members.
A3. can perform your tasks and can work by yourself
A4. can explain how your self-directed activities have impact on entire project and can explain that self-directed activities is appropriate or not
A5. can figure work and role that you should do
A6. can plan that others should do proactively, encourage it, and evaluate the self-directed activities of the members

Question B "Responsibility"
In the application development by the team, please answer about your level stage of the "responsibility".

B1. know that you should tackle to the challenge
B2. can explain and understand their role as part of a team, should be responsible for their own actions
B3. can understand your role as a member of the team, should be responsible behavior
B4. can understands your roles as a member of team, and can act with responsibility and social common sense considering the effect on the team
B5. can recognize the role of engineer as a member of society, and can self-evaluate with social responsibility
B6. can practice a social responsibility as a member of society and organizations, and can objectively evaluate and improve it.

Question C " Logical thinking"
In the application development by the team, please answer about your level stage of the "logical thinking".

C1. know that you have to propose a logical problem-solving method.
C2. can explain the problem solving method logically
C3. can implemented in accordance with the proposed method logically in order to solve problems
C4. can propose implementation of a solution that is able to take the logical consistency, even if issues are complex
C5. can compared to other methods logically
C6. can make an implementation plan by the best way in advance

Question D "Identify topics"
In the application development by the team, please answer about your level stage of the "identify topics".

D1. know that found problems, must be resolved, in order to achieve the purpose
D2. can identify gaps between current and desired due to the references, and can demonstrate the need for its resolution
D3. can find the gap between the current situation and objectives, and show the cause-and-effect relationship clearly , and can propose and implement specific solutions
D4. can implement feasible ways to narrow from a number of proposed solutions
D5. can formulate and implement specific and feasible solution and can verify its effectiveness and impact
D6. can find completely new gap between the current situation and purpose that has not been verified until now, show the cause-and-effect relationships and priority clearly, while planning a concrete and feasible solutions, verify the effectiveness and impact, and implement the plan

Question E "Teamwork"
In the application development by the team, please answer about your level stage of the "identify topics".

E1. know that teamwork is important in advancing the collaboration.
E2. understand the needs, rules and etiquette for the team in order to work together effectively
E3. can respect the opinions of others as part of a team, and can work together with the appropriate communication
E4. can understand the goals of the team and the individual roles, think himself the action to be taken to achieve the targets, and carry out
E5. can evaluate the progress and level of completion of the project throughout the work
E6. can promote duties as a team member by performance at your full ability or aptitude

Question F "Leadership"
In the application development by the team, please answer about your level stage of the "leadership".

F1. know the role of leader for advance the collaborative work efficiently
F2. can explain the leader's role which is needed for a collaboration
F3. can encourage appropriate cooperative actions to others, to work jointly
F4. can indicates the direction of the team, understand the progress and individual work situation, and can take informed decisions and actions for the goals
F5. can assess work status and progress of the team and the behavior of the members
F6. can selected the best human resources in the execution of the project, to maximize the individual's ability, can promote joint work

Question G "Communication"
In the application development by the team, please answer about your level stage of the "communication".

G1. can know that the method which facilitate communication should be devised
G2. can know that the method that facilitate communication have a need to be devised
G3. can explain own opinion and thoughts, and can tell ideas to others using narratives, diagrams, texts, etc
G4. can hear others' opinions, communicate while devising the way depending on the opponent's own ideas and communicate smoothly
G5. can tell your own opinions and ideas taking advantage of the features of the dictation, charts, text, etc, and can evaluate its effectiveness
G6. can propose and implement explanation which is able to gain a deeper understanding from others

Question H "Consensus Building"
In the application development by the team, please answer about your level stage of the "consensus building".

H1. know some methods of consensus building and information gathering, information utilization and dispatch of information
H2. can explain each features of methods of consensus building and information gathering, information utilization and dispatch of information
H3. can build a consensus, can gather information, utilize and spread it, on the basis of a certain way
H4. can choose what works best from several different methods depending on the purpose, consensus building and information gathering, information utilization and dispatch of information
H5. can evaluate the effects of consensus building with particular group, and information gathering, information utilization and dispatch of information
H6. can plan consensus building with non-specific populations, the efficient method of information gathering, information utilization and dispatch of information

Figure 12. Items of rubric assessment for activities on PBL - Visualization of Learning Outcomes (Practical Version)

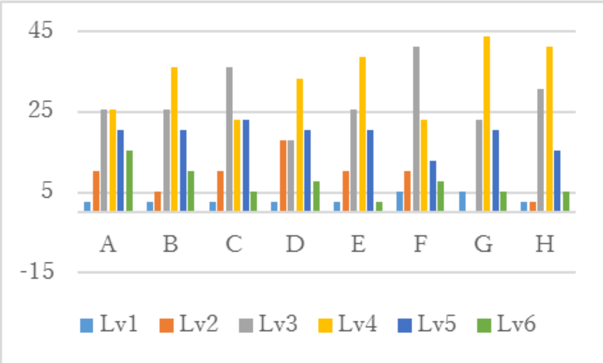

Figure 13. Bar chart of Rubric assessment

Table 4 shows rubric assesment sheet, and table 5 shows aggregate result using it. Figure 13. Bar chart of Rubric evaluation sheet. 5 Items that are "Responsibility", "Identify topics", "Teamwork", "Communication" and "Consensus Building" has been most marked as stage of level 4. Overall, it can be confirmed that the Level 3 and Level 4 is marked more than other levels. The obtained results are close to the level that we assume beforehand.

Effective utilization of ICT in education

Here, we provide miscellaneous topics related to the classwork. There is a sufficient number of Windows PCs in the classroom, all students are able to use the PC. We have confirmed the operation of the App Inventor and its emulator using Google Chrome on each PC. However, if possible, we recommend the use of actual machine such as an android device. It is important to ascertain the behavior of the application in the actual equipment. Also, when your app uses sensors, actual equipment is required to check the behavior of the sensor. However, since it is difficult to prepare a sufficient number of smartphones, it seems like the idea that the recommendations of BYOD (bring your own device) is worth considering to solve the problem. We use cloud service and LMS actively to provide to provide teaching materials to participants and tuition questionnaire or submission of files. Presentation videos of each team was provided using Google Apps for Education. App project files, installation files, reports, presentation files are submitted to the LMS.

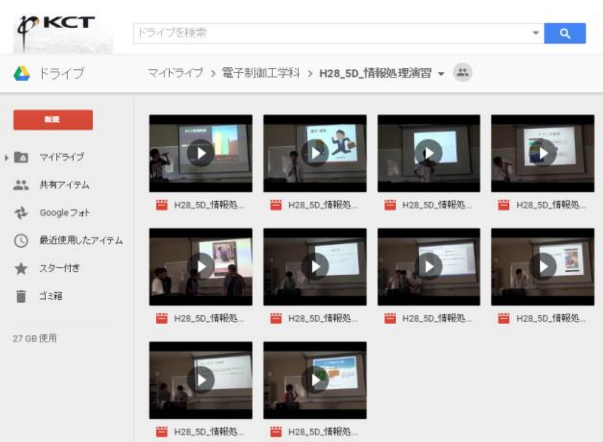

Figure 14. Presentation video Viewing

Figure 15. Tuition questionnaire on LMS

Conclusions

We carried out the practical PBL style classwork, those theme is to develop an android app using App Inventor. It was confirmed that students can develop android apps in a short period of time. Each group has developed an android app based on brainstormed ideas. We have defined a rubric for self-assessment of learning outcomes in this lesson by visualization of learning outcomes based on Bloom's taxonomy. We confirmed that most of the participants achieved the learning objectives that we expect. In order to increase the motivation of participants, we explained to them that each group should be like startups. however, there still remains many issues, we continue with this approach in future.

Acknowledgements

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CHALLENGES OF IMPLEMENTING PEER TUTORING PROGRAMME

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Abstract

This paper discusses the challenges faced while implementing a peer-tutoring programme. The programme attempted to help students who would score poorly in examinations. Students took a qualitative survey after attending the programme. The students have feedback that the programme was beneficial to them. This paper discusses the challenges of conducting the programme and proposes recommendations.

Keywords: *peer tutoring, collaborative learning, engineering, examination*

Introduction

Polytechnic students, during their course of study, will always find certain modules difficult to learn and do well in examinations. In Republic Polytechnic (RP), School of Engineering (SEG), some of the engineering and technology modules have high failure rates. Students generally find these modules technically or conceptually challenging. Peer tutoring can be one of the ways to help this group of students. Various institutions have adopted this learning approach as a form of a supplementary programme in addition to their regular ways of conducting classroom learning. Research findings have found that peer tutoring was an effective method of instruction (Beasley, 1997; Colvin, 2007; Magin & Churches, 1995; Mahdi, 2006). According to Goodlad & Hirst (1989), this could be due to various reasons. The peer tutor has the ability to give more individualized instruction to his tutees. The programme provides a climate in which tutees can feel less inhibited about asking question and seeking help. Lastly, the tutee can learn better from the tutor who has an empathetic appreciation of what a tutee need to know and do. Learning can be more effective when the process fully involves the tutee in a supportive and non-threatening environment strengthened by a collaborative approach between students (Mahdi, 2006, p. 278).

Peer Tutoring Model

Various institutions adopted different ways in conducting peer tutoring programmes. In Murdoch University (Beasley, 1997), monetary incentives were provided to higher year students who have achieved good grades in the nominated modules to function as peer tutors to first year international students. One of the objectives of such programme was to help these students to adapt to differing cultural and educational traditions. A two-hour workshop was included for the tutors as a form of training to prepare them on the roles and responsibilities of tutoring. In University of New South Wales (Magin & Churches, 1995), there was a need to change from traditional pencil-and-paper engineering design subjects to a programme in which design teaching was based on computer graphics. Due to the limitation of workstations, one group of students was the first to learn the computer graphics software. They would then serve as peer tutors to the rest in the same cohort, to bring up to the same level of mastery in the use of the software. In University of Limerick (Mahdi, 2006), the Department of Electronics and Computer Engineering tried out peer tutoring as a non-traditional approach in courses that had high failure rates. The intention was to provide an effective learning environment and encourage students' active self-directedness, involvement and critical thinking. Based on faculty recommendation, a specially selected group of higher year students attended a short training programme in facilitation of study. After the training, they volunteered as peer tutors to facilitate active learning to a group of first year students. In University of Utah (Colvin, 2007), a peer tutoring training course was developed to address the social dynamics in peer tutoring programme occurring among students, tutors, and instructors. The course explored communication, interaction, and identity concepts and also covered diversity, research, socioemotional bonding, community outreach, and instructional issues. Students enrolled in the course, who wanted to practice what they have learned, could apply for the tutor internship to serve as mentors and facilitators in an introductory course.

As described above, institutions customised peer tutoring programme to their specific situation and needs. It may be difficult for other institutions to follow the same programme entirely. As such, in RP SEG, a taskforce has developed a peer tutoring programme, which was tweaked to the situation and needs of the students.

Republic Polytechnic

RP has advocated and extensively use a type of pedagogy approach called problem-based learning (PBL) (O'Grady & Alwis, 2002). PBL is an "instructional format requiring students to participate actively in their own learning by researching and working through a series of real-life problems to arrive at a 'best' solution" (Arambula-Greenfield, 1996). Through the implementation of PBL, RP devised a learning process called one-day, one-problem approach (O'Grady & Alwis, 2002, p. 3), where students are given different but related real-life problems every day. On each day, students will receive a lesson package consisting of a problem statement, worksheet and additional resources, such as video clips, simulation software or customised scaffold program. They are required to solve the problem as a group through deliberation and experimentation within a day.

In RP, a Programme Chair, who is the person-in-charge of a diploma programme, would oversee the academic aspect of all the students taking the diploma and also manage the modules that form the curriculum of the diploma. A Module Chair, who is the person-in-charge of a particular module, would design and implement the module in accordance to the pedagogy advocated in RP. In addition, the Module Chair would perform the administrative, managerial, and logistic role for the module. There are two summative assessments conducted in each module, namely, Mid-Semester Assessment (MSA) and End-Semester Examination (ESE). MSA is normally conducted after the seventh week of the module while ESE is conducted at the end of the module.

Engineering Programme for Achieving Excellence

Engineering Programme for Achieving Excellence (EPACE) is an initiative by SEG, to create a peer tutoring platform with the objective of helping students, who generally did not perform well at examinations. The school setup a taskforce to coordinate this programme. The taskforce piloted the programme in 2014 for a few modules. However, there was no survey conducted and thus analysis could not be done to review the effectiveness of the programme.

In 2015, a more systematic approach was in place. The programme was conducted twice over two semesters for different modules. The taskforce did not select all the modules in SEG for the programme as it was still in its pilot run. Programme Chairs of various diplomas in SEG would identify the modules that they perceived as technically challenging for the students or the module had historically high failure rates. The taskforce would brief Module Chairs of these selected modules on the objective and tasks of the programme. Module Chairs would then inform their lecturers, who were teaching their modules, to observe and identify two groups of students in their class, namely, Volunteers and Learners. Volunteers were students who have shown good capability to grasp concepts and were actively participating in class. Learners were students who have shown weak ability to understand the concepts covered in class. The lecturers would identify these groups of students based on their performance in the first two lessons of the module. Taskforce members will conduct a briefing to the Volunteers by explaining to them the expectation required in the programme and the benefits they will gain through volunteering their services. For the Learners, email notifications were sent to them and lecturers of their respective classes would inform and encourage the Learners to attend the sessions.

Discussion

There were slight differences on the approaches when conducting the programme across two semesters in 2015. This paper seeks to discuss on the delivery of the programme in Semester 2. For each module, there were two sessions conducted before the Mid-Semester Assessment (MSA) and three sessions conducted before the End-Semester Examination (ESE). Module Chairs will invite the students, who attended the last EPACE session, to do a survey to give feedback of the programme. In RP, a typical lesson for any module stretches throughout the whole day for seven hours. Hence, each module will have EPACE session once per week for two hours after class lesson. There would be cases where Volunteers and Learners would need to attend two to three EPACE session per week for different modules. Volunteers and Learners were commonly grouped in a ratio of 1:5. During the EPACE session, respective Module Chairs had the freedom and flexibility in the mode of conducting the session. For example, in E204 Linear Circuits and Control, students came from two different diplomas. Thus, the Module Chair grouped the Volunteers and Learners according to their diplomas and classes. During the session, Learners were familiar and comfortable with the Volunteers, as they know each other from the same class. The Module Chair would specify a few topics to cover for each EPACE session and Volunteers would use the worksheet questions, to guide the Learners. Another example, in E114 Mathematics for Engineering, the Module Chair would similarly assign the Volunteers to the Learners according to their diplomas and classes. There were extra revision questions given besides the usual lesson package. Thus, the Module Chair would suggest a topic range for the Volunteers to cover, and make use of the revision worksheet to guide the Learners.

There were eleven modules identified by Programme Chairs of various diplomas in School of Engineering in 2015 Semester 2. In these eleven modules, there were a total of 244 Volunteers and 650 Learners recommended by their class lecturers through observations of their class performance during the first two weeks of the semester. Among the 244 identified Volunteers, 133 of them expressed interest and willing to step forward to serve as peer tutors. Figure 1 shows the attendance of the Volunteers. About half of the Volunteers attended three or more sessions. This shows that the Volunteers were committed to volunteer their service to help the Learners. Out of the 650 identified Learners, 370 students attended at least one of the sessions. However, only 67 students or 10.31% attended three or more sessions. Figure 2 shows the breakdown of the attendance for the Learners.

Figure 1: Attendance of the Volunteers

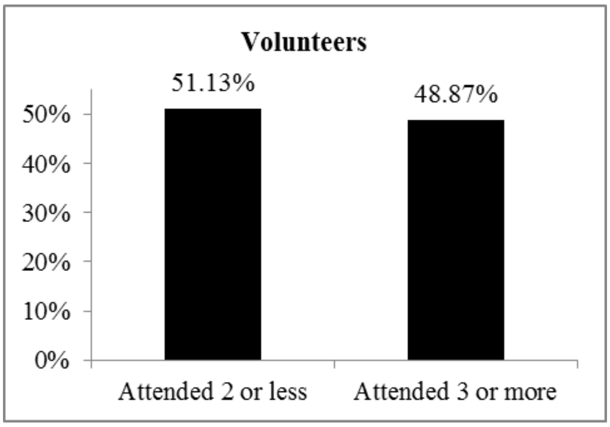
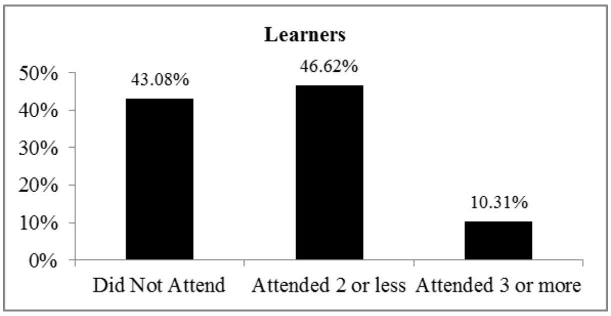


Figure 2: Attendance of the Learners



Through the feedback collated after the programme, both group of Volunteers and Learners generally felt positive on what they have achieved through the programme. Three examples of the Learners' feedback are given below.

Student A: "I have more understanding and I got help during the sessions to get more in depth about the module."

Student B: "I had some doubts and questions regarding certain concepts from the module that I needed to clarify. Therefore, through the programme, my peers helped me out and I was able to have a better level of understanding of those concepts. I also needed help in solving certain worksheet questions and I am glad that with guidance from my peer tutors, I was able to solve the questions."

Student C: "I was able to do more questions after the programme with the help of my student coach. He gives me sufficient help to be able to work out the questions on my own and explain to me where I have make mistakes in my answers."

Three examples of the Volunteers' feedback are given below:

Student D: "Through this program I have achieved in teaching my peer this module. When there is anything they do not know I will teach them. So through this programme I learn how to teach."

Student E: "I have a clearer understanding of the problems as I have to teach the students step by step which helped me understand the concepts clearer."

Student F: "Through this programme, I have motivation to learn all of the theory. Due to I have to teach my peer and this is my responsibility to help them. Therefore, I would make sure that I must understand all of the theory and problem before teaching them."

From the above feedback, they do concur with the benefits shown in research findings that peer tutoring offers tutors the opportunity to build up their confidence as they could re-present the knowledge to their peers (Colvin, 2007; Goodlad & Hirst, 1989, p. 61).

Challenges

As shown in Figure 2 above, the first challenge that the programme faced was the poor attendance of the Learners. Majority of the Learners either attended one or two sessions or did not attend at all. There were mainly two reasons based from feedback gathered from the students. One group of the students commented that they were unaware on the purpose of the programme and the benefits they could reap from attending the programme. Another group of the students stated the reason that they need to work after class. Some of these students have to work as they come from poor socio-economic background. As such, they require additional income to support themselves or their family. However, working part-time after class can cause a vicious cycle affecting their learning. They would have insufficient sleep, as they normally need to work until late night and have to wake up early the next day for class. They will not be able to focus well in class during the day and this will affect their learning ability. Thus, as the Learners are not able to attend the programme, they would miss the opportunity to improve their study skills.

Another challenge was the selection process of the Learners. Lecturers will recommend their students based on their performance in class during the first two lessons. Feedback from the Module Chairs was that this method of selection was subjective and might not be able to identify accurately those students who really need help. For these groups of students, when they failed their MSA, they will be encouraged to join the programme. However, they would have missed the opportunity to attend the first two peer tutor sessions.

Recommendations

One recommendation to heighten awareness of the programme is to make use of a platform to introduce the programme to all students. Normally, there is a PC (Programme Chair) briefing held at the start of every semester for all students. PC could make use of this platform to explain the purpose and benefits of the programme to the students and to show recognition to the Volunteers of the previous semester by presenting them a 'Certificate of Participation'. This is a chance for the students to know the Volunteers and this may trigger a start of their own peer tutoring group organically.

Another recommendation is to improve the selection process for the Learners. One suggestion could be to select students based on their cumulative grade point average (GPA) as a first level of selection. Subsequently, class lecturers can still identify their students who might need help, based on class observation and include them into the programme.

Conclusion

This paper seeks to discuss on the challenges faced through the delivery of peer tutoring programme (EPACE) initiated by Republic Polytechnic, School of Engineering. The objective is to help students who would score poorly in examinations. While the programme had good intention to help the students, one of the biggest challenges was the poor attendance of the Leaners. This paper cited various challenges and proposed recommendations. Qualitative feedback has shown that peer tutoring benefitted those students who have participated in the programme, with the reason that they can interact in a more open and less threatening learning climate. In particular, Learners can make use of this platform to acquire better understanding of the subject matter and improve their study skills.

Acknowledgement

The authors would like to express their gratitude to the management of School of Engineering, Republic Polytechnic, the Programme Chairs of various diplomas involved, and the Module Chairs of the EPACE modules, for the strong support they have given to the programme. Last but not least, deepest appreciation to all the members of the taskforce, who have taken up various logistics or administrative roles, to coordinate and ensure that the programme is carried out smoothly.

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ACTIVE AND INTERACTIVE LEARNING ACTIVITIES IN MATSUE COLLEGE

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Abstract

In recent years, active learning is attracting great attention in engineering education as innovative education methods. The active learning can take wide variety of forms, for example, PBL, flip teaching, engineering design, group works and so on. Engineering design exercises through PBL model, faculty development workshop, and so on are introduced in Matsue college. This paper provides information regarding the possibilities of active and interactive learning through some practical activities in Matsue college.

Keywords: *active learning, interactive learning, engineering design, faculty development*

1. Introduction

Active learning has become an important and essential technique as innovative education methods over past several years. In General, active learning can take various forms, for example, PBL, flip teaching, engineering design, group work and so on. In Matsue college, some active learning activities are achieved and the faculty development workshop was held to teaching practices in the interactive learning.

In this paper, engineering design exercises through PBL model and faculty development workshop in Matsue college are introduced. Especially, the engineering design process is a series of steps that engineers take in creating functional products and it is highly interactive. Furthermore, question techniques were practiced to improve student-teacher classroom interaction in the faculty development workshop in Matsue college.

This paper provides information regarding the possibilities of active and interactive learning through some practical activities in Matsue college.

2. Active and Interactive Learning

Reference[1] says "*Active learning is a process whereby students engage in activities, such as reading, writing, discussion, or problem solving that promote analysis, synthesis, and evaluation of class content*".In short, active learning includes most activity that students do in a classroom other than merely passively listening to an instructor's lecture.

Needless to say, there are wide variety of forms to use active learning in the classroom, for example, cooperative learning, interactive learning, problem-based learning(PBL), flip teaching, group works, case studies, role playing, jigsaw discussions, brain storming, self-assessment, clarification pauses.

In particular, active learning does not have to replace traditional lecturing. To give an extreme example, a rudimentary case of active learning introduce only few active and cooperative learning exercises that work, so teachers can break up long lectures and see if students understood what they just taught them.

In Matsue college, some active learning activities are introduced in recent years, such as engineering design exercises through PBL model and the faculty development workshop on interactive learning via some question techniques.

3. What's Engineering Design?

The international-standard accreditation for Engineering education, such as ABET(USA), JABEE(Japan), IES(Singapole), ABEEK(Korea), IEET(Taiwan), BEM (Malaysia) and so on, is proof that a collegiate program has met certain standards necessary to produce graduates who are ready to enter their professions.

The engineering design component of a curriculum must include at least some of the following features in those accreditations :

- development of student creativity
- use of open-ended problems
- development and use of design

In general, the engineering design process is a series of steps that engineers take in creating functional products. Strictly speaking, "*Engineering design is the process of devising a system, component, or process to meet desired needs, specifications, codes, and standards within constraints such as health and safety, cost, ethics, policy, sustain-ability, constructability, and manufacturability*"[2].

A typical design involves clarification of clients' requirements, identification of both constraints and the context in which the product will be used. Moreover, development of one or more design concepts for consideration by the client. Then, the process of defining functions and specifications, detailed design, and analysis of production issues follows[3].

On the other hand, though there are many text books about engineering design in English(Figure.1), only 3 text books are published in Japanese. One of text books in Japanese (Figure.2) is translated by T.Beppu, who is co-author of this paper[4].

Figure 1 Text Books of Engineering Design in English

Figure 2 Text Book of Engineering Design in Japanese

4.Engineering Design Exercises in Matsue College

In Matsue college, there are some engineering design related subjects in 1st grade of advanced school(See Table 1) and engineering education process of department of information engineering(See Figure 3).

Table 1 Engineering design related subjects

Subjects	Semester in 1st Grd	Credits
Engineering Design	1st semester	2
Engineering Design Semminor	2nd semester	1
Systems Engineering Experiments 1	1st semester	3
Systems Engineering Experiments 2	2nd semester	1

Figure 4 Photograph of Poster Presentation

The Japan Accreditation Board for Engineering Education(JABEE) defined engineering design as "*an interactive open-ended process of creativity*" to their curriculum. Most universities and colleges added exercises of creativity to their curriculum in Japan, they do not teach the basics of the engineering design process in their education program.

For example, as described in above chapter, ABET defined "*The process of devising a system, component, or process to meet desired needs*". So, in this definition, clearly defined engineering design process is developed to meet the needs and requirements of customer or client.

In Matsue college, the engineering design exercise in the subject, which is System Engineering Experiment 1 of Table 1, with following procedure:

(a)Identify a problem and a need of customer or client as a form of PBL model.
(b)Define requirements and constraints.
(c)Generate ideas or brainstorm for set possible solutions.
(d)Use requirements and constraints to evaluate possible solutions.
(e)Use the chosen solution to design and build a prototype.
(f)Test and evaluate the prototype and modify if necessary to finalize prototype.
(g)Communicate the results through some kinds of presentation(design review).

Table 2 gives two specific themes of engineering design execise through PBL in 2013 and Figure 4 shows the photograph of poster presentation. Futhermore, Figure 5 and 6 show examples of the poster(Theme 1).

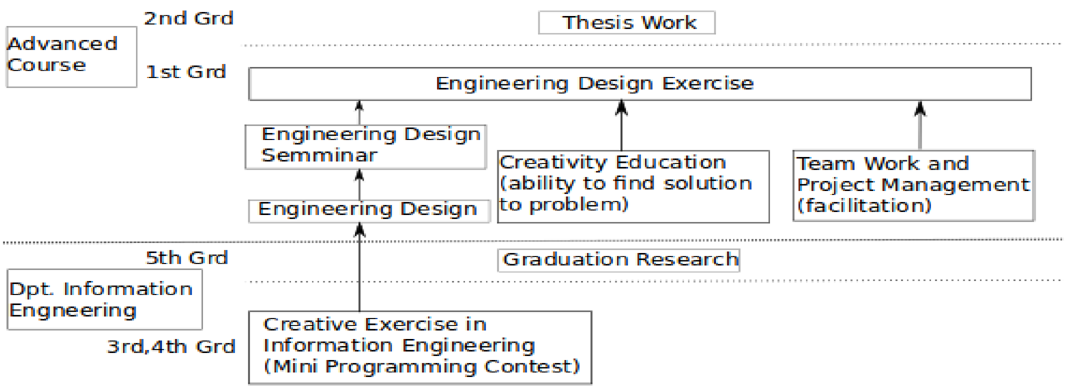

Figure 3 Engineering Design Education Process of Dept. Information Engineering

Table 2 Themes of Engineering Design Exercise

No.	theme
1	Development of fun and interesting toy for children
2	Development of the security / crime restraint / criminal arrest system

In engineering design exercise, each student group must designs and develops a new product using the above procedure according to given theme within 7 weeks, and the budget is only 7,000 yen (about 70 US dollars) per each group. Finally, each group must give the poster presentation as the design review of the developed product.

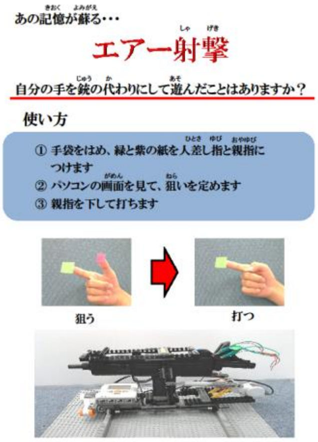

Figure 5 An Example of Poster(A)(Theme 1)

Figure 6 An Example of Poster(B)(Theme 1)

5.Fuculty Development Workshop for Interactive Learning in Matsue college

Figure 7 Photograph of FD Workshop

The question in the class is an important process to let the students participate in the educational activities. However, ongoing interaction between students and teachers using some question techniques is often difficult to achieve. For example, when classroom interaction occurs, a teacher may not be able to identify all the relevant factors. Furthermore, there are class sessions in which an instructor receives minimal response from students in spite of following a lesson content that got a great discussion in a previous class.

To improve teacher's ability to interact with students we must learn the effective teaching methods. The question technique is one of them, however, it will give a relatively big improvement by small efforts.

In Matsue college, some question techniques were practiced to improve student-teacher classroom inter-action in the faculty development workshop at 26 February 2016. The workshop was held to teaching practices for 2 hours, and 36 teachers (include 4 teachers of Yonago college) participated(Figure 7).

Then, we are going to have a series of this workshop at 25 November 2016.

6.Conclusion

Active learning is not a theory but a teaching method that supports learning of students. The method uses some techniques that promote analysis, synthesis and evaluation that guide students towards achieving learning objectives. This paper shows some active and interactive learning activities which are introduced in Matsue college. Especially, we think that engineering design exercises through PBL model are effectively achieved in Matsue college. However, measurement of educational outcomes of engineering design education and faculty development workshop is not done.

Therefore, this results leads us to analyse our active and interactive activities form the point of view of educational outcomes .

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1501

REVIEW SHEET TO RECORD CHANGES OF STUDENTS` EMOTIONS

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Abstract

It is widely agree that emotions affect the active learning attitudes of learners or students, but this basic formula is neither put into practice in higher education nor well regarded as an index to consider how to improve curriculum. This paper aims to investigate how various kinds of students' emotions can be analysed and turned into a set of data that can be used for the improvement of classroom lectures and PBL(Project Based Learning). To clarify the relationship between the students' emotion and lectures and hands-on practices, this paper focuses on two targets for students: (1) the ability to achieve things themselves and (2) the competency to show their own capabilities and talents in a group. First, we measured their emotional changes in some lectures and PBL classes using our review sheet. We also took data after extracurricular social-oriented activities. The results so far are: it is quite difficult to read the change of students' emotion from visual observations made in the classroom lectures alone. Therefore, it is not be easy to utilize visual observations to think of the way to improve both teachers' skills and what content to teach. On the other hand, it is much clearer to read and understand their emotional changes from the review sheet for the PBL. Upon review of this data, we can effectively discuss how we may improve teachers' skills and focus on what content to teach. We are also able to use the data of the review sheets for improvements in the coaching measurements as well as in reflections on the teaching by the teachers. In sum, this paper recommends to use the review sheet to improve teachers' coaching skills especially with respect to PBL, which may cultivate students' competency, under the circumstance that the students would generate not just positive emotions but also negative ones, such as nervous and regrettable, since it seems to be an effective tool to function for change in the ways of our teaching.

Keywords: *Change of students' emotions, review sheet, ability, competency, PBL*

Introduction

We are facing rapid social changes due to the recent circumstances such as the trends in which globalization generates more people who have a wider range and more diverse sense of values in which the progress of ICT makes it faster to acquire information. This urges people to refresh and renew their own abilities constantly along with these social changes. Thus, an ability to keep learning actively has become much more significant now than ever before. We are also facing complicated problems that involve multidisciplinary issues require an ability to cooperate with other fields of professionals to tackle this complexity. Unfortunately, however, this level of collaboration may be difficult to achieve in Japan due to the declining birth rate and growing tendency of "play alone" single child family.

As we hypothesize here, the necessary interaction may require both positive emotions and negative emotions from students for them to keep learning. In this paper, we compare in the change of the emotions within and between three classes. One class is the newly introduced class in our college, "Co$^+$work" which is administered in a PBL style, and the second is a traditionally employed lecture, "Politics and Economics", as is the third "Civil Engineering Materials". We took surveys of students' emotions after each class by the "review sheet" to capture their emotions, and attempted to draw out the emotional keywords necessary for the active learning.

Students rarely have a chance to cooperate with other students enrolled in different departments. They are all enrolled in one of four technical majors which are mechanical engineering, electrical and information engineering, civil engineering, and architecture. Thus, our college started the new course, "Co$^+$work" as a compulsory credit to address the problem of that situation. The course includes three grades students, 2nd, 3rd, and 4th, year students from each of the four departments. In total, 523 students were enrolled in this course, and were divided into 63 groups to match up with 63 faculty members. As a result, each group contains 8 or 9 students, and one teacher per group takes care of his or her group as a coach.

This course aims to cultivate competency in autonomy, cooperation, and creativity through the interaction of students from the different fields as they tackle the same project. The name "Co$^+$work" is derived from the thought of having a need to create something by cooperating in practice. And we believe it is important to have "co-" for communication, consensus, commitment, cooperation, collaboration.

Similar exercises have been implemented in many university and NIT colleges, but ours is unique in that the students consider and decide their topics to tackle rather

Table 1. Words of Emotion

Positive Emotion	Negative Emotion
楽しい(Fun)	疲れた(Exhausting)
おもしろい(Interesting)	眠い(Tiresome)
やばい(Cool)	わからなかった (Confusing)
ワクワク(Exciting)	退屈(Dull)
感心した(Admirable)	焦った(Rushed)
驚いた(Surprising)	つまらない(Boring)
ドキドキ(Exciting)	怖い(Scary)
テンション上がった (Intense)	緊張した(Nervous)
もっとやりたい (Inspiring)	悔しい(Mortifying)
嬉しい(Enjoyable)	惜しい(Regrettable)
	嫌だ(Disagreeable)
	恥ずかしい(Embarrassing)
	興味なし(Pointless)
	やりたくない (Undesirble)

than the teachers deciding and proposing what projects to do for them.

Cooperative learning projects need to introduce a pedagogy that triggers off positive emotions including fun, interesting and surprising in order for the students to achieve active learning. In addition, these projects need to draw out negative emotions such as impatience, stress from working with unfamiliar people, and anxiety about new tasks and environments. And it should help students overcome these emotions in order to improve the competency of the students. In sum, it is necessary for students to experience feeling joy and trust after overcoming their negative emotions.

In this course, we focus on the students' emotions, and make our students describe their emotions briefly along with what they have learned in each week using the review sheet. Dolan (2002), brain scientist cites that "emotion interacts with and influences other domains of cognition, in particular attention, memory, and reasoning."

Felten et al. (2006) also claims an importance of emotions in a time of reflection of service learning. Wang et al. (2012) report the results of first-year education that incorporate emotion-based education although they don't explain how they simply capture the changes of emotions at school.

This paper aims to argue two points as follows:
1) Students' choice to describe their emotion in the review sheet,
2) Effectiveness of usage of the review sheet to capture their emotion in classroom lectures as well as in PBL.

Results and Discussion

(1) Words to describe emotions

Table 1 shows a list of the words we used for our students to describe their emotions. There are 24 words in total, which consist of 10 words of positive-side emotions and 14 for the negative-side. The word "やばい(Cool)" used to be spoken when people wanted to show a feeling of danger, but currently it turns out to describe an opposite meaning, so we categorize it into the positive.

First, we tried to use the review sheet in the classroom lectures of "Politics and Economics" and "Civil Engineering Materials" which are taken by second-year students. We delivered it to the students of the civil engineering department during the last 5 minutes of each weekly class and they wrote what they learned and how they felt.

Figure 1 illustrates the appearance ratio of the words the students chose in week 1 through week 15 (week 8 was for mid-term exams, so 14 weeks were for lectures). The total number was 475 words after all. The most frequently appearing word was "fun" on the positive-side, followed by "interesting" and "cool". And these three words accounted for 51% of all of the students' feedback. On the other hand, the top three words from the negative side, "exhausting", "tiresome", and "confusing" occupied 27% of the feedback.

Figure 2 shows the appearance ratio of the words written by the students who are taking the new course "Co^{+}work," and we gathered 1,384 words to investigate. Lowest 10 appearance ratio of the words both Co+works and the lectures which are 嬉しい(Enjoyable)、つまらない(Bull)、怖い(Scary)、悔しい(Mortifying)、惜しい(Regrettable)、嫌だ(Disagreeable)、恥ずかしい(Embarrassing)、興味なし(Pointless)、やりたくない(Undesirable) can be eliminated.

The word "difficult" was not included in a list of the 24 words, but it appeared and accounted for 5% in the review sheet of Politics and Economics and had an appearance ratio of 2.5% for Co^{+}work. It is not really an emotional description, but it may be useful to capture the degree of difficulty of class.

(2) Changes of emotions

In this paper, we attempt to evaluate the changes of emotions of the students empirically. The positive-side words listed in table 1 get +1 and the negative ones take -1. Figure 3 illustrates the class average of 'Politics and Economics' and 'Civil Engineering Materials' using the data of 40 second-year students from the civil engineering department.

The 'Civil Engineering Materials' was only lecture style. The 'Politics and Economics' was taught by the classroom lecture style including plenty of group-work. Table 2 shows the schedule of 'Politics and Economics'. The students learned Economics in the second half of this class, which is week 16 through 30. In this class, the main issue is to understand how and why we have different levels of lives among rich nations and poor nations, or developed countries and developing countries. In addition, the students not only learn the situations we face but also consider the possible and potential solutions with a way of economics thought. As the introduction of this course, the teacher gave students some examples using short movies to help the students find their own issues. From week 2 to 15, the students tackled tasks with a team of three or four persons. They used the textbook written in English, which is not a regular style in our college, so they needed to take more time than they did in other

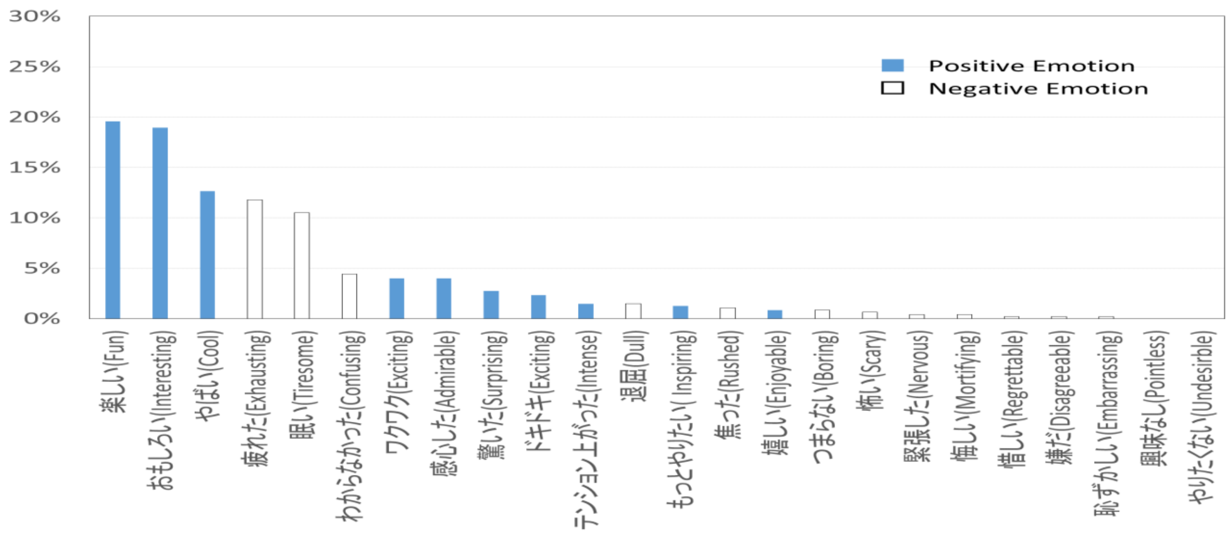

Figure 1. Appearance Ratio of Emotions at Politics and Economics

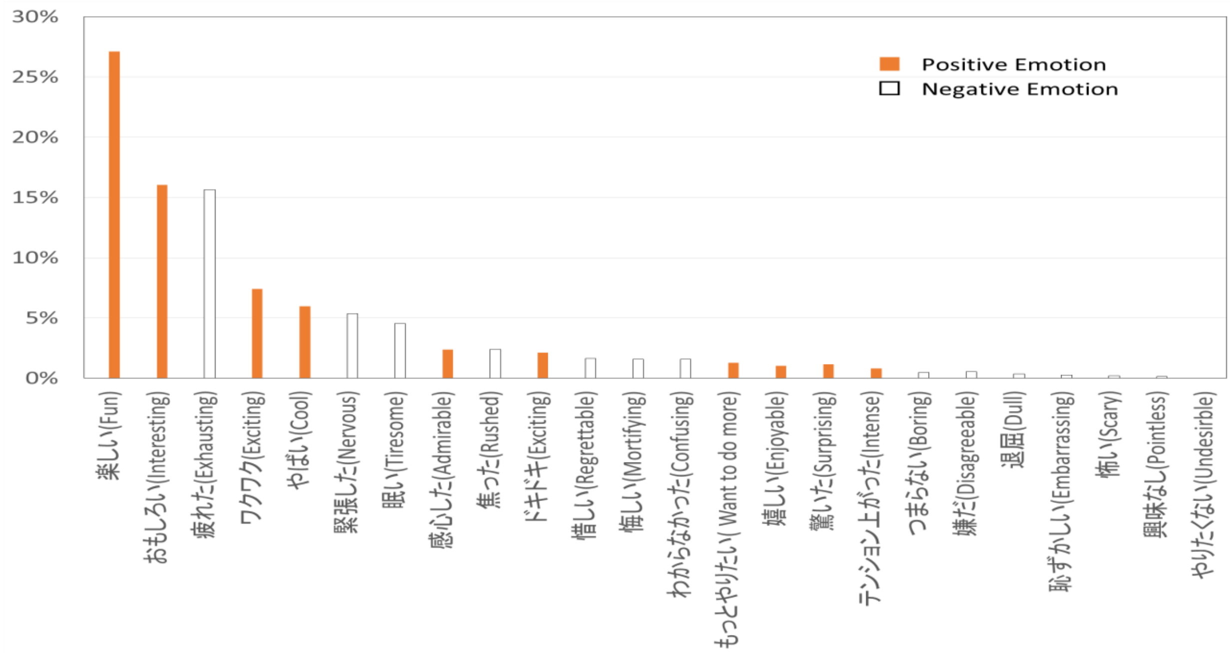

Figure 2. Appearance Ratio of Emotions at Co+work

courses with textbooks written in Japanese. Therefore, they felt some difficulties all the time throughout the course.

Even though the students thought it was difficult to understand in a non-native language, it seemed that they took on the challenged quite vigorously. The teacher asked several questions to help them understand the key contents and thoughts, and the students read and discussed the questions with group members at the same time as asking and tutoring each other.

Looking at the figure 3, the emotional evaluation of the students scored high in the beginning when they thought of their own choices in their lives, but after starting the contents of the textbook which described the reality of rich and poor nations and explaining the ways of thoughts in Economics, more students felt difficulties. Some students, however, felt surprised, nervous, and scared by their learning of the reality of the world. Their score was categorize as negative, but perhaps it can be included in the positive-side since it results in good attention from the students.

At the final stage, the students did quick research to make presentations in terms of the status and effort in the developing countries. It seemed to give them more interesting classroom experiences.

Figure 4 is made using the data of the Co$^+$work class, and counted in the same way with the Politics and Economics class. And, the average score is calculated by each team. Table 3 shows the schedule of Co+work. It tends to have more fluctuations comparing to the lectures. In addition, it finds the score below zero which means more students claimed negative emotions.

For example, the score of team-no.20 has minus value in the 3rd week. In this week, a short-term exchange

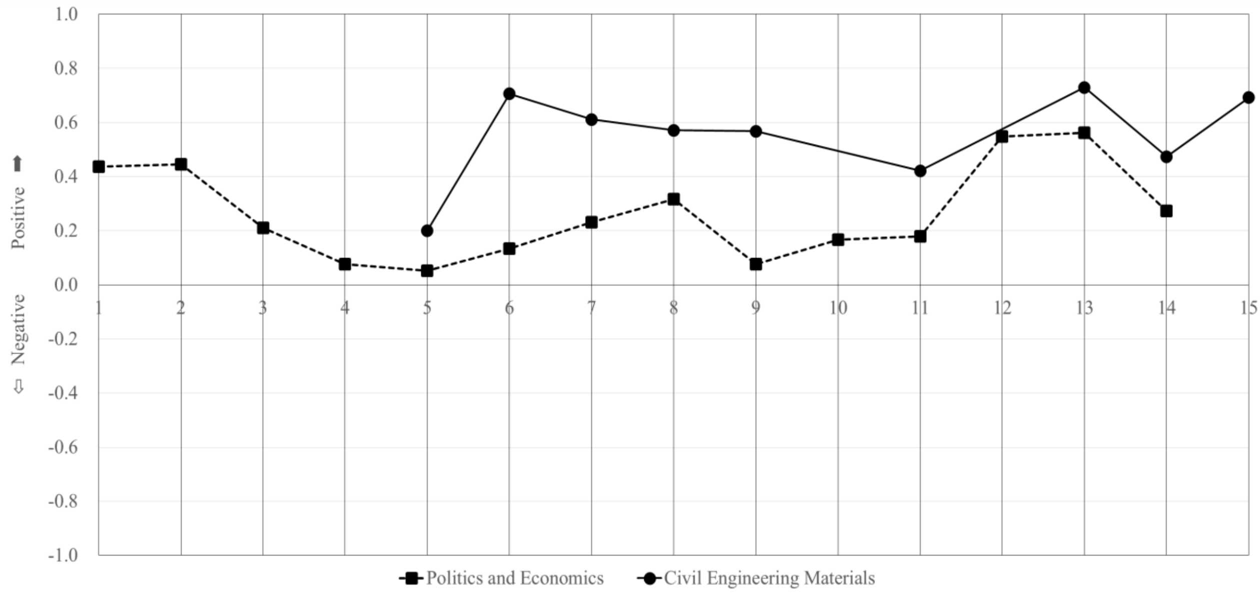

Figure 3. Changing Emotion at Lectures

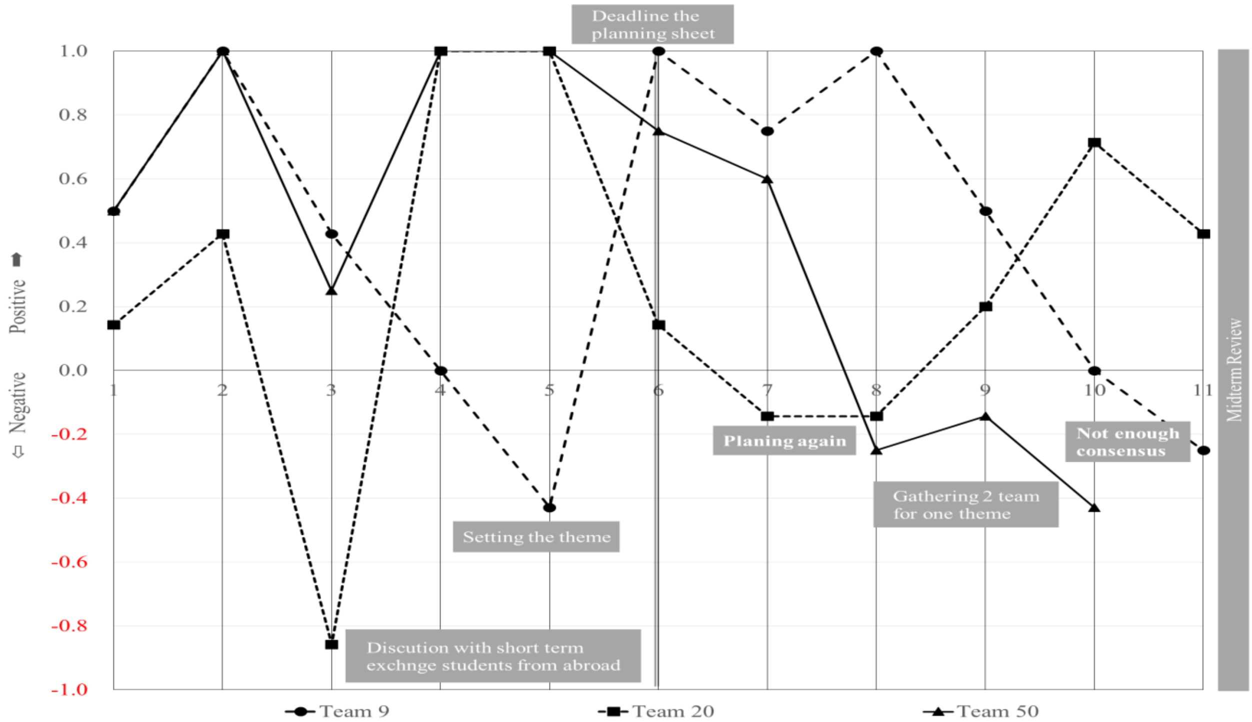

Figure 4. Changing Emotion at PBL (Co+work)

student from Indonesia joined this team. Our students do know some English and have fair communication skill, but they don't have enough confidence to communicate with someone from far away and from a different culture by expressing their opinions and feelings in English. Thus, their evaluation in terms of emotion resulted in a negative score. Week 6 and 7 gave students the opportunity to reach a consensus about the project they would do with their own team, and the score shows that they seemed to face difficulty in these weeks.

Another example from team-no.9 during week 5 tells us that the students experienced difficulties. According to the teacher of that team, his students discussed and became divided over three different topics, but they still needed to choose one and achieve a consensus. Finally, they came to select one topic, and they worked on creating a "Man-powered Refrigerator". Even though they seemed to reach consensus about creating the Man-powered refrigerator in their team, some students couldn't keep their motivation to work on it due to the

Table 2. The schedule of 'Politics and Economics'

1st	Guidance and to think how to make choices in one's own life using short movies
2nd	To know and think how the lives are different between developing countries and developed countries using the textbook (group work)
3rd– 4th	To know the long macroeconomic history and think how economics can approach to uncover the process of making disparity and current status, and setting up a model for analysis (group work)
5th	To know how the people having great achievements made choices in their lives, and think about one's own choice again (group work)
6th	To compare the developing and developed nations using data (group work)
7th – 9th	To think how to look at the well-being of our world and the proposal of Human Development Index by UNDP. Economic growth does not always bring happiness to our lives (group work)
10th-13th	To know what kinds of consultations have been done in terms of sustainable economic development, and think about the details from a point of view of environmental economics, for example free trade and climate change (group work)
14th–15th	To search what kinds of problems people in the developing countries have been facing and what kinds of reactions have been taken to solve the problems (group work)

Table 3. The schedule of 'Co^{+}work'

1st	Guidance and team making in the gym
2nd	Ice Breakers with teammates and practice writing out plenty of ideas in the gym
3rd	Indonesian students joined our NASA Game for making consensus in the gym
4th – 7th	Setting the project theme by each team
8th – 11th	The Project is progressed by each team
12th	Intermediate Presentation 4 teams present each project at one room. 7 minutes presentation and 8 minutes for questions and comments

fact that they couldn't assume their share of the responsibility.

The team-no.50 quickly achieved their consensus to implement the project on "remodeling the benches in the campus", but another team reached a similar idea and chose the same place to implement their project. After discussing the matter, these two team reached a consensus to work it out together, but they came to face difficulty indeed over how to implement the remodeling.

In sum, the average score went down to the negative side regarding emotions after week 8.

As we see above, the review sheet from the PBL-style class showed us the students' status and changes regarding emotion along with the contents of classes. It may be a great source for teachers to consider how to coach students or when to intervene with teams. In addition, it may bring up the possibility and influence the fostering of meta-perception by checking with the past events when we look back for a middle or long range.

Conclusions

In this paper, we showed 14 effective words adopted in the review sheet to choose one's emotions during class work. This paper argued that it would be effective for coaching teachers to gather their student's reflection and comments of emotion on the contents and the tasks and interactions of each class as the semester goes along in order to improve their effects to foster active learning.

Acknowledgement

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1503

Extensive Reading Program as an Active Learning

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Abstract

In the past, we adopted the conventional methodology, which focuses on the explanation of grammar and sentence structure, in reading classes. However, the lecture-style lessons made our students less motivated. As the result, most of the students failed to improve their ability in English. In 2010 we introduced extensive reading program, which had been successful at Toyota College and other schools, in order to boost their motivation for studying English. In our program, we have the students read as many books as they can. They can decide what to read by themselves as far as they follow the rules. We have three basic rules: (1) the books should be easy for them to understand without consulting dictionaries, (2) they should guess the meaning from the picture or the context when they come across unknown words, and (3) they should stop reading when they find the books difficult or boring. As requirements, we tell the students to keep reading records and to fulfill quantitative assignment. On a record sheet they write down date, level, book title, word count, time, and summary. As for quantitative requirements, we usually tell the students who have taken extensive reading lessons for the first time to read 100 books and 100,000 words during the school year. In our program, a teacher plays a role as an adviser. They check whether the students read appropriate books following the rules by watching the way they read during a lesson and examining the records. They give advice on what to read to the students. After launching the program, we found out that extensive reading is suitable for our students who prefer active learning to lectures. Their attitudes in a reading class have improved drastically, and even the students who are not keen to study English work on the program actively. The results of English proficiency tests show that our program helps the students to boost their English ability. In conclusion, extensive reading program as an active learning has a good impact on the students' ability as well as their motivation.

Keywords: *English education, extensive reading, active learning, motivation, English ability*

Introduction

Teachers are likely to follow the methodology under which they learned. That was the case with English teachers at National Institute of Technology, Tokuyama College (hereafter NITTC). In the past years, we adopted conventional methods, according to which we explain grammar and sentence structure, translate English sentences into Japanese, and get the students to work on drills in grammar. Such methods were not successful with our students. They got less and less interested in studying English. Consequently, we had been worried with their deteriorating attitudes in class and their slump in proficiency in English.

We conducted a questionnaire survey on their attitudes towards studying English to the students in the lower grades from 2008 to 2010, so that we could find out a solution to our problems. We found that more than 80% of the respondents, though they didn't study diligently, felt they should master English (Takahashi, Kunishige and Harada, 2009). We also found that students who were interested in cultures of English-speaking countries were more motivated to learn the language (Kunishge, Takahashi and Harada, 2011). Examining the results, we supposed that our students were ready to learn English as they were aware of its significance and that they would start to learn the language actively if we could awake their interest.

As a method to summon the students' motivation, we introduced English extensive reading, which National Institute of Technology, Toyota College had been using successfully, into class in 2010. The students got attracted to the new approach and came to participate in a lesson actively as we had expected. As the result, they improved proficiency in English as well as their learning attitudes.

This paper shows how we apply extensive reading at NITTC and how effective it is as an active learning.

Methods

English extensive reading has spread as SSS (Start with Simple Stories) method in Japan. Junior and senior high schools, universities, and cram schools have adopted the method since the late 1990s. Among national institutes of technology, Toyota College has been using it successfully (Nishizawa et al., 2011; National Institute of Technology, Toyota College, 2011).

Applying the method of Toyota College, we introduced extensive reading into class in 2010.

In our program, we gave a 50-minute lesson twice a week from 2010 to 2015. We have the students read as many books as they can in class. They can decide what to read by themselves as far as they follow three basic rules. The rules are the following: (1)Read books you can understand easily without consulting dictionaries, (2)Guess the meaning from the picture or the context when you come across unknown words, and (3)Stop reading the book when you find it difficult or boring.

In our program, it is essential that our students read books whose outline they can understand without trouble. We classify books according to the difficulty so that students can choose appropriate books easily. In the SSS style of extensive reading, YL[1], or, "Yomiyasusa level" (readability) is used to show the difficulty of a book. Using YL, we classify our library of books, which consists mainly of graded readers for English learners and leveled readers for young native speakers. Then, we put a color sticker on each book according to the difficulty as shown in Table 1 and Figure 1.

Table 1. Classification of Books at NITTC

color	YL	CEFR[2]
white	0.0~0.4	
pink	0.5~0.9	
red	1.0~1.9	A1
orange	2.0~2.9	A2
yellow	3.0~3.9	A2
green	4.0~4.9	B1
blue	5.0~5.9	B2
none	6.0~	C2

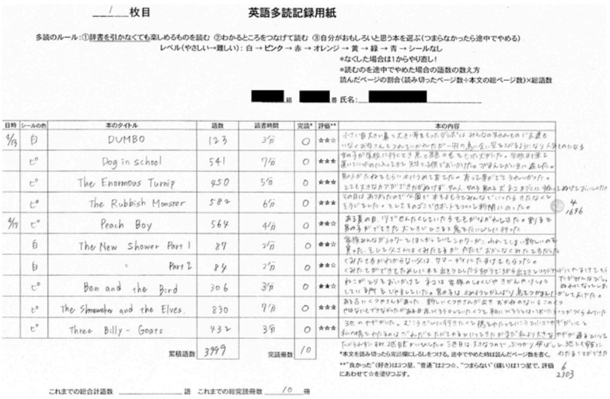
Figure1. A Book for Extensive Reading Program

Our students check word count aside from color, for students who are not accustomed to reading find it tough to read a long book. Checking the information, they choose books to read on their own and start reading them as shown in Figure 2 and Figure 3.

Figure 2. Students Choosing Books

Figure 3. Students during a Lesson

After reading books, the students keep reading records. They write down date, color (difficulty), book title, word count, time, and summary on a record sheet as shown in Figure 4. We check their record sheets in each lesson.



1 枚目　　英語多読記録用紙

多読のルール：①辞書を引かなくても楽しめるものを読む ②わかるところをつなげて読む ③自分がおもしろいと思う本を選ぶ(つまらなかったら途中でやめる)
レベル(やさしい→難しい)：白→ピンク→赤→オレンジ→黄→緑→青→シールなし
*なくした場合は1からやり直し!
*読むのを途中でやめた場合の語数の数え方
読んだページの割合(読み切ったページ数÷本文の総ページ数)×総語数

[redacted]組 [redacted]番 氏名：[redacted]

日時	シールの色	本のタイトル	語数	読書時間	完読*	評価**	本の内容
4/13	白	DUMBO	123	3分	○	★★☆	[illegible]
	ピ	Dog in school	541	7分	○	★★★	[illegible]
	ピ	The Enormous Turnip	450	5分	○	★★★	[illegible]
	ピ	The Rubbish Monster	582	6分	○	★★★	[illegible]
4/17	ピ	Peach Boy	564	4分	○	★★☆	[illegible]
	白	The New Shower Part 1	87	2分	○	★★☆	[illegible]
	白	〃 Part 2	84	2分	○	★★☆	[illegible]
	ピ	Ben and the Bird	306	3分	○	★★☆	[illegible]
	ピ	The Shoemaker and the Elves	830	9分	○	★★★	[illegible]
	ピ	Three Billy - Goats	432	3分	○	★★★	[illegible]
		累積語数	3999	完読冊数	10		

*本文を読み切ったら完読欄にしるしをつける。途中でやめた時は読んだページ数を書く。
**"良かった"(好き)は3つ星、"普通"は2つ☆、"つまらない"(嫌い)は1つ星で、評価にあわせて☆を塗りつぶす。

これまでの総合計語数 ＿＿＿ 語　これまでの総完読冊数 10 冊

Figure 4. A Sample of Record Sheet

In extensive reading class, a teacher plays a role as a guide and role model, as Bamford and Day explain (Bamford and Day, 2004). We sometimes tell the students how to read in order to improve proficicency in

English and recommend books. Basically, however, we let them read on their own and just watch whether they read appropriate books following the rules by observing the way the students read during a lesson and examining their record sheets. We give advice on what to read to the students when they often read too difficult books. We also instruct them to write summaries clearly when they don't do that, as we find the students who give concise summaries have got more proficient in reading.

We grade our students by their average score of term tests and their participation in class. In a term test, we give a reading-comprehension test and cloze tests. We check the students' reading fluency with a reading-comprehension test, in which they read a story while taking notes and then answer questions about the story relying on their memory and notes. In cloze tests, we see how well they master grammar and develop vocabulary. As for participation, we give them the quantitative assignment: we tell them to read 100 books and 100,000 words during the school year, for example.

Results and Discussion

After launching the program, we found out that extensive reading is suitable for our students who prefer active learning and project-based learning to lectures. We observed that they welcomed extensive reading class as a type of active learning and work on the program keenly. The results of a questionnaire survey conducted after introducing the method shows that their motivation and attitudes improved (Takahashi, Kunishige and Harada, 2012).

This program proves to be helpful in improving English ability. After taking extensive reading class for three years, some students said that they didn't feel difficulty especially in solving reading-comprehension questions in an English proficiency test although they had not made special preparation for it. The average score of an English proficiency test called ACE[3] endorses this. As shown in Table 2, the students who entered our college in 2010 and who took extensive reading class for three years got the score which exceeds standard score for high school students in the second and the third grades, which had not been achieved before. Seen by department, they also raised the average score consecutively as Table 3 shows.

Table 2. The Average Score of ACE by Admission Year

	1st grade	2nd grade	3rd grade
standard score	430	450	470
2006	408	421	434
2007	425	422	461
2008	410	442	447
2009	429	426	478
2010	425	470	500

Table 3. The Average Score of the Students admitted in 2010 by Department[4]

	1st grade	2nd grade	3rd grade
ME	430	475	516
IE	444	490	518
CA	396	440	459

These results show that extensive reading program is an active learning, which enables students to improve their ability unwittingly, and that it is more effective when it is used consecutively.

Extensive reading is a good way to learn English in an active and autonomous way. However, just introducing the method into class is not enough. This method should be applied by teachers who are familiar with books as well as methodology. In other words, teachers must be voluminous readers themselves. We have got some problems with teachers. In one case, a teacher, who didn't read simple stories enough, misguided his students by letting them read too difficult books. As the result, they got less motivated, which is supposed by comparing with the other classes (Takahashi, Kunishige and Harada, 2012). In another case, the class, most of whom don't find it necessary to learn English, almost failed to improve the score at proficiency tests. As shown in Table 4, the students admitted in 2010, who took extensive reading lessons consecutively, improved the score constantly, but the others failed to improve in the third grade, when a teacher was inexperienced (those admitted in 2011) or when a teacher stopped using extensive reading (those admitted in 2012 and 2013).

Table 4. CA Students' Average Score of ACE by Admission Year

	1st grade	2nd grade	3rd grade
2010	396	440	459
2011	437	463	468
2012	440	475	483
2013	434	475	478

These cases show that extensive reading method is effective for boosting students' motivation and ability when a teacher who is also an avid reader uses it consecutively. Thus, it is important to build up a team of teachers who are familiar with the method in order that we can give extensive reading lessons in succession.

Conclusions

We have English lessons aside from extensive reading at NITTC, and it is possible that the combination of our lessons brought about the improvement observed in our past researches. We also have problems to tackle so that we conduct our program more effectively. However, extensive reading program as an active learning has a good impact not only on the students' motivation but also their ability as far as we observe.

Acknowledgements

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Notes

1) YL is an indicator of the readability. It ranges between 0.0 (the easiest) and 9.9 (the most difficult). Japanese teachers and readers, who are the leading members of a study group of extensive reading method, have set it according to vocabulary, grammar, sentence length, letter size, and cultural background. See Takase (2010)

2) CEFR stands for Common European Framework of Reference for Languages. It is a guideline for learning a language and assessing learners. It has been used in European countries, and now it is increasingly used in other countries including Japan.

3) ACE is an English proficiency test for high school students. It stands for Assessment of Communicative English. The questions vary from junior high school level to college entrance examination level. The full mark is 900.

4) This paper uses abbreviations for departments. ME stand for Department of Mechanical and Electrical Engineering, IE for Department of Computer Science and Electronic Engineering, and CA for Department of Civil Engineering and Architecture.

1504

A STUDY OF LEARNING STYLES OF ENGINEERING STUDENTS IN VOCATIONAL EDUCATION IN HONG KONG

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Abstract

Students have different learning preferences of receiving, processing and internalizing knowledge and skills. If the learning environment is advantageous to the learning styles of the students, there is a higher chance that the students can achieve the intended learning outcomes. Previous research on understanding the learning styles of students suggests that the use of learning style models helped teachers design effective instruction and could help students better understand their own learning preferences. Felder and Silverman (1988) proposed a learning style model, which was designed to capture the important learning style differences among engineering students. The model categorised learning preferences into four dimensions, namely, active/reflective, sensing/intuitive, visual/verbal, and sequential/global (Felder and Spurlin, 2005). After identifying the learning styles of the students, corresponding teaching strategies can then be developed for more effective learning.
This research was an preliminary investigation of learning styles of engineering students studying vocationally oriented higher diploma programmes in Hong Kong. Data from over 140 students in two engineering programmes was collected and analysed to identify the learning characteristics of students. It was found that the sample students were marginally reflective, predominately sensing, visual, and sequential learners. Observations from the analysed data provided valuable information for teachers to design more effective teaching strategies.

Keywords: *Learning styles, learning characteristics, index of learning styles, engineering education, vocational education, Hong Kong.*

Introduction

Vocational education is a strategic development in the education system of Hong Kong. In the 2014 Policy Address, the Chief Executive of Hong Kong Special Administrative Region highlighted the importance of vocational education and announced a series of initiatives to promote vocational education and recognition of its value. It is advocated that vocational education plays an indispensable role in offering multiple pathways to young people with diverse abilities and aspirations to excel in their career. Vocational education is also crucial in nurturing the necessary manpower to support the sustainable development of the city.

While vocational education advocates a unique approach of enabling students with the expertise, skills and professional attitude to tackle real-world situations, the success of vocational education depends on how well the students fulfil the intended learning outcomes. Students have diverse ways of receiving, processing and internalizing the knowledge acquired in their studies. The higher level of awareness teachers have about the differences in their students, the better chance they have of meeting the diverse learning needs of all of their students, and, as a result, the higher likelihood the students have of achieving the intended learning outcomes.

Understanding the learning characteristics of students has been a continual focus in education research worldwide. Coffield et al. (2004) appealed to the idea that teachers and course designers should pay closer attention to students' learning styles: by diagnosing them, by encouraging students to reflect on them and by designing teaching and learning interventions around them. A systematic review of 13 major models of learning styles was done by Coffield et al. (2004).

In the context of engineering education, Felder and Silverman (1988) proposed a learning style model designed to capture the important learning style differences among engineering students. The model was later revised by Felder and Spurlin (2005), which categorised students' learning preferences into four dimensions, namely, processing (active/reflective learners), perception (sensing/intuitive learners), input (visual/verbal learners) and understanding (sequential/ global learners). The index of Learning Styles (ILS) is an instrument designed to assess preferences on the four dimensions of the Felder-Silverman learning style model. The web-based version of ILS, developed by Soloman and Felder (1997), was taken hundreds of thousands of times per year.

The ILS was widely used in a quite number of published studies (Felder and Spurlin, 2005). Constant (1997) administrated ILS to Materials Engineering students in Iowa State University and suggested the use of multimedia techniques to address diverse learning styles of the students. Paterson (1999) explored the use of different internet-based learning tools to suit the diverse learning styles in the class of environmental engineering students. Dee et al. (2002) investigated the learning styles of biomedical engineering students at Tulane University. Compared to other engineering student populations, their sampled students contained the highest percentage of students preferring the global learning style. Zywno (2003) identified a mismatch between learning styles of the majority of the sampled students and the reported prevalent traditional teaching. The study suggested that students whose learning needs were not consistently supported by traditional instruction underachieved in such an environment. Improved academic achievement in the study was linked to an increased accommodation of student learning styles.

The research on learning styles was still active in the past decade. Alumran (2008) used ILS to study the relationships between learning styles in relation to gender, field of study, and academic achievement for students in University of Bahrain. Do et al. (2008) attempted to create a new perspective on assessing the effects of learning English in Hong Kong, which is a predominately Chinese-speaking country. The learning styles of multi-disciplinary students who studied the same English module were investigated. Kolmos and Holgaard (2008) used the Felder-Silverman ILS and found that the first year engineering students at Aalborg University were predominately active learners. The finding leaded to a discussion of whether reflection and conceptualization should be facilitated further in the curriculum to balance the learning style of the students. Direito et al. (2012) investigated engineering undergraduates' perceptions of soft skills by looking into the relations of self-efficacy and learning styles. Mohamad et al. (2014) studied the disparity of learning styles and cognitive abilities in vocational education. The ILS was given to building construction students from three Vocational Schools in Malaysia. Tee et al. (2015) explored the pattern of learning styles of Business students in a vocational college in Northern Malaysia.

After identifying the learning characteristics of the students, corresponding teaching strategies can then be developed for more effective learning. Studies have shown that better learning may occur when teaching styles of teachers match learning styles of students than when they are mismatched (Felder and Silverman, 1988 and Hayes and Allinson, 1996).

Methodology

Investigation of learning styles of engineering students in this study was conducted based on Index of Learning Styles (ILS) developed by Soloman and Felder (1997). The learning style dimensions and the notions for the sub-scales in ILS are summarised in Table 1. The processing dimension measures the preference of how the student processes information, either actively through engagement of physical activity or discussion, or reflectively through introspection. The perception dimension measures what type of information the student preferentially perceives, either through external sensory, such as sights, sounds, and physical sensations, or internal intuitions, such as possibilities, insights and hunches. Input dimension concerns about the most effective sensory channel of the student to perceive external information, either through visual means such as pictures, diagrams, graphs and demonstrations, or through verbal means, such as words and sounds. The understanding dimension measures how the student progress toward understanding, either in a sequential manner in continual steps or in a global and holistic manner by large jumps. Detailed descriptions of the characteristics of these learning styles are given in Felder and Silverman (1988) and Felder (1993).

The ILS is a structured questionnaire of 44 questions. Each of the four dimensions in Table 1 is measured by 11 questions. Each question has two options, which represents a tendency toward either sub-scales in a dimension. For each dimension, the frequency of the two chosen sub-scales in the 11 questions are first counted. The sub-scale with the higher frequency is selected as the dominant scale for the dimension.

The score for each dimension is then calculated to represent the tendency of the student's learning on a dimension. The score is the net difference between the higher frequency of the sub-scale and the lower frequency of the other sub-scale. As a result, the score for a dimension is odd numbers ranged from 1 to 11. The score therefore represents the degree of preference of the student has for the dimension. If the score on a dimension is 9 or 11, the student has a very strong preference for the dimension. The student can learn very quickly in a teaching environment which favours the dimension. On the contrary, the student may have real difficulty in learning when the teaching environment is unfavourable to the dimension. If the score is 5 or 7, the student has a moderate preference for the dimension and will learn more easily in a favourable teaching environment. If the score is 1 or 3, the student is a fairly balanced on the learning dimension.

Table 1 Learning Style Dimensions

Dimension	Sub-scale	Notation
Processing	Active	ACT
	Reflective	REF
Perception	Sense	SEN
	Intuitive	INT
Input	Visual	VIS
	Verbal	VRB
Understanding	Sequential	SEQ
	Global	GLO

The questionnaire was developed for the engineering students in the Department of Construction in Tuen Mun campus of Institute of Vocational Education (IVE). IVE is one of the 13 member institutions of Vocational

Training Council, which was established in 1982 and now is the largest vocational education provider in Hong Kong. The department offers three full-time Higher Diploma programmes, namely, Higher Diploma in Civil Engineering (CE), Higher Diploma in Building Studies (BS) and Higher Diploma in Architectural Studies. This study focused on the first two programmes, which are more related to engineering. Both of the full-time programmes are delivered on a two-year duration.

The questionnaire was bilingual. Chinese translations of the original English questions were provided, so that the students could easily understand the questions and make appropriate selection of the options.

The questionnaire was disseminated to the students through a web link of a cloud internet platform. Students could access the questionnaire conveniently through mobile phones or any online computers. Their answers to the questionnaire were collected through their online devices and stored on the cloud storage. Whenever a student submits the questionnaire, the researcher will receive an email notification instantaneously. At the same time, the learning style index scores will then be calculated automatically by the script program in the cloud system and the scores will be sent to the student's email directly.

A total of 141 students completed the online questionnaire. Both first and second years of CE and BS students were invited to take part in the research. The students were given a short overview about the research, they could voluntarily participate in the research. The majority of the responses was from first year students, because some of the second year students were having industrial attachment during the research period. The numbers of completed questionnaires from CE students and from BS students were 75 and 66 respectively.

After all the participants had completed the questionnaire, the researcher provided a debriefing to the participants about different characteristics of learning styles. The students generally expressed that the learning style questionnaire was useful in helping them to be aware of their own learning characteristics.

Results and Discussion

The results of learning styles preferences of IVE students are given in Table 2, along with the reported Felder-Silverman learning styles preferences of various universities and vocational institutes. The samples were all engineering students, except sampled populations 7 and 9. In this study, of the total 141 sample completed the ILS, 48.2% were classified as active learners (and by implication 51.8% were reflective learners). 78.7% were sensing learners (so 21.3% were intuitive learners). 73.0% were visual learners and 68.8% were sequential learners.

With the given breakdown of the results of the two programmes in Table 2, the learning styles preferences of the CE students and the BS students could be compared. It was found that the students of the two programmes were relatively consistent in all the dimensions, except the first ACT/REF dimension. The net differences between the percentages of the two programmes in the SEN/INT, VIS/VRB and SEQ/GLO dimensions were 5.8%, 0.6% and 4.5% respectively. Nevertheless, substantial difference was noted in the ACT/REF dimension for the two programmes. 57.3% of CE students were reflective learners, whereas 54.5% of BS students were active learners.

Considering the preferences of the ACT/REF dimension in all sampled populations in Table 2, it was observed that only IVE and Hong Kong University of Science and Technology (HKUST) had the majority of sampled students as reflective learners. The percentage of reflective learners in IVE students was 51.8%, whereas the percentage in HKUST was 54%. Since the two sampled populations were both in Hong Kong with predominantly Chinese students, whereas other sampled populations were non-Chinese students. As previous research indicated (Biggs, 1991), Chinese students may have different learning styles, when compared to students in western countries.

With regard to the SEN/INT dimension, all the sampled populations in Table 2 had the majority of sensing learners. The IVE students had the highest percentage of sensing learners of 78.8%, which was about 12% higher than the second highest percentage reported in sampled populations 2 and 8.

Table 2 Comparison of Learning Styles Preferences

Sampled Population	ACT	SEN	VIS	SEQ	Size	Reference
1. Institute of Vocational Education (IVE) Results of the two engineering programmes	48.2%	78.7%	73.0%	68.8%	141	This study
Civil Engineering (CE) students	42.7%	76.0%	73.3%	66.7%	75	
Building Studies (BS) students	54.5%	81.8%	72.7%	71.2%	66	
2. Iowa State University, Materials Engr.	63%	67%	85%	58%	129	Constant (1997)
3. Michigan Tech. University, Env. Engr.	56%	63%	74%	53%	83	Paterson (1999)
4. Ryerson University, Elec. Engr. 2002 cohort	63%	63%	89%	58%	132	Zywno (2003)
5. Tulane University, Biomedical Engr.	66%	55%	88%	41%	128	Dee et al. (2002)
6. Aalborg University, Engr. students	73%	65%	87%	44%	493	Kolmos & Holgaard (2008)
7. Hong Kong University of Science and Technology, multi-disciplinary students	44%	57%	94%	50%	166	Do et al. (2008)
8. Three Vocational Schools in Malaysia	77%	67%	84%	56%	128	Mohamad et al. (2014)
9. Vocational College in Northern Malaysia	72%	55%	90%	72%	60	Tee et al. (2015)

In the VIS/VRB dimension, all the sampled populations had the majority of visual learners. It was found that the IVE students had the lowest percentage of visual learners of 73%, while the highest percentage of visual learners of 94% was reported in HKUST.

In the last SEQ/GLO dimension, 6 of the 9 sampled populations had the majority of sequential learners. It was observed the two vocational institutes, namely, IVE and the Malaysia's Vocational Collage, had the highest percentage of sequential learners of around 70%.

To further understand the distribution of the learning styles preferences of the CE and BS students, histograms of the two programmes in the four dimensions were given in Figures 1a, 1b to 4a and 4b respectively. The horizontal axis was the ILS score from the maximum score of the left sub-scale, i.e. 11, to the maximum scale of the opposite right sub-scale. The vertical axis was the frequency of the samples. By assignment of negative score to the left sub-scale, the mean (μ), standard derivation (σ), and skewness of the distribution were also given in the figures. The skewness measures the asymmetry of the frequency distribution and has a value of zero if the distribution is normal.

The distribution of active and reflective learners in the two programmes were compared in Figures 1a and 1b. The mean value of the CE distribution was 0.71 (balanced reflective), whereas that of the BS distribution was -0.88 (balanced active). Although the mean values were of opposite sides, the values were still close to zero, which suggested a fairly balanced preferences in the processing direction. The standard derivation of the two distributions was around 4.5. The skewness values of the two distributions were in opposite signs. The skewness of the BS distribution in Figure 1b had the minimum value of 0.05 among all calculated skewness values, suggesting the distribution was close to a normal distribution.

In the second SEN/INT dimension given in Figures 2a and 2b, the mean values of the two distributions were very consistent with a value of -3.8 (moderate sensing). It was observed that the standard derivation of the two distributions was the highest among all the four dimensions. In addition, the both distributions were asymmetrically skewed to the right, both with the highest skewness values of 0.6 among all the distributions in the four dimensions. The peak of the distributions coincided at SEN9. After all, a very strong preference to sensing sub-scale was observed in the perception dimension in both student groups.

In the third VIS/VRB dimension shown in Figures 3a and 3b, the mean value of the CE distribution was -2.63, whereas that of the BS distribution was -3.35, it was evident that both groups were visual-learner dominant. The standard derivation of the two distributions was around 4.5. Both distributions were asymmetrically skewed to the right, with a skewness value of around 0.3. As shown in Fig 3a, the peak of the CE distribution was VIS3. In Fig 3b, the BS distribution had two peaks at VIS5 and VRB1.

In the last SEQ/GLO dimension given in Figures 4a and 4b, while both distribution was dominant by sequential learners. The mean value of the CE distribution was -1.77, whereas that of the BS distribution was -2.45, it was evident that both groups were sequential-learner dominant. The standard derivation of the two distributions was around 4. Again, both distributions were asymmetrically skewed to the right, with a skewness value of around 0.3.

Given the close relationship between learning styles and teaching styles, it is favourable to minimise the mismatch between the learning styles and the teaching styles. In the processing dimension, the active and reflective learners were fairly evenly distributed. Active learners learn best through active experimentation, which involved discussing, explaining, or using information in the external world. On the other hand, reflective learners learn by reflective observations, which involved examining and manipulating the information introspectively. Active learners work well in groups; reflective learners work better by themselves or with at most one other person. When designing class activities for the IVE students, alternate activities for active and reflective learners should be arranged. Examples of activities for active leaners are group discussions, problem-solving activities, brief presentations, experiments, hands-on practices. Potential learning activities for reflective learners are lectures with occasional pauses for thought, exercises for fundamental understanding and pair discussions.

Nearly 80% of the IVE students were sensing learners, who like facts and data and solving problems by standard routine methods but dislike theories and abstract concepts. Sensing learners are slower in understanding symbols and words than intuitive learners (Felder and Silverman 1988). Vocational education and training is particularly suitable for sensing learners, where the theoretical knowledge and practical application is blended throughout the curriculum. Theories and concepts are often illustrated with practical examples and demonstrations.

73% of the IVE students were visual learners, who remember best what they see, therefore any graphic inputs, such as pictures, diagrams, flow charts, animations, and demonstrations, favour learning of the visual learners (Felder and Silverman 1988). It is recommended that more graphical materials should be provided in teaching and learning activities. Advanced computer techniques such as Building Information Modelling with 3D model visualization and augmented/virtual reality technology could be applied in teaching engineering skills and knowledge.

Around 70% of the IVE students were sequential learners, who learn best when material is presented in a steady progression of complexity and difficulty. Sequential learners follow linear reasoning processes when solving problems (Felder and Silverman 1988). In this regards, while the curricula, module syllabi, and learning materials of IVE were designed to be sequential, teachers could pay closer attention to the learning progress of the students. Regular formative assessments may be done to check on the students' mastery of subject knowledge and skills.

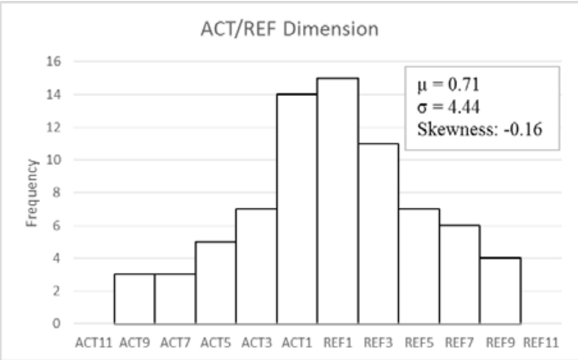

Figure 1a ACT/REF Dimension for the CE Students

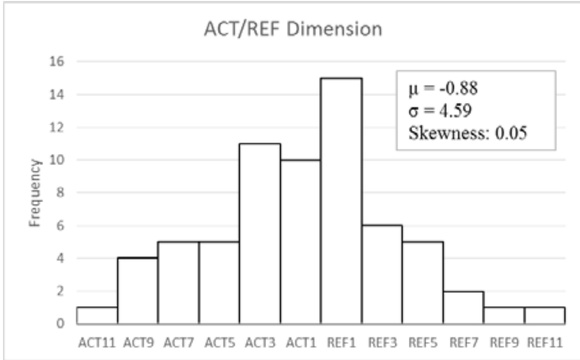

Figure 1b ACT/REF Dimension for the BS Students

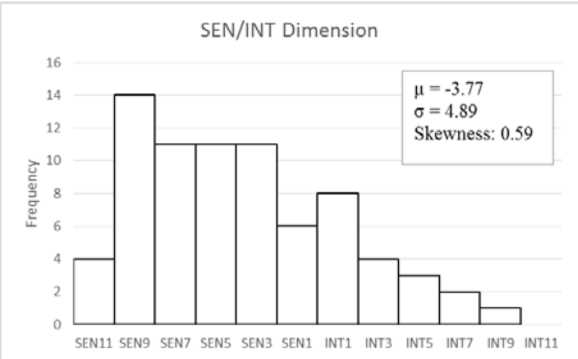

Figure 2a SEN/INT Dimension for the CE Students

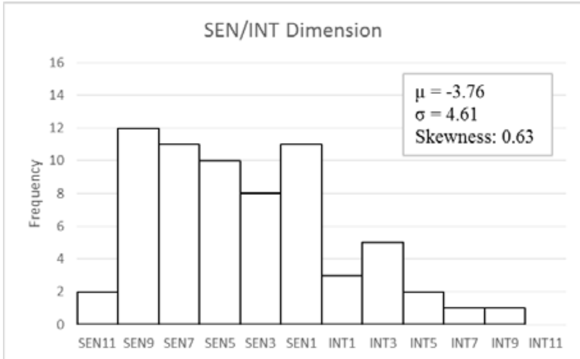

Figure 2b SEN/INT Dimension for the BS students

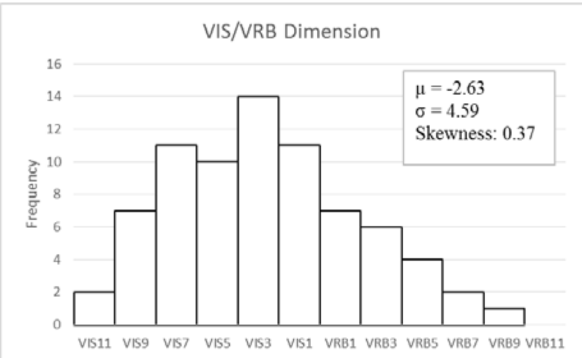

Figure 3a VIS/VRB Dimension for the CE Students

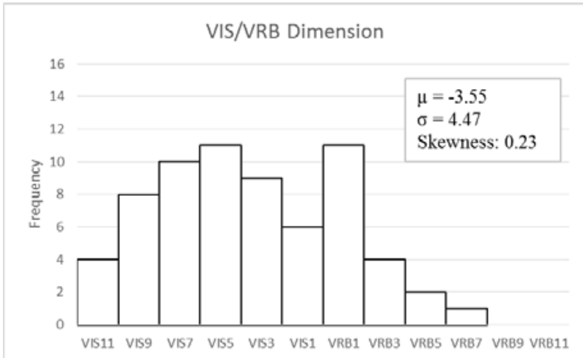

Figure 3b VIS/VRB Dimension for the BS Students

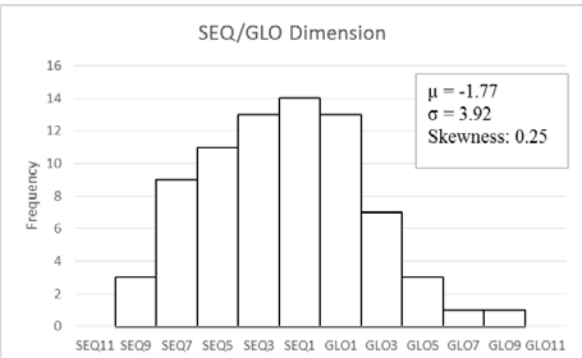

Figure 4a SEQ/GLO Dimension for the CE Students

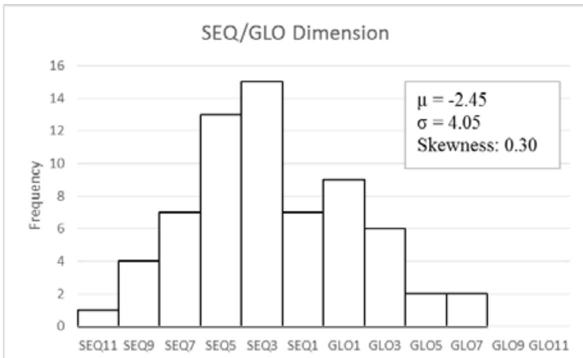

Figure 4b SEQ/GLO Dimension for the BS Students

Conclusions

A Chinese-English version based on Felder-Silverman learning style model was developed on a cloud platform and administrated to two groups of engineering students studying vocationally oriented programmes in Hong Kong. The results of the 141 samples were analysed and compared to ILS-based studies of engineering students in eight universities and vocational institutes. In general, the learning styles preferences of the IVE students were marginally reflective, predominately sensing, visual and sequential. The findings of this study offered valuable insights to inform more effective teaching and curriculum development in vocational education.

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1505

A PROPOSAL OF THE SIMPLIFIED IC FAB ESTABLISHIED IN THE AVERAGE SCIENCE LABORATORY FOR CULTIVATING SCIENTIFIC MIND

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Abstract

This study shows the result of a feasibility study for creating an educational environment that the design, fabrication, and evaluation of semiconductor devices can be accomplished under circumstances where only limited kinds of apparatuses are equipped. To achieve this purpose, the simplification of three key processes which are lithography process, impurity diffusion and fabrication of silicon dioxide layer were proposed, and the feasibility of the application to the nMOS FET fabrication was investigated. The simple mechanical alignment method that we named, "alignment less lithography" was proposed to simplify the exposure process. The photo mask design and fabrication were also simplified by using the personal computer with common presentation software to design the integrated circuit pattern. It was obtained that the resolution of the lithography was approximately 200μm, and the standard deviation δ of the alignment error was approximately 10μm. It is recognized that this result is sufficient as the lithography process for this purpose. The thermal oxidization under normal air environment was investigated. The index of refraction of the oxidized layer was approximately 2.4 which was almost the same value of SiO_2. Finally, the nMOS FET fabrication process was designed using these processes and tested. The typical I_{SD}–V_{SD} of the nMOS FET was obtained. It was obtained that this process provided easy to handle, high yield and good reproducibility with low cost. It concludes that it is possible for any school that has a science laboratory to be able to establish simplified IC FAB by these methods, and to provide students a learning environment for cultivating scientific minds with experiencing the actual device fabrication process.

Keywords: *MOS FET, Sol-Gel, Lithography, Device, Fabrication Process, Discovery learning*

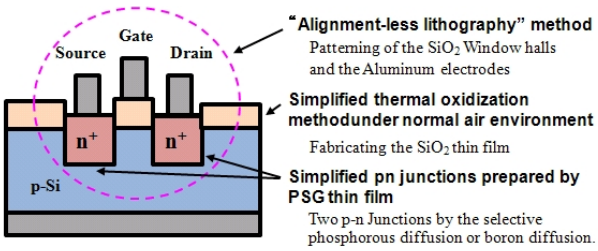

Fig.1 The key issures of the simplification of the MOS FET

Introduction

It has already past more than half century since the transistor was invented[1]. There were variety and unique ideas about device fabrication had been proposed and demonstrated since them, especially at the early stage of the development of the transistor and the integrated circuit. It is an important way to generate creative ideas for the students to study, to emulate and to acquire these brilliant ideas that are the achievements of our predecessors. It would be one of the best ways to cultivate the scientific mind in the students who are the candidates for the scientist and the creative engineer.

However, the sophisticated apparatus and facility were required to conduct this idea[2],[3]. This may be the barrier to widely demonstrate this procedure in the classroom. This situation may be the cause of the prevention to get interest about the device and therefore the nanotechnology. If the actual device can be fabricated and evaluated easily in the classroom, like a common science laboratory as same as the program that has already been demonstrating combining the classroom lecture and the experiments, for example, electronics circuits, robot, and the software education, it would be a nice program to encourage the students to introduce nanotechnology and science world. The impurity diffusion, fabrication of insulation layer and the lithography processes are the key issues to bring in the nanotechnology device fabrication in the classroom. The simplification of these processes is the key issue to achieve this purpose.

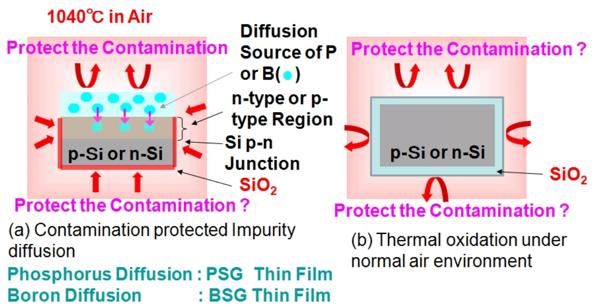

Fig.2 Hypothesises of the simplified SiO_2 thin film fabrication and impurity material diffusions under the normal air environment

Hypothesis of the key processes

It is understood that there are three key processes to achieve the simplification of the device fabrication, which are the lithography, impurity diffusion, and the thin film fabrication of the insulation layers as shown in Fig 1.

In the simplification of the impurity diffusion using the phosphorus silicate glass (PSG) thin films prepared by the Sol-Gel materials was proposed and successfully demonstrated[4]. It substantiated the hypothesis shown in Fig.2(a) that the PSG thin film was performed not only as the diffusion source, but also as to prevent the penetration of miscellaneous materials from the air environment. Furthermore, it also expected that there is a sufficient possibility about the fabrication of the thermally oxidized layer (SiO_2) on the surface of the silicon substrate under normal air environment, if the initial growth of the SiO_2 layer can affect the same effect of PSG thin film as shown in the Fig.2(b). If this hypothesis performs well, the total thermal treatment process can be significantly simplified.

The simplification of the lithography apparatus and

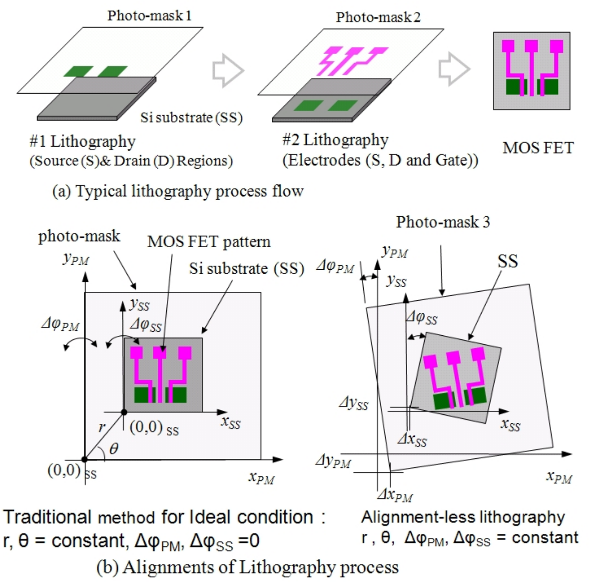

Fig.3 Hypothesis of the Alignment-less lithography method

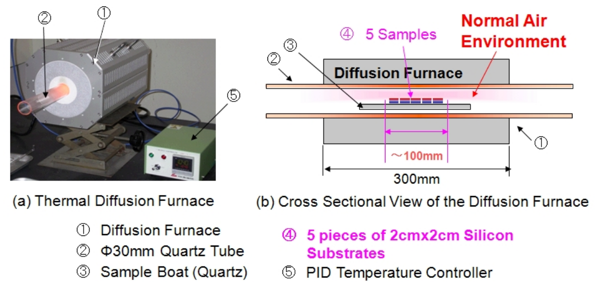

Fig.4 Simple thermal diffusion furnace for the experimental use apparatuses

preparation and revising the photo-mask set are the most important issues in the lithography. The simplification of the lithography apparatus and the preparation of the series of the photo-masks set from A to Z. It means that the photo-mask set fabrication from the pattern design, fabrication and revising to be finish easy and quick under the limited circumstance by student themselves.

Fig.3 shows the idea to achieve this requirement. If the positions of all of the circuit patterns on the photo mask and the size of the photo-mask substrates are fabricated very accurate and exact the same in size, in addition, the silicon substrate and the photo-masks can be set the exact the same position every time, the photo lithography process can be achieved without photo-mask alignment. And the complicated photo-mask alignment using x-y-z-θ stage can avoid, the apparatus can be significantly simplified with keeping reasonable accuracy. The positioning errors of Δr, $\Delta\theta$, $\Delta\phi_{PM}$, $\Delta\phi_{SS}$ may happened. However, it will only be a cause of the offset of the total circuit patterns on the silicon substrate. We named this method, “Alignment-less lithography”. It is expected that the errors would be determined by the accuracy of cutting and printing of the photo-masks.

Experimental method

Fig.4 shows a photograph and a cross sectional view of the electric furnace that was used in this experiment. This is a simple furnace with a 3cm diameter straight quartz tube as the furnace tube which was equipped with one zone heater. The temperature can be controlled by a PID controller up to about 1150°C. The uniform temperature area is about 10cm wide. And the following all of the thermal diffusion and the experiments took place in a normal air environment[4].

Fig.5 shows the simplified exposure apparatus and photo-mask preparation method. The common commercially available Ultra Violet (UV) lamp was used as the light source for the exposure system. The UV light radiation is not parallel ray, but radiating in all directions from the line spot. This is the cause to decrease a resolution of the photo resist pattern. However, several tens microns in the resolution is considered as the total design rule in this process. Therefore, this effect can be ignorable, and the exposure

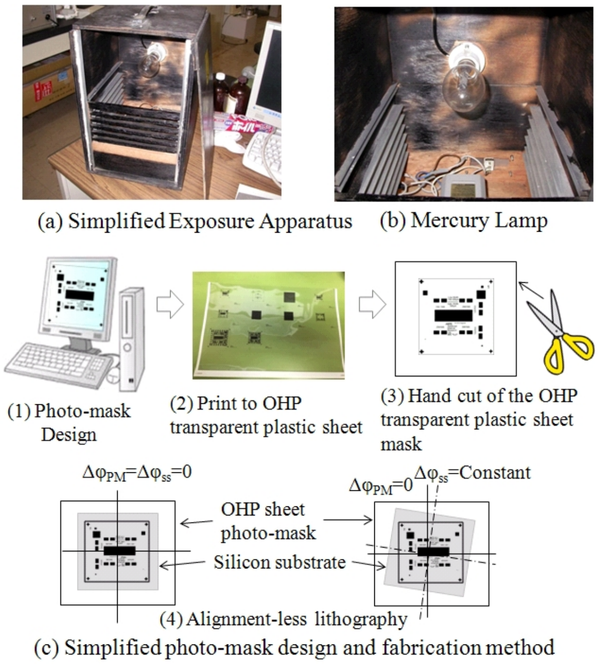

Fig.5 Simplified exposure apparatus and photo-mask fabrication method

apparatus can be significantly simplified. In addition, it is necessary to establish the circumstance to make the photo-mask set easily and quickly by one's own design and revise by oneself. The mask patterns were designed and revised by the personal computer with common presentation software. The transparent plastic sheet for the over head projector as the photo-mask blanks was used and the patterns were printed by laser printer and prepared by hand-cut in use [5].

Fig.6 shows the schematic view of the "Alignment-less lithography" process. The simple aluminium mechanical jig was prepared to achieve the positioning of the substrate and the OHP transparent plastic photo-masks. The jig has double concaved structure to mechanically set to keep the right positions, r, θ and ϕ between the photo-mask and silicon substrate described in Fig.3. The depth of the concave for the silicon substrate is set slightly bigger than the thickness of the substrate to achieve the proximity lithography. The alignment between the photo-resist pattern and the circuit patterns can be achieved mechanically without alignment of the photo-mask.

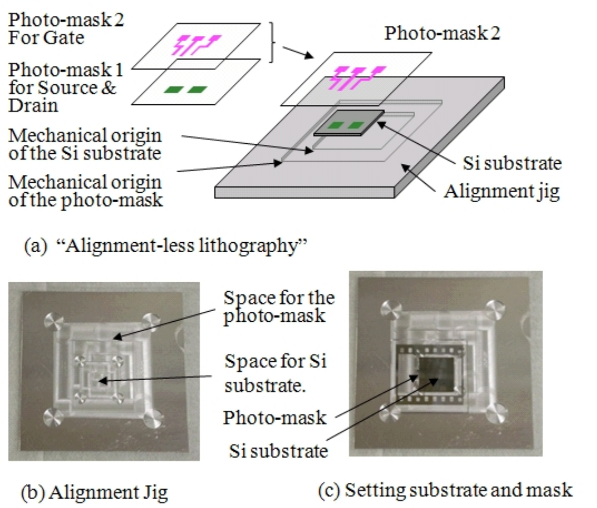

Fig.6 The methodology of the "Alignment-less lithography method"

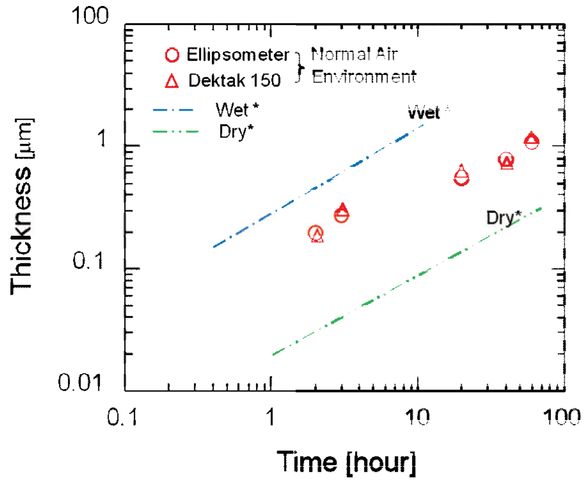

Fig.7 Thermal Oxidation under normal air environment

Experimental Results

Fig.7 shows the results of oxidation under the normal air environment. The result of wet oxidization and dry oxidation were shown for comparison. The oxidation speed was intermediate in between the speeds of average wet oxidization and the dry oxidation. It was obtained that SiO_2 thin film prepared under normal air environment can be made and the thickness was also controlled as well as same as the traditional oxidation methods.

Fig.8 shows the evaluation results about the alignment accuracy of alignment-less lithography. More than 50 trials were finished. It was found that the accuracy of approximately 70 % of the trial were within about 20μm including zero error samples. It is expected

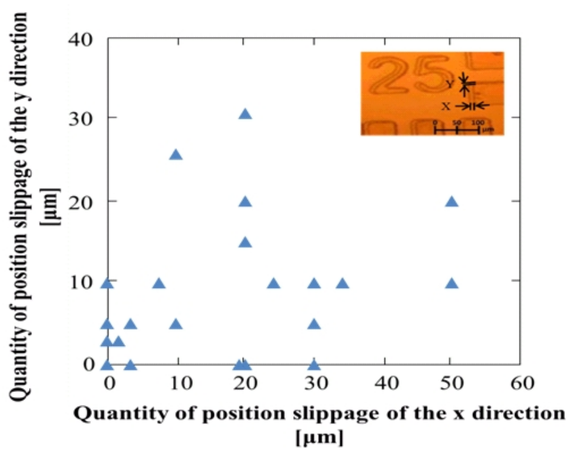

Fig.8 A typical measurement result about the alignment accuracy of the Alignment-less lithography method

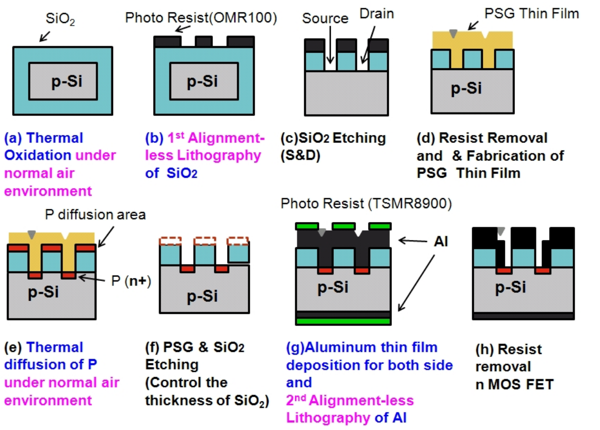

Fig.9 Simplified nMOS FET fabrication process for the simplified IC FAB

that the variation of the alignment could be reduced by the improvement of the jig.

It was understood that the reliable resolution of the lithography, which can be understood as the minimum design rule would be approximately 200μm with considering the variation of the printing performance and the grain size of the toner for the laser printer. The alignment error is about 10% in the worst case. However, the value can be improved by increasing the minimum feature size of the circuit. This relationship may give a good chance to consider the design rule, since the design rule have to be considered when the students design the device.

The flow chart of the total processes including the heat treatments and the lithography process, "alignment-less lithography" using two photo masks of one's own making by the transparent plastic sheet for Over Head Projector (OHP) use is shown in Fig.9. There is no difference in the process of the phosphorous thermal diffusion between the proposed manufacturing method of the nMOS FET and the manufacture method of the p-n junction that we reported[6]. Because, it is recognized

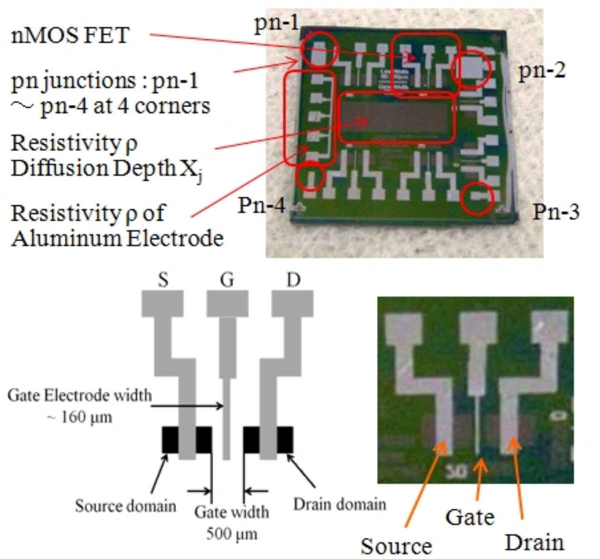

Fig.10 A photograph of the typical nMOS FET chip fabricated in the IC FAB

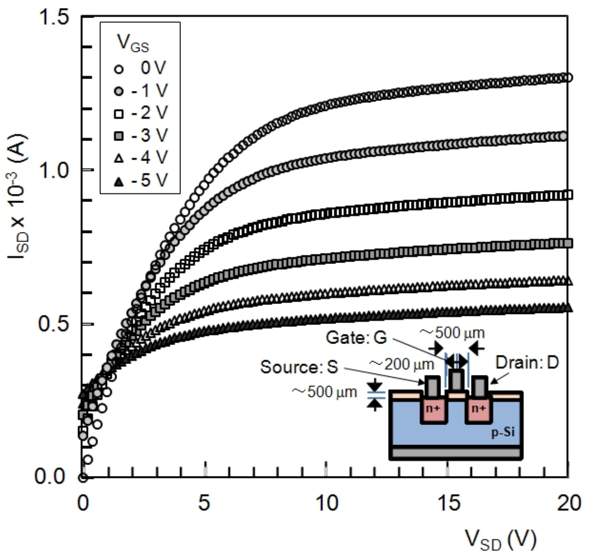

Fig.11 The typical I_{SD}-V_{SD} characteristics of the simplified nMOS FET fabricated at the simplified IC FAB

that the nMOS FET includes two p-n junctions that have same device character placed beside the gate insulation layer of the device.

Three additional processes are attached to the simplified p-n junction fabrication process. One is thermal oxidation process under the normal air environment to make SiO_2 layer on the surface of the silicon substrate shown in Fig.9(a). The other two processes are the lithography processes using the alignment-less lithography. One is to make SiO_2 windows to determine the source (S) and drain (D) areas in the SiO_2 layer shown in from Fig.9(b) to Fig.9(c). The other one is aluminium electrode making processes shown in from Fig.9 (g) to Fig.9 (h).

Fig.10 shows a photograph of the nMOS FET. It was found that the mask alignment using alignment-less lithography worked well. In this case, the maximum resolution was determined by the resolution of the photo-mask making process. And it is evaluated approximately 160 μm. Therefore, the channel length was designed from 300 μm to 500 μm and the gate width was about 200μm, since the mask alignment margin was estimated ±200μm in the worst case. It was found that it was possible to make nMOS FET using two masks process that was designed.

Fig.11 shows the typical I_{SD}-V_{SD} property of the nMOS FET fabricated by the simplified fabrication processes. The drain current I_{SD} was increased by the gate voltage. It was recognized that it performed as the depression type. However, I_{SD} at V_{SD}=0 was increased when the V_{GS} was increased. The impurity diffusion during the thermal oxidation process may be the cause of this phenomena. Considering about the prevention method of this phenomena using wet oxidation or using the spin on glass (SOG) thin film instead of the current SiO_2 layer are a future subject. It was confirmed that it performed as the enhancement type FET. It is recognized that the simplified fabrication process has a

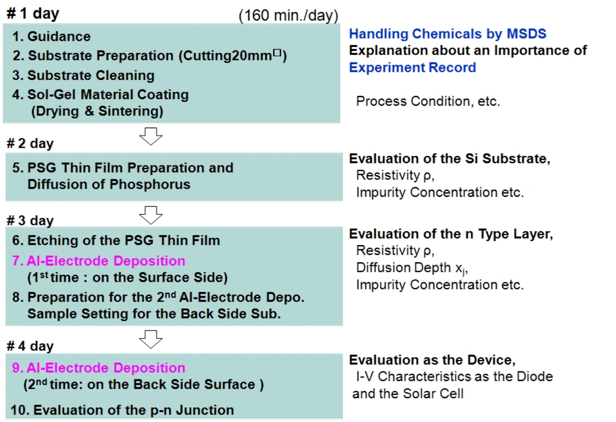

Fig.12 An idea of the experimental program at the IC FAB

possibility to apply on the hands-on experience to learn the device physics.

Discussion

In the IC FAB, the students can design, fabricate and evaluate a variety of the semiconductor devices, such as the solar cell by simply modify the p-n junction, nMOS FET and simple integrated circuit like a ring oscillator, counter, etc. that they learn in the classroom. They will notice the different part of the evaluation results from the comparison, when they compares all of those results. They will think why these property differences come from, and what the cause of the difference could be.

Fig.12 shows an idea about the schedule of nMOS FET, design, fabrication and evaluation program that was considered based on the result of the experimental program[7]. The thermal oxidation to make SiO_2 layer fabrication and the lithography processes are included without term expansion. It shows that there is a possibility to arrange 4 days program using the method that the extension of the time by increasing the processes can be absorbed using the waiting days and

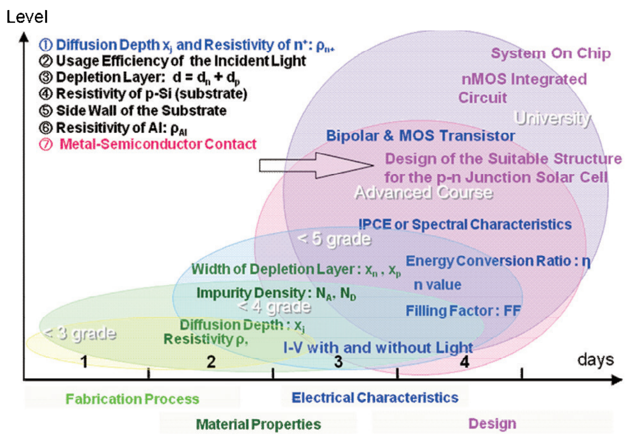

Fig.13 An idea of the road map of the Problem Finding and Solving Program with seamless education manufacturing scenes

the time between the scheduled days.

And they make the hypothesis to determine the biggest cause of the problem they recognized, and they focus to consider the method to solve. Students can acquire how the research is by osmosis. This procedure is the procedure that has typically been using in the research laboratory. And students also can learn deeply about the topics that they learned in the lecture at the class room, through this procedure.

On the other hand, if no advanced experiments are needed, the period of the experiment will be reduced from 4 times to 2 or 3 times, in some cases, it may be able to reduce to 1 time. It can be considered as the introductory program for the semiconductor device.

The PBL type exercise for an electronics laboratory course is available to apply. It is recognized that this program makes possible to create a problem finding and solving the problem style exercise for an electronics laboratory course, and to introduce and to provide a variety of programs at several knowledge levels of the students from lower grades to the advanced course in the KOSEN.

Conclusions

The simplification of the important 3 key processes lithography, impulity diffusion and fabrication of the silicon dioxide thin film for the device fabrication were investigated using common apparatus in the average science laboratory. A new litography method, "alignment-less lithography“ was proposed and successfully demonstrated. The lithogorahpy process which is wellknown as the most important process in the IC fabrication process was drastically simplified by this method.

In addition, thermal oxidation under normal air environment on the surface of the silicon substrate for making SiO_2 layer was proposed and successfully demonstrated. From this results, a simplified lithography process without any sophisticated apparatus was successfully achieved. And the simplified nMOS FET fabrication process was designed and successfully demonstrated. It is expected that pMOS FET will be also demonstrated by the modification of the nMOS FET process by just changing the materials. Furthermore, even CMOS device could be possible to make simultaneous diffusion process with limited process expansion.

It suggests that this simplified IC FAB has a possibility to expand the application, such as the fabrication of the other kind of the devise, like MEMS device etc. It was showed this program could be modified to enrich the content, seamless program or to reduce the hours by reducing the manufacturing time of aluminum electrodes. This result shows to accommodate the semiconductor device physics education using this program to the variety knowledge levels of the students.

It concludes that it is possible for any school that has a science laboratory to be able to establish the technology platform, simplified IC FAB can be established by this method, and to provide students a learning environment for cultivating the scientific mind with experiencing actual device fabrication.

Students can relive the historical innovative ideas by actual experiment one by one by this method and simplified IC fabrication facility established in the average science laboratory. And they can feel how to make an idea, and they can practice it by themselves. It will be a good educational environment to cultivate the scientific mind to develop the future technology and the new field.

Acknowledgements

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Report on Science and Technology Camp at Ngee Ann Polytechnic

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Abstract

This paper reports on the two-week Science and Technology Camp held at Ngee Ann Polytechnic in March 2016 for National Institute of Technology (NIT) students of Japan. The previous program of this camp was started in 2014 and second program was held in 2015. We evaluated and improved the programs then this year we held the Camp. The previous programs and this camp have same goal that is improving students' technical English presentation skill. Students in Japan often find it difficult to present their research work or talk their speciality out in English. They rely heavily on the use of Japanese as the primary medium of instruction due to the lack of lessons conducted in English language. As such, we need to expose them to an English-speaking learning environment by displacing them to a foreign school, where they have to attend technical lessons and give oral presentation in English, facilitated by non-Japanese speaking instructors. A total of 12 students, 2 from the advanced course, 3 from the fourth year course and 7 from the third year course, of various NIT's, at Kagawa, Ube, Hiroshima and Tsuyama, participated. The Science and Technology Camp was organized into 2 parts:

1. **Lectures of physics, general English and presentation;**
2. **Research presentation.**

Through attending lectures in fundamental physics and general English, students re-learned these subjects in a different approach. They observed the way technical concepts were introduced in words and through the use of tools like pictures and animation. These lessons have not only provided them with valuable models to follow, but also an experience that helped to strengthen their confidence in overcoming the language barrier. The students had several opportunities to give presentation in the lectures of physics and general English. We noted that the lectures have helped students in expressing technical terms and ideas, and asserting the effectiveness of the physics and English lectures. To evaluate the effectiveness of the camp and gather suggestions on points of improvement, we conducted a questionnaire with the student participants. Almost all of the students felt that the lectures were substantial and satisfied with the camp. In view of the encouraging feedback, along with our observation of the students' interest and progress in class over the two weeks, we consider this camp effective in improving students' technical English presentation skill.

Our camp was supported by Student Exchange Support Program by Japan Student Services Organization.

Keywords: *english for specific purposes (ESP), english for general purposes (EGP), overseas training, active learning, intercultural understanding, student exchange*

Introduction

This paper reports on our Science and Technology Camp at Ngee Ann Polytechnic in 2016. Favourable outcome of a technical English program at Temasek Polytechnic was reported in Abe et al. (2012). It seems that the aim of the program was to improve students' presentation skill. Kikuchi et al. (2014) reported on a previous version of this Science and Technology Camp, known then as the Technical English program at Ngee Ann Polytechnic, drawing inputs from questionnaire survey conducted with student participants of the program. The main purpose of the Technical English program was to impart basic knowledge and skill for giving presentation in English. The authors maintained that while most college students had plenty of opportunity to speak, they might not have enough of it to attend lessons in English. The instructors served as role models for the Japanese students to imitate, and their lessons as reference for learning presentation techniques. In the Technical English program, lessons in English were given considerable weight. The main purpose of the program could be achieved by providing an immersive and interactive experience.

We improved the Technical English program and changed the title to Science and Technology Camp. This camp placed more focus on learning science and technology than on learning English, as we believed that students would be able to experience intercultural exchange through daily life in Singapore anyway. The modification made included the following:

1. Beginning student recruitment in April instead of November;
2. Removing the excursion;
3. Changing the eligibility of student participants from 5^{th} grade or advanced course to 3^{rd} grade or above.

These changes had some effect on the camp. In consideration that students would need more time to prepare for the camp, we brought the recruitment drive forward. As the purpose of this camp more about learning science and technology than a cross-culture experience, we decided to do away with the excursion. This camp was conducted in March, the same time when college graduation ceremonies are held in Japan. Since almost all 5^{th} grade students would be attending the ceremonies during the period, we revised the eligibility criteria for participants to include students who had learned basic physics at the 1^{st} or 2^{nd} year grade level. So the camp offered students an opportunity to review elementary physics.

This paper presents the camp outline and the lecture details in Section 2 and Section 3 respectively. Section 4 analyzes the results of a questionnaire survey conducted with the student participants. Conclusions follow in Section 5.

Summary of the Camp

The detail of our camp is the follows:
Term: March 12 to 28, 2016
Place: Ngee Ann Polytechnic
Number of student participants: 12
Qualification of students: 3^{rd} or 4^{th} grade students, or 1^{st} grade student in the advanced course
TOEIC Score: more than 400 (5 students)

Table 1 shows the affiliation, qualification, and number of the various student participant groups.

Table 1: Details of student participant groups

College	Grade	Number
Kagawa	Advanced 1^{st}	1
Hiroshima	3^{rd}	4
Ube	Advanced 1^{st}	1
Ube	4^{th}	1
Tsuyama	4^{th}	2
Tsuyama	3^{rd}	3

The average TOEIC score of student participants was 449, taken over a range from 380 to 640. We regarded these scores to be typical of college students. These students might not be strong in English but were motivated English learners. Students receive scholarship from Japan Student Services Organization (JASSO) if their TOEIC score is more than 400 or if they obtain excellent English assessment results in the last school year. We started advertisement for participants at Tsuyama College in April 2015. Students had 5 opportunities to take TOEIC test. Some student participants obtained over 400 in their TOEIC score. Thus the scholarship may be an incentive for taking the TOEIC test and to score above 400.

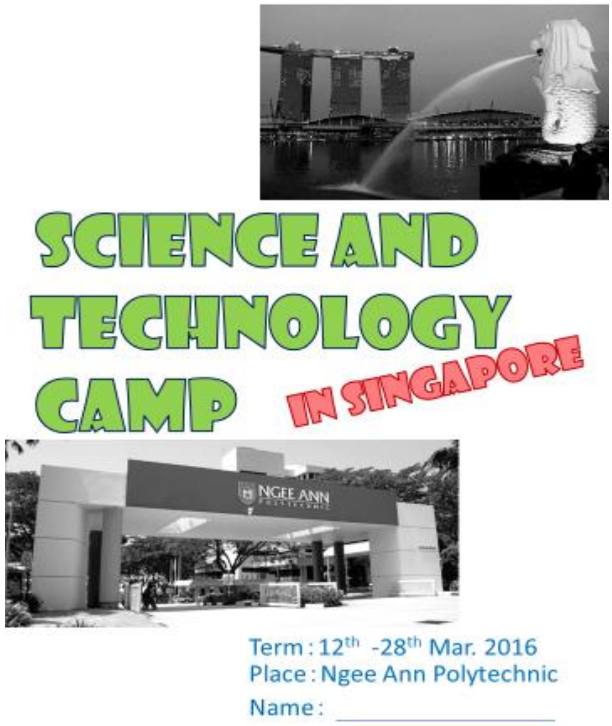

Figure 1: The cover of guide pamphlet

We prepared a guide brochure for this camp and distributed it to the students before departure to Singapore. We had no time to meet all student participants, since they came from different colleges. Each student was to prepare for the camp by himself/herself. The cover of the guide brochure is shown in Figure 1. It included the Singapore map, the subway (MRT) route map, travelling and daily life information in Singapore, flight and immigration details, baggage allowance, hostel and room assignment information, participants' list, and the schedule (see Figure 2).

Contents of the Science and Technology Camp

The lectures in this camp can be separated into the following 3 parts:

(1) Lectures on physics;

(2) Lectures on general English;

(3) Lectures on presentation.

On a daily basis, students attended classes in physics and general English. If the physics class was taken in the morning, then the general English class would fall in the afternoon. As each class lasted for about three hours,

Date	Morning 9:00am – 12:00pm	Afternoon 1:00pm – 4:00pm
14 March 2016 Monday	9:10 Welcome speech by NP ECE management 9:15 Introduction to NP (corporate video screening) 9:25 Welcome speech by NIT professor	General English Lesson 1 Location: 08-06-02
15 March 2016 Tuesday	Science and Technology Lesson 1 Lu Tan Location: 08-06-02	General English Lesson 2 Location: 08-06-02
16 March 2016 Wednesday	One-day Science and Technology Activity Lu Tan Location: 08-06-02	
17 March 2016 Thursday	Science and Technology Lesson 2 Lu Tan Location: 08-06-02	General English Lesson 3 Location: 08-06-02
18 March 2016 Friday	Science and Technology Lesson 3 Lu Tan Location: 08-06-02	General English Lesson 4 Location: 08-06-02
19 – 20 March (Sat & Sun)		
21 March 2016 Monday	Science and Technology Lesson 4 Patrick Fung Location: 08-06-02	General English Lesson 5 Location: 08-06-02
22 March 2016 Tuesday	Science and Technology Lesson 5 Patrick Fung Location: 08-06-02	General English Lesson 6 Location: 08-06-02
23 March 2016 Wednesday	One-day Science and Technology Activity (requires Microsoft PowerPoint Version 2010 or above) Patrick Fung Location: 08-06-02	
24 March 2016 Thursday	Science and Technology Lesson 6 Patrick Fung Location: 08-06-02	Free Slot (for preparation for final presentation)
25 March 2016 Friday	Final Presentation Location: 08-06-02	Free Slot (for free and easy activities)

Figure 2: Schedule of the camp

the students took six hours of classes on a typical day. Lecture on physics and general English had 6 classes respectively. Hence, in this camp, students took 18 hours of lessons on physics and general English each.

The physics lessons dealt with classical mechanics mainly. Besides topics like vector, velocity and speed, distance and acceleration, more advanced ones such as relativity were also discussed. The teaching materials were original and were shown by projector to students. The topics in the classes were similar to those in first grade physics in the participants' colleges. However the students did not have much experience of taking them in English and some students had forgotten some of those topics. The physics lessons were good but still hard for the students. The teacher also gave the students some mathematics quizzes to solve, and the students enjoyed them. The quizzes seemed to be useful in stimulating their intellectual curiosity.

Conversation accounted for a majority of the general English class activities. The general English class might not be harder than physics for the students, since fewer technical terms were involved. Moreover the original textbook for this camp was pitched just right at the level of the student participants. They seemed to understand some Singapore culture and have tried to communicate with some Ngee Ann students.

The students sometimes worked on physics and general English assignments in the hostel until midnight. These assignments seemed to have a positive impact on their attitude towards learning English.

There were three lectures on presentation skills in the camp. The students learned to use Prezi in the first class, and PowerPoint in the second. As it was their first time to use Prezi, the tool appeared hard for them to use efficiently. The second class introduced students to animation using PowerPoint. As they had used PowerPoint before, they enjoyed making animation

Figure 3: Students preparing their presentation

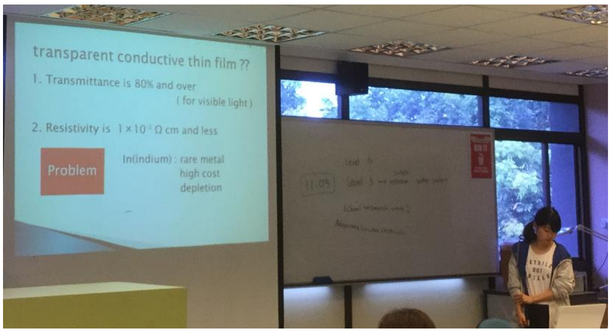

Figure 4: A scene of student presentation in the last class

slides. The third and last class was students' presentation on their research projects (see Figures 3 and 4).

Result of questionnaire survey

After the camp, we conducted a questionnaire survey with the students to identify areas of improvement for the camp. The survey contained 15 questions; 12 of them were multiple choice questions, and the remaining 3 were narrative type of questions.

The multiple choice questions are shown in Table 2. The numbers in the parentheses indicate the frequencies at which the choices appeared. Students supported their choices with reasons in some of these questions.

Table 2: Summary of questionnaire results

No.	Question	Response
1	Duration	Short(2) Long (1) Appropriate(9)
2	Timing	Suitable(11) Unsuitable(1)
3	Cost	Inexpensive(1) Expensive(3) Appropriate(8)
4	Degree of satisfaction	Satisfied(11) Almost satisfied(1) Dissatisfied(0)
5	Orienteering	Very meaningful (9) Meaningful(2)

		Not meaningful(1)
6	Timing of orienteering	Too early (1) Suitable(11) Next week would be better(0)
7	Difficulty level of lessons	Very easy(0) Easy(1) Suitable(5) Hard(6) Very hard(0)
8	Comprehension of lessons	About 30%(1) About 50%(4) About 70%(7) About 100%(0)
9	Meaningfulness of lessons	Very meaningful (6) Almost Meaningful(6) Not meaningful(0)
10	Activity for lessons	Active(7) Little bit active(5) Not active(0)
11	Motivation to learn English	Enhanced(11) Enhanced slightly(1) Same as before participating(0)
12	Attitude towards different culture	Changed a lot(9) Changed slightly(2) Same as before participating(1)

Question 2 asked about the timing of this camp. One student thought that it would be good if this camp was held in summer. However several programs were held in summer by NIT Colleges. We think it is important to give students choices on timing in their overseas program participation.

Question 4 asked the students to rate the degree of satisfaction with the camp. No student participant was dissatisfied with the camp. Based on the comments, the students found the experience in this camp meaningful and their life in Singapore enriching. This camp made them realize the importance of studying English for science and technology. That was one of the reasons for choosing "Satisfied".

Question 5 asked whether orienteering had help them to improve communication skills with foreigners of a different culture. A student who chose "very meaningful" answered "I got to speak English without hesitation by starting from basic conversation such as asking the way because I was very nervous". The student who chose "not meaningful" answered "Time was short and I could not ask someone in English well because my English was not good enough". The day of orienteering was rainy. Thus, there was not enough time to play orienteering.

Question 6 was about the timing of the orienteering. The reason for "too early" was "I was insecure because I just arrived". The same reasons for "Suitable" were "I thought it would be meaningless if this orienteering was carried out after we got used to Singapore", "Participants' bonding deepened through this orienteering", "I started feeling like talking in English through this orienteering" or "Participants got closer". We think orienteering has provided a good opportunity for students to get used to Singapore and to make friends with other college students.

Question 7 asked for the difficulty level of the lessons. Half of students felt that the lessons were hard for them. However from the view-point of the teacher leader, this result was meaningful and at this point, the camp seemed to be successful. Since they felt the lessons were hard, they studied harder in Singapore than in Japan. This was a proof that the camp was not a mere cross-cultural program. Moreover in Question 8, over half of the students answered that they could understand about 70% of the content in the lessons. As the numbers attest, the student participants studied hard to understand the lessons. This result shows that the camp is very instructive for the students.

Question 9 inquired about the meaningfulness of the lessons. The students chose "Very meaningful" or "Almost Meaningful". Some reasons that students answered "Very meaningful" were "The opportunities the teachers gave us to speak have made it easy to be engaged in classes", "I was able to learn about presentation a lot", "I was able to review what I had learned in Japanese before" or "During class, teachers did not speak in monologue, but asked us many questions". Some reasons why students answered "Very meaningful" were "I was able to learn words used in physics even though they were difficult" or "It was difficult to learn physics in English although I had learned it before".

Question 11 was concerned with the change of students' motivation to learn English. The students felt that their motivation was enhanced after participating in the camp. The students chose "Enhanced" or "Enhanced slightly". They mentioned the reasons for this choice: "I realized that my English proficiency was lacking and I felt that I had to study again", "I want to brush up my English conversation skill and improve my vocabularies more" or "I felt fun when I was able to communicate in English". These reasons implied that this camp could serve as a stimulus to the students' motivation. They would like to speak English well since they were aware that their English skill was inadequate and would like to expand their English vocabularies. The camp focused on science and technology but the student participants not only learned these specific subjects, but also learned the need for good English skill.

Question 12 was concerned with the change of the students' attitude towards a different culture. 75% of student participants chose "Changed a lot". Some reasons were "I felt that my English had improved by speaking to foreigners actively. And I found some differences between Singapore and Japan, such as food culture, so I thought I needed to adjust to their culture", "I realized that I was able to communicate with many people if I could speak English", "I found that I was able to communicate even if I could not completely speak English" or "I found it interesting to be exposed to a different culture".

From the students' answers in the questionnaire, the camp gave the students opportunity to learn physics, general English, daily life in Singapore and so on. Moreover the camp has enhanced the students' motivation to learn English and improved the students' English skill.

Students' daily life in Singapore

The students enjoyed Singapore life but almost all of the students were in poor health in two or three of the days during the camp. Some students had fever. The teacher leader needed to attend to their health and behavior. Furthermore the teacher needed to be able to respond to students' physical infirmity at the initial adjustment stage.

Conclusions

This paper reports on the Science and Technology Camp at Ngee Ann Polytechnic in 2016. This camp was held for about two weeks but has motivated student participants to learn hard. Runnning this program in the long term may motivate students to take TOEIC test and to obtain higher score. We conclude from the reslut of the questionnaire for student participants that this camp has completed successfully. Overseas ESP program, like this camp, may achieve the purpose of overseas EGP program.

Acknowledgements

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1507

IMPROVING STUDENT ENGAGEMENT THROUGH GAMIFICATION

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Abstract

In education, it is not uncommon to find cases of students who are not eager to learn in the classroom. To tackle this issue and improve student engagement, the approach of gamification is employed to devise teaching strategies. By applying relevant game design theories into a non-game related activity, people can be motivated to perform tasks that they ordinarily consider boring. While there are many significant cases of gamification being profitable for business, there are less indicative examples in the field of gamification in education. Therefore the purpose of this research is to investigate the effectiveness of gamification in enhancing student engagement while tackling existing problems in the modern classroom so as to support the achievement of learning outcome established in the curriculum.

Action research was utilised, where both the educator and the students worked hand in hand together to refine and enhance the teaching and learning process. Gaming motivation theories were applied to selected classroom exercises and practices, providing students with psychological rewards similar to those awarded to gamers. A full cycle of observation, reflection, planning and action had been achieved, where the initial stage of the second cycle was also observed to deduce the effectiveness of the methods applied.

At the conclusion of the research, the learning outcomes were achieved and students' views were reviewed in gauging the effectiveness of gamification in education. The end result showed improvements in all areas, where the statistics gathered from the survey suggested that the students have found the gamification plans to be enjoyable, implying that student engagement has improved.

The research managed to accomplish what it set out to do; making improvements in the areas identified as the problems, with the gamification plans executed without the introduction of elaborate teaching equipment while still achieving learning outcome.

In order to apply relevant game design theories into a learning activity, it is important to first understand the elements that make a game fun and motivating. By designing educational activities with the idea of providing psychological rewards such as achievement, recognition and satisfaction, lesson plans may have the potential to be as immersive as games that engage students and make teaching and learning more effective.

Keywords: *Gamification, Games, Student Motivation, Engagement, Action Research, Learning Psychology*

Introduction

Gamification has only been as a viable trend in recent years (Turco, 2014), using the theories behind game mechanics to help solve problems and engage users in promoting products and services (Zichermann & Cunningham, 2011). But significant case studies on its effect on education has been scarce so through careful planning, this research aims to dwell into this fresh concept to incorporate the elements of gamification to provide students with a learning experience that is both enriching and engaging while tackling existing issues at the School of Interactive & Digital Media (SIDM) in Nanyang Polytechnic, Singapore.

In schools, it is not uncommon to find cases of students who are not eager to learn in the classroom. There are times during lectures where the students are more interested in fiddling with their mobile devices than to be engaged in the lesson. In more severe cases, some of them may choose to play truant. This lack of participation in the classroom hinders the effectiveness of teaching and a solution to the problem can greatly enhance their learning potential.

Through action research on *Storyboard & Art Direction*, a module selected for this study, the pedagogical issues were examined and evaluated before the approach of gamification was utilised to devise plans of improving student engagement. These strategies were designed to be flexible and hassle-free, where there would not be drastic interference to existing module syllabus and neither would there be elaborate teaching equipment being introduced in the classroom.

The basic theory behind gamification is to apply game design mechanics to real life tasks in non-game contexts, in order to influence and encourage users. With the proper application of these game design techniques, people are motivated to perform tasks that they ordinarily consider boring (Marczewski, 2012).

In recent years, the idea of gamification has been deployed in various ways in numerous business, including customer engagement, personal development, and health and wellness (Burke, 2013). One notable example is the success of the Nike+ App, which has now developed into a gamified sport that not only furthers Nike as a global brand, but is also encouraging customers to keep fit and stay healthy (Sanusi et all., 2014). Another well-known example is McDonald's Monopoly promotion, which in 2010 helped the fast food chain generate a 5.6% increase in sales profit in the United States (Thestar.com, 2010).

While there are many significant cases of gamification being profitable for business, there are less indicative examples in the field of gamification in education and most of them exist as experiments rather than as an integral part of the syllabus.

Yu-kai Chou (2013), a practitioner of gamification who received the award of "#1 Gamification Guru" by the World Gamification Congress, listed a number of ingenious gamification case studies in his personal website. But many of the listed examples not only involved the creation of a digital component such as an application or a videogame but also existed as more of an individual entity where its intention was not to be fully integrated into an existing lesson plan.

In Huang & Soman's (2013) research on the gamification of education, several case studies were presented but similar to Chou's recommendations, these examples also involved the implementation of additional applications.

The intent of this research is the utilisation of gamification through efficient yet inexpensive means, without the inclusion of new teaching equipment as the creation of applications or purchase of software licenses. The use of these added tools often implicate an increase in budget and manpower, which may be subjected to lengthy approval processes in most institutions. It is important that the gamification plans fit seamlessly into the existing curriculum and that teaching materials do not go through a drastic overhaul.

While gamification involves the application of game design theories, it does not necessarily suggest that the outcome must involve the creation of games (Zichermann & Cunningham, 2011). Although playable videogames may be viable in some cases, the main purpose of this research is not to create a game out of the module but to incorporate game design mechanics, where necessary, to promote student engagement.

The module which this research was applied to was *Storyboard & Art Direction*, a core module that is taught to all first year students in the Diploma in Digital Game Art & Design at SIDM. It is a 60-hour module, inclusive of 13 hours of lecture and 45 hours of practical, which is delivered once per week over the course of 15 weeks. Each practical lesson is 3 hours long, with variable unsupervised hours each week that are allocated for self-study or completion of assignments. The objective of the module is to allow students to have a basic understanding of the roles and functions of a storyboard, in the production of various media productions. A total of 74 students were registered for the module in the semester which the research was conducted.

Methodology

Action research was utilised in this project as it encompasses the methods mentioned in the attempt to not only address but also to improve the situation (Craig, 2009).

Improving student engagement has been a goal for many educators who specialises in art and design programmes so as to encourage students to realise their fullest potential (Rutherford, 2015). But both the educator and the students must work hand in hand together in order to refine and enhance the teaching process where the eventual purpose is to create a learning experience that is both enriching and engaging.

Moreover, many other educators from other universities have also been applying action research in their own pursuit of resolving pedagogical issues (Norton, 2009), which further establishes its suitability in teaching and learning.

In order to apply relevant game design theories into a non-game related activity, it is important to first understand the elements that make a game fun and motivating.

Tekofsky (2010) suggests that when playing videogames, there are 3 major psychological rewards offered to players where at least one of 11 basic psychological needs is fulfilled each time.

Tekofsky's 3 psychological rewards are:

1. Achievement
2. Recognition
3. Satisfaction

Tekofsky further explains that one or more of these 3 psychological rewards are presented to the players when 11 basic psychological needs are fulfilled, where at least one of the needs is accomplished each time they play videogames:

1. Knowledge
2. Skills
3. Competence
4. Perseverance
5. Creation
6. Danger Management
7. Competition
8. Cooperation
9. Caring
10. Emotional Regulation
11. Optimal Choice

While some of Tekofsky's ideas may not be applicable in some gamification projects, there are many ideas that are useful in considering what motivates students and this research hope to inject some of these theories into the process of gamifying lesson plans.

The achievement of "Best Sketch" was created for the module, where to be eligible, the students had to submit their pencil sketches from the first two weeks of classes and the lecturer would decide one person in each tutorial group for the award for a total of four winners. The reward would be the freedom to select the content of the practice panel for the lesson on week 5, meaning the winner could request for any media-related character or movie or game, and the lecturer would source for one suitable screen capture of the requested content for everyone in the module to draw.

The idea was devised because in game design theory, it is essential to understand the elements that will not only draw players to the game but they will continue to stay motivated to play it. Some players wish to win respect in the multiplayer games that they play by getting achievements, where even if this accomplishment does not affect their status in the game. There are also some players who will make the extra effort to clear a task in order to receive an in-game reward, even if the reward does not necessarily make their in-game characters stronger. The role of game masters also appeals to certain players, where they like access to different game settings to create their personal unique game experience. The motivations of these three groups of gamers, as suggested by Tekofsky (2010) in his studies, are combined in an idea that may encourage the submission of ungraded exercises, where the final outcome will present the students with the reward of both achievement and recognition.

On the first lecture, when it was revealed during lecture that the best sketch of each tutorial group would get the chance to pick the content that the rest of the class would be drawing on the tutorial lesson on week 5, there was a brief commotion among the students as they were unsure what to expect, as they had not gone through a tutorial lesson yet. It was also highlighted that all sketches were part of practice and grades were not given to them, although it was still recommended that they were submitted for critique.

Later in the first week, during each group's tutorial class, the gamification plan of rewarding students with the best sketches was reiterated as students were practising their sketches and this time, it was met with increased enthusiasm from the students as some students were naming some videogame characters that they would like to pick and one student even asked if it was acceptable if he chose a photograph of himself if he had won.

At the end of the tutorial classes on the second week, there were a few students who were more eager than the rest and would immediately hand their sketches in the moment class was dismissed. The rest of their classmates would seem motivated by these students and would hand their own sketches in too, where all the ungraded sketches were submitted by the end of class.

As the module leader, I would proceed to look through all the sketches with the module tutor, writing down comments for each student on how to improve their work, as well as picking the best sketches.

When the winners were revealed in week 3 during lecture, some students expressed more excitement than others as they started to recommend to the winners what content they should pick. The choices of four winners were diverse as they each selected content from a videogame, a recent anime, a classic anime and a blockbuster movie. One of them was also very specific about her selection, requesting that the character she picked must come from the recent live action movie rather the classic animated movie or recent animated series.

As the winners' selected content was presented on week 5's tutorial lesson for the students to draw, it is worth taking note that it sparked short conversations between the students about their passion for some of their favourite videogames or movies, where it would seem that they were enjoying themselves even as they were doing work.

The percentage of students who submitted ungraded sketches for this semester was at 100%. This outcome is remarkable, as during the last run of the module for the previous cohort, although the exact number was not officially recorded, it can be recalled that approximately less than half the sketches were collected.

With all 74 students submitting their work which they knew it would not be graded, it would be safe to deduce that the gamification plan of rewarding students who produce the best sketches had been fruitful in encouraging the students.

Figure 1 shows an example of a student sketch from a provided image, which was used to determine the quality of the students' sketches.

Figure 1: Example of a student sketch from a provided image.
Source: *Wreck-It Ralph*, Walt Disney Studios, 2012

For the first few weeks for the module, the students were practising their sketches with existing images from all manner of popular media that were selected by the lecturers. The exercises given to the students in *Storyboard & Art Direction* were meant to enhance students' skills in producing the correct proportion, composition and maintaining clean line quality. So while all of them were working on creating the images diligently, some of them might have struggled with some of the images, taking longer to finish their work, especially those who were not accustomed to drawing extreme angles and perspectives. The development of other drawing skills was to be covered by other modules such as *Life Drawing*; therefore certain components were not critical in the assessment of their storyboard at this stage. So those who were weaker in drawing were seen to look tense during class, creating an environment that might seem stressful.

From the third week onwards, students were given the choice in choosing between two different images that let them practise similar learning objective. When presented with the chance to pick, it was observed that the class became livelier, as the students discussed enthusiastically which picture they would prefer, presumably making their decisions based on how difficult they felt it was to create the image and the popularity of the content on the picture.

While the two images presented to them might look different, the aim of drawing these set of images was for the students to understand how to create concepts such as contrast in their compositions. The students were presented with an approach which let them feel a sense of control over what they could do each week, be it choosing an image which they feel was easier to draw or picking a character which they fancied more.

The incorporation of this idea draws on Tekofsky's point that the need for creation exists in players where they feel a sense of achievement if they can accomplish the tasks.

Figure 2 shows an example of two images which students could choose from in their practice.

Figure 2: Students get to pick which image to draw.
Source: *The Walking Dead*, Telltale Games, 2012
***The Last of Us*, Sony Computer Entertainment, 2013**

For the first graded assignment in Storyboard & Art Direction, the students could work on creating their storyboard individually or in pairs and as part of the marking criteria; they were required to present their story to the class. The contest of "Best Presenter(s)" was introduced on week 6; where the students themselves could vote for who they felt was the most entertaining presenter in the class on week 7, who would later go on to compete with the winners of other groups to determine the overall first-placed presenter in the whole cohort on week 8.

With the introduction of the competition, it was noticed that the students were more eager to listen to their classmates present their work and when it was their own turn to go forward, the more outgoing individuals would appear more animated when telling their story to the class. As there was something more at stake than just grades, many students were shown to be more attentive during the whole session.

As the votes were counted for each class, the winners of two of the group won unanimously, receiving more than 90% in the poll, while the results of the other two groups were closer, where the runner-ups were edged out by just a handful of votes. When the winners of each group were announced, the other classmates were cheering them on, anticipating the final part of the competition on the following week. Some students even offered some advice to their winning classmates, suggesting improvements such as the kind of voice they should imitate during the dialogue parts of the story or even their overall posture when they point at the story panels.

On week 8 in the lecture theatre, the atmosphere amongst the students was much more energetic than usual as they anticipated the commencement of the competition to determine the best of the best among the presenters. The crowd roared as each presenter was introduced, where everyone was seen to be cheering for their own group representative.

The winners of each group took turns to present their story to the whole lecture theatre as all students were fully invested in listening to them as they could be seen to be amused by the presentations and were laughing at some of the humourous details of the storyboard along the way.

To determine who the overall best presenter honour should be awarded to, the ideal manner would not be by a poll as it was likely that the students would just vote for their own group representative. So the most fitting way of deciding the winner should be the judging of a lecturer who would serve as a neutral party and be watching these students present for the first time. The course coordinator for this batch of students, who was also the manager in charge of the *Storyboard & Art Direction* module, was invited to be the judge.

The items that were given out as prizes to the participants were surplus gifts from previous school events, including notebooks from the last School of Interactive & Digital Media graduation showcase and other stationery items.

As the runner-ups and winner were announced to collect their prize, the competitors were seen shaking hands to congratulate each other, maintaining that they were still friends and course mates regardless of the outcome of the contest. Everyone else seemed to have thoroughly enjoyed themselves in the session as they cheered and clapped for all participants.

The purpose of such a contest was to not only allow competition among students; it also promoted cooperation among students of the same tutorial group to function like a gaming guild, where they could socialise with each other in helping their class representative improve to win the overall competition.

A lecturer's marking criteria for outstanding presentations might be different from what the students feel were the most entertaining story or presenter so the outcome of the votes of each group might not necessarily be the highest scoring individual in the eyes of the lecturer, which was the effect intended, as it helped show that recognition could be given to other students too and not just the usual top students.

Results and Discussion

To truly gauge whether the students' have felt the lessons to be engaging, it was essential that feedback was gathered from the students themselves, where both quantitative and qualitative data were essential as a broad range of information would reveal more about the students' point of view (Groves et all., 2011).

During the lecture portion of week 8, after the competition to determine the best presenters, all 74 students who were present during the session took part in the survey which targeted at assessing the engagement level of students.

In the first portion, students would state how much they concur with each statement from a scale of 1 to 5, with 1 disagreeing, 3 being neutral and 5 agreeing. The total ratings given by all 74 participants of the survey were averaged and the statistics can be seen in the chart in figure 3.

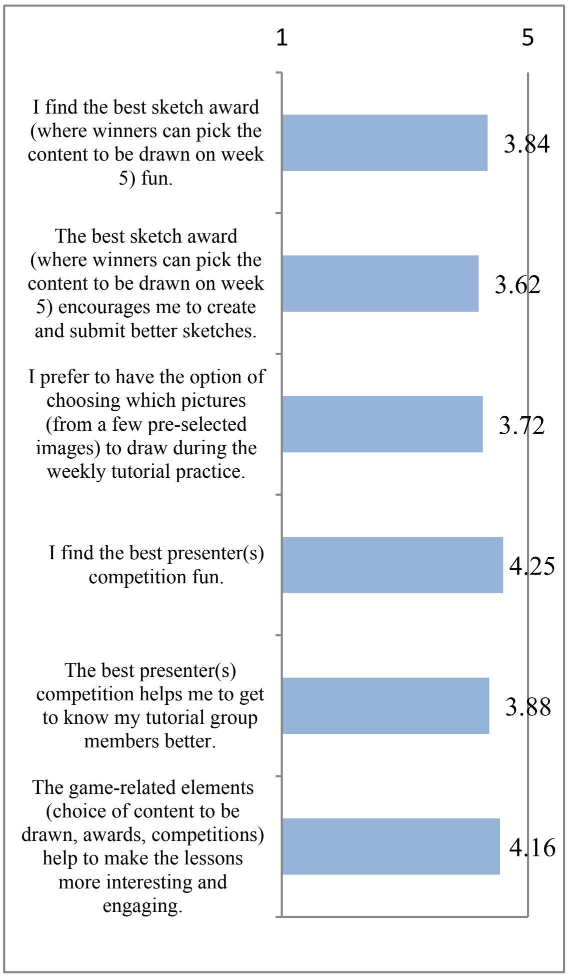

Figure 3: The outcome for the first section of the survey.

With all the figures above the neutral range as shown in the chart, it can be derived that in general, all the students welcomed the use of gamification plans in the lessons that they have experienced.

The best presenter competition was the most popular, as the students not only found it fun, they also found it as an opportunity to get to know their classmates better. This outcome helped to support Tekofsky's idea where other than the psychological needs of competition being fulfilled, there was also the cooperation aspect which provided the psychological rewards of achievement, recognition and satisfaction, resulting in the highest level of fun and motivation.

For the data seen in the chart, the best sketch award was also agreeable to the students, as they found the concept to not only fun but it also encouraged them to submit better sketches. The success of this award was also supported by the submission of ungraded sketches from all students.

While less sophisticated in execution than the other two gamification ideas, having the option to pick which pictures to sketch was also welcoming for the students and overall, most of the students agreed that the introduction of gamification elements had made the lessons more interesting and engaging.

The next portion of the survey allowed the students to write comments to state the part of the lessons which they enjoyed and many of them highlighted that the best presenter's presentations were their favourite, further supporting its effectiveness on engaging the students.

Some of the comments written by students can be found in table 1.

Which part of the Storyboard & Art Direction lessons did you enjoy and why?
1. Mostly everything since the lecturer made it very entertaining for the most part.
2. The presentation. All the presenters were funny.
3. The best presenter's presentation.
4. The presentations. It's fun to watch my classmates stories and it is also happy for me to know that people enjoy my jokes.
5. I find presenting our story was fun because I can see their reactions.

Table 1: Some of the comments given by students.

Overall, the feedback provided by the students has been largely positive, stating that the lessons have been fun and that they have enjoyed the whole learning process.

Conclusions

Using Tekofsky's theory of gaming motivation as a guideline, all the psychological rewards of achievement, recognition and satisfaction have been fulfilled by the gamified lesson plan as multiple basic psychological needs have been addressed. The competition and cooperation elements, along with the option of creation, have helped the students in developing knowledge and skill, and through perseverance, some of them have also gained competence.

The research has managed to accomplish what it set out to do, by addressing the needs suggested by Tekofsky making improvements with the gamification plans being carried without the introduction of elaborate teaching equipment while still maintaining the learning objectives of the syllabus.

The large sample size of students participating in the survey also helped generate data with reduced random results, where overall, the submission of all ungraded exercises and the statistics gathered from the survey, would suggest that the students have found the gamification plans to be enjoyable, implying that student engagement has improved.

Acknowledgements

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1508

3D Serious GAME Supporting Physics Learning

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Abstract

This study aims to develop 3D serious game that to encourage the students to learn physics. The 3D serious game was designed to be used as PC software, therefore it requires only computer environment, which all NITs already have, to set it up as the material. Furthermore, large-scale or microscopic physical phenomena could be replicated much easier than conventional experimental teaching material.

In this paper, several themes of the 3D serious game were developed and a trial lesson and a questionnaire survey were carried out to evaluate effectiveness for physics learning compared to conventional assignment such as hand-out.

As a result, many students answered that they enjoyed learning with the games, understood some formulas intuitively. However, the rate of students who they got interested to physics through the learning with the games went no further than 50%. This result indicates that the games could promote the students to learn and understand physics and has a margin for improvement. At end of the paper, the new design of the games, which is being developed to solve the problems now, are described.

Keywords: *Physics teaching, Serious game, 3D game, Unity, Motivation*

Introduction

Physics is the most important general education subject for NIT students because the knowledge of this subject underlies many technical subjects that they learn in the upper grades in NIT. However, many students seem to lose interest for learning physics because the formula is difficult to intuitively understand. Aoki(2003) confirmed that material to promote them to understand intuitively was effective for subjects that they need to understand both formulas and phenomena such as physics. Therefore, many physics teachers have been trying to explore ways to promote instinctive feel for physics learning. Experimental teaching materials (e.g.: Mechanics truck) are good solutions to promote understanding toward the formulas through seeing the actual examples. However, it is difficult to line up a round of the instruments due to the high price line of them. Furthermore, one experimental teaching material cannot use for other physical phenomena and replicate large-scale or microscopic physical phenomena.

Recently, various serious games have been developed as educational material to solve the problem. The serious games have worked well for students who used to games all over the world. However, Macgonigal(2011) pointed the problem that teachers heavily burden to replace existing curriculum with new curriculum to introduce serious games into the curriculum. Therefore, this study develops 3D serious game that aims to be used in existing curriculum and to encourage the students to learn physics. The game is designed to require only computer environment. All NITs already have them. Thus, to set it up as the material is easy for NITs.

So far, various themes of the game such as motion with constant acceleration, Hooke's law, buoyant force, static frictional force and specific heat capacity were addressed. After the themes of 3D serious game have developed, they were employed as educational materials for NIT, Kagawa students to evaluate the effectiveness for physics learning compared to conventional hand-out assignment. A questionnaire survey was carried out after the learning, many students answered that they enjoyed learning with the game, understood some formulas intuitively. However, the rate of students who they got interested is relatively low. Therefore, the system of the game is needed to be changed the game more interesting. At end of the paper, the new games, which is being designed to solve the problems now, are described.

Development Environment of 3D Serious Game

Learning physics is necessary to be engineers as basic knowledge. Therefore, NIT students study physics in lower grade and students who major in math and science in other high-school study physics as basic subjects. Not NIT students but also other high-school students tend to have issues to study physics. It could be difficult that students bring up the image of movements of objects from formulas. This might be a cause of difficulty of studying physics. To solve the problem, many experimental teaching materials have been employed in physics class. The materials can have them to watch the real movement of object and promote intuitive understanding toward physics formula. Figure 1 shows a famous experimental teaching material in Japan as a typical example. A truck goes down a slope and pulls a tape. Tape recorder puts holes at regular intervals. Students can see the change of speed from interval of holes.

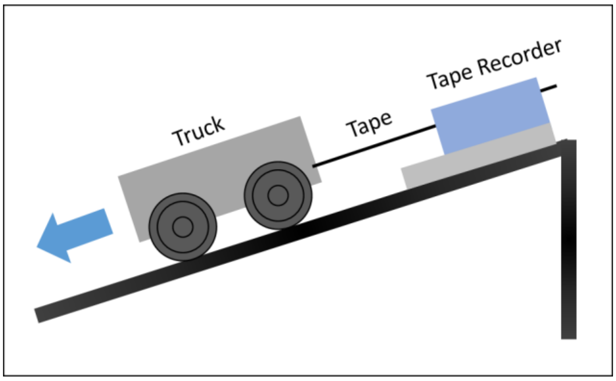

Figure 1 An example of experimental teaching material

It is easy for the students to practice calculation after understanding of formula by the experiment. Therefore, many teachers have developed physics course that calculation exercise comes after the experiment using these kinds of material. However, school cannot provide the material to each students because of the materials are very expensive. In addition, there are some learning items that cannot be duplicated such as amount of exercise and atom etc. Flash movie is one of famous countermeasure for this problem. Many movies that shows physics phenomena have been available on internet.

However, it might not be effective that the student still need to open their textbook after watching the movie to practice calculation. When teachers think to realize self-learning material or material for flip-classes, the material should include not only part for intuitive understanding but also part for practice of calculation. To realize the self-learning and teacher support material, 3D serious games for physics learning are made in this study.

This study employed Unity as a development environment of the 3D serious games. Unity has a sophisticated physics engine. Therefore, that is sufficient processing ability to realize physical phenomena. In addition, some theories in Newtonian such as dynamics force of gravity and friction force can be used only have to check the setting box. Unity is relatively easy-to-use development environment and has an interface named as "Unity editor" that enables developers to check movements of objects on the moment. Therefore, our students can develop the games relatively easily.

Concept of 3D Serious Game

In this study, some themes of 3D serious game are developed to support learner to study physics. Common flow of the games is described below.

First, problem statement showed when the learner starts the game. The statement asks the learner the formula of the theme of the game. The game requires the learner to fill the text-entry fields for formula. Statement of computational problem can be answered if correct answer of the formula is inputted. This problem can be solved by using the formula that was answered just before. "See the result" button will be pushed when the learner finishes to answer the question. The learner can see a movie that is representation of the movement of the object according to the formula. The learner can choose to play the game again or not after the movie.

Common functions of the game are described below. The text-entry field is designed to regard the answer that operator "*" and "/" is omitted, shift of terms before or after "+" and "-" and random order of variables. The computational problem is showed when the answer of the formula is correct. A hint of formula is showed when the learner fills incorrect answer five times. The movie shows the correct movement when the answer is correct and another movie shows when the answer is not correct. The incorrect movie is designed to promote the learner to try the question again. Therefore, more showy performance than that of correct movie was implemented.

Developed 3D Serious Game

To promote their motivation to study physics, The learning items are free fall, elastic force, frictional force and so on. These games will be showed below in order.

First game is themed on the free falling object and that of formula $v=gt$ where v is velocity [m/s], g is acceleration of gravity [m/s^2] and t is time [s].

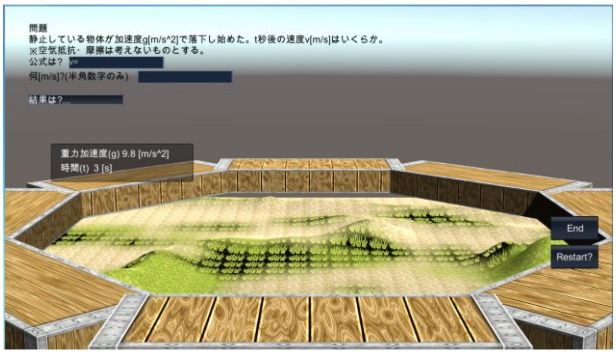

Figure 2 Screen shot of free fall game

Figure 2 is a screen shot when the problem statements are showed. The learner is required to fill the black text-entry fields and push the result button to see the result. The computational problem is to calculate that the height from the goal that the ball should be set to pass the goal on specified speed.

Figure 3 shows the movie for checking the answer. The ball is set to the answered height on the former problem, then it begins to fall down. Various mile posts are set to intuitively grasp the distance. The result is showed when the ball the goal that represents a speed probe.

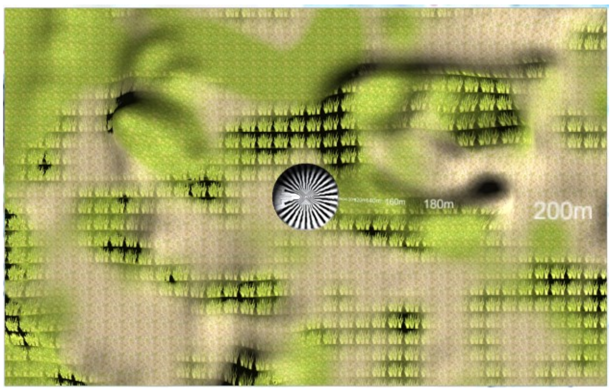

Figure 3 Answer checking movie

Figure 4 and Figure 5 shows the result . Fireworks and a message are rendered when the result is correct. On the other hand, the ball is exploded when the result is not corrected. This performance is quite showy not to feel regret for the mistake but to make the learner smile and promote him/her to see the performance of the correct answer and to try the same problem again.

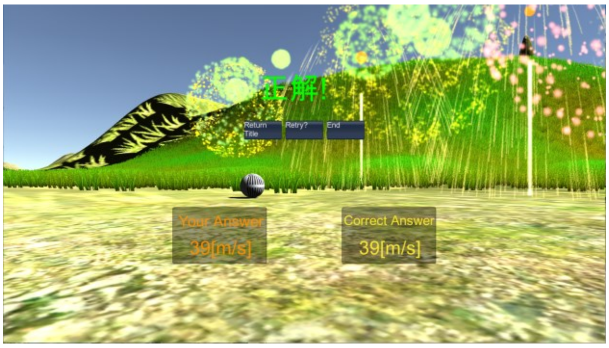

Figure 4 Result movie when the answer is correct

Figure 5 Result movie when the answer is wrong

The second game is themed on elastic force of spring and that of formula "$F = kx$" where F is force [N], k is constant of spring and x is displacement [m].

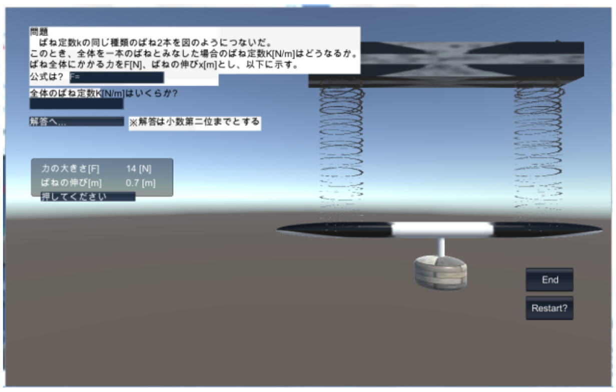

Figure 6 Screen shot of elastic force game

Figure 6 is a screen shot when the problem statement is showed. The learner is required to fill the black text-entry fields and push the result button to see the result. The computational problem is to calculate that the constant spring that is combined two springs. F and x is randomly given. The learner can see the movement of the whole system when push a button under the gray text box on the screen before filling the answers because the movement of the spring is not so viewy.

The third game is themed on frictional force and that of formula to calculate maximum static frictional force "$F = \mu N$" where F is force [N], μ is static friction coefficient and N is perpendicular force [N]. The flow of the game is same as the other games.

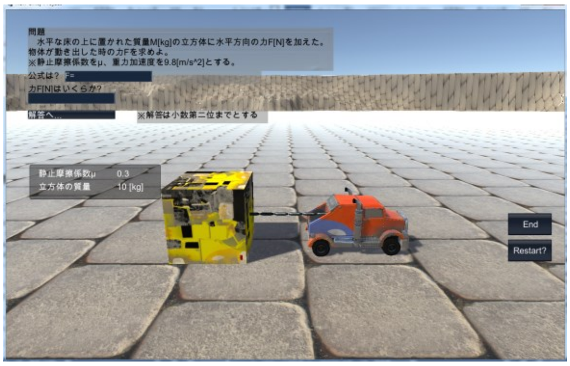

Figure 7 Screen shot of frictional force game

Trial Lesson Using 3D serious game

To confirm the effectiveness of these games, a trial lesson was carried out for 24 students in NIT, Kagawa College students. First, hand-out assignments were given to the students. Then, they practiced the calculation of physics as conventional learning method. The games were given to the students for physics learning after learning with hand-outs. The students played the 3D serious games with computers. Finally, questionnaire was carried out to compare student's impression of learning with hand-out and the 3D serious games.

Result and Discussion of the Trial Lesson

In this section, the result of a questionnaire that was carried out after the trial lesson would be discussed. Number of respondents is 24.

To measure the effectiveness of games, five questions as described below were asked to the students.

1. Did the students enjoy the games?
2. Did the students think the games could help them to understand physics intuitively?
3. Are these games easy to understand compare with the conventional educational materials?
4. Which material could motivate the students to study physics, the games or hand-outs?
5. Have the students found physics interesting through the trial lesson with the games?

The result of the questions are shown from Figure 8 to Figure 12. Figure 8 shows that 79%(19 out of 24) of the students enjoyed the games. Figure 9 tells that 67%(16 out of 24) of the students think the games help them to understand physics intuitively. Figure 10 shows that 67%(16 out of 24) of the students felt that learning with the games is easier than learning with the hand-outs. Figure 11 shows that the games could motivate 54%(13 out of 24) of the students to study physics. Figure 12 shows that the games were tantalizing educational material of physics for 43%(10 out of 24) of the students.

From these results, it is confirmed that the games is better educational material for physics learning than conventional material such as hand-outs. However, it is also confirmed that the games have limited impact on motivating the students to study physics. In addition, the questionnaire has revealed that the games were poor to have the students find physics interesting.

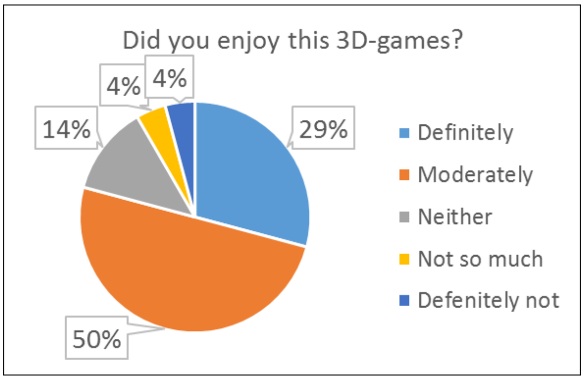

Figure 8 Rate of the students who enjoyed the 3D serious game

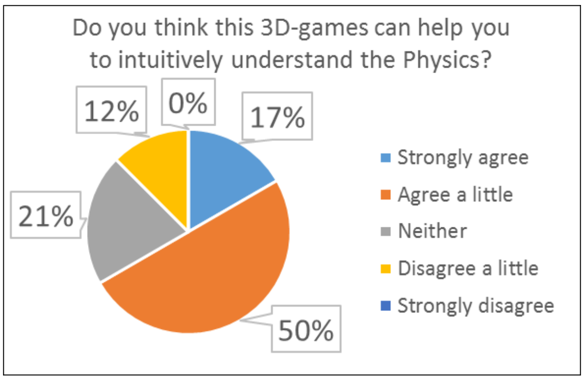

Figure 9 Rate of the students who felt that the game helped them to understand physics intuitively

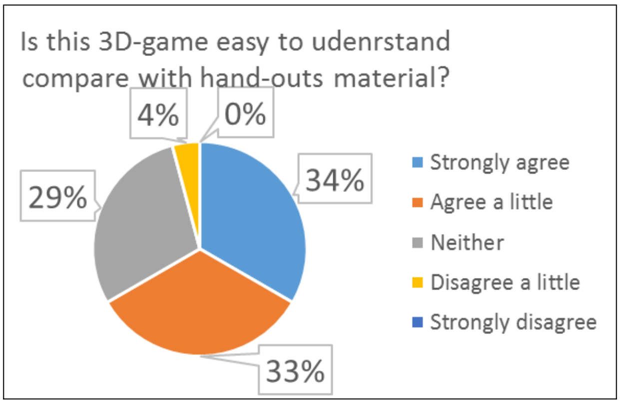

Figure 10 Rate of the students who felt that the game was easy to understand than hand-outs material

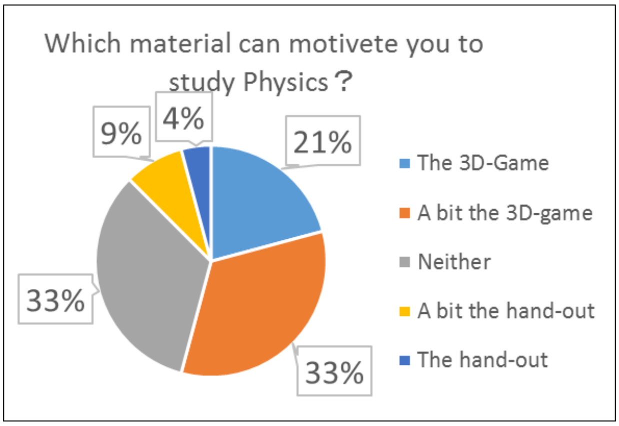

Figure 11 Rate of the students who wants to study physics with the 3D serious game

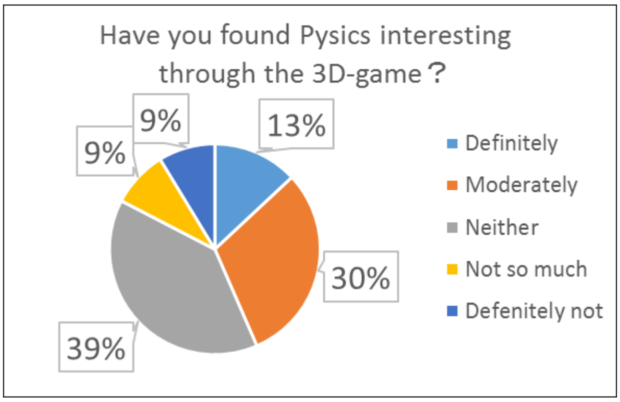

Figure 12 Rate of the students who found physics interest by the learning with the 3D serious game

The questionnaire includes free description form. The students expressed their opinions as mentioned below.

1. More performance movies for wrong answers
2. New function to answer the question ask them a formula by arranging in order
3. Implementation of calculator function
4. Implementation of memo function

New 3D serious games are designed by reference to the results of the questionnaire and the opinions.

Developed New 3D serious game

Newly designed games are developed based on the result of the questionnaire that has been discussed. Various changes from previous version are described below.

1. Set movie to show the movement of each formula before showing the problem statement
2. Function to rearrange terms to answer the question of formula
3. Change the movie when the answer is correct/not correct

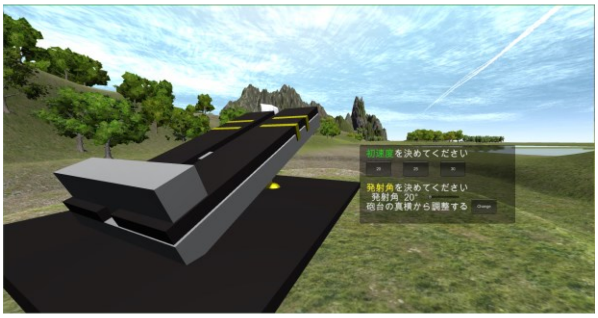

Figure 13 Screen shot of the new 3D serious game themed on projectile motion

Figure 13 shows the screen shot of the projectile motion game. The learner can change launch angles of a missile and check the movement of that. In previous version of the game, the learner can watch the movement just after answering the question. This function realizes that the learner could understand how factors effect to the movement first. This would bring result that the learner would gain the formula as their knowledge.

Figure 14 is a screen shot of the new game that shows a problem statement that asks the formula of projectile motion. The learner can sort or choose terms and make equations to answer the question. To add a new kind of performance to promote the learner to study more, humanoid character, robot character are shown on the screen. Figure 15 shows new movie for correct answer. Three themes of games have been developed such as projectile motion, sinusoidal wave and superposition of wave now. A trial lesson and a questionnaire survey will be carried out again when various game are completed to confirm change of effectiveness for motivation to study physics and for physics interest.

Figure 14 Problem statement of the new game

Figure 15 New movie for correct answer

Conclusion

In this paper, several themes of the 3D serious game were developed. Then, trial lesson and a questionnaire survey were carried out to evaluate effectiveness of the games for physics learning.

As a result of the questionnaire, we confirmed that many students enjoyed learning and understood some formulas intuitively. However, the rate of students who they got interested to physics through the learning with the games went no further than 50%. This result indicates that the games could promote the students to learn and understand physics and has a margin for improvement. To improve the games, the new games are developing now. By the end of this year, trial lesson and a questionnaire survey will be carried out again.

Acknowledgements

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1509

THE EXERCISE OF PHYSICS BY GROUP WORK

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Abstract

There are little time to do the exercise of physics in the class. Though many students study hard before exam and do homework, regular exercises of physics are needed for getting scholastic abilities. The author had the class of the exercise of physics in two college.

In N.I.T. Kagawa College (Takuma Campus), the author made the subject about the exercise of physics, "Exercise of Physics". Its class was held in second grader since 2011. In 2014 the author taught the class and adopted the typical method for exercises, that is, homework, the explanation by the teacher and quiz. According to questionnaires and examinations, though there were some effects of the education, in classes the students were passive and not active.

So in N.I.T. Kumamoto College (Yatsushiro Campus), the author taught the class of the exercise of physics, "General Science II". In its class, homework and quiz were held in similar way, but the explanation by the teacher was replaced with Group Work. Furthermore the method of the quiz was revised, the others were held in same way through one year.

In the examinations of 2015, many students got high marks and there were some effects on the rise of their scholastic ability. However in the questionnaire of 2015, the choice of the explanation by the teacher or Group Work was equal as the whole, but in each classes the best choices were different. The best method depends on the states of class and other good ideas are needed.

Furthermore in N.I.T. Kumamoto College, so as to be active in today's class and the students to teach each other, the method of the quiz was revised. The change didn't effect on the results of the quiz, but the motivation of students went rise and students became active in the class.

Keywords: *Physics Education, Motivation, Active Learning, Group Work*

Introduction

Physics is indispensable for engineers. However it is difficult for the students and some students get bad marks in the examinations. One of the reason is that there are many contents of physics to teach students and little time to do the exercise in the class. Furthermore every students who get high marks in regular examinations do not have sufficient scholastic abilities. Though many students study hard before exam and do homework, regular exercises of physics are needed for getting scholastic abilities.

In N.I.T. Kagawa College (Takuma Campus), that the author belonged to until March, 2015, the author made the subject about the exercise of physics, "Exercise of Physics" ("Exercise of Mathematical Sciences", "Science Seminar"). Its class was held in second grader since 2011. In 2014 the author taught the class and adopted the typical method for exercises, that is, homework, the explanation by the teacher and quiz.

In N.I.T. Kumamoto College (Yatsushiro Campus), that the author belong to since April, 2015, the author taught the class of the exercise of physics, "General Science II". In its class, homework and quiz were held in similar way, but the explanation by the teacher was replaced with Group Work. Furthermore the method of the quiz was revised, the others were held in same way through one year.

In this paper the concrete procedure of the exercise of physics are introduced. Furthermore the results of students' questionnaire in two college are analyzed and its effectiveness is discussed.

Procedure in N.I.T. Kagawa College

Before 2011, there were little time for the exercise of physics. First grader had three credits and second grader had two credits, but a credit is the lecture of forty five minutes for thirty weeks. However there were a little time for the exercise in classes. Therefore the author made the subject about the exercise of physics, "Exercise of Physics" ("Exercise of Mathematical Sciences", "Science Seminar").

In 2014, the author had three classes of the exercise of physics, "Exercise of Mathematical Sciences". The flow of procedures is described in Figure 1. In the previous class, the print for exercise was distributed the students. By today's class, they had to exercise the print. In today's class, the teacher checked the prints so as to let the students do homeworks. After that, the teacher explained about the print in the blackboard and they studied about it. In the end of the class, they submitted the print and the teacher checked it, so as to let them study in the class. After that, the teacher distributed the print of the next class. In another supplementary class, the quiz was held.

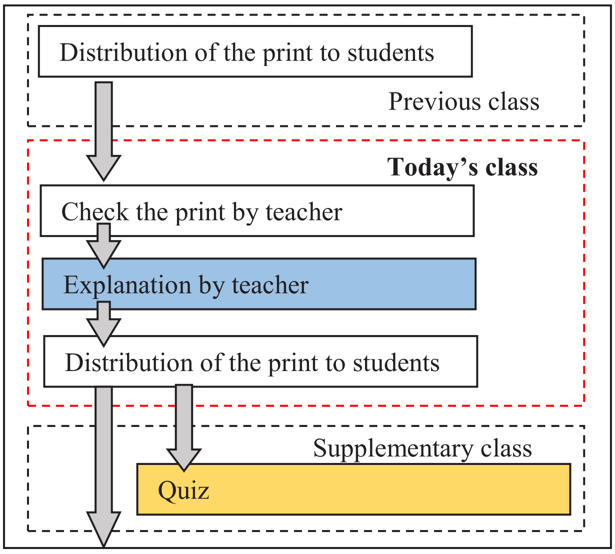

Figure 1, the flow of procedures in N.I.T. Kagawa College

In these procedures, there were two problems. One of them is that it take much time to check the print. The other is that the students were passive and not active. Though the author had to improve the procedure, the author moved to another college, N.I.T. Kumamoto College.

Questionnaires in N.I.T. Kagawa College

In the end of second grader, questionnaires for the students in three classes were held in N.I.T. Kagawa College, Takuma Campus. The number of students in the class A was 38, the one in the class B was 42 and the one in the class C was 42. The results of questionnaires are analyzed below.

Figure 2 shows the result of Q1 "Is the exercise of physics necessary?". Though more than half of the students answered "Yes", the percentage of answer "No" is large. However, as the reason of answer "Yes", there are opinions of the students, "We could review physics.", "We could understand physics deeply".

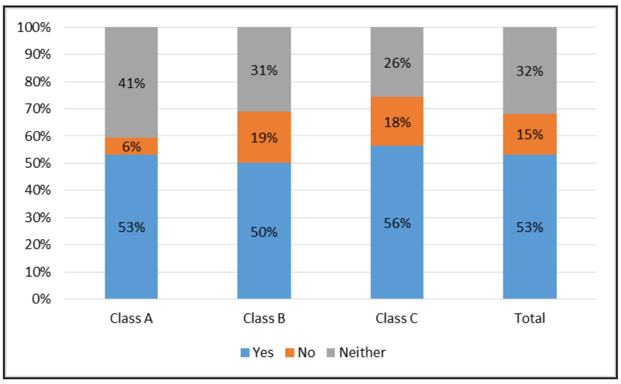

Figure 2, Q1 "Is the exercise of physics necessary?"

Figure 3 shows the result of Q2 "Is the exercise of physics effective for you to understand physics?". The percentage of answer "Effective" is more than 80%. As the reason of answer "Effective", there are opinions of the students, "We could understand it what I hadn't understood.", "We had much time to study physics", "We could review it", "It was good to study it with the print".

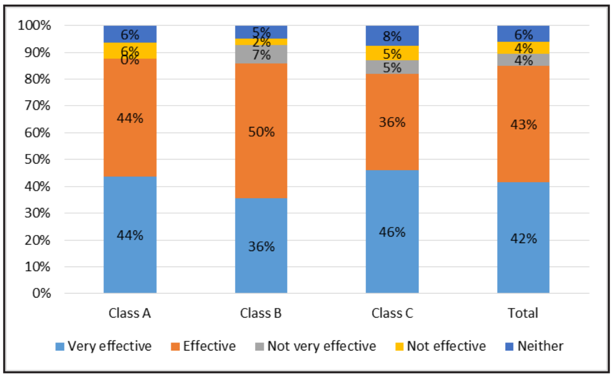

Figure 3, Q2 "Is the exercise of physics effective for you to understand physics?"

Figure 4 shows the result of Q3 "Did you study for the quiz?". More than 60% of the students studied it for the quiz. Figures 5 and 6 show the results of the quiz. The class C that is high percentage of study for the quiz had high average mark.

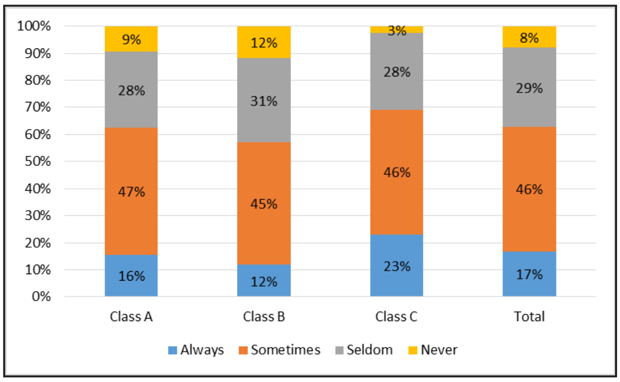

Figure 4, Q3 "Did you study for the quiz?"

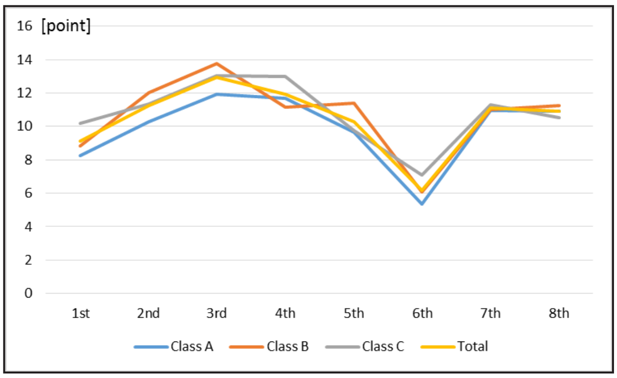

Figure 5, the average marks of each quiz (1st~8th)

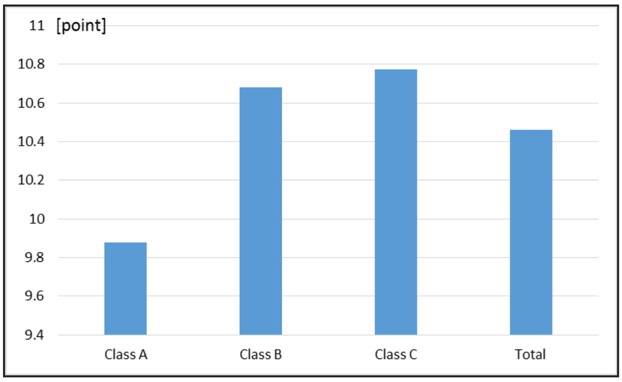

Figure 6, the average marks of all quiz (1st~8th)

Figure 7 shows the result of Q4 "Where did you study for the quiz?". The percentage of answer "Home" is more than 70% and most of the students have custom to study at home.

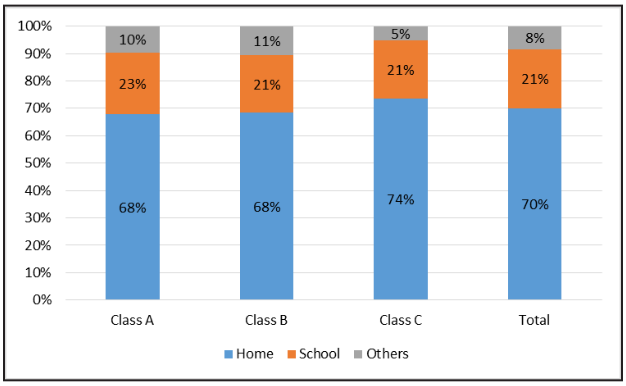

Figure 7, Q4 "Where did you study for the quiz?"

Figure 8 shows the result of Q5 "Is the quiz for the exercise of physics effective?". The percentage of answer "Effective" is more than 70%. As the reason of answer "Effective", there are opinions of the students, "We could check what I hadn't understood.", "We could use it for study of examinations", "We could review it".

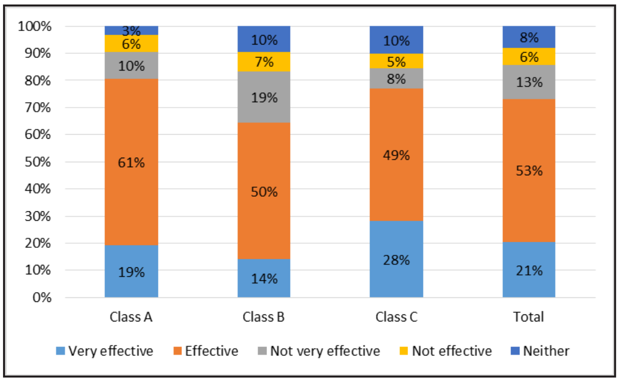

Figure 8, Q5 "Is the quiz for the exercise of physics effective?"

Procedure in N.I.T. Kumamoto College

In 2015 the author moved to N.I.T. Kumamoto College and had three classes of the exercise of physics in third grader. In Yatsushiro Campus, from last quarter of first grader to the end of third grader the students studied physics with the contents of highschool. First grader had a half credits of physics class, second grader had three credits and third grader had two credits, but a credit is the lecture of forty five minutes for thirty weeks. Moreover third grader had a credit of the exercise of physics. Though there are the class of the exercise of physics, the time of the exercise of physics wasn't enough.

Since 2015, the author had three classes of the exercise of physics, "General Science II". The flow of procedures is described in Figure 9. Similar to Kagawa N.C.T., in previous class the print was distributed to the students. But they submitted it by the previous day of today's class and the teacher checked so as to let them do homework. In today's class, first of all, the students took the quiz in the contents of the previous class. Then the teacher returned these print and the previous quiz to them. The teacher didn't explain it but distributed the solution of the print to each groups. The students checked the answers and taught each other, that is, Group Work. In the end of class, the teacher distributed the print of the next class.

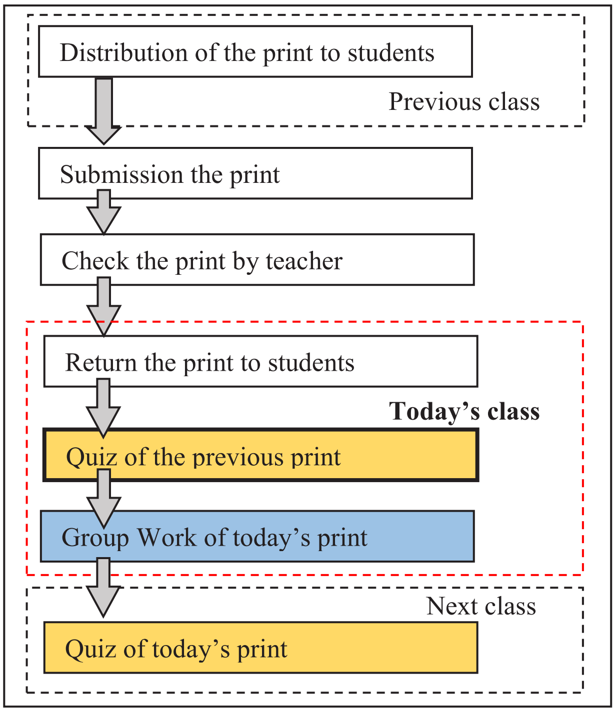

Figure 9, the flow of procedures in N.I.T. Kumamoto College before change of the quiz

However, the students were not active. So as to be active in today's class and the students to teach each other, the method of the quiz was revised. As soon as they checked answers and taught each other, they took the quiz of today's contents. The flow of procedures is described in Figure 10.

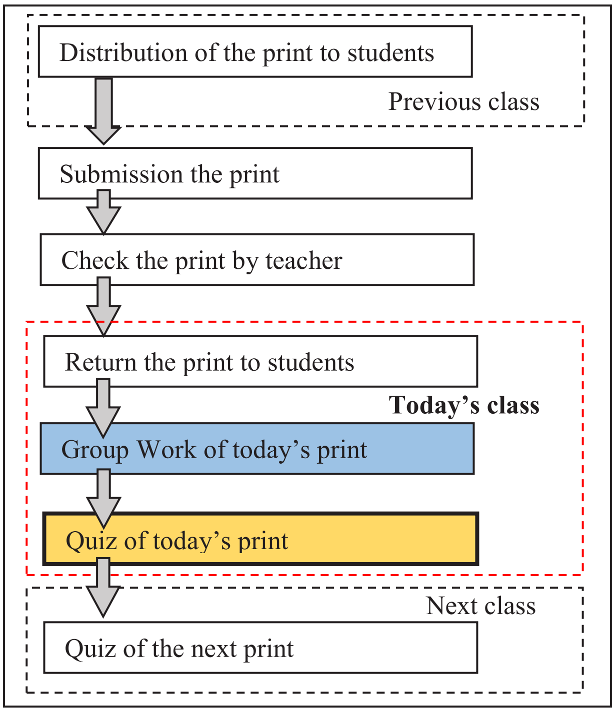

Figure 10, the flow of procedures in N.I.T. Kumamoto College after change of the quiz

Questionnaires in N.I.T. Kumamoto College

In the end of third grader, questionnaires for the students in the three classes were held in N.I.T. Kumamoto College, Yatsushiro Campus. The number of students in the class D was 42, the one in the class E was 34 and the one in the class F was 36. The results of questionnaires are analyzed below.

Figure 11 shows the result of Q1 "Which do you like the explanation by the teacher in blackboard or Group Work?". Though the percentage of answers "Blackboard" and "Group Work" are almost equal, the percentage of them are different in the classes. As the reason of answer "Blackboard", there are opinions of the students, "In Group Work it was noisy.", "We remember it in the explanation by the teacher in blackboard". On the other hand, as the reason of answer "Group Work", there are opinions of the students, "We could teach each other.", "Group Work was enjoyable.", "The class by Group Work wasn't sleepy".

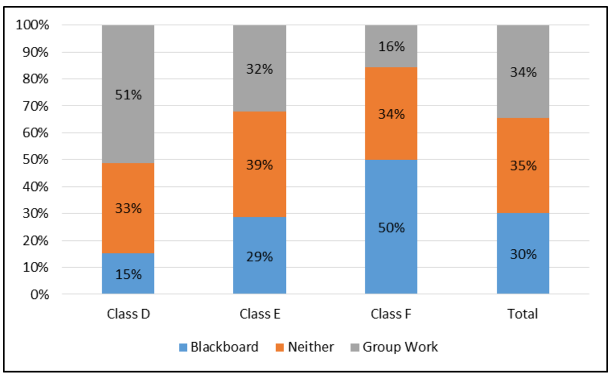

Figure 11, Q1 "Which do you like the explanation by the teacher in blackboard or Group Work?"

Figure 12 shows the result of Q2 "Are the students active in Group Work?". Though the percentage of answer "Active" is about 70%, the percentage of them are different in the classes. These result is relevant to the result of Q1. In the class where Group Work was active, many students liked Group Work better than the explanation by the teacher in blackboard. As the reason of answer "Active", there are opinions of the students, "We could teach each other actively.".

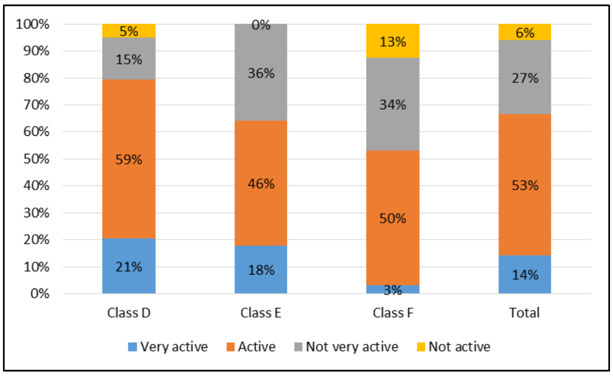

Figure 12, Q2 "Are the students active in Group Work?"

Figure 13 shows the result of Q3 "When do you want to take the quiz?". Though the percentage of answers "Next day" and "Today" are almost equal, the percentage of them are different in the classes. As the reason of answer "Next day", there are opinions of the students, "We want to review the contents at home.". On the other hand, as the reason of answer "Today", there are opinions of the students, "We remember the contents today better than next day". Figure 14 shows the results of the quiz. Though the results of the 6th quiz that changed the method went down, then the change of the method seem not to effect on the results of the quiz.

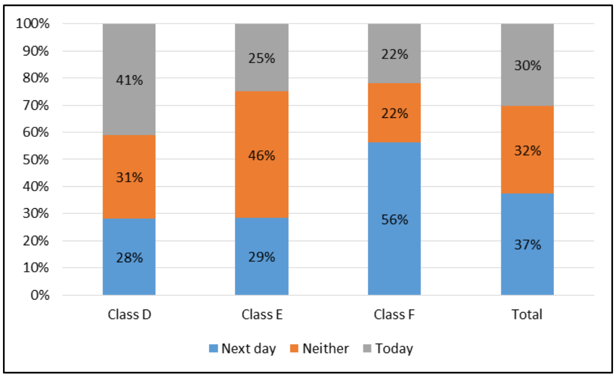

Figure 13, Q3 "When do you want to take the quiz?"

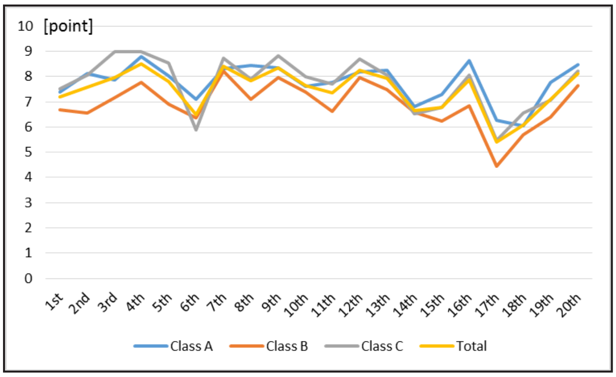

Figure 14, the average marks of each quiz (1st~20th)

Conclusions

In N.I.T. Kagawa College (Takuma Campus), according to questionnaires and examinations, though there were some effects of the education, in classes the students were passive and not active.

In N.I.T. Kumamoto College (Yatsushiro Campus), according to questionnaires, the choice of the explanation by the teacher or Group Work was equal as the whole, but in each classes the best choices were different. The best method depend on the state of class and other good ideas are needed.

Furthermore in N.I.T. Kumamoto College, so as to be active in today's class and the students to teach each other, the method of the quiz was revised. The change didn't effect on the results of the quiz, but the motivation of students went rise and students became active in the class. According to examinations of 2015, many students got high marks and there were some effects on the rise of their scholastic ability.

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EVIDENCE-BASED FLIPPED CLASSROOM CASE STUDY – TEACHING CHEMICAL PROCESS SAFETY

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Abstract

This paper provides a case study of how Evidence-Based Teaching (EBT) was applied to a flipped classroom format and implemented in a core module *Plant Safety and Loss Prevention* from the Diploma in Chemical Engineering from Singapore Polytechnic. The paper firstly outlines the plant lifecycle approach which served as an advanced organizer for students' learning of the main outcomes in this module. This is followed by a summary of the curriculum restructuring and introduction of the pedagogic framework adopted. In particular, it shows how the out-of-class (online) components are pedagogically aligned to in-class activities and technology tools are integrated to strategically and creatively enhance key aspects of the learning process. The paper then, based on work done during the first 6 weeks of the programme, illustrates how the framework is effectively applied in real online and classroom contexts. This includes a comprehensive week-by-week teaching plan which guides the design of suitable learning activities, both in-class and out-of-class, using core principles of learning. These learning activities are designed to scaffold students learning the underlying key concepts that lead to application in real-world problem-solving. Evidence of student learning is captured using Web 2.0 Tools such as Socrative, Google Doc, etc. These are communicated as formative feedback to students, often in real-time when possible. Connections between key concepts and transfer of learning from case studies learnt in class to solving real-world problems (albeit some simulated) are emphasized throughout the learning process. Sample marking rubrics to assist students in understanding learning expectations are prepared and communicated to students. Mock tests are conducted whereby students are given opportunities to use the rubrics to mark their own paper as well as carrying out peer marking. Examples of evidence gathered, their analysis and feedback given to students are shared, providing important two way feedback relating to both task specific and process aspects of the learning activities. Finally, the paper presents the result of an interim evaluation of the students learning experience to date and key instructional issues identified.

Keywords: *Evidence-based teaching, flipped classroom, formative assessment, chemical engineering*

Introduction

The pedagogy for evidence-based flipped classroom has been shared previously by Cheah (2016). The module in this case study is entitled *Plant Safety and Loss Prevention*, a Year 3 Diploma in Chemical Engineering core module (60 hours, fully in-course, i.e. no examinations) taught to all 120 students in Semester 1 of an academic year. The framework used in teaching the module is shown in Figure 1.

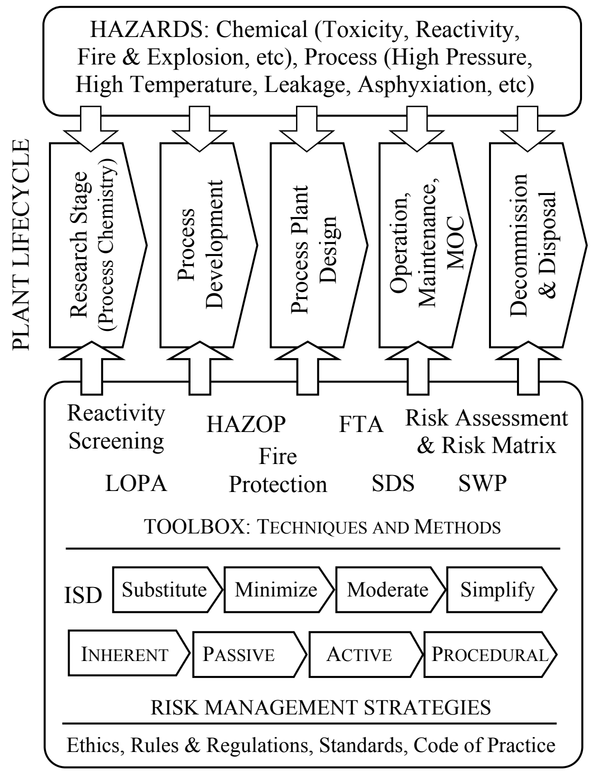

Figure 1. Framework for Teaching Chemical Process Safety based on Plant Lifecycle (Cheah, 2015)

The module is taught over a period of 15 weeks using case study as the core pedagogic method. Contact hours are 4 hours per week which is devoted to classroom activities designed to engage students in applying the concepts learned during the online components. The main learning outcomes from the module are:

1. Identify from the assigned cases the correct safety issues at the proper stage of the chemical plant lifecycle
2. Infer and interpret probable causes that can lead to deviation from safe operating conditions and predict likely consequences or damages
3. Apply the correct preventive or mitigation strategies to prevent the occurrence or minimize the impact of any occurrence of a chemical process hazard
4. Transfer key concepts and principles from analysis of earlier cases to new cases presented at a later part of the semester

These outcomes frame the type of assessment evidence to be derived from the various student activities.

Summary of Work Done

The flipped classroom approach was used to teach this module for the first time in Semester 1 of Academic Year 2015, which began in April and ended in August. The approach and methods adopted have been presented elsewhere by Cheah et al (2016). A major learning point from the pilot work was the need for a higher level of facilitation skills by lecturers to facilitate these challenging learning outcomes.

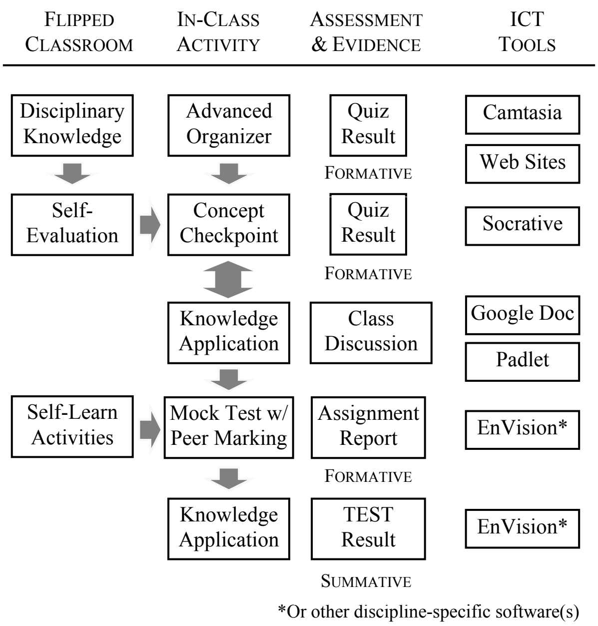

Figure 2. Example of an Evidence-based Flipped Classroom Format (Cheah, 2016)

The work presented here is the re-designed model using an Evidence-Based Teaching (EBT) approach (e.g. Petty, 2009; Hattie, 2009), employing various high effect size strategies such as challenging goals, feedback, and advance organizer. The framework in Figure 1 was in fact, used as an advance organizer to help students learn this module. A workbook is also provided to help students work through the classroom activities. For each week, a set of guidance notes are given to students, which explain in greater detail the topics and learning outcomes for the week, as well as the resources made available. These notes are given to students ahead of their weekly lessons so that they can better prepare for the flipped classroom. Figure 2, illustrates the revised curriculum plan of the module for Semester 1, Academic Year 2016, based on an EBT flipped format (Cheah, 2016). The teaching plan for the first 6 weeks is shown in Figure 3.

	Flipped	In-Class Activities using ATU	
Week 1		Principles of Loss Prevention, How to Learn this Module, Expectations	Flixborough, Plant lifecycle as Advanced Organizer, Bhopal as "Anchor" case
Week 2	Inherently Safer Design (ISD), Management of Change (MOC)	Bhopal ISD, MOC; Guided Discussion on ATU Process Description + P&IDs	Google Doc submission on Questions for ATU Process Description + P&IDs
Week 3	Self-learn steady state simulation exercises + Mock Assignment	Bhopal LOPA: BPCS + SIS W318 Distillation Pilot Plant (DPP) LOPA	Google Doc: Discussion on PD+P&IDs Peer Marking of Mock Assignment
Week 3 (cont'd)	Basic Process Control System (BPCS) & Safety Instrumented System (SIS)	ATU Concept Checkpoint on BPCS & SIS Apply BPCS & SIS to ATU HP Absorber	Mock Test: Apply BPCS & SIS to ATU LP Absorber (Guided Self-Assessment)
Week 4	Pressure Relief System (PRS) Video: BP Texas, Site visit to W318 DPP PRS	Bhopal relief scenarios + extras (BP Texas, etc) Apply PRS to DPP	Apply PRS to ATU HP Absorber, Self-learn ATU Malfunction exercises
Week 5	Hazard & Operability Study (HAZOP), Info on Olefin Dimerization	HAZOP for Bhopal + other exercises (BP Texas, etc)	HAZOP for Olefin Dimerization, Mock HAZOP for selected ATU unit
Week 6	Complete ATU Malfunction exercises, Reading on proposed ATU Modification	Google Doc discussion on ATU malfunctions, Peer Marking ATU HAZOP	Discussion: HAZOP for new plant vs plant modification: Case of ATU

Figure 3. Module Structure for Weeks 1 to 6

In this mode of learning, every week from week 2 onwards, students come to class after going through key safety concepts on their own in the online components. These are mostly video recordings of the lectures, created with the content development tool, Camtasia, and, where appropriate, supplemented by reading materials either from published literature, curated by the author, and suitable videos from YouTube or the U.S. Chemical Safety Board (CSB). At the end of each lesson, students can choose to complete a short quiz (usually 4-5 multiple-choice and/or true/false questions, created using Web 2.0 tools such as Socrative) as self-asssessment of their understanding of the key concepts and principles underpinning the structure of the topics covered. When in class, the lecturer will first show the advance organizer (Figure 1) to help students track the progress of the lessons. He/she will then give a brief summary covering the key points of the flipped lessons. A mini-lecture is given if results from Socrative showed a significant number of students did not fully grasp the concepts. The lesson then proceeds with the lecturer providing relevant activities to engage students in applying the concepts learned. These activities are based on the Bhopal Gas Disaster as an "anchor" case study, supplemented with other cases such as Piper Alpha and BP Texas Explosion. For facilitating transfer of knowledge to new cases, we designed a new case study based on the Amine Treating Unit (ATU) dynamic simulation model from EnVision. We also introduce new cases where appropriate to give students additional practice in applying what they are learning.

For example, as shown in Figure 4, the majority of students are quite clear that answers C and D are correct examples of Safety Instrumented System (SIS), but not so certain between answers A and B. As it turned out, the majority of students selected the wrong answer 'A', which means that they still had difficulty applying the concept of SIS (safety instrumented system) to certain aspects of chemical plant operation. The lecturer then uses necessary classroom time clarifying the concept further with other examples or analogies.

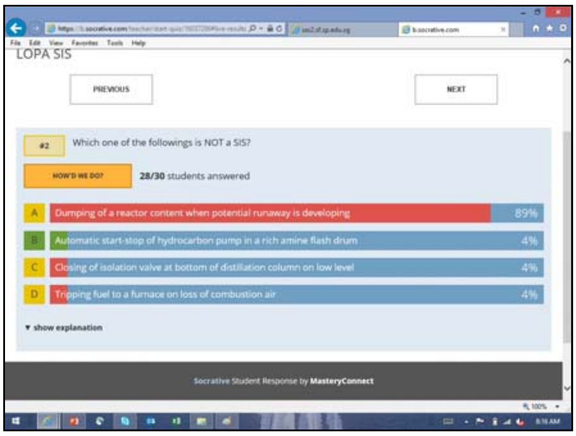

Figure 4. Sample result from Socrative

Classroom discussions utilize Google Doc, whereby a class of 18-22 students is divided into 4-5 groups of 4-5 students each. Students discuss within their groups and present a group answer to the questions posed by typing in real time into the response box created in Google Doc. In some situations, students are asked questions that have more than one correct answer, so each group is required to provide a different answer. In other situations, different questions are asked to each group, so that they need to collaboratively come up with parts of the answer in order to obtain a complete solution.

Area of Application of Loss Prevention Principles	Case of Bhopal (explain why it is not desirable)	How application of Inherently Safer Design can reduce the hazard(s).
Plant operation	Refrigeration system decommissioned for a long time. Safety interlocks bypassed. Vent scrubber decommissioned. SOP not followed, blind not inserted. Flare tower under maintenance since long time ago, not enough manpower. Control instruments such as T and P gauges not working properly	(Design) Moderate - The refrigeration system should never be decommissioned to ensure safer storage of MIC. YES! That is correct. Minimise - Storage of MIC should be done in smaller tanks. 10 small tanks are safer than 3 large tanks. Better still and to adhere strictly to the principles of ISD: have 3 smaller tanks. Otherwise the tendency is to fill all 10 small tanks! Substitute - Since water reacts with MIC in a exothermic reaction, alternative material such as nitrogen or plant air can be used to purge or wash the pipes during maintenance Good thinking. You got that right!
Plant layout and design	There was supposed to be four vent gas scrubbers for stand-by. Since in Bhopal there was only one vent gas scrubber. There was no standby vent for maintenance. The capacity of the flare is incapable in managing the volume of waste gas produced.	Vent, flares etc are not part of inherently safer design. They are 'add-ons' installed to mitigate any consequence of MIC leak. They fall under the active (as opposed to passive) protection strategies. Since this group identify the area of loss prevention as "Plant layout and design", for the layout part you could consider the location of the plant - it is close to slum areas where a large population existed. One can SUBSTITUTE this location with one which is safer, and not have the wind blowing MIC in its direction.
Plant design – Materials of construction	Using carbon steel instead of stainless steel for plant design. After a long time, rust will form which is the catalyst that triggers the reaction between MIC and water.	Substitute - Use stainless steel instead to reduce the chance of formation of rust hence reducing the amount of catalyst produced, thus leading to a slower reaction between MIC and water even when there is water flow into tanks. GOOD - you got this right!
OVERALL COMMENTS: Most of the answers above centred about Plant Design or Operations. Remember that more can be achieved by considering Process Development at the earliest opportunity, at the R&D stage. One can consider not using this reaction chemistry between phosgene (itself a toxic substance) and MMA altogether, and use something much less hazardous. This will achieve the aim of SUBSTITUTE of ISD. If really the MIC route must be used, then the next best thing to do is to MINIMISE the quantity of MIC stored on-site.		

Figure 5. Sample entries in Google Doc

A sample of Google Doc entry is shown in Figure 5, where most students are able to apply broad principles of loss prevention to different stages of plant lifecycle, but some are confused between safety strategies that are inherently safer and those which are added on (such as vent and flare) to mitigate the risk. Student responses in this example also revealed that most, if not all of them, had overlooked an important aspect of loss prevention, which is to handle hazards at the process development stage, which is highlighted by the lecturer in his overall comments. This ongoing formative assessment, which fosters effective two-way feedback, is a high effect method in terms of student attainment (effect size of 0.73, Hattie (2009).

There are 2 summative assessment after 6 weeks of lessons (Figure 3). One is the mid-semester test scheduled for week 7. Topics tested include inherently safer design (ISD) and Layer of Protection Analysis (LOPA). The other is a HAZOP Report due at end of Week 8. Coupled with the ongoing formative assessment (feedback) mentioned earlier, we created opportunities for students to receive adequate practice before taking the graded (summative) assessment. As noted in the literature, repeated testing results in promoting transfer of learning gained in one context to other new contexts (e.g. Rohrer, Taylor & Sholar, 2010; Carpenter, 2012).

Questions 1, 2 and 3	Level 4: Exceeding Expectation	Level 3: Meeting Expectation	Level 2: Approaching Expectation	Level 1: Poor or Below Expectation
Explanation of Observation Noted	Offer good explanations and deep analysis to all observations, including both that changed and those that did not change; plus additional insights inferred from the observations.	Noted which process variable changed and which do not, but offer only surface explanation to the observations, i.e. still lack deeper analysis or insights.	Only noted those process variable that changes, but failed to account satisfactorily for the changes, i.e. missed out on certain important analysis.	Little or no mention of any noteworthy observation, nor any effort in offering explanations for the changes observed.
Use of Evidence	Excellent use of data to support observation noted and referenced all pertinent tag numbers and corresponding PVs.	Satisfactory use of data to support observation noted and made good reference to some (but not all) tag numbers and their corresponding PVs.	Some use of correct data but linkage to observation noted is weak or lack clarity, e.g. certain value of PV cited but no reference to the correct tag number.	Little or no citing of suitable data to support claim made, or wrong data used, or no data cited whatsoever.

Figure 6. Sample Rubric for ATU Exercise

Week 2 is devoted to familiarizing students with the ATU, followed by self-paced simulation exercises that culminate in a mock assignment. To convey our expectations of what constitute a good report by students, we provided them with the marking rubric (see Figure 6). Practice marking using the rubric was carried out in class, and the students are also informed that the same rubric will be used for a graded assignment later. In Week 3, students are required to do a peer marking exercise using the rubric.

All the learning tasks for engaging students in the classroom are decided by what strategy and method combination is most likely to work best, and applied thoughtfully in terms of core principles of learning (Sale, 2015). Key strategies used include activation of prior knowledge, proving advance organizers, direct instruction, peer tutoring, and two-way feedback. In Week 3, students build on their knowledge of ATU and also learn new concepts of LOPA, namely basic process control system (BPCS) and SIS. BPCS is a topic that students had learnt before in Year 2, so we provide a brief recap so as to introduce the topic on SIS. Besides Bhopal, we also require students to re-visit the distillation pilot plant (DPP) which they had studied and operated on in an earlier module in Year 2, but now from the perspective of LOPA. Students are then taught how to apply LOPA to an equipment in ATU, namely the HP Absorber. Another activity is created whereby students can self-assess how well they apply LOPA to another equipment, this time the LP Absorber. Similarly, we continue to build-up students' knowledge and application in Week 4 (covering PRS – pressure relief system) using this approach.

As conceptual understanding is particularly important for long-term retention and transfer, we consistently revisit earlier concepts in subsequent lessons. Concept checkpoints are built into the lessons, where we pause the activity at suitable points to assess students' understanding. A checklist of learning outcomes that they need to master is shown at suitable interval during class. This checklist, together with the ongoing feedback, enables students to keep track of their own progress and take necessary corrective actions, such as completing more self-paced exercises. In this context, the use of dynamic simulation software such as EnVision has proved valuable in offering many scenarios where students can try out at a pace comfortable to each individual. A notable example was in Week 5, during which the topic of HAZOP is introduced, again using Bhopal as example, supported by other cases (such as Piper Alpha and DPP). Students are also encouraged to try out, at their own time, various ATU malfunction exercises (up to 40 available!) designed to familiarize them with potential problems in the plant, which is a key tenet of HAZOP. Sample entries are provided in Google Doc so that students are aware of the desired way to report their findings. To further strengthen their competency in carrying out a HAZOP process, a mock test is administered in Week 5, followed by peer marking of HAZOP with rubrics in Week 6. To add realism, a scoresheet (Figure 7) was also created so that students can 'officially' convey the result of the marking to the peers.

Evaluation of Student Learning Experience

Evidence-Based Reflective Practice (Sale, 2015), as the term implies, involves more than personal reflections in isolation, but a structured thinking process (e.g. analysis and evaluation) using EBT principles in relation to all valid evidence sources (e.g. students, peers, peer observers). As a holistic process it enable a better understanding of the *reality* of classroom learning (e.g. what is happening, and how this is affecting the learning process). From this base, we can then creatively design and facilitate instructional strategies that have high predictive capability for enhancing the learning experience and attainment levels.

Report received from: Class: DCHE/3A/0___ Group: ____	Sour gas feed from Battery Limit to LP Absorber and treated gas to Refinery Fuel Gas System		Lean DEA from Lean Amine Cooler to LP Absorber and Rich DEA to Rich Amine Flash Drum	
	Score Given	Comments to Support Score	Score Given	Comments to Support Score
Explanation on cause(s) of deviation				
Use of Evidence				
Explanation of Possible Consequences				
Use of Evidence				
Explanation of Existing Safeguard(s) Available				
Use of Evidence				
Explanation of Additional Safeguard(s) Recommended				
Use of Evidence				

Figure 7. Scoresheet for HAZOP Peer Marking

Specifically, in evaluating the learning experience we are looking for the presence or otherwise of the following:

- Appropriate method use to maximize learning opportunities in this Situated Context (e.g. learning outcomes, learner profile, learning space and resource access)?
- Clear presentation of learning goal, purpose and expectations to these learners?
- Activation of prior knowledge and subsequent connection to new knowledge presented?
- Emphasis on the key concepts and principles underpinning understand of the topic area?
- Activities (e.g. questions) that facilitated the types of thinking necessary for building understanding?
- Variation in the modes and methods of information presentation and interaction?
- Application of practices consistent with human memory processes (e.g. chunking, linkages, rehearsal and review)?
- Use of Deliberate Practice (where relevant)?
- Use of formative assessment activities to provide quality two-way feedback?
- Rapport building Interactions that promoted a climate conducive to success and some fun in the learning process?
- An aspect(s) of creativity (e.g., story, humour, activity, presentation style, example) that enhanced Intrinsic Motivation?

The evaluation of the flipped classroom is on-going and is using a range of evaluation methods to ascertain both the student learning experience and attainment. At present the data collected is from the learning experiences of our student co-participants (Lincoln 1990), who have been an essential part of the on-going evaluation process. They provide a more ethnographic understanding of how students are actually experiencing what we are teaching and their perception of its usefulness from their perspective.

To date, they have provided a wide range of data on different aspects of the flipped classroom experience, but only those of most significance to this context are presented here. Overall, the students found the use of advance organizers (e.g. Figure 1) useful, although some found it difficult to understand at first. Students generally cite its usefulness in helping them to keep track of their learning progress and how the various topics are connected to form the big picture.

Students agreed that the use of self-evaluation exercises after every topic (multiple choice and/or true/false questions in Socrative) are useful. However, some students did not use these exercises the way intended – they attempted the questions after the day's lessons instead of doing it before coming to class! As for Google Doc, students reported that classroom discussion is very useful in helping them to learn, especially from each other. This also applied to the case studies where different questions were posed to different groups, so that each group must work on one aspect of the issues presented and jointly the contribute to the solution of the whole problem. Here is a typical comment from one of the co-participants:

"*Yes, the collaborative approach with regards to group discussion is indeed a much more interesting and engaging learning experience. This allows sharing of opinions and ideas, and allows each student to justify their way of thinking. With this, I was able to actively listen to others, and with their responses, make appropriate modifications to my answer in order to achieve a thorough learning …I am able to identify faults in my arguments and answers, thereby promoting a self-marking and self-accessing approach in my own learning.*"

The "chunking" of information into smaller bits, especially for the ATU, certainly helped students in understanding the 'operation' of the plant. Coupled with the use of rubrics for peer marking in a mock tests, this enabled students to do the necessary thinking to developing understanding of the requirements of the module. The following examples, illustrate this:

"*Peer Marking with Rubrics helped me gain a better understanding of this topic area as it guided me on how to assess my peer's answer and hence, give her feedbacks on ways of improvement. In addition, I know what is the lecturer expecting when marking for our test papers too.* "

"*…teammates would be able to constantly provide feedback on the answering style of different individual, hence suggesting improvements for students to improve.*"

Another method that facilitated student learning was the use of DPP that activated their prior knowledge. They reported that working on the problems based on the DPP served to reinforce their learning of the safety topics in the module. The response below captures this:

"*It allows us to visualise first hand, how the LOPA concepts can be applied in the DPP plant. Furthermore, it allows us to make hypothetical improvements to the DPP plant so that it encompass the LOPA concepts. This enhanced learning, as the team could discuss about the technicalities behind the DPP plant, and move on to applying LOPA*."

These in-class activities provide the lecturer with the opportunity to walk around and listen to the students' group discussions, which makes their thinking visible. In this way misconceptions can be quickly identified and dealt with and necessary checks in understanding performed. That lack of such affordance is made painfully clear in Week 3, which is a SP designated "Home-based Learning" week, where students do not come to campus for lessons but work fully online. Due to the lack of face-to-face classroom interaction, it is not possible to usefully ascertain students' ability to sketch the proper engineering diagrams depicting how SIS can be implemented. On hindsight, it would have been more effective to ask students to submit their sketches for marking. This issue was only noticed in a later week when the lecturer introduced another class activity that required students to build on this knowledge in a different application.

On the other hand, the use of checklist drew mixed responses from students. The checklist was shown in class after approximately 1 hour of lesson as mid-point summary and again as end-of-class summary. One student's response was particularly interesting:

"*No, the checklist (mid-point or end of lessons) has not helped myself as individual to keep track of my learning based on the lesson objectives …Even though, the use of a checklist does push me to think about the learning outcomes, it does not actually prove that I am indeed competent in these aspects."*

As things turned out, the lecturer often did not have sufficient time to go through the checklist in details with the class. On reflection, the checklist could have been better included in the workbook instead, for students to monitor their own learning after they had completed all the activities of a given topic.

Lastly, an important insight gained from this experience is that students tend to 'optimize' their time devoted to studying this module by balancing the activities designed for this module with the demand of other modules, especially those with examinations. There was one occasion where the students did not complete some simulation exercises for classroom discussion, and when inquired, they were quite frank in revealing this reason for non-submission. Also, at this time of writing, we are not able to evaluate students performance from various summative assessments.

Conclusion

The feedback from student co-participants had shown that many of the strategies employed in the teaching of *Plant Safety and Loss Prevention* via a flipped classroom approach are positively impactful in in supporting their learning, particularly the advanced organizer, use of Socrative for self-evaluation, and Google Doc for classroom group discussion.

While some (e.g. use of checklist) have not been as effective, this does not necessarily mean the method choice was inappropriate. As teaching is a highly complex and situated activity, it is always going to be heuristic, never algorithmic. However, the use of an EBT approach provides our best basis for useful heuristics as it is grounded in validated knowledge relating to how humans learn and an extensive research base on method effectiveness.

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RESEARCH ON STUDENT ATTENDANCE AND TEACHING STRATEGIES FOR TECHNOLOGY EDUCATION.

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Abstract

The purpose of this research is to investigate and uncover factors that lead to students missing class in an Engineeering School. It is imperative to understand the factors which influence students' attendance, experiences and needs to help improve attendance and achievements in lectures. Lecture-tutorial system was devised for effective delivery of information en-masse to maximize resources in terms of venue and time for greater productivity in tertiary institutes. This despite the lack of interaction and discussion opportunities between students and lecturers. Cleary-Holdforth (2007). Some students attend lectures as they think attendance is compulsory. However when they realised that attendance is not compulsory, we observed that students have a higher tendency to skip attending the lectures. The methodology undertaken is a mix approached, a qualitative research approach where students across different diplomas were randomly selected to be interviewed to understand year 2 and 3 students experience in lesson and a quantitative survey to understand Year 1 students experience
A criterion for the selection is that the sample has to have a good mix of different academic capabilities. Students were interviewed individually as we would like to prevent their responses to be potentially confounded and influenced by responses from their peers. The study has given insights on the reasons why students do not attend lectures.

Keywords: *Attendance, E-learning, Blended, Engineering Education, Motivation*

Introduction

Temasek Polytechnic, School of Engineering is an institution that provides tertiary education opportunities for post-secondary school students. Lecture- tutorial system was devised for effective delivery of information en-masse to maximize resources in terms of venue and time for greater productivity in tertiary institutes. This despite the lack of interaction and discussion opportunities between students and lecturers. Cleary-Holdforth (2007).

Generally, students have to attend a two hour lecture, together with a two hour tutorial and a two hour laboratory (lab) lesson for each subject, each week. However, attendance is compulsory only for tutorials and lab sessions. On average, Year 1 and 2 students are required to attend more than 30 hours of lessons per week.

The school has students from diverse backgrounds in terms of wealth and social status and family make up. In addition, students age gap varies with most are fresh graduates from secondary schools but there are a handful of mature students with work experience or have served national service prior to joining the polytechnic. The school has a large number of international students from Asia such as China, India, Philippines, Myanmar, Malaysia and Indonesia. Even among the local students, the students capability within class could be large as the freshmen students entry score ranges from 8 pointers – 26 pointers in their GCE O level. With this diverse of students back ground, learning culture, prior technical knowledge acquired, language proficiency and learning competency, it is a challenge for lecturer to design a curriculum cater for such a wide spectrum of diverse students' needs.

Other than having good attendance rate of first semester in year 1 students, many lecturers noted a growing trend of students' absenteeism for lectures in the second semester of their first year. The problem is greater in years after. It is not uncommon to have an attendance rate of only 50% or less for lectures. The attendance soon starts to drop after the few weeks of the term and attendance would only pick up again during the last week of the term.

On Student Attendance

We have monitored students lecture attendance rate for an Engineering core subject Electronics Device (Edevice) which conducted in Year 1 semester 2. This was done through an electronic device installed in lecture theatres. Students have to scan their student card when they enter the lecture theatre. Table 1 shows the attendance of 4 lecture groups recorded over a period of 4 months with mean attendance recorded between 23-36%

Lecture group	# Students	Average attendance rate
LE01	67	36.20%
LE05	91	36.14%
LE06	42	28.87%
LE10	81	23.37%
Total	**281**	**31.15%**

Table 1: Edevice Lecture Attendance

The mean attendance of these 281 students had an average of 31.15 %. Such poor attendance for lectures is common to many others subjects especially when there is a mismatch in students motivation and competency toward the subject. There is a concern on lecturer attendance as it may have some impact to academic performance. Rodgers, J. (2001). O'Dwyer, A. (2011).

It is apparent that mass delivery of content in a lecture format is counter-productive in the School of Engineering and it is not effective for the students' learning due to their low attendance.

Methodology

In order to uncover the factors which contributed to low attendance of lectures, we need to understand why student choose to attend or skip lesson. We uses mix approaches to understand students' needs and expectation for learning.

The first phase of study involves qualitative research to help us understand student experience in class and their motivation for attending lectures.

We have selected 6 students from 3 different diplomas to participate in the interview. Of the 6 students, two are academically above average students, two are academically average students and the remaining two are academically weaker students in this study. Out of the 6 students, 3 of them were in the 3rd year and the rest were in their year 2. A summary of the students grouping is as shown in Table 2. Students were individually interviewed so that their responses are not peer-influenced.

In the second phase of study, we conducted an online survey from 42 freshmen. Freshmen refers to students whom have just started their education with us and tends to attend lecturers regularly. The survey was conducted after they have been through 6 weeks of lesson. The survey seeks to understand the students' experience with their lecturers and what are their needs or expectation on the mode of lesson delivery.

Participants	Participant background
2 students from Diploma in Business Process & Systems Engineering	Yr3 Student 'A' O-level 18pts (Poly CGPA : 3.0) Academic Average
	Yr3 Student 'B' O-level 16pts (Poly CGPA : 2.7) Academic Average
2 students from Diploma in Green Building & Sustainability	Yr2 Student 'C' O-level 22pts (Poly CGPA : 2.4) Academic weak
	Yr3 Student 'D' O-level 20pts (Poly CGPA : 2.4) Academic weak
2 students from Diploma in Integrated Facility Management	Yr2 Student 'E' O-level 15pts (Poly CGPA : 3.7) Academic Above average
	Yr2 Student 'F' O-level 16pts (Poly CGPA :3.2) Academic Above average

Table 2: Students' Background

Results and Finding

The data showed that student have difference needs, expectations and reasons for not attending lesson. Student attendance were influenced by

- Teacher factor-Whether student likes the lecturer
- Pedagogy- Whether student likes the teaching method or approaches
- Subject factor- Whether student likes the subject content
- Motivation factor- Whether student find it worthwhile to attend the lesson
- Time factors- Whether student have the time to attend lesson

In this paper, we focus our exploration on the Pedagogy and Motivation factors

Qualitative Analysis

The finding here shows teacher teaching style has a great influence on student attendance. Students need to find the purpose or motive to go for lessons. Poor attendance may be due to poor pedagogies as well. Students only attended lectures if they see 'value' in them. Massingham & Herrington (2006).

If the students are not able to understand or absorb the lesson content, then the student will not want to attend the lecture. Most students do not want to spend time to attend a lesson that they are unable to learn or benefit.

Pedagogy Factor

When they skip lessons, student will not be able to catch up with the school work and this will have a spiral effect. Students resort to memorizing content and regurgitating it in the examination without much learning taking place. This is very bad for Engineering students as they need strong fundamental knowledge to build on in order progress to learn more difficult levels of content. The current situation is disadvantageous to students as poor pedagogy will lead to poor learning and therefore affect student attendance. For example, Student 'C' said "*I remember there is one lecturer..like she blindly teach…All of our classmates know that she's good at what she do but she just cannot tell us how to do things. No proper explanation in lesson … her class is noisy and no body listen in class..As in everyone tried to listen initially then nothing gets in so everyone 'died off'… they are just helpless….. Students have the perspective that lectures are useless… Most of the student will think lecture are redundant…*" All students interviewed commented there may have some pedagogy weakness from some lectures. Students encounter lecturers who read from presentation slides during lecture where the content is the same as those printed in their lecture notes. Hence, there is a lack of deeper engagement. Students also like lessons that are more interactive, Student 'B' likes lecturers who engage students with questions, she said *" Like asking questions. The Lecturer asked questions and we will have to give the answer so that he will know where our understanding… and for us to know the correct answer "*

Students 'A' commented on her experience from some lectures she attended *"They don't even explain, they just read through what is on the lecture notes and to me I find that if I'm going to spend like my time listening to him like making a recital, I might as well go home and I could use of the time to do things I want. Because like in the tutorial lesson ..if we have any questions, the tutor will still bother to explain to us so to me is much more beneficial to go to tutorials than lecture lesson."*

In such situations, where students are still be able to receive the same content, they rather choose to go for tutorials rather than attend the lecture for they interact and solve questions which helps them learn. Students hate boring classes. It is important for the lecturer to make connection between theory to life experiences or situations to the student in class.

On the other hand, there are lecturers whom use many relevant and interesting examples to make students understand the practicality of their subject. Students appreciate such effort by lecturers as gathered from the research.

Another noted teaching approach favoured by students is the use of technology to bring about interactivity. Students are impressed with lecturers who apply technology into their teaching. Students are also appreciative of lecturers whom put in effort to look for good video to use in their lesson.

Another good usage of technology is to have the lessons recorded so that students can always refer to it anytime, anywhere at their own pace.

Students mentioned that they favored online post lecture. Online lecture seem advantageous as it will allow students to revisit the lessons especially when the lecture learning environment is not conducive as many students talk and make a lot of noise in the lecture. Unless all students are engaged and attentive, it will affect student learning.

The way the lecture speaks projects their passion for the subject and students do feel it as gathered from the research. Hence, lecturers have to be mindful and avoid speaking in a monotone or with a soft voice in lectures.

Generally the lecturers teaching style, voices, pacing or the way he speaks, with appropriate examples, videos, technological gadgets and asking questions will help improve student engagement in class and may increase lecture participation rate.

Motivation Factor

Motivation affects student attendance and can be both intrinsic and extrinsic. The level of motivation has an impact on student learning. If students have low motivation towards learning, they may find the lessons boring and therefore, would not attend the classes Kottasz (2005).

Student will weigh whether it is worth to spend time attending lesson. Student 'A' stated *" At the beginning of the semester yes .. It depends on whether I find the lecture worth going or not."* According to Student 'A', if she enjoyed the lesson, she will continue to attend the lesson but once she doesn't find it beneficial, she will stop attending the lesson. *Student 'B' said "*…sometimes we feel that its not beneficial to us so we will just skip… lectures is not compulsory because we don't need to have our attendance taken so we if there is no need to go, then we won't go.." Similarly, according to one of the student, if he knew that lecture attendance is not compulsory, he too will skip the lesson. Many students have the misconception that lecture attendance is compulsory, especially when they just started their schooling with us.

If students are not motivated to attend a lesson, they will find excuses to justify why they skip lesson. For example, Student 'D' skips lesson after lunch time to have a longer lunch break and rest time *"… nowadays the canteen is always so crowded. In order to get the food, we need to queue at least half an hour…So we need extra time…"*

Students whom are motivated will not skip lesson. From the student's response, we found out that if the student likes a certain subject; they will be self-motivated to attend the lesson. It is worth noting that motivation can be influenced by the teacher or the pedagogy.

Two students we interviewed were from the Diploma of IFM. Student 'E' has a CGPA of 3.7 and student 'F' with a CGPA of 3.2. Both had higher confidents, self-esteem, attended lessons more regularly than the other 4 students who have lower CGPA scored.

When asked if student 'E' and 'F' attended class regularly, Student 'E' response was *" ... I won't miss lectures and tutorials, even if half of my friends skip, I will still go for lectures. I mean I will go for every lecture and tutorial unless I'm late or I got something on.."* Student 'F' gave a similar response *"If I can, I will go for all the lectures.."* Therefore it may be a coincident that student with good CGPA seems to have higher motivation but the fact is higher CGPA students seems to be more motivated to attend lecture. This resonates well with Van Blerkom (1992). Students with higher self-efficacy tend to have higher motivation towards their study and to improve academic achievement and attendance.

Quantitative Analysis

We have gathered 42 students to participate in a survey to understand their lesson experience. The purpose of the survey is to find out what are the factors that will motivate or otherwise drive away students from attending lesson and what are the prefer modes of lesson delivery the students find it useful to their learning
The freshmen students in the 7^{th} weeks of their lessons from 3 classes of students doing Engineering Mathematics where morale are higher and are still excited due to they are new in polytechnic education. .

The survey results show that students 78% of the students are aware that attending lectures are important to their learning.

In addition, the survey result indicated the following factors that will motivate students attend lessons.

- Up to individual mindset
- Self Interest,
- To score better in study and self motivation
- To learn new things
- More interesting lesson
- Lesson must be fun , not dry.
- If the Lecturer is more interesting to teach the class I think more people will attend the class
- Must be fun and entertaining
- Compulsory Attendance
- The tutor/lecturer has a good sense of humour
- The lessons must be interesting to capture the student interest
- Depend on the methods the teacher uses can really help me learn.
- Depend on lecturer passion
- The enthusiasm and fun

The following are the factors that students have indicated that will drive students away from attending lessons.

- None productive lesson
- Due to distractions from large number of students attending, noise level is high and disrupts class
- Lecturer poor class management.
- Hard to concentrate, hard to listen as class is noisy
- The teacher just teaches and doesnt care if students are able to absorb the content
- Lecturer doesnt' bother of students learning
- The lecturer giving a dry and boring lesson
- The lecturer should not be monotone and no interact with the students
- When attend lecture end up learning not much things after the lessons

From the result, it resonate well that that students self-motivation is one of the factors affect students attendance. Lecturer passion, ability to teach well and make lesson interested will affect students attendance as well. However poor class management and none conductive environment due to noise and distraction will drive away students.

When asked what the preferred mode of lesson delivery is if they are given a choice, most students still prefer tutorial as it is easier to learn due to smaller class size, lower noise level and less distraction. Another advantage of tutorial is more interaction between tutors and students. Easier for students to ask questions and tutor to answer question.

Peer teaching is the next most preferred mode of learning. Students usually feel more comfortable and open when interacting with a peer than with a lecturer.

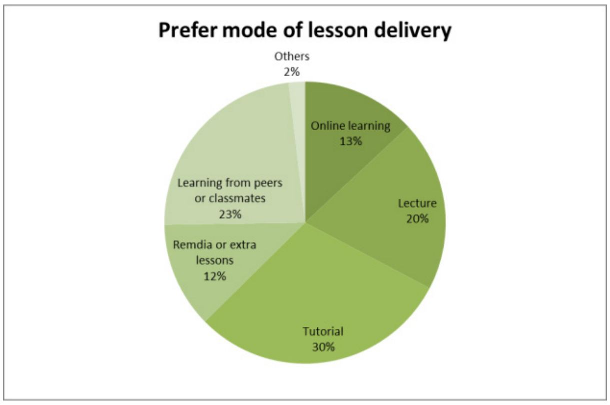

Table 3: Preferred Mode of Learning

Some students prefer online learning where they could learn from home and at their own time or in class by watching video. Lecturer has to learn to design curriculum that could encompass diversity to engage students to make lesson interactive and interesting. One of the ways is to use Information and communications technology (ICT) pedagogy, Stickel and Hum (2008).

Using video clip in class lesson could also help to engage students better; allowing students to understand real world situation which provide effective teaching and enhancement of student's self-efficacy. McConville and Lane (2006)

Discussion

The survey data and interview shows students do understand why lecture is important to their learning initially as freshmen but as they progress into their 2nd years of study, some students start to gathered reasons why not to attend lectures. In order to help improve student attendance, we need to look into the various factors that affect student attendance for lectures.

Making attendance mandatory for lectures may be a quick fix. However, the interview data, firms up what St. Clair (1993) states. Students need to take ownership in their studies. We should focus on motivating student to attend lesson instead. If students are motivated to learn, they will automatically attend lesson to seek the needed knowledge. Otherwise, if the class is full of unmotivated students, the consequences may be simply be very noisy group of students 'forced' to make their appearance in the lecture theatre. The unmotivated students will talk and therefore spoil the learning environment and affect students who are interested to learn.

The finding suggests that video materials are helpful for students learning as stressed by Wieling et al (2010) and McConville et al (2006). We can also relate our finding to Kottasz (2005), who states that students choose to skip lessons when they are rushing for assignments, or poor teaching quality or poor timing of lectures. Therefore we may need to improve teaching and lesson delivery if we want to improve student attendance.

Students like interactive lessons than passive ones. Our finding resonates with Van Blerkom (1992). Higher self-efficacy students will have better motivation to attend class. Students with higher GPA score were more motivated to attend classes than students with lower GPA score. Better academically inclined students have higher motivation towards learning. Implementing intervention programs can help improve student's self-efficacy and improve attendance indirectly.

Tackling student motivation alone is not enough to improve student attendance rate. The school should look into improving teacher and pedagogical factors for a more effective lesson experience for students. Lecturer need to understand and be aware of the human aspect on student motivation. We have to keep improving our teaching pedagogy in order to help students learn. As long as student learnt better, student attendance will be improved automatically.

Conclusions

The purpose of this study is to understand students' experience in attending lectures and seek factors that could aid improving student attendance in lecture.

Our finding resonates with Van Blerkom (1992) which also noted that higher self-efficacy students will have better motivation to attend class. Motivation affects student attendance and can be both intrinsic and extrinsic. It is the root cause that impacts student attendance. On the hand, our research findings also noted that tackling student motivation alone is not enough to improve student attendance rate. The school should look into improving teacher and pedagogical factors for a more effective lesson experience for students. Students like interactive lessons than passive ones.

The research finding here shows that teacher teaching style has a great influence on student attendance too. In conclusion, students need to find the purpose or motive to attend lessons. If the students are not able to understand or absorb the lesson content, then the student will not want to attend the lecture. Most students do not wish to spend time to attend a lesson that they are unable to learn or benefit. Understanding what causes low attendance will help formulate relevant policies or recommend appropriate training to teaching staff to engage our students in technology education..

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Topic 2

Teaching and Learning

2101

ICT AND ACTIVE LEARNING USING DIGITAL TEACHING MATERIALS AND IPAD IN ENGLISH CLASSES FOR KOSEN STUDENTS

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Abstract

This study attempts to measure the effectiveness of making use of Information and Communications Technologies (ICT) and Active Learning (AL) in the subject of English for KOSEN students. The way in which we measure the effectiveness is by the use of both digital teaching materials and iPad. We measure them through the views of teaching and learning respectively. The advantages of ICT and AL for both teachers and learners for English as the target language (L2 learners) are discussed, followed by the observations of the atmosphere in the classrooms as well as the results of the questionnaires filled out by L2 learners. The main reason behind this attempt is as follows. Education systems in KOSEN have been widely acknowledged as one of the forerunners of AL in specialised courses such as mechanical, electrical, materials and civil engineering because of the wide variety of experimental tasks required for KOSEN students. However, it can be said that there are other subjects in general education that have still been taught by the ordinary teaching way. The first author has tackled these tasks in this academic year for 1st-year KOSEN students. First, as for ICT, from the view of teaching the author has tried to utilize the digital teaching materials supplied by the publisher of an English textbook which has wide variety of contents including several English teaching methods. Second, in terms of AL, the use of iPad for all students in a class was attempted for the first time in Nagaoka KOSEN. Then Siri of iPad and Skype were used for L2 learners' speaking practices. In conclusion, the effectiveness of the use of ICT was observed, and then the environment of iPad usage for all students in class was confirmed. Finally, Siri and Skype gave us a lot of hints for the new ways of English teaching in schools.

Keywords: *Digital Teaching Materials, iPad, Siri, ICT, Active Learning, Skype*

Introduction

In National Institute of Technology, Nagaoka College, or known as Nagaoka KOSEN, the use of Information and Communications Technology (ICT) has been widely applied in classrooms including five-year courses as well as two-year advanced courses. In addition, Active Learning (AL) has been in the spotlight as the subjects of Faculty Development (FD) and therefore the teachers in Nagaoka KOSEN have had opportunities to take several workshops for learning how to conduct AL during classrooms recently. Because of these current teaching pedagogies, the use of these methodologies in classrooms has been becoming the main stream for KOSEN education. It can be said, however, that they have been mainly used for engineering and scientific subjects in engineering departments and not been widely applied for the subjects in general education departments such as physics, mathematics, history, and English.

Because of this background mentioned above, it is fairly to say that students in KOSEN have acquired high ICT literacy due to specialised educational programs in engineering subjects. On the other hand, they are thought to have lesser motivation in studying English than in studying other engineering subjects. The authors think that by utilizing ICT with AL in classrooms for studying English in some ways, students in KOSEN will find it more interesting to learn English than the conventional teaching ways which do not use ICT in classrooms. In addition, this might make students learn English in more spontaneous and active manners so that they can actively participate in the classrooms. Furthermore, the introduction of ICT with AL may give benefits not only for students but also for teachers as ICT saves teacher's preparation time for classrooms.

In terms of ICT used for English class, Matsumoto (2016) indicated from her research as well as previous results of questionnaires that the current high school English teachers have not been used to utilizing ICT for their English classes. Concerning pedagogies for English class, there are several methods which have been developed. Some of the examples are the use of flash cards and slash reading. MacQuarrie (2002) evaluated the effectiveness of the use of flash cards for second language acquisition. Making use of flash cards for learning new words or phrases can retain them in a learner's brain memory for longer period. Saruwatari (2006) then developed a computer software for students to learn English vocabulary using flash cards system. As for slash reading, Stevens (1981) insists slash reading can help readers understand the meaning of each phrase or chunk in sentences. Associated with ICT used for AL, Iwai (2012) has experienced the use of iPad for his German language classes for a long period and then the effectiveness of AL has been measured. The way in which he has utilized iPads in classrooms is composed of some steps: pronunciation checking, video recording and writing short script by group work, listening to the pronunciation of the words in the script by using some software applications such as "Speak it!" and "Dragon Dictation".

The first author, as an English teacher in Nagaoka KOSEN tries to introduce digital teaching materials for learners for English as the target language (L2 learners) in classrooms. The reason why the author selects the materials is that it contains several language-teaching methodologies. These are applied for learning new words and improving reading skills such as the use of aforementioned flash card and slash reading, respectively. The use of the digital teaching materials is to be performed with the aid of a laptop computer, a liquid crystal display (LCD) projector and a speaker is to be applied for every single class for teaching English to 1st year students.

Nagaoka KOSEN has also planned to attempt the use of iPads connected with Wi-Fi which are to be given to all students in classrooms for the purpose of introducing AL into classroom. The way in which we use iPads for L2 learners is simple – the use of Siri for L2 learner's speaking practice. It can be utilized as long as iPad is connected with the Internet. When people ask Siri some questions, it can respond and search information through Safari, the search engine technology of Apple. The response from Siri is not just one answer but has some variations. In addition, some of the answers make people smile, so it can be said that Siri has been programmed with sense of humour. For example, when we say to Siri 'You are smarter than you think.' which is the title of Lesson 3 in the text book, it replies not only a normal answer like 'Thank you', but it also says 'Flatterer'. It is in fact that the attempt i.e., the use of iPad for all students in classrooms is the first challenge in Nagaoka KOSEN. Therefore, it is required to confirm whether or not Siri of iPads can properly work when all students use them at the same time in a classroom, in addition to Skype for their AL.

The Information and Technology Centre (ITC) group has installed Skype for business in the fifty-one iPads. Skype has been known as one of the frontiers in video communication tools throughout the Internet free of charge for more than ten years worldwide. In Nagaoka KOSEN, students can use this application with unique allocated login ID and pass code, which are the same as Microsoft's Office 365 accounts that they can use.

In this paper, the teaching method and ICT materials used for this challenge are introduced first, followed by the results obtained from questionnaires answered by L2 learners. Then some proposals seeking for new ways of teaching using ICTs based on the attempts are expressed.

Method and Materials

Digital Teaching Materials: PROMINENCE Communication English I, one of major English textbooks for Japanese high school students adopted for 1st year students, published by Tokyo Shoseki, has supplied digital teaching materials as a teacher's manual. The digital teaching materials are packed in a DVD-ROM. It covers all lessons mainly produced by Microsoft's Power Point files. Hence the teachers download the files in their personal computers and utilize them in classrooms using projectors and speakers. The contents of the digital teaching materials include not only full textbook with audio, but also some well-known English teaching methodologies such as site-translation with slash reading, and new words with flash cards. It also has some functions for adjusting narration speed and displaying time for audio and slides, respectively. Moreover, the DVD-ROM contains syllabus samples, a vocabulary testing system, evaluation tests, and its supplemental materials such as *Prominence Supply, Workbook, Preparation Notebook.*

iPad: Fifty-one Apple iPad mini 2(16GB), which can connect to the Internet over Wi-Fi, have been procured for student ICT education in Nagaoka KOSEN. Forty-eight iPads are for students' use, two for backup and one for teacher's use. (See Fig. 1) The language setting was intentionally set as English, not Japanese, for the purpose of using Siri spoken in English. Some security measures to protect any tampering by students have been taken by the ITC group in Nagaoka KOSEN.

(Fig.1: Fifty-one iPads stored in containers in a cabinet)

Wi-Fi setting: In order for all students in a classroom to be able to use iPads with the Internet connection at the same time comfortably, following devices have been prepared by the ITC group: Buffalo virtual private network or one VPN router (model: VP-S1000), one Panasonic switching hub (model: Switch-M5ePWR) and four Buffalo wireless LAN access points (model: WAPM-1166D). (See Fig. 2)

(Fig. 2: Network devices stored in a container)

Other ICT devices: A laptop computer, a projector, a speaker for making use of the above-mentioned digital teaching materials in the classroom were Microsoft Surface (model: Pro3), Epson LCD projector (model: EB-1751), and Bose SoundLink mini, respectively. The laptop computer and the projector were connected with High-Definition Multimedia Interface (HDMI) whilst the laptop computer and the speaker were by Bluetooth connection. All these devices can be said as relatively modern products as of the date written in this paper due to their product release date. The author has decided to select them from the view of portability since they are to be carried to classrooms.

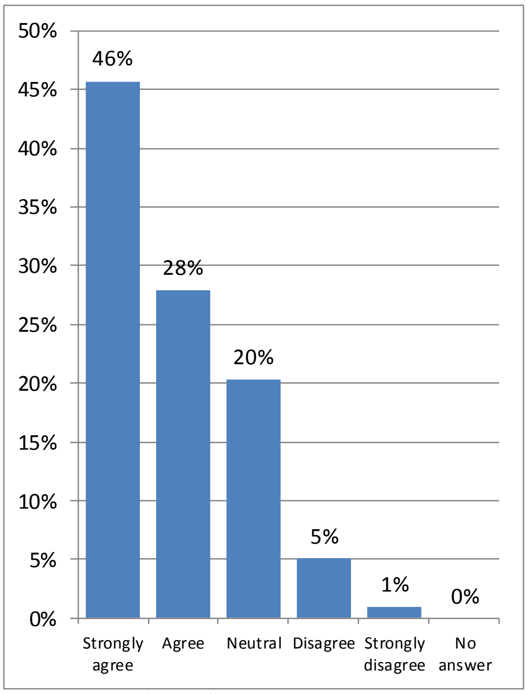
1) Teaching English with digital teaching materials: All 1st year students, totalling 209 registered students, in five classes are to be taught English with the digital teaching materials including some linguistic pedagogy, used by the ICT devices during the period between April and June 2016. In this period, it covered Lesson 1 to Lesson 3 in the textbook. The linguistic pedagogies used were mainly flash cards for new vocabularies, slash reading with site-translation on the textbook. The language used in the classroom was mainly English, followed by some Japanese in order for students to understand better. After these three months, students were asked to answer an anonymous questionnaire with Likert scale and free comments for evaluating the way of teaching English with ICT using the materials.

2) English speaking practice with iPad: All 1st year students in five classes were asked to use Siri of iPad as a warm-up activity at the beginning of the lessons. Students were required to speak to Siri by using given questions. For example, the following practice was used for the second trial of the lessons using Siri of iPad, for the purpose of familiarising the English sentences with indirect interrogatives, which was planned to be taught in Lesson 3 of the text book: Q1) I don't know when I'll be back.' Q2) Can you tell me how to get to Sesame Street?' Q3) Can you tell me where to buy a ticket?'. Students were required to ask these questions to Siri. Then they wrote down what Siri understood or heard from the speaker. Furthermore, they wrote what Siri responded. All students experienced this practice three times in June and July 2016. All students were then asked to answer simple anonymous questionnaires with Likert scale and free comments after the first and third lesson were completed.

3) Skype: Skype has been widely known as a communication software, which provides video chat and voice call services through the Internet. Since most of the functions in Skype can be used as free of charge, this software has been used not only for private communication purpose, but also for other purposes such as business communication, commercial use and so on. This is especially useful for long distance communication to other countries since overseas calls are generally expensive. The purpose of using Skype in the English classrooms is for one of ALs in English communication. The author thinks that it might be useful for students in the future if they can smoothly communicate in English with people in overseas through Skype. In order to confirm if this application software can work properly in the classroom when students use it at the same time. To protect students' privacy information, the telephone number of Nagaoka KOSEN was used for the entry telephone number to start Skype operation, is used as the telephone number of Nagaoka KOSEN. Two classes out of five attempted to use Skype for their speaking practice in June.

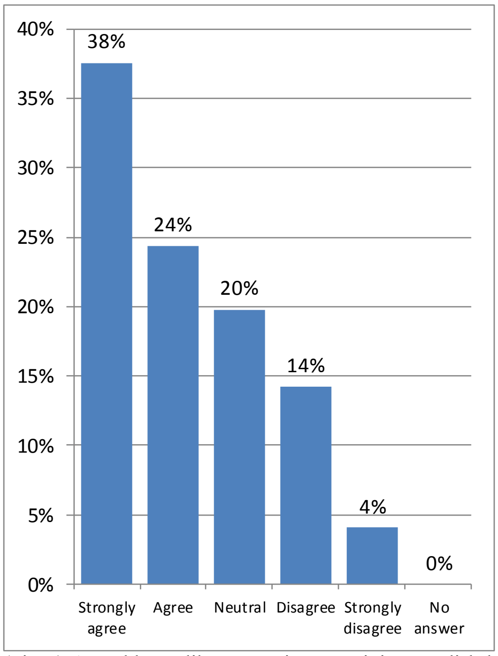
Results and Discussion

1) Teaching English with digital teaching materials: In the questionnaire, the first question was 'Would you like to continue receiving lessons with a projector?' Note that the word 'projector' here means not only the use of a LCD projector, but also the use of a speaker as well as a laptop computer because they are a package of ICT devices that the author has used in the classrooms. The result of the questionnaire as shown in Fig. 3, 197 out of 209 students answered. To this question, 46% strongly agreed, 28% agreed, 20% stayed in a neutral position, 5% disagreed and 1% strongly disagreed. This means that 74% of the students were in favour of the use of ICT in English class. Most students wrote their opinions to this question. Here are some typical comments: 'Easy to understand due to the Japanese translation shown together with the English text', 'Clearer to see words and sentences on the screen than on the blackboard', 'Can save time', 'Have been used to studying with a projector since junior high' (Strongly agreed), 'Good for my listening practice' (Agreed), 'Too long pause between slash', 'Difficult to see' (Neutral), 'Makes me want to sleep' (Strongly disagreed). Second question was 'Would you like to continue receiving English lessons taught in English?' and its results are as shown in Fig. 4. Again, 197 students answered to this question. 38% and 24% strongly agreed and agreed, respectively. On the other hand, 14% and 4% disagreed and strongly disagreed. 20% took a neutral position. Here are typical comments from the students: 'It's no problem as difficult sentences in English were translated into Japanese.' 'English will be necessary for me to use in the future.' (Strongly agreed) 'Difficult to understand' (Neutral), 'Do not understand', 'Hate English' (Disagreed/Strongly disagreed)



(Fig. 3: 'Would you like to continue receiving lessons with the projector?')

From the user's side, thanks to the all-in-one materials, the author realised that it could save significant time for the preperation for each class. However, there were some unexpected happenings in the classrooms while using the ICT devices. One was due to the laptop computer. In class, a touch screen problem suddenly occured and the author instantly could not solve the problem. Therefore students had to wait for a few minutes and lost their study time. Second, one happened on the Bloothooth speaker. It disconnected from the laptop computer time to time.

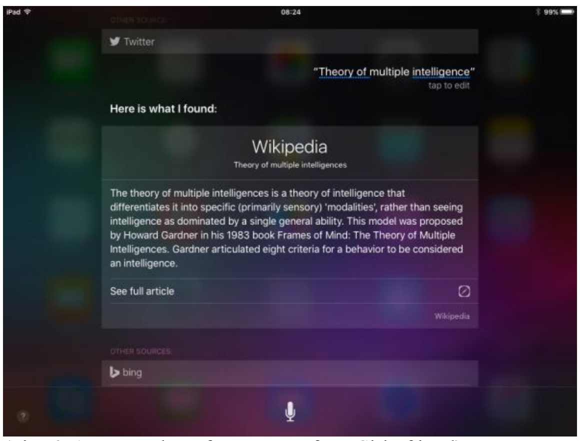


(Fig. 4: 'Would you like to continue receiving English lessons taught in English?')

2) English speaking practice with iPad: Fig.5 showed the scene of a classroom using Siri of iPad for their speaking practice. Some students used their own earphones whilst others asked Siri questions directly. Fig. 6 shows a screenshot of iPad. It displayed a result of the response from Siri after speaking the words "Theory of multiple intelligence", which is taught in Lesson 3. The screenshot shows Wikipedia's English site. This was the site where Siri took the student to. It explained the theory of multiple intelligence, which contains up-to-date information. The author utilized it to generate extra questions to the students. As seen in the screenshot, on top right it says 'The theory of multiple intelligence.' This is what Siri heard from a student. On top left slightly below the above-mentioned words, it says 'Here is what I found'. This is what Siri responded and it took the student to Wikipedia's site.

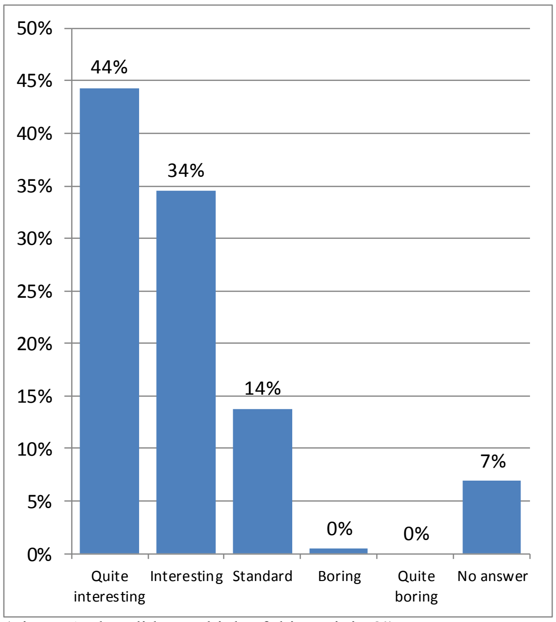
(Fig. 5: Students using iPads in a classroom)

As shown in Fig. 7, the author received the initial feedback from students by asking them to fill in the questionnaire right after completing the first lesson using Siri activity in the classrooms. The question was 'What did you think of this activity?' 203 students in five classes out of 209 registered 1st year students responded. 44% felt that this activity was quite interesting. 34% felt it interesting, 14% found it standard. One student or 0% found it boring. No one felt this activity was quite boring and 7% did not answer. 78% gave positive feedback.

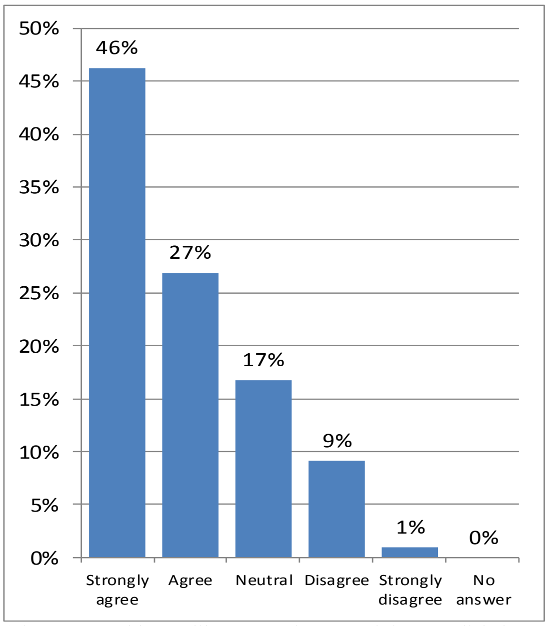


(Fig. 6: A screen shot of a response from Siri of iPad)

In Fig. 8, the author also received a further feedback from the students after their third lesson with iPad activity was completed. This time, 197 students in five classes responded. The reason for the decrease in number was due to absence from class because of their club activities. This time, the question was 'Would you like to continue receiving English lessons with iPad?' The results were as follows. 46% strongly agreed, 27% agreed, 17% stayed in a neutral position, 9% disagreed, and 1% strongly disagreed. 73% gave positive feedback.



(Fig. 7: 'What did you think of this activity?')



(Fig. 8: 'Would you like to continue receiving English lessons with iPad?')

3) Skype: Two out of five classes had an initial trial for using Skype in the classroom on the 27th and 28th of June. Some students smoothly logged-in to Skype as per an instruction and they communicated with each other via. Skype with some English conversation practices were given by the teacher. There were some howling noises due to many Skype users in the classroom. It can be said that half of the students did not remember their Office 365 passcode and because of that, they spent some time to login by asking the ITC group who managed students' passcode. Some students could not even login for some reason. The observation from the view of the teacher for this activity was relatively chaotic because of the howling noises as well as the students struggling to login. The first author noticed during this attempt that students who are the current users of Skype in Japanese, they could smoothfully operate it even though the iPad setting was in English. On the other hand, students who used Skype for the first time, took a long time.

Conclusions

In conclusion, majority of the students who took English lessons with ICT devices preferred to continue receiving the lessons because of some reasons such as being able to see and hear clearly, saving time for notetaking, and being able to hear a native speaker's voice. More than half of the students also preferred to take English class taught in English. Majority of the students also liked the activity of iPad for the speaking practice because they can spontaneously practice one-on-one English speaking training with the robot partner utilized with advanced technology. However, in terms of the ICT devices in classroom, the problem from the user's side, wireless disconnection led to the interruption of the class. It therefore required to have stable and robust operating environment of ICT devices used in the classroom. The author realised the significant reduction in preparation time by the use of digital teaching materials. In order to prove it, the first author plans to compare the efficiency in preparation time for teachers with and without the use of the materials in the future. In terms of Skype, for those students who have experienced to use it in their private time, it was easy for them to utilize it and they could use it for communication practice in English. On the other hand, for those students who used it for the first time, it seemed quite difficult for them to even log-in. The author thinks of Skype as a powerful tool and hence the next challenge is to use Skype in the future to connect with students overseas such as Thailand and Malaysia that have academic exchange programs with Nagaoka KOSEN.

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REFLECTION FOR TRI-CITY STUDENT EXCHANGE PROGRAMMES ON STUDENTS' LEARNING

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Abstract

Student exchange programmes or study tours have been used in various education institutes in different regions to enrich students' learning experience. Previous studies have demonstrated the positive impacts of student exchange programmes to students' learning and development. However, the effectiveness in achieving the intended goals of a student exchange tour might substantially affected by the programme design, planning and implementation. This paper discusses the development and implementation of a tri-city student exchange programme in achieving the intended learning outcomes based on a joint student exchange programme to Ngee Ann Polytechnic (NP), Singapore. A group of higher diploma engineering students in Hong Kong attended the second tri-city student exchange programme in Singapore and mixed together with the local Singaporean students and another group of National Institute of Technology (NIT), Kumamoto College students from Japan for a series of exchange activities, including joint project development, industrial visits and cultural activities. With the effective coordination among the three institutes involved, the tour was successfully completed with positive feedbacks from various stakeholders.

This paper aims to address and reflect the benefits of undertaking a student exchange programme to higher diploma engineering students in Hong Kong. Students' feedbacks and reflective writings of the programme will be reviewed and analyzed. Discussion on the design, planning and implementation for future multi-city student exchange programmes as an effective learning tool is also provided in the paper. Recommendations in organizing similar programmes will be addressed.

Keywords: *curriculum design, intended learning outcome, problem based learning, student exchange programme*

Introduction

In this era of knowledge and information explosion, knowledge acquisition of students should not be confined to the chalk and talk in the classroom. Various education institutes started to incorporate student exchange programmes or study tours into curriculum as a way active learning to enrich students' learning experience.

Recently, a 10-day tri-city engineering student exchange programme to Singapore was arranged in collaboration among the Department of Engineering, Hong Kong Institute of Vocational Education (Sha Tin) in Hong Kong, the Department of Engineering, Hong Kong Institute of Vocational Education (Chai Wan) in Hong Kong, the School of Engineering, Ngee Ann Polytechnic (NP) in Singapore, and the National Institute of Technology (NIT), Kumamoto College in Japan. This was the second time collaboration of the three institutes to provide an academic and cultural exchange opportunity for the tri-city students. The intended learning outcomes of the programme were to widen students' horizons in terms of academic and cultural perspectives through interactions with students from three regions; to experience the style and discipline of dormitory life at NP; and to gain good practices in Singapore institute's programme delivery and in industry's operation and management.

The exchange programme was designed with a good balance between academic activities and cultural exchange activities. In the programme, students from three regions were mixed and formed into groups to complete a hands-on technical project. A series of lectures, workshops, and presentations were conducted. Industry visits were arranged to provide students with a first experience in industrial practices. Furthermore, city tours and cultural visits were arranged for students to explore and experience the beauty and the culture of Singapore.

Although different elements can be incorporated into a student exchange programme, it is known that the effectiveness of a student exchange programme in achieving the intended goals might substantially affected by the programme design, planning and implementation. This paper discusses the development and implementation of the abovementioned tri-city student exchange programme. The aim of this paper is to address and reflect the benefits of undertaking a student exchange programme to higher diploma engineering students in Hong Kong. The results can be a reflection for tri-city student exchange programmes on students' learning. Hopefully, it can be a reference for organizing similar student exchange programmes.

Literature review

Defined by Miao (2006), a study tour is a learning and researching activity through personal visits to one or more unfamiliar sites, where those sites are the subject of study. Various education institutes around the world organize student exchange programmes or study tours to enrich students' learning experience (Sakurai, 2012). It is a means of fostering students' personal and academic capabilities (Sakurai, 2012). Cross-cultural connectivity and professional development have been emphasized as the major benefits or functions of student exchange programmes or study tours by plenty of studies. Stone *et al.* (2014) mentioned that study tours are intended to attain more than a superficial knowledge of another culture, and thereby to understand the culture of one another. The study of the culture of another is to learn more about how one's own system works (Hall, 1990). Hall (1990) believed that the most effective way of learning about ourselves, our own values, culture, and beliefs can be achieved from learning about another culture. Therefore, cross-cultural experiences can attain students with global-mindedness, stimulate students' intellectual growth and professional development, and enhance students' personal development such as maturation, self-awareness and independence (Harrison, 2006; Koskinen *et al.*, 2009; Sakurai, 2012; Stone *et al.*, 2014).

Organizing a student exchange programme or a study tour is a multi-tasking work that involves the participations of a number of stakeholders. Though the organizers play a key role in decision makings on various aspects, perspective from students should not be overlooked. Developing a programme that prospective students perceive as useful and valuable will enhance the probability of success in operating a short term study tour (Evans *et al.*, 2009). Evans *et al.* (2009) conducted a study to investigate student perceptions of different aspects of a short study tour. At the same time, student preference for different aspects of a short study tour was identified. It was found that cost is the most important criteria, followed by the country or countries in which the tour will take place.

Methods

Qualitative methodology was used in this evaluative research. It reveals the effectiveness of a tri-city student exchange programme in achieving the intended goals. The programme was examined critically by analysing the collected information, characteristics and outcomes of programme.

The information and characteristics about the programme were collected from the accompanying staff of the programme from Hong Kong. The outcomes of the programmes were evaluated based on students' responses to a routine questionnaire designed by the institute and the students' reflective writings. The questionnaire was divided into two parts (Part A and Part B). Part A of the questionnaire evaluated various components of the programme. Students were requested to rate the components in a 4-point scale (4: excellent; 3: good; 2: Fair; 1: bad). Part B of the questionnaire evaluated the extent of improvement of the students on various aspects or abilities in a 4-point scale (4: very much; 3: much; 2: some; 1: little), and the overall satisfactory level in the programme in a 4-point scale (4: very satisfied; 3: satisfied; 2: neutral; 1: dissatisfied). Table 1 summarizes the questions in the questionnaire. For the reflective writings, students were asked to share their opinions or unforgettable experiences of the programme.

Table 1: Questions in the questionnaire

Part A: **Evaluation on various components of the programme**
1. Working/Living experience 2. Seminars/Training courses 3. Company visits, tourist attractions 4. Exchange activities with foreign students 5. Suggestions (e.g. theme, content, venue or events suggested to be added for the activity)
Part B: **Evaluation on the extent of improvement of the students on various aspects or abilities, and the overall satisfactory level in the programme**
1. Study/Work culture 2. Knowledge of history and culture 3. Communication skills 4. Team spirits 5. Self-management skills 6. Willingness of studying/working overseas 7. Foreign language ability 8. Willingness to participate in the similar activity in future 9. Overall satisfactory level in the programme 10. Additional comments and suggestions 11. Things learnt from the programme

Tri-city engineering student exchange programme

The host institute of the programme was Ngee Ann Polytechnic (NP) in Singapore. NP is one of the Singapore's leading institutions offering programmes at higher diploma level (Ngee Ann Polytechnic, 2016). Another partner institute was National Institute of Technology (NIT), Kumamoto College in Japan. National Institute of Technology (NIT) (also named as KOSEN) in Japan focuses on engineering education. It offers programmes from higher diploma to degree level aimed at educating students to be engineers with practical knowledge and creativity and to be able to contribute to the communities with professional skills and knowledge of technology (KOSEN National Institute of Technology, 2016). While Hong Kong Institute of Vocational Education (IVE) is a leading vocational and professional education provider in Hong Kong. It offers an array of disciplines and programmes at levels from diploma of foundation studies to higher diploma (Hong Kong Institute of Vocational Education, 2016). To enhance the internationalization of students and strengthen the strategic relationships with the overseas partners, the above three institutes collaborated together for the second tri-city student exchange programme.

The exchange programme was designed for engineering students. A series of academic activities and cultural exchange activities was conducted within 10 days of the programme. During the period, students from the three institutes were mixed together and formed into groups. The students were required to complete a hands-on technical project that involved the design, assemble and programming of autonomous load carrying vehicles. The vehicles with loadings were able to change their directions and climb up a slope automatically from a starting point to a destination in a period of time as short as possible. To increase the work incentive of students, a competition was organized. Merits were given to the group of students that their vehicle could deliver the heaviest load accurately from the starting point to the destination and with the shortest period of time. As a kind of problem based learning, the students should attend a series of lectures and workshops, and work together to solve any problems encountered in order to complete the project. Each group of them was required to give a final presentation at the end to share their work outcomes. In addition, industry visits were arranged to provide students with a first experience in industrial practices, for example an industry visit to the factory of a world famous flight engine manufacturer, a site visit to the Marine Barrage, and etc. Furthermore, city tours and cultural visits were arranged. Students could take the opportunity to interact with students from other countries in any time during the trip. Other than attaining professional and technical knowledge, the students could develop a cross-cultural connectivity.

Participants from Hong Kong

A total of 20 students from the Department of Engineering, Hong Kong Institute of Vocational Education (Sha Tin), and the Department of Engineering, Hong Kong Institute of Vocational Education (Chai Wan) participated in the exchange programme. They were studying higher diploma programmes in building services engineering, computer engineering, electronic and communications engineering, electrical engineering and mechanical engineering. The students were aged between 18 to 23 years. All the students were male.

Students' feedbacks and reflections

All the 20 students completed and returned the questionnaires. The results are summarized in Table 2. Satisfactory results on different aspects were obtained.

From the results of Part A of the questionnaire, average scores above 3 were obtained in all the evaluated components, namely working/leaving experience, seminars/training courses, company visits, tourist attractions, and exchange activities with foreign students. This indicates various assessed components in the programme were satisfied by the students. According to the opinions of the students, most of them mentioned the exchange programme was well organized and hoped that the duration can be extended.

From the results of Part B of the questionnaire, average scores above 3 were obtained in all the evaluated aspects or abilities, namely, study/work culture, knowledge of history and culture, communication skills, team spirits, self-management skills, willingness of studying/working overseas, and foreign language ability. It reveals that most of the students thought they achieved very much improvement on all these aspects or abilities. Moreover, all of the students satisfied with the exchange programme, an average overall satisfactory level of 3.35 was obtained. In addition, all of the students showed their willingness to participate in the similar activity in future.

With the review of responses of questions 10 and 11 in Part B of the questionnaire, as well as students' reflective writings about the exchange programme, all the students treasured this exchange opportunity to learn and to experience the life of students in Singapore. Within a short period of time, the students had not only opened their eyes but also gained lots of useful knowledge and experience that might influence their lives. The students attempted to re-evaluate themselves. Through the interactions with foreign students, Hong Kong students realized their strengths and weaknesses. For example, they discovered that they were relatively inactive and hesitative to raise questions. Moreover, the exchange experience unreservedly revealed the importance of communication to the students, especially the communication in English. Besides, the students learnt to appreciate different cultures, values, beliefs and social manners. Through sharing and mutual understanding, students from various countries had developed friendships. This strengthened students' social networks which would be useful in their lives or future careers. As far as personal development of students is concerned, it was the first time for most of the students to live aboard with other classmates. On one hand, they had learnt to be independent without their parents. On the other hand, they had learnt to be adaptive in living with others harmoniously.

Discussion and recommendations

Based on the feedbacks and reflective writings from students, the intended goals of the tri-city student exchange programme were achieved. In general, the success of an exchange programme greatly relies on the preparation and implementation efforts. The whole programme is a cyclic process as shown in Figure 1.

Table 2: Questionnaire results

Part A: Evaluation on various components of the programme						
	Number of responses					**Score (4-point scale)**
	Excellent	**Good**	**Fair**	**Bad**	**Total**	
1. Working/Living experience	9 (45%)	11 (55%)	0 (0%)	0 (0%)	20 (100%)	Average: 3.45; Standard deviation: 0.51; Mode: 3; Median: 3
2. Seminars/Training courses	6 (30%)	12 (60%)	2 (10%)	0 (0%)	20 (100%)	Average: 3.20; Standard deviation: 0.62; Mode: 3; Median: 3
3. Company visits, tourist attractions	9 (45%)	11 (55%)	0 (0%)	0 (0%)	20 (100%)	Average: 3.45; Standard deviation: 0.51; Mode: 3; Median: 3.5
4. Exchange activities with foreign students	10 (50%)	10 (50%)	0 (0%)	0 (0%)	20 (100%)	Average: 3.50; Standard deviation: 0.51; Mode: 3; Median: 3.5
Part B: Evaluation on the extent of improvement of the students on various aspects or abilities, and the overall satisfactory level in the programme						
	Number of responses					**Score (4-point scale)**
	Very much	**Much**	**Some**	**Little**	**Total**	
1. Study/Work culture	8 (40%)	9 (45%)	3 (15%)	0 (0%)	20 (100%)	Average: 3.25; Standard deviation: 0.72; Mode: 3; Median: 3
2. Knowledge of history and culture	9 (45%)	9 (45%)	2 (10%)	0 (0%)	20 (100%)	Average: 3.35; Standard deviation: 0.67; Mode: 4; Median: 3
3. Communication skills	11 (55%)	8 (40%)	1 (5%)	0 (0%)	20 (100%)	Average: 3.50; Standard deviation: 0.61; Mode: 4; Median: 4
4. Team spirits	9 (45%)	10 (50%)	1 (5%)	0 (0%)	20 (100%)	Average: 3.40; Standard deviation: 0.60; Mode: 3; Median: 3
5. Self-management skills	10 (50%)	8 (40%)	2 (10%)	0 (0%)	20 (100%)	Average: 3.40; Standard deviation: 0.68; Mode: 4; Median: 3.5
6. Willingness of studying/working overseas	7 (35%)	10 (50%)	3 (15%)	0 (0%)	20 (100%)	Average: 3.20; Standard deviation: 0.70; Mode: 3; Median: 3
7. Foreign language ability	11 (55%)	9 (45%)	0 (0%)	0 (0%)	20 (100%)	Average: 3.55; Standard deviation: 0.51; Mode: 4; Median: 4
	Number of responses					/
	Yes		**No**		**Total**	
8. Willingness to participate in the similar activity in future	20 (100%)		0 (0%)		20 (100%)	/
	Number of responses					**Score (4-point scale)**
	Very satisfied	**Satisfied**	**Neutral**	**Dissatisfied**	**Total**	
9. Overall satisfactory level in the programme	7 (35%)	13 (65%)	0 (0%)	0 (0%)	20 (100%)	Average: 3.35; Standard deviation: 0.49; Mode: 3; Median: 3

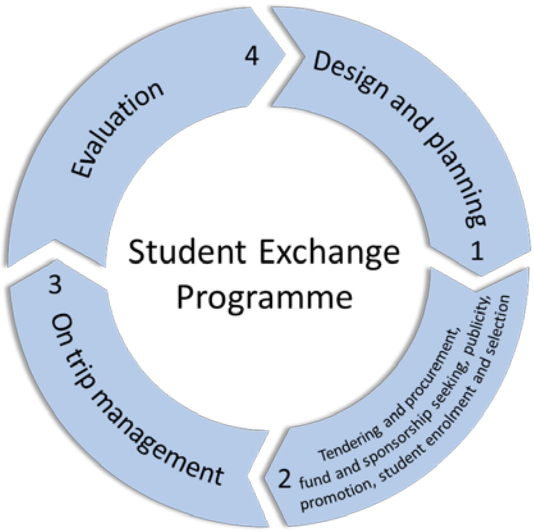

Figure 1: Cyclic process of an exchange programme

First of all, a working group with representatives from all of the organizing institutes should be established. Committee members of the group should cooperate closely in the design and planning of the exchange programme. They should attain a consensus on the dates of the exchange period. For the design of the programme itinerary, a good balance of the durations of academic activities and cultural exchange activities should be struck. This is to ensure both of the academic and culture exchange functions of the programme. The contents of activities should also be designed carefully as this may affect the attractiveness and effectiveness of the programme. To enhance the probability of success, it is necessary to design the programme with student perspective.

Once the framework of the programme is obtained, various pre-trip implementation works should be preceded, for examples, tendering and procurement of flight tickets, accommodation and tour packages, fund and sponsorship seeking, publicity, promotion and student enrolment and selection. Committee members of the working group should provide and update necessary information with each other in order to ensure the work progress and accuracy of decisions, such as correct quantity in procurement. Taking into account the affordability of students, the cost of the exchange programme should be reasonable. Fund and sponsorship should be sourced to support the students by minimizing the cost contribution by the students. Regarding to the publicity, promotion and student enrolment, it would be a good practices to make good use of e-resources, for example, Intranet, Internet, e-mail, online application system and etc. For the selection of students, selection criteria should be clearly specified at the beginning. Student selection should be done based on fair opportunity principle.

Before the departure of the trip, briefing to students should be conducted to update the students with the latest information about the destination, for example the weather conditions; to advise on travel requirements, for example the limitations on luggage; to advise on health and safety, for example food safety and hygiene; and to collect students' miscellaneous information, such as emergency contacts, health declaration and etc. During the trip, accompanying teaching staff plays an important roles in guiding the students, managing and solving any problems encountered. While students should be encouraged to use their free time to delve deeper into the culture of the country they visit.

At the final stage of the exchange programme, solicitation of students' feedbacks and evaluations regarding all aspects of the programme is an important post-tour activity to wrap up the programme. Students' feedbacks and evaluations are useful information to validate the successfulness of the programme. Achievements and deficiencies can be identified for future programme development and improvement.

Conclusions

Student exchange programme can extend the classroom and provide an active learning experience for students. Appriopriate and meticulous designed, planned and implemented student exchange programme can be an enhancer of students' professional and personal development. In curriculum design, educators can further investigate how to intensify the integration of student exchange programme and curriculum.

Positive feedbacks from students participated a tri-city student exchange programme were illustrated in this paper. The results reflect the successfulness of the programme in achieveing the intended learning outcomes. Recommendations for organizing similar student exchange programmes are suggested. Further investigation can be conducted to investigate the influence of a student exchange programme to the academic performance of students by comparing the academic results of students before and after the trip.

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Gamification for Motivating Student Learning of Computer Programming: The RP Experience

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Abstract

Digital games have been very popular for the past ten years. Millions of people around the world spend countless hours and large amounts of money on it. The power in well-designed games can drive players to persist throughout the process in order to reach their final desired goal. Recently, the huge motivational power of digital games has led to its adoption in non-entertainment contexts as well. The new term is named gamification, which is to incorporate gaming elements into a non-gaming process. Gamification has been widely adopted in many domains, like training on how to perform a certain tasks, helping people to become healthier or become more productive. Gamification has also been adopted in an educational context to boost students' motivation towards certain courses. This paper describes a study we conducted at Republic Polytechnic (RP) to incorporate gamification in the learning of computer programming by making use of a Learning Management System (LMS) called Coursemology that incorporates gamification elements, including experience points (EXPs), levels and a leader board. All these elements serve as an extrinsic motivation to the students' learning. We describe the daily curriculum components we have in the module in the past, followed by the components we have managed to convert to online exercises on Coursemology and integrate them as part of in-class exercises and after-class exercises. To assess the result, we have collected system data from the use of the platform by the students as well as feedback from students. Results were quite encouraging as nearly half of the students attempted the optional exercises. Many of the students' feedback show that the gamification features motivated them to try out more exercises, while some show that they are not motivated by gamification or there is not enough motivation to make them do more exercises. We finalize by discussing the limitation of the platform and other possible better gamification platform we will explore in the future.

Keywords: *LMS, eLearning, Programming, Gamification, Motivation*

Introduction

The *School of Infocomm* (SOI) within *Republic Polytechnic* (RP) uses a *Problem-Based Learning (PBL)* approach (O'Grady & Alwis, 2002) which equips students with the necessary knowledge through daily problem solving. Currently, the students usually go through the following steps for their whole day of work:

1. Take a start-of-class quiz (to assess quality of prior learning and assigned pre-reading).
2. Posed with a problem statement
3. Start to work on a worksheet sheet or scaffold which is provided along with each problem to guide students in learning the necessary knowledge and skills before they proceed to tackle the problem of the day.
4. Start to work on the problem statement
5. Respond to the problem statement
6. Take the end-of-class quiz
7. After class, take an after-class quiz

Currently, students take five modules a week in year one and year two and for each day, their focus will be the lesson for one particular module. The start-of-class quiz and end-of-class quiz are all distributed to the students in paper format. After the specified time limit, the facilitator in class takes back all the papers for marking, and the students can only get back their marked quiz paper, with feedback, in the subsequent lesson, which is usually the following week. By then, many students do not have a clear re-collection of the questions and their answers. They have to take time to recall why they answered in such a manner. In addition, for worksheets or scaffolds in which they are required to respond to certain questions, they may not know whether they have answered the questions correctly unless they asked the facilitator in class or the facilitator goes through the answers in class.

The background of the students is another challenge. A fair number of students have poor O level results and as a result, they may not be in their preferred school and course. The School of Infocomm could be their last few choices or not even in their choice. Therefore they feel like they have being thrown into the course, so they have an inherent low motivation towards core IT modules, like programming. Furthermore, their analytical and logical thinking abilities are not as strong. Programming relies a lot on analytical and logical thinking, which therefore poses another challenge to them. In addition, since the course as a whole has quite a number of programming modules, if the students fails to do well for one programming module, they have the idea that they cannot do well for programming, so these ideas will make their learning of the next programming module even more challenging.

Literature Review

The term gamification means to incorporate game elements into a non-game process (Deterding, Dixon, Khaled, & Nacke, 2011). Gamification has been widely adopted in many areas, like training on how to perform a certain tasks, helping people to become healthier or become more productive (Sheth, Bell, & Kaiser, 2001). In the meantime, the use of information technology in traditional school education context is getting popular, with some being adopted in the flipped classroom (Thompson, 2011) whereby students can learn the lesson content online and engage in problem solving in class with the help of a facilitator.

A study on the application of gamification in the education context was conducted in which an MSc course, Multimedia Content Production was gamified (Barata, Gama, Jorge, & Goncalves, 2013). The feedback from the students shows that the course is more motivating than other non-gamified courses.

Proposed Solution

For programming modules, unlike the essay questions in soft-skill modules, the answers for most of the questions set for a quiz or an exam are more well defined, especially when the students are required to construct a computer program to achieve a specific result or to provide the expected result for a given computer program. That makes automation of the marking of the answers possible.

Furthermore, in order to incentivise students to answer the quiz and worksheet questions, we can award the students experience points and have a leaderboard to rank the students according to the point they have accumulated.

Coursemology is a gamified learning management platform which was developed in the National University of Singapore (NUS) and is currently in use at NUS and several local schools. There are two types of exercises on Coursemology, namely trainings and missions. Trainings are meant to be self-directed since it is auto-graded. It can support MCQ questions and Python coding questions. Missions on the other hand, are meant for assignments and higher order practices. The questions are usually open-ended and therefore manual grading is required.

The advantage of Coursemology is it's incorporation of gamification components in the exercise as follows:

- Experience Points (EXPs) are earned through attempting trainings and missions. One can define different levels of different points. When the students reach a certain EXP level, they get "levelled up".
- Badges can also be awarded for students for special achievements, like completing all exercises or completing certain training with more than 90% correctness.
- The platform also provides a leaderboard to show the students' ranking in term of level and EXP gained (see Figure 1).

Figure 1: Course Leaderboard

- For coding and MCQ questions, after students have keyed in the answers, they can check the correctness of questions instantly. They can also attempt a question as many times as they want until they get it right.

Method:

We adopted Coursemology in one of our programming modules – "Multimedia Programming" (MP). MP is the second programming module using the Python programming language, the first being "Introduction to Programming". The module cohort consists of 109 students from the Diploma in Interactive and Digital Media.

The duration of the module is from late-Oct 2015 to mid-Fed 2016. There are 13 learning weeks, with four weeks of term break and a mid-semester examination in between.

We have made use the Coursemology in the following ways:

- converted the start-of-class quizzes from paper form to (Coursemology) trainings
- converted part of the worksheet from paper form to trainings
- converted after-class quizzes to trainings
- provided some additional programming questions as trainings

Surveys on the student's experience of using Coursemology were administered using Google Form at the seventh week of the semester, just before the mid-semester examination.

Results and Discussion

After the Mid-Semester Assessment (MSA), we collected the result from the student's MSA result and compared with the achieved levels by the students on Coursemology. The full mark of the paper is 50 and the passing mark is 25. We are pleased to find out that students who had achieved level 12 and above passed MSA on average (see Figure 2). To be more specific, among the 72 students who achieved level 12 and above, 51 (71%) passed the MSA as compared to the 37 other students, only 11 (30%) passed the MSA. This result provided us the basis for motivating students to 'level-up'.

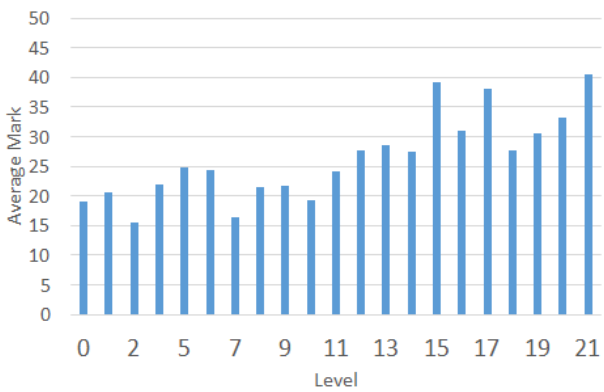

Figure 2: Average MSA mark vs. Achieved level

97 students (89% of the total cohort) completed the survey. Table 1 below shows the result on the question "Do you think the Coursemology platform is helpful to your learning?"

Table 1: Result on the helpfulness of Coursemology platform

Option	Percentage
Yes, it is very helpful	32%
Yes, it is a bit helpful	53.6%
No, it is not very helpful	10.3%
No, it is not helpful at all	4.1%

For features like instant checking and feedback, and multiple attempts, 72.2% of students find them useful.

Table 2 below shows the result on the question "Does the gamification features motivate you to try out more exercise?"

Table 2: Result on the motivation of gamification features

Option	Percentage
Yes, it certainly does	23.7%
Yes, but to a limited extent	41.2%
No, it does not really motivate me	16.5%
No, it does not motivate me at all	18.6%

The result suggested that 35.1% (16.5%+18.6%) of the students are neutral or not motivated by gamification. It is different from the earlier study (Barata, Gama, Jorge, & Goncalves, 2013) whereby the students considered that the gamification experiment applied to the course performed very well (4) [1 – terrible; 5 – excellent] using a five-point Likert scale. The reason is probably because we did not make use of the challenges and badges in our gamification elements and the platform does not support cooperation and sharing of opinions.

Delving further into the details of the student's feedback gathered, some typical comment from those who were motived by gamification include:

- "It will motivate me as I feel a sense of accomplishment when I level up."
- "By knowing the level of other students, one will have the urge to step up by getting an even higher level, which requires doing even more exercises. Hence, this motivates me to try out more exercise."
- "It motivates me to compete with my classmates"

Some typical comments from those who are not motivated by gamification are either they feel that the ranking does not matter to them, their main focus is just to complete the exercises or they feel that there is not enough motivation or rewards, therefore there is no incentive in levelling up.

Conclusions

From the system data and user feedback we have gathered and analysed, we conclude that

- A gamified LMS platform is generally effective in attracting students to do more exercises.
- Features like instant checking of answers and multiple attempts are helpful to students' learning and work better than traditional worksheets in the form of a Microsoft Word document.

Limitation of the Platform

Currently, the programming languages that the platform supports is limited to Python. There is no support of other popular programming languages, like C, C++ or Java. The support for different "types" of coding questions is also quite restricted. It can only test writing of a function. The correctness is verified by comparing the return value of calling the function of different arguments with expected return value. Therefore, it could not be used for questions that need to write code to display certain text in the console since there is no return value. In addition, there is no way to supply the test code with different input values when running the code.

Other limitations include there is also no support of a question bank, the grouping of students and the setting of different training opening time for different groups. There is also no support of online discussion among students which hinders collaborative learning among students.

The leaderboard only shows the ranking of students according to total EXP. There is no weekly or monthly ranking.

Future Work

There are many other LMS's which support certain kinds of gamification and auto-marking of MCQ and coding questions. For example, Moodle has a CodeRunner plugin for auto-marking of coding questions. It also has a ranking plug-in to add points to activities and show overall ranking, weekly ranking and monthly ranking. Moodle also supports a discussion forum which allows students to engage in collaborative learning. We will be exploring its features in future semesters.

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The Use of the Self-Study Materials Enhancing the Effect of the Ship Training

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Abstract

Our college training ship practice course for students of maritime technology department in NIT, Yuge college is a intensive training carried out within a limited time. Therefore, the preparation and the review of the ship training are essential in order to perform it effectively. In addition, it is also important to take advantage of the time, effort and cost efficiently. Empirically, to learn quickly the name and the arrangement of the ship's equipment, machines and devices has been said to be effective for the lower grades in the ship training. Therefore, during the ship training, students visit the job site in small groups, see and touch the real thing, and take a note of what they learned. In the past, the preparation and the review of the ship training has been performed with the paper-based materials. However, there are many technical terms and unique abbreviations to be used in the maritime field, so it takes a lot of time for students to understand.

Therefore, the authors developed the walk-through simulator systems (The navigation bridge system and the engine room system) of our college training ship "Yuge-maru" using the technique of the virtual reality as the self-study materials experimentally, and we have been utilized it for the preparation and the review of the ship training for the lower grades. This materials are freely available on the Internet, at any time. The advantage of using this materials is that the students can learn the names and arrangement of onboard equipment at anytime, as if it were a game. In addition, this materials have many times the amount of information compared with the paper-based material. These systems are similar to the Google view, so if there are accumulation of basic photographic image data, it is possible to create even with some free software. Furthermore, it is possible to recommend it to other colleges as a good teaching materials with excellent convenience and high cost performance.

Keywords: *Ship training, Teaching materials, Preparations and review, Self-study*

Introduction

There are 51 national colleges of technology in Japan and each education system are the same, and are for junior high school graduates. In national colleges of technology, only 5 national colleges including Yuge college have the department of maritime technology.

In the maritime technology department, the lecture period is 4.5 years, and the navigational training period with a large size (over 1000 gross tonnage) training ship is 1 year in total for the embarkation history. The navigational training has been carried out in the split training period, one month in the second grade, 5 months in the fourth grade, and 6 months in the sixth grade since 2013 after the transition period. The privilege of the maritime technology department is that the written examination of the third grade maritime officer (Navigation or Marine engine) is exempted depending on a specialty. After graduation, the students take a physical examination and an oral examination, and then, they can get the licence of the third grade maritime officer. The capacity of the class in each college is 40 persons, and total 200 persons in five colleges of maritime technology. The maritime technology department of each college has the college training ship (size is about 200 tons) for basic training as the college training ship practices, though the training period is not allowed to write in embarkation history because of the size of the ship.

The National Institute of Technology, Yuge college is in a remote island called Yuge island (Kamijima-cho), which is in the center of the Seto Inland Sea. Yuge island is in the Seto Inland Sea National Park, and it is endowed with natural environments. The Yuge college has 3 departments, the first is the maritime technology, the second is the electronic mechanical engineering, and the third is the information science and technology. Education and study system are supported by more than 50 teachers and 15 technical officers.

Yuge college has a college training ship named “Yuge-maru”(240tons). This ship is active in a variety of college events as the face of the college, and it is used not only for the basic trainings but also as study materials.


Figure 1 Campus area of Yuge college

Figure 2 Location of Yuge college


Figure 3 Training ship "Yuge-maru" of Yuge college

Table 1 Main item of the training ship "Yuge maru"

Licensed	coastal waters – No. 4 level vessel
Main dimensions	length 40.0m, width 8.0m, 3.3m in depth
Gross tonnage	240 tons
Range	about 2,300 nautical miles
Max speed	about 13.75 knots
Main engine	Daihatsu 6D, M-24 SL diesel engine
Main generator	2 units (187.5 KVA)
Shaft generator	(150 KVA)
Capacity	9 crew, 44 students 3 others, total 56

Figure 1 shows the campus area of Yuge college.
Figure 2 shows the location of Yuge college.
Figure 3 shows the training ship "Yuge-maru" of Yuge college.
Table 1 shows main item of the training ship "Yuge maru"

One of the characteristic subjects of the maritime technology department is the college training ship practice. This is an intensive training carried out within a limited time. Therefore, the preparation and the review of the ship training are essential in order to perform it effectively. In addition, it is also important to take advantage of the time, effort and cost efficiently.

The authors developed the self-study teaching materials that could be used for the preparation and the review, and tried to evaluate its effect. In this paper, the authors will report the summary and results.

Development of the self-study teaching materials

The college training ship practice is 1 credit intensive course of four days, which is carried out in each grade for 5 years.

Empirically, it is said to be effective for students to learn quickly the name and the arrangement of the ship's equipment, machines and devices in the lower grades in the ship practice. Therefore, during the ship practice, students visit the job site in small groups, see and touch the real thing, and take a note of what they learned.

In the past, the preparation and the review of the ship training were performed with the paper-based materials. However, there are many technical terms and unique abbreviations to be used in the maritime field, so it takes a lot of time for students to understand them. Therefore, the authors experimentally developed the walk-through simulator systems (the navigation bridge system and the engine room system) of our college training ship "Yuge maru", using the technique of the virtual reality as the self-study materials. We have been utilized it for the preparation and the review of the ship training for the lower grades. This walk-through simulator system is similar to the Street View feature of Google Maps. This system has a lot of information and a sense of reality in comparison with the paper-based material.

Figure 4 shows sample image of the Google Maps Street View.

We will briefly describe the making process of this system below.

At first, we created a large number of the composite image with pictures which were taken from fixed height 140cm (height of a person's point of view), at the same interval (60cm spacing) on the passage and at regular angles.

To create a composite image, the stitching software "Hugin" was used. This software has a function of outputting a single panoramic image, when inputting a series of overlapping images taken from the same position.

Figure 4 Sample image of near the training ship mooring area of Yuge college (from Google Maps Street View)

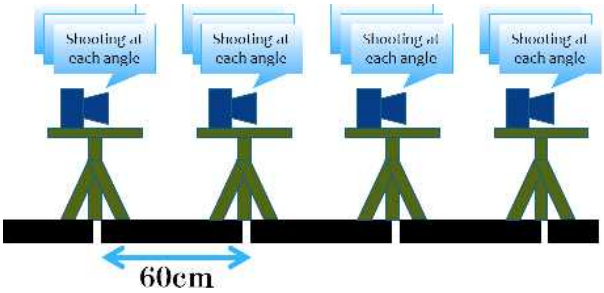

Figure 5 Method of shooting in the camera

Figure 6 Camera and gimbal device used for shooting

Table 2 Direction of shooting photos (per viewpoint)

Elevation angle (degrees)	Azimuth angle (degrees)
90	0
60	0, 90, 180, 270
30	0, 60, 120, 180, 240, 300
0	0, 45, 90, 135, 180, 225, 270, 315
-30	0, 60, 120, 180, 240, 300
-60	0, 90, 180, 270
-90	0

Figure 7 Sample of a panoramic image (In the Navigation bridge)

Figure 8 Sample of a panoramic image (In the Engine room)

Figure 5 shows the method of shooting in the camera.

Figure 6 shows the camera and the gimbal device used for shooting.

Table 2 shows direction of shooting photos (per viewpoint).

Figure 7 shows the sample of a panoramic image (in the navigation bridge).

Figure 8 shows the sample of a panoramic image (in the Engine room).

Secondary, the composite image was incorporated in the display program each of the panoramic image that was created at each point. Finally, it was completed by writing descriptive matter and displaying necessary items on the screen.

By presenting finished self-study teaching material (the engine room walk-through simulator system) as examples, the function will be explained easily below.

Figure 9 shows the white squares displayed on the floor that indicate the direction in which the screen image can be moved.

Figure 10 shows the main engine and the displayed name（characters of yellow）

Figure 9 White square displayed on the floor that indicates the direction in which movable

Figure 10 The main engine and the displayed name (characters of yellow)

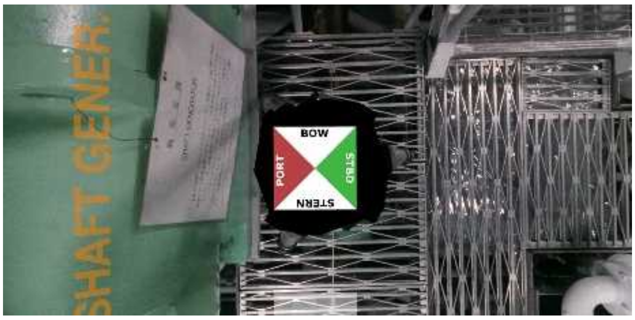

Figure 11 Symbol indicating the current position and direction (enter of the screen)

Figure 11 shows the symbol indicating the current position and direction (center of the screen).

Pressing the arrow keys on the keyboard, or clicking the white square on the floor (as was shown in Figure 9) by using the mouse, it is possible to move the location on the screen. By dragging the screen using the mouse, all of the direction of the engine room can be seen. By turning the mouse wheel, it is possible to scale the screen. By clicking on the name (yellow characters) displayed on the screen, it is possible to read the detailed description.

These self-study teaching materials (the navigation bridge system and the engine room system) are freely available on the Internet, at anytime. The advantage of using these materials is that the students can learn the names and arrangement of on board equipment at anytime, as if it were a game. In addition, these materials have many times the amount of information compared with the paper-based material.

Evaluation of these materials

For the evaluation of these materials, a questionnaire survey was conducted for the students who had used them. The method of the survey will be explained below. The survey was carried out for the students of the maritime technology department in Yuge college, and the target students were 153 students from the first grade to the fourth grade. In each class, after carrying out the demonstration for about 10 minutes, we asked the students to use freely these materials for about 30 minutes. Then, we conducted the anonymous questionnaire survey.

The questions were as follows:

1) Do you want to use the material in the classroom?
2) Do you want to use the material in the preparation of college training ship practice?
3) Do you want to use the material to review the college training ship practice?
4) Do you think that the operation of the screen is easy?
5) Do you think that the display of the screen is easy to understand?
6) Do you think that these materials are useful in preparation and review of the college training ship practice?
7) Do you think that the detailed descriptions of the equipment and devices are easy to understand?

The evaluation was performed in the 1-5 stage, 1: Definitely No, 2: Probably No, 3: Undecided, 4: Probably Yes, 5: Definitely Yes.

Results of the survey, for any of the items, included many positive responses.

Figure 12 shows sample of the survey result (the average of all students).

The result of the survey indicated that most of the students gave positive answers, especially to Question 2, Question 4, and Question 6. On the other hand, looking at question 1 in Figure 12, it can be found that the positive answer is not so many, compared with other questions. From Question 5 and Question 7, it can be said that the level of satisfaction with this system is not enough.

According to the survey results, the necessity of these materials are not very high for the lesson in the classroom compared with the need for the preparation and the review. This system is a prototype, not a finished product. In reference to these results, we will improve the contents of the display method and the description of the screen in order to increase the user's satisfaction.

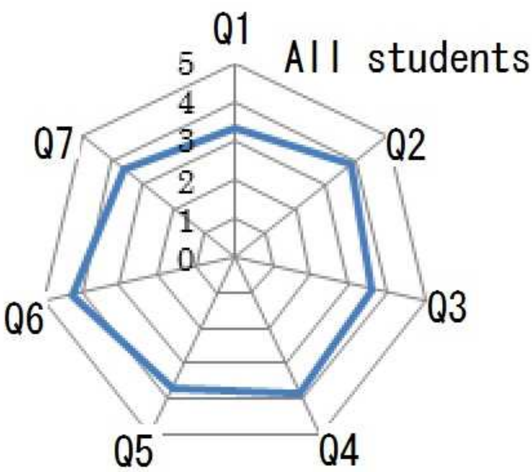

Figure 12 Sample of the survey result
(the average of all students).

Conclusion

The authors developed the self-study teaching materials called for the walk-through simulator systems. These systems are similar to the Street View feature of Google Maps, so if there are accumulation of basic photographic image data, it is possible to create materials even with some free software. Furthermore, it is possible to recommend them to other colleges as a good teaching materials with excellent convenience and high cost performance.

The results of the questionnaire survey for students of the maritime technology department showed that these self-study materials were found to be effective in the preparation and in the review than the use in lecture in the classroom.

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A COLLABORATION OF SCIENCE AND LITERATURE TO FOSTER THE LOGICAL THINKING ABILITY OF STUDENTS TO LEARN ENGINEERING

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Abstract

The lack of communication skills has been a problem, when students exercise presentations in native language class. There is, however, another problem which is more serious than that. That is students haven't been given enough preparation and practice needed for presentation. They unanimously say, "what do I tell?", "how do I tell?" and so on. They believe the failure in presentation is due to their lack of communication skills.

Why did they fail? The authors consider it's because they are short of training for improving their logical thinking. They need more chances in class to exercise and demonstrate their logical thinking on their own initiative. Through this training, they must be able to learn how to clarify the points to be presented and how to present them. Teachers should also fully realize this and provide students with appropriate training.

For this reason, the authors propose an active learning that is founded on the collaboration of science and literature. A physics teacher gives students the problems that lead them to understand physics fundamentally. They try hard proactively to find scientific laws necessary for solving the problems. For this, they search for a scientific basis and set up a scientific presumption. After this a literature teacher lectures them on the techniques of presentation.

The aim of the above training is a proactive learning of students. This training method gives them self-confidence and challenging spirit.

Keywords: *logical thinking, scientific law, Interdisciplinary cooperation, active learning, presentation*

Introduction

It is very important to use the native language properly, but unfortunately, Japanese students consider the subject of mother tongue language is not so important. This trend is particularly noticeable to students of science and engineering.

One of the reasons can be the curriculum of native language subject in Japan. The contents of the curriculum includes a very wide range of study. For example, novels, essays, criticism, poetry, modern grammar, modern communication skills, presentation techniques, Japanese classic novels, Japanese classic essays, Chinese classic novels, Chinese classic essays, etc. We, even teachers, are also surprised with this variety.

Some students ask, "What is the core point of national language class?" The author's answer to this question is, "The core point of Japanese language class is the training of logical thinking."

Then how do we train the logical thinking of the students? Only one Japanese language teacher can do nothing. In other words, it is difficult to achieve the goal of "the development of logical thinking ability" only with the traditional Japanese language curriculum. Japanese Language teachers must have the courage to cooperate with physics teachers and establish the new contents of education.

Information about the subject students of the research

The subjects of this research were 160 second graders of National Institute of Technology, Tsuruoka College, in the current school year. They took the native language class of Kada (abbreviated as K hereafter), one of the authors, last year. Even while teaching them novels and critics, K continued to emphasize the importance of logical thinking ability in class. The main teaching methods practiced by K in class are as below.

1. instructed to make good use of their scientific ways of thinking and knowledge such as mathematical formulas in order to foster the logical thinking ability
2. instructed to strictly eliminate the ambiguity of the wording in order to clarify the matters to be conveyed
3. emphasized the importance of "writing", by thoroughly making them write down the knowledge

obtained orally on their notebooks. K preached that memory is enhanced and fixed by "writing".
4. pointed out the points which are possible to be improved in each presentation individually when they announced the results of their group discussion. In addition, K had the whole class share his feedback immediately.
5. taught the same instruction contents repeatedly in order to fix new knowledge into the students. Unfortunately students forget newly obtained knowledge. The expression "forget" may not be correct. In fact, they often do not memorize it in the first place.

Last year the first graders investigated on things of their interest and produced posters using the Power Point in class. In order to introduce the subject of their interest to others in the form of posters, only the knowledge how to use the software is not enough.

They themselves are required to well-organize and understand precisely the appeals of the subject. When they reviewed the others' posters mutually, many students noticed that they hadn't understood their own subjects precisely and that it was due to their lack of "logical thinking ability" necessary for organizing their thoughts

The students have begun to check up the ambiguity of their expressions. In their poster production, they gave a thought to what kind of layout was the most effective.

Then they remembered K's instruction. It was the one that K had always carried out for "upbringing of the logical thinking" They came up with the idea to apply it to the training.

The followings are some of the remarks that K had the whole class take notice of after picking up their voices.

1. to take advantage of scientific way of thinking in order to communicate accurately with the other party
2. to try to facilitate understanding of the other party by showing a specific examples
3. At that time, to exhibit effective charts.
4. to keep always in mind the importance of the entire layout of a poster
5. to eliminate the ambiguity in word meanings as much as possible and to express clearly in order to get an accurate understanding of the other party
6. to make effective use of the comments on the poster given in the group discussions, and the like

As described above, the subject students have fostered the thought to put great importance on "logical thinking ability". The authors carried out the new instruction method with them for the purpose of "upbringing of the logical thinking ability" developed by the collaboration of physicists and literary educators.

The background of the research

Last year, Niwa (abbreviated as N hereafter), one of the authors, was in charge of the physical class for the first grade of National Institute of Technology, Hachinohe College. N devised and practiced "an instruction method in which the students can acquire the attitude of considering things actively".

N's aim in the method was that the students make use of scientific ideas in engineering study based on the understanding of the difference between science and engineering.

The target of science would be "to study the nature to the limits and to awake unexploited universal laws in there". On the other hand, the target of engineering would be "to contribute to human beings' happy and wealthy lives". Science does not contribute directly to human's happiness. However, it does not mean that science is inferior to engineering, because science teaches scientific process when judging things.

When students must solve a problem, they must observe the problem. Based on the observation, they assume a procedure for solution and predict an answer in accordance with the procedure. It is a too simple process. However, they feel it's fresh.

For example, they are supposed to have made full use of the power of logical thinking" for the examinations of "physics" and "mathematics, but many of them prepare by just memorizing the whole model answers taught in class. Students are bound too tight by utilitarian view. They strongly tend to pursue the things that they feel useful for the moment, such as memorization for high scores in exams. If the students of science and engineering are left in the intellectual negligence, their future as engineers would be hopeless.

N had a strong sense of crisis about the future of the students who show a learning attitude like the above. N wished strongly "the students take advantage of the scientific idea for the study of engineering based on the understanding of the difference between the science and engineering" To execute this teaching philosophy N has developed a new teaching methods of "physics" stated below.

1. To give "questions" arousing the students' intellectual curiosity
2. "Questions" must be solved by the students' active learning.
3. Therefore to require the students to do a group work
4. Students must devise the ways to solve the questions for themselves and at this stage teachers do not intervene as much as possible.
5. When students devise a solution, they must incorporate scientific ideas.
6. The students must perform a group work in the following order. Observation, assumptions according to it, the design of solutions, the submission of the conclusion with the reasoning.
7. Each student writes down the conclusion on the "learning sheet" and submit it to their teacher.

The instruction of N is committed with his policy: "not to intervene in the students as much as possible". Teachers are required the patience strong enough to wait for the students' initiative actions. If the teachers lose their patience, the students cannot shake off their utilitarian ideas, and may lose opportunities to mature into creative human beings. This is the challenging step for teachers, against the temptations like "I want to give them more instructions. I want them to grow quickly".

As a result, the students responded to N's practices positively. They said unanimously, "I got to like the physics." Many students in senior grades, who could not take N's class also said, "I heard about the content of this year's physics class from the first graders. I wanted to take the class like that when I was in the first grade." The students are aroused their intellectual curiosity, and discovered the joy of learning physics voluntarily. It can be said that "the students have taken the first step to the creative engineers". The above is the background of the authors' motivation for this research.

Let us put an additional remark here. We have to introduce Dr. Michiyoshi Nakamura. He approves of N's instruction method and adopts it in his own class. Thanks to Dr. Nakamura's understanding and help N was able to put his new instruction method into practice. An understanding person like Dr. Nakamura is absolutely necessary to carry out a new trial like this one.

The research methods by the authors

The teaching method conducted in N's "physics" class could be applied to the class of "national language" by K.

The authors examined fusing the teaching method of "physics" into the one of "national language".

It is expected that the educational cooperation by physicists and literary persons should become important in the schools for science and technology in future. Therefore, one method was conceived. It is giving the letter of "question" from N to the students of K's school. The details of the teaching method is described below.

1. The letter with a "question" from N was distributed to the students. This letter was introduced as "a letter from the physicist X". This experiment is planned to be conducted two to three times a year. This year it was carried out once in mid-July. Since this is the first year, we are working on it carefully, and one more is scheduled this year.
2. The content of the "question" is related with the daily life of the students, so as to draw their interests. The "question" carried out in May this year is "How many people are snoozing in your school at this moment?" The "question" was created by N with a lot of ingenuity so as to draw a strong interest of the students. The following is the two example "questions" by N.

①"Please measure the gravitational acceleration of the earth."
②"Please measure the size of the Tokyo Dome by using only your body."

These "questions" may seem strange at first glance, but on second thought, you would notice that the gimmick to awaken the scientific idea is applied. To make such a gimmick is difficult to outsider. K has suffered very much from creating good "questions" in order to foster the logical thinking ability in the national language class. It is sure that the collaboration with physicists who can make appropriate "questions" will enrich the literature education for science and engineering students.

3. A "question" is solved by students' active learning.
4. For this reason, students are required to work in group. The number of group members is decided 4. When they announce the result of their group discussion, K indicated points to be improved in line with the each presentation content. This instruction method is familiar for them. The instruction method with this collaboration would be more effective if students have the experiences such as group discussions.
5. It is important that the resolution of a "question" must be devised by students. At this stage, teachers are supposed not to intervene as much as possible
6. When students devise a solution, they must incorporate scientific ideas.
7. Students must perform a group work in the following order. Observation, assumptions depending on it, the design of a solution, the submission of a conclusion with the reasoning for that.
8. Students write down the conclusion in a "learning sheet". Then K sends them to N. The questions written in "learning sheet" is as follows.

1) "What would the work by the engineer who hasn't learned science be like?"
2) "What kind of ideas do you need in order to answer the questions by the physicist X?"
3) "Do the ideas that you described in the previous question have any scientific ingenuity? Please explain".
4) "Please answer the question by the physicist X properly."
5) "What have you learned from this question? Please explain"

Evaluation method for this assignment are as follows.

A: It meets the conditions of B, and also has the originality.
B: It meets the conditions of C, and the answers for question 4 and Question 5 are described in detail without any excess and deficiency.
C: The answers obtained in the group discussion are properly described.
D: resubmit

9. Near the end of the school year, a special lecture to the students by the physicist X is scheduled.

The above are the research methods by the authors.

The practice results and discussion of the authors

This educational practice was carried out by K with 160 students who were in second grade at National Institute of Technology, Tsuruoka College last May. The "learning sheets" were submitted by all the students. Evaluation results of the "learning sheets" is as follows. The 160 students are divided into the four classes: Department of Mechanical Engineering, Department of Electrical and Electronic Engineering, Department of Control and Information Systems Engineering, Department of Chemical and Biological Engineering.

Table I Evaluation results of 2nd year students.

	A	B	C	D
Mechanical	34	5	1	0
Electrical	31	4	5	0
Information	27	9	4	0
Chemical	28	11	1	0
All classes	120	29	11	0

Unit: number of people

This result was much better than the assumption of the authors. It was unexpected that 120 students, two thirds of the whole, got grade A. Or this evaluation might be too generous to students. But considering that the students are boys and girls from 16 to 17 years old, it cannot be too optimistic. Japanese boys and girls nowadays have had a hectic school life and they are not in the environment that they can focus only on the issue of one subject. Extra-curricular activities, a wide range of learning, socializing on the Internet.

During this decade, the learning environment surrounding them have changed dramatically. In the environment that looks harsh for such young people, the students made the maximum effort to work on the "letter from the physicist X". They have realized that "science" gives the ways of thinking necessary for the "engineering". Here are some of their quotes.

≪Scientific thinking. I learned this. Relying on intuition, or answering by fortune-telling, I don't think I should be in such a manner.

①What kind of thinking procedure should I follow in order to solve a problem? (Logical?)

②Is my procedure incoherent or not? (Systematic?)

③Is my answer based on the fact or not? (Empirical?) After having considered these, I want to set up an equation. I was able to learn this kind of scientific thinking by this assignment. ≫

≪By learning the scientific way of thinking, I realized the importance of setting up a hypothesis while thinking. Also I found the way to think about things by substituting X and Y. Variations of my thinking has spread. These are the things I learned from this assignment.≫

≪If you do not learn science, you will not be able to understand the operation principle of what was made with the technology so far. You would not be able to understand the advantages and disadvantages of inventions. While trying to improve things, deteriorating may be caused instead. Therefore, if people do not learn science, technology will be lost and both technology and society will slide into decline.≫

≪Just how important things I've overlooked so far, and why didn't I try to reconsider such a way of life, It was an eye-opener to make me realize how stupid I had been.≫

≪In trying to answer the question this time, at first, I had easily thought that just thinking scientifically is enough and easy. However, it has been difficult for me to put "the estimates" and "the reasoning of the estimates" into words. In order to learn engineering, it is important to have a lot of knowledge and experiences, such as science and wording. I learned this by this exercise.≫

≪Expecting that the answer would be such and such and explaining about its possibility are just not enough. We must verify the possibility carefully. We must analyze in detail. We learned that this way of thinking leads to a clear result.≫

The quotes would be sufficient. The comments by the other students were almost the same as the above. This fact backs up that "the educational practice to develop logical thinking ability of students" have almost succeeded.

The conclusions and recommendations

As mentioned above, the authors began the collaboration between different fields in engineering education. As the comments by the students listed in the previous section, "in order to learn the engineering, it is important to have a lot of knowledge and experiences, such as science and language."

Therefore teachers should try actively the fusion of teaching methods of the two. In order to build students' bright future, active learning must be carried out for themselves in a variety of subjects and in various occasions, The active learning practice by the authors can be a dynamic training across the various fields in the future.

The collaboration of the "Health and Physical Education" and the "mother tongue". Collaboration of the "mathematics" and "mother tongue". Collaboration of the "foreign language" and "mother tongue". There are a number of collaboration styles that the authors came up with immediately. More knowledge and wide-ranging experiences will arouse students' motivation and intellectual curiosity.

The students who could have the intellectual curiosity look at the world around them. In the world opened in front of their eyes, their future exists. In such world, the students must be required to observe things in order to better communicate with others and to have logical thinking ability for mutual understanding on their jobs.

And in order to foster their logical thinking ability, it is essential to improve the content of national language class. If language teachers and physical faculty collaborate, great effect can be expected in the development of logical thinking ability of students. Therefore the authors suggest the following proposal. "Let's start the educational collaboration of different fields with us!"

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FLIPPED CLASSROOM APPROACH FOR A PROGRAMMING MODULE

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Abstract

There is increasing research that the Flipped Classroom approach can create effective and engaging learning experiences in introductory level technological skills classrooms (Davies et. al, 2013), and in the same post-secondary institution (Teoh & Wan, 2014; Chong et. al, 2015). Motivated by these positive outcomes, a study was conducted to determine the effectiveness of the Flipped Classroom approach piloted for two classes in a programming module for Engineering Diplomas. This paper summarizes the instructional design approach, which determined the choice of methods and technology tools used, and examining its effectiveness during pre-class and in-class activities. A particular focus was on enhancing student motivation, which required the adoption of selected theories of human motivation as basis for developing instructional strategies (e.g., methods, activities, resources) This involved the chunking of lesson segments to help students manage cognitive load of programming concepts, ongoing formative assessment through quizzes, integrated at critical points to check students' understanding of key concepts and clarify misconceptions. Also of importance was the creation of a psychological climate in which students could feel confidence to ask questions and engage in critical thinking on the key areas of the subject content. A post-implementation survey was conducted to determine student satisfaction of the approach, and how the formative assessment methods have facilitated learning. The results of a summative assessment (lab test) conducted at the end of this approach, was also examined for students in these classes, as compared to students from other classes who were not exposed to this approach. Findings showed students being positively motivated towards this approach of learning and being more engaged in the learning activities. They spent more time learning prior to the face-to-face classes, as they could be better prepared for deeper learning in-class. The majority also found the different formative assessment methods to be an effective means for facilitating their learning. The median scores of the lab test for the two pilot classes were also higher than that of the cohort. The findings support the conclusion that the Flipped Classroom approach is able to effectively engage learners in this programming module that traditionally employed a traditional face-to-face approach.

Keywords: *flipped classroom, motivation, instructional design, formative assessment, engineering education, education technology*

Introduction

Educational Technology has always been an integral part of the first year Structured Programming module that is taught as a common core module to students of 5 diplomas in the School of Electrical and Electronics Engineering (EEE) at Singapore Polytechnic (SP). One of the learning outcomes for this module is to develop technology savviness in EEE students so that they would apply technological skills both towards their different disciplines (applying programming knowledge and skills) and for learning (engaging in and augmenting educational technologies to deepen their knowledge and skills).

Motivated by the findings from the meta analysis of online research by the U.S. Department of education, that reported that students in blended learning approaches performed the best when compared against fully online and face-to-face approaches (Means, Toyama, Murphy, Bakia, & Jones, 2010), I decided to extend the educational technologies for this module beyond the classroom using the Flipped Classroom approach – to activate pre-class learning, to deepen in-class learning, interactions and engagement, and to examine the student learning experiences and achievement in this pilot.

This Flipped Classroom pilot for Structured programming was initiated on the belief, purported by Dziuban, Hartman, & Moskal (2004) and Garrison & Vaughan (2008), that the blended learning environment, would offer 'the best of both worlds' – the accessibility and convenience of the online setting to develop knowledge and skills prior to face-to-face class, as well as, engaged learning and interactions with lecturer and peers in class.

Next, I launched an exploration of the Flipped Classroom approach used by educators of similar contexts, to examine the learning design and measures of effectiveness. Positive outcomes of the Flipped Classroom approach were recorded by Davies, Dean & Ball (2013), in their introductory level technological skills classrooms, and Teoh & Wan (2014), in the same polytechnic. I was encouraged by their findings that the Flipped Classroom approach generated positive learning experiences and enhanced student achievement in their modules.

In a call for research into the motivation and cognitive load experienced by students in the Flipped Classroom approach, Abeysekera & Dawson (2015) highlighted student motivation issues in flipped classroom approaches as troubling, and emphasised that "the success of in-class activities" anchored on "the likelihood of students completing their pre-class assigned work", and that motivation issues in the Flipped Classroom approach tended to be "perenial problems of student preparation".

The key research questions of this pilot are:

(1) What kind of instructional design would address student motivational issues, such as student preparation, in a Flipped Classroom approach? More specifically, could motivations frameworks such as the SP 4EC other established models help guide the instructional design to ensure effective and engaging learning?

(2) which educational technology tools and platforms could be applied to effectively engage learning and enhance achievement opportunities in the Flipped Classroom approach?

Bearing the caution of "perennial problems of student preparation" in mind and to address the motivational elements in my Structured Programme Flipped Learning pilot, especially to encourage students to prepare themselves better before class and be engaged in active learning in-class, I adopted the Singapore Polytechnic (SP) 4EC Framework for the Design of Learntech Experiences and integrated the Keller's ARCS motivational elements (Keller, 2010) to carefully design the learning pre-class and in-class so as to enhance success of my pilot. This paper describes the design considerations and rationale for the choice of different educational technology tools used in this pilot, in the hope of sharing my learning and reflections with others who are exploring similar design consideration, features or tools, so as to short-cut their exploration and experimentation process.

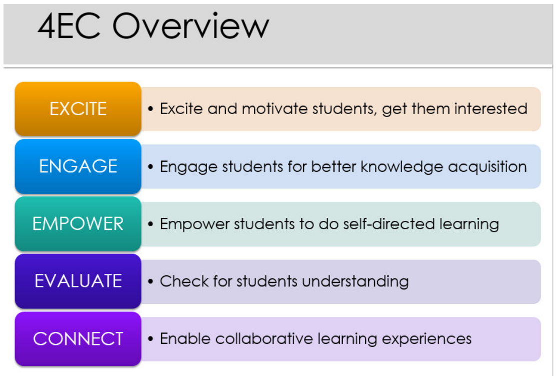
Methods & Pedagogy

SP 4EC Framework for the Design of Learntech Experiences to motivate learning

As a member of the team drafting a framework for the design of effective and engaging learning experiences using educational technology for the polytechnic in 2014, we had examined

- intrinsic and extrinsic barriers to the use of ICT for learning
- various motivational elements that would
    - develop the inspired learner who would take ownership of their learning with suitable use of ICT tools; and
    - harness the power of ICT to enhance student's learning experiences so that they learn better, perform better, and therefore can execute their tasks well.

Eventually, the SP 4EC Framework for the Design of Learntech Experiences evolved as follows:



In effect, the SP 4EC Framework is very much a model for motivating and engaging learners. This is aligned to the philosophy of the student-centred Flipped Classroom approach, and the framework could potentially address intrinsic and extrinsic student motivation issues in my pilot by

- ***exciting*** them in active learning and getting them interested to learn prior to class;
- ***engaging*** them in the pre-class content and in-class learning activities;
- ***empowering*** them to be independent and self-directed learners in being prepared for class and completing any pre-class assigned work;
- ***evaluating*** if the pre-class learning was effective, if students have learnt, and if the learning objectives were achieved;
- ***connecting*** with learners and engaging them in collaborative learning experiences.

Keller's ARCS motivational model

I also examined Keller's ARCS motivational model for effective learning and performance in my instructional design for this pilot. It was essential to

- gain my students' **attention** through arousing their curiosity in the topics and video content, and learning activities;
- help them establish the **relevance** of the programming topics by demonstrating the value of learning these topics and the contexts in which they could apply what they have learnt through pre-class online resources and in-class activities;
- help students gain **confidence** by designing and engaging them in learning resources and activities and guide them to evaluate for themselves the likelihood of their success, providing feedback and allowing them control over their learning and assessment;
- ensuring student **satisfaction** in learning the topics through achievements, rewards, and making them see the benefits of learning the topics.

With the 4EC framework and ARCS model as guides, the pre-class and in-class learning activities and resources were designed and educational technology and web platforms and tools were explored; and those selected (e.g. Edpuzzle, recorded video, quizzes on LMS Blackboard, Kahoot) were ones that were effective in augmenting the affordances of the educational technology tools to activate the motivational elements in the 4EC framework and ARCS, encourage students to be prepared before class, participate actively in class, and most importantly achieve the learning objectives for the topics in my pilot.

Implementation

The pilot was implemented in the first year Structured Programming module for two classes. The Flipped Classroom approach was applied to two large chapters in this module, covering a total of 5 weeks, and 7 sessions for each class. While the Flipped Classroom approach could be applied to topics of different nature, including fundamental and basic concepts where learning was straight forward and could be simply undertaken by students on their own, I chose two chapters, Chapter 6-Functions and Chapter 7-Arrays & Strings, that were a little more complex for these Year 1 students who could be new to the Programming language. This was because I believe the Flipped Classroom pilot, if well designed, could potentially scaffold students learning in more advanced concepts and create more opportunities for higher-level thinking, application and practice in class.

Prior to the trial, the pedagogical issues faced in this module included students' weak understanding of concepts, the lack of time in-class for application and practice, and students' poor motivation to apply and practice after class. These issues were no different from those in language classes since studying programming is like learning languages. Learners would need lots of practice and opportunities to apply the language in different contexts, as well as having others to practice with - preferably good language speakers to "converse" with, to guide and to refine. In my non-flipped-classroom, teaching and clarification of concepts would precede practice, and whilst I was around to facilitate, coach and guide, there was usually very little time for students to practice during class. As a result, more advanced and complex concepts were sometimes not discussed in class due to a lack of time or level of understanding on students' part. In the flipped classroom pilot, students learnt concepts on their own prior to class, and thus, there was more space for clarification of concepts, application and practice in class. There was even time to guide students in solving complex problems that were previously absent from my lesson delivery due to lack of time.

The instructional design considerations which guided the implementation methodology were as follows:

(1) *Pre-class learning and preparation*

Gaining and sustaining the interest and **attention** of students for the first two advanced chapters they encounter and have to learn independently prior to face-to-face class was a critical success factor of my pilot. Having led and taught this module for 8 years, I had an estimate of the first year students' attention span and the time they would need to grasp the concepts in these chapters. Each chapter was first chunked into key concepts and each concept further broken down to sub-concepts. This is to heighten the engagement of the students as they viewed these videos. A video was created for each sub-concept, and the length of video would correspond with the average attention span of my students, which was about 5min per video. A total of 49 self-recorded videos were made in the recording studio for the two chapters.

For each concept, the video series would precede with short segments to **excite** the students about the possibilities for the programming concepts they would be learning and the real-world applications for the concepts in Functions and Array & Strings. This would also help to pitch to students the relevance of learning these concepts.

Videos were uploaded to EdPuzzle, a platform with annotation features, and I would embed multiple-choice and reflection questions throughout the video to keep the students **engaged** with the content of the video, **evaluate** their learning and help build their **confidence** as they learn the concepts on their own, without the lecturer's direct instruction. Questions served as further chunking of learning of sub-concepts. The use of multiple-choice and reflective questions were used to check conceptual understanding and encourage thinking to provide prior practice before more the more complex applications carried out during class. The engagement and preliminary practices were aimed to **empower** the students (ability to apply in simple applications even without lecturer guidance) and create some level of satisfaction for the students with regards to learning on their own.

The EdPuzzle platform also allowed videos to be replayed anytime anywhere, and multiple attempts (thus practice) at the recall and simple application questions, and tracked the viewership, time spent at different portions of the videos and attempts on the questions. Thus, I was able to use the data and analytics for more effective delivery and engagement during the face-to-face class.

The distribution of the videos on EdPuzzle was organized as follows:

(Chapter 6-Functions; Chapter 7-Array & Strings)
Session 1 in Week 1 – 13 video clips from Chap 6
Session 2 in Week 1 – 9 videos clips from Chap 6
Session 3 in Week 2 – 6 video clips from Chap 6
Session 4 in Week 3 – 7 video clips from Chap 7
Session 5 in Week 4 – 5 video clips from Chap 7
Session 6 of Week 4 – 3 video clips from Chap 7
Session 7 of Week 5 – 6 video clips from Chap 7

(2) *In-class active learning, application and practice*

Prior to each face-to-face class, I would access the data and analytics in EdPuzzle to determine the viewership and achievement of my students in the multiple-choice and reflection questions. The items I focused on include:

- the average number of wrong answers for each video, and questions where students consistently pick wrong distractors (which indicates possible misconceptions or simple poor question design),
- segments of videos where students viewed more than once, and
- most importantly, videos that have not been viewed by students at all.

With this background, I was able to shortlist sub-concepts that required recap. At the start of each lesson, a Kahoot quiz would be run. Kahoot offered gamification of learning which would excite and gain the attention of my students. There is music, timer for each question and a leaderboard in Kahoot which would provide a list of top achievers at each lesson. The top 3 achievers would be given a small prize. The winners on the leaderboard would be tracked over the 7 sessions and there was a prize for overall best performance at the final class.

This Kahoot activity at the start of each lesson served many purposes: mainly to validate the observations I collected from the EdPuzzle analytics on areas of misconceptions and those needing recap or deepening, as well as to engage students in active participation, and to create another level of opportunities for students to evaluate their learning and receive feedback, and to activate learning for those who could learn through the quiz questions (Assessment as Learning). This would build the confidence of students who were prepared and those who were not, prior to the recap, application and practice, and ensure the satisfaction of students through intrinsic reinforcement and extrinsic rewards. The Kahoot quiz created a lot of excitement and interest amongst the students from the first lesson, and in subsequent lessons there were different students who ascended the leaderboard. The unique feature of the Kahoot leaderboard was that there could be different leaders with every question creating opportunities for students to do catch up on subsequent concepts, or even subsequent lessons since I was giving away prizes for overall top 3 performers. For one of the two classes, there was no repeat winners, for another class, only two students were winners in two out of the six sessions. This showed that students who were weaker in concepts learned in previous classes were motivated enough to learn, prepare and catch up in subsequent lessons.

Following the quiz, the "teaching" would start with recap of areas where (1) students had watched video segments more than once and (2) there were still misconceptions and questions that showed in the video questions. This would be succeeded by a teaching segment of the same concepts at a deeper and application level, and time for practice as a big group before individual practice, with lecturer's guidance and coaching. Compared to previous semesters where I had not "flipped" the learning, I found that students used less time to carry out the individual application and practices. There was also less instances of individualized coaching, signaling that students felt empowered to attempt the practices on their own. The independent learning mindset that was inculcated pre-class was carried into the classroom as well. I had also designed a few scenarios that were more complex for each concept. Generally there was time in these lessons to go through the scenarios, compared to previous semesters where we worked on the standard tutorial worksheets. While guidance was needed for these complex scenarios and some of the problem-solving was conducted as a class, students generally were engaged and felt challenged to solve the problems together. This was a pleasant observation, as in previous semesters, once lessons touched on more advanced topics like Functions and Strings & Arrays, there would be a small proportion of students, about 10-15%, who would not be to follow and would be distracted, even during guided practice and application.

(3) *Learning Support, Guidance and Feedback*

A very critical part of the 4EC framework is **Connect**. In a Flipped Classroom approach towards learning, the creation of learning support opportunities between lecturer-students, and amongst peers is instrumental to the success of such self-directed learning approaches. I had surmised that the "problems of student preparation" highlighted by Abeysekera & Dawson (2015) could pertain to, in my pilot, lack of motivation on my students' part to start preparation on seemingly advanced topics, inability to comprehend concepts on their own, and a need for the assurance of support and guidance. So for this pilot, I set up a discussion forum on Blackboard, our Learning Management System, and a What's App group chat, to facilitate the dissemination of information, to activate students when videos have been uploaded for viewing for the different weeks, to have students chat about what they need to prepare, to evaluate their learning progress vis-a-vis their peers, as well as to empower them to post queries and answer each other's queries as far as they could, prior to the intervention of the lecturer on these platforms. It was in the hope of engaging students in peer learning and collaborative learning, and empowering them to learn in a community, that these platforms were set up. At the same time, one of the meetings was conducted on Microsoft Lync, a synchronous online chat session. This served to familiarize students to the possibility of real-time synchronous online collaborative learning, and to give and receive real-time feedback. This was a good supplement to the discussion forum and mobile chat group where questions posed earlier could be missed and not responded to by peers or lecturers.

(4) *Post-class evaluation*

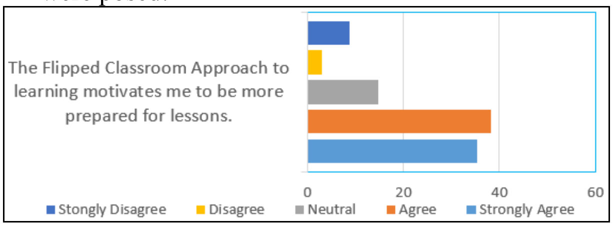
At the end of each chapter, students took a practice quiz, with multiple attempts allowed, on Blackboard that was meant to consolidate their learning for each chapter, and also as an opportunity to help them **evaluate** their learning prior to a practical test. This quiz included questions that were concept-based, as well as application-based.

Results and Discussion

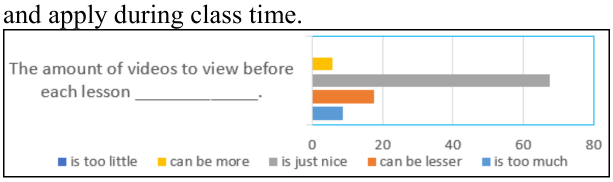
Student Feedback

A survey was conducted for each class at the end of Flipped Classroom Pilot. 39 students from both classes were surveyed (Class A 17 students and Class B 22 students). A total of 34 participated in the survey. The response rate was 88.2% and 86.4% for Classes A and B respectively. The overall response rate was 87.2%. Students responded to a 15-item survey, of which 10 were opinion items on a 5-point Likert Scale (Strongly Agree to Strongly Disagree), four items set out to determine efforts spent on learning and preferences, and the last was a free response item that collected comments and feedback on the Flipped Classroom approach. The findings are discussed as follows:

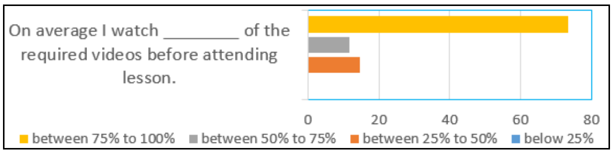
To explore if student preparation was a major issue in my Flipped Classroom pilot, these survey items were posed:



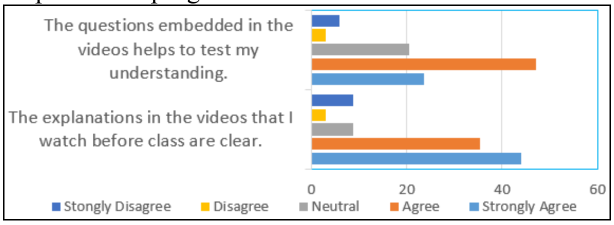
73% of students felt that they were motivated to be more prepared for lessons (Strongly Agree & Agree). This is a very encouraging percentage, as based on literature the issue of "student preparation" was called a "perennial problem". 12% of students disagreed that they were motivated to be more prepared for lessons. This percentage is not unexpected as these two chapters were more advanced topics and in previous semesters, there would be about 10-15% of students who would struggle with the concepts in Functions and Strings & Array. These students would benefit from being more prepared so that they had more time to clarify, practice and apply during class time.



68% of students felt that the amount of videos to help with their preparation was just right, with about 6% commenting that it was too few and hoped that there would be more.



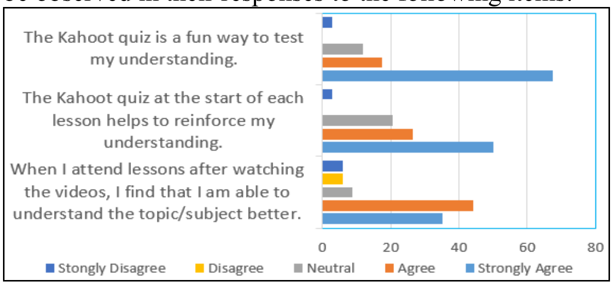
It was a pleasant surprise that 73% of students reported that they watched 75%-100% of videos. And 85% watched more than half of the videos uploaded. No student reported watching less than 25% of videos. Yet again, this debunked the notion that student preparation in Flipped Classroom approach was a problem. This could be due to the chunking of the concepts and length of videos that were available for viewing that corresponded with their attention span. They were short and enabled quick and concise learning of concepts and sub-concepts. There were many factors that contributed to the willingness of students to view the videos and learn prior class. Factors included clarity of explanation and scaffolding in terms of questions to aid learning and help evaluate progress:



Students' comments:

- *The flipped classroom approach was effective has the lecturer explained the concepts clearly in the videos,*
- *I feel that kahoot and edpuzzle is really good.*
- *First term I was totally clueless but come to term 2 the flip classroom teaching deepens my understanding, made me feel like I can actually do sprog unlike term 1 where I just feel like giving up. youre the best cher thus far cherrrrr!!! :)*

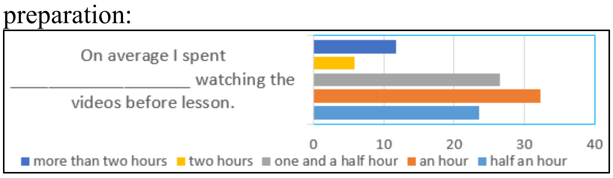
At the same time, another factor that contributed to the flipped learning was the active learning activities in the face-to-face class (Kahoot, scenarios and problems for application and practice) that required students to prepare before attending class so that they could learn more productive and be better engaged in class, as could be observed in their responses to the following items:



Students' comments:

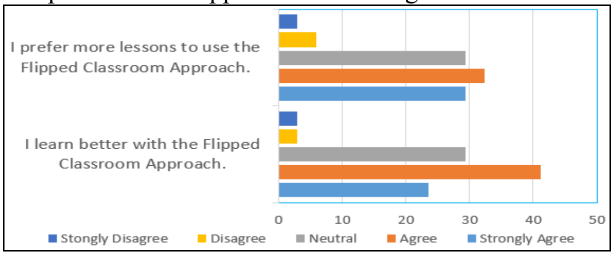
- *MORE KAHOOOOOOOOOOOOOOOT*
- *I can study at my own pace, and students have more lesson time to practice and apply the concepts we learnt through the videos.*
- *I need help with my lecturer because I don't understand how to do the questions.*

However, there was a worrying finding in terms of amount of time student spent in their pre-class preparation:



The expected lesson preparation time for these advanced topics in the pilot was estimated to be about 1.5 hours weekly, and 82% reported spending this amount of time or even less. It was also worrying that about 12% of students were spending more than 2 hours to learn the concepts on the videos. This amounted to 33% or more time spent on the learning resources than expected. If the Flipped Classroom was applied over all the topics in the module, workload could increase significantly for students; and with many modules in School of EEE trialing Flipped Classroom approach, there should be more concerted effort at the course / school management level to examine the overall workload of our students in a short 15-week semester.

Nonetheless, more than 60% of students felt that they learnt better with the Flipped Classroom approach and preferred this approach of learning:



And the primary reasons why they preferred this method of learning:

- What I like about the Flipped Classroom Approach is ___________

Students' comments:

- *Overall it's good.*
- *Good for self-learning.*

Student Achievement at Lab Test 4

The learning on the two chapters on Functions and Strings & Arrays, in the Flipped Classroom pilot culminated with a lab test to assess students' practical skills and application. A comparison of Lab Test 4 result showed that the mean result of students in the Flipped Classroom was better than the mean result of the whole cohort. The median score of students in the Flipped Classroom was 74, compared to the median score of 71.5 for the whole cohort.

Conclusion

The pilot commenced with an intent to extend educational technologies to beyond the classroom in a flipped classroom approach. To motivate students to prepare prior to face-to-face class and engage them in self-directed learning prior to class, two motivation frameworks (SP 4EC framework and Keller's ARCS Model) were applied to the instructional design of lessons in the 5-week-long pilot.

Whilst this involved increased efforts on the part of the lecturer in preparing an extensive range of of online resources, and more time spent by students prior to class viewing videos, completing concept and practice questions prior to class, the overall experience was found to be positive in terms of motivation and student achievement during the weighted assessment was favourable.

In conclusion, the SP 4EC and ARCS motivational frameworks were useful guiding heuristics for the instructional design process, especially for ensuring a more active and engaging learning experience. The educational technology tools were selected to engage students and facilitate the key learning outcomes. As a result, this pilot was successful in reducing the "perennial problem of student preparation", with students responding in the reverse direction, calling for more lessons to use the flipped classroom approach and giving suggestions to enhance the learning design further. Finally, of note, lecturers attempting to use the flipped classroom format will need to plan for an overall increase in workload (at least initially) both for themselves and students.

Acknowledgements

Special thanks to Dennis Sale and my friends who guided me in making sense of my pilot implementation approaches and evidencing my learning and reflection in this paper.

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Team-based Learning for Third Year Students in Electrical Engineering Courses

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Abstract

Digital Circuits is one of the most important subjects for students in the Electrical Engineering field. In Anan College, the Digital Circuits course has always been taught in the traditional lecture style, using a blackboard. However, from this academic year, our college has adopted a team-based learning style for lectures since it is renowned for enabling students to study actively. Furthermore, the method is effective in fostering students' independent problem-solving ability. In this study, some examples of team-based learning are presented. We also examine the results of a survey conducted to determine students' preferred teaching style between a normal lecture style or an active learning style.

Keywords: *team-based learning, group work, scratch cards, digital circuits, engineering education*

Introduction

Digital Circuits is one of the most important subjects in the Electrical Engineering field, a subject that students need to study to develop and design logical circuits and solve problems logically. In Anan College, third-year students of the Electrical Engineering course choose Digital Circuits during their first semester. In the second year, these students have Basic Electricity and Electronics, Electric and Electronics Laboratory, Electromagnetism, and Electrical Circuit theory as compulsory subjects. As these subjects are not directly related to Digital Circuits, the latter is a very new subject for third-year students. Until the last academic year, the college organized lectures in the traditional lecture style, using a blackboard. However, it is sometimes difficult for students to maintain their concentration level during lectures, as the lecture duration is generally 90 minutes. Therefore, we adopted a team-based learning approach since it is renowned for enabling students to study actively. In this paper, the possibility of utilizing team-based learning methods is investigated.

Digital Circuits: Lesson Structure

The Digital Circuits curriculum is shown in Table 1. We have one lecture per week with 15 weeks allotted for the first semester. The number of students is 31. A Digital Circuits lesson structure comprises two or three parts. A two-part lesson includes a short lecture and group work while a three parts lesson includes an individual quiz in addition to the short lecture and group work. To spare enough time for group work, we attempted to reduce the duration of the individual quiz and short lecture to less than 40 minutes. Figure 1 illustrates an example of lecture slides used in the short lecture. Furthermore, students completed worksheets that were handed out at the beginning of the lecture. The worksheet had some blank spaces so that students paid attention to what the teacher said and noted down the important words and drew figures.

Table 1 The curriculum of Digital Circuits.

Week	Contents
1	Digital and analogue
2	Binary, octal, decimal, and hexadecimal
3	Radix conversion
4	Basic boolean algebra
5	How to use true table
6	Derive boolean equations from a true table
7	Construct digital circuits from boolean equations
8	Construct digital circuits from boolean equations
	Midterm examination
9	Decimal to BCD encoder & BCD to decimal encoder
10	BCD to 7 Segment Display Decoder
11	Data selector & demultiplexer
12	Comparator & Parity adder
13	Half adder & full adder
14	Half subtractor & full subtractor
15	Review
	Final examination

During group work, students were divided into eight groups with each group comprising three or four students. These groups were finalized according to the students' examination results in the previous academic year. For the group work in the first four weeks of Digital Circuits class, scratch cards were prepared. Figure 2 shows these scratch cards. The scratch cards offered the advantage of allowing

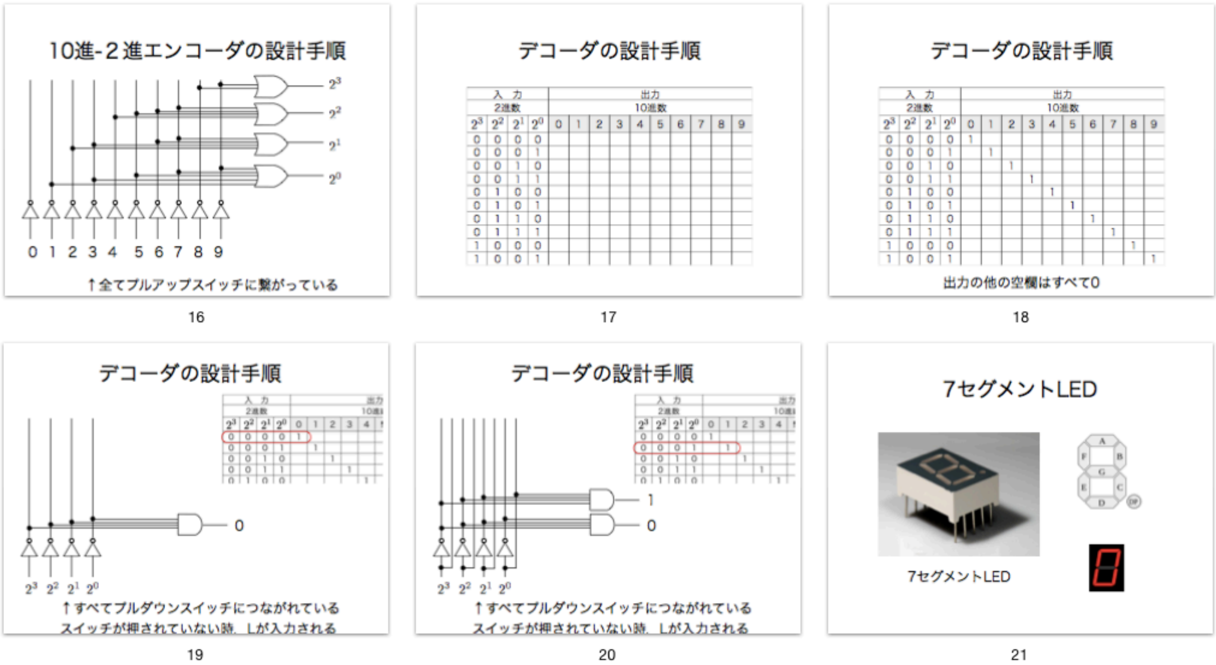

Figure 1 Example of lecture slides used in a short lecture.

students to know the answers to the quizzes promptly. In addition, using scratch cards is a useful method for achieving the gamification of learning. However, creating a multiple choice quiz for scratch cards was time consuming because the course became very complicated in the latter part of the curriculum. Therefore, during the group work in the latter weeks, the students worked with some worksheets shown in Fig. 3.

As we progressed through the topics covered in Digital Circuits, the content became more complicated. Hence, reviewing the content covered in the previous lecture was important. Therefore, some homework was assigned to students, and the lecture slides were made available on the Learning Management System so that students could individually revise the learnings from previous lectures.

No.3 April 25, 2016

1 班 点数

1.	A	B	C	D *
2.	A	B	C *	D
3.	A	B	C	D *
4.	A	B *	C	D
5.	A	B	C	D *
6.	A *	B	C	D

チーム名（ ） 合計

1 回目=3 点， 2 回目= 2 点， 3 回目=1 点， 4 回目=0 点

Figure 2 Scratch cards used in class.

Results of the survey

After 12 weeks of lectures, a survey was administered to the students to investigate their preferred learning styles. Figures 4, 5, and 6 show the results of the survey. A total of 31 students participated in the survey. According to the results of the survey, 62% of students preferred the active learning style over the lecture style. The reasons provided were as follows: 36% of students felt that the active learning style provide a good learning environment and 28% found the active learning style enjoyable. However, 25% of students still preferred the traditional lecture style to the active learning style because they thought that they could concentrate more in the traditional lecture style session and were also more comfortable with this session style, as shown in Fig. 6.

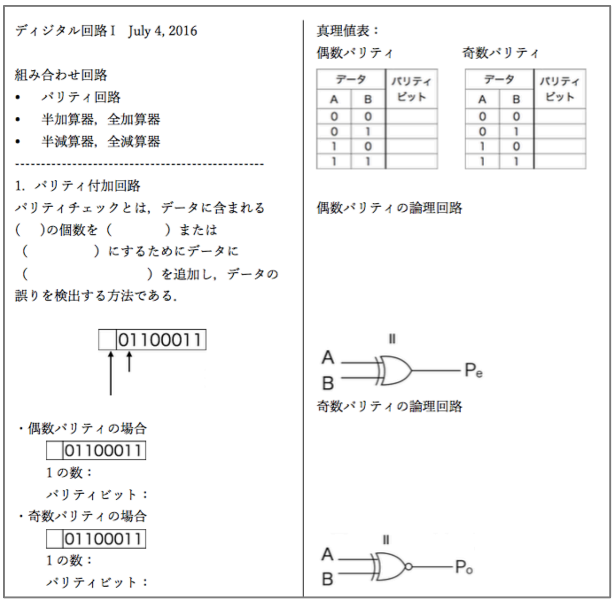

Figure 3 The part of working sheet used during the active learning.

Conclusion

In this paper, our attempt to replace the lecture style with

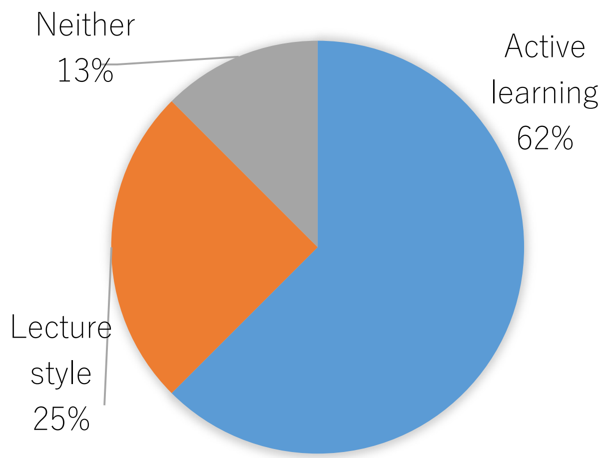

Figure 4 Result of the survey asking students which learning styles they preferred.

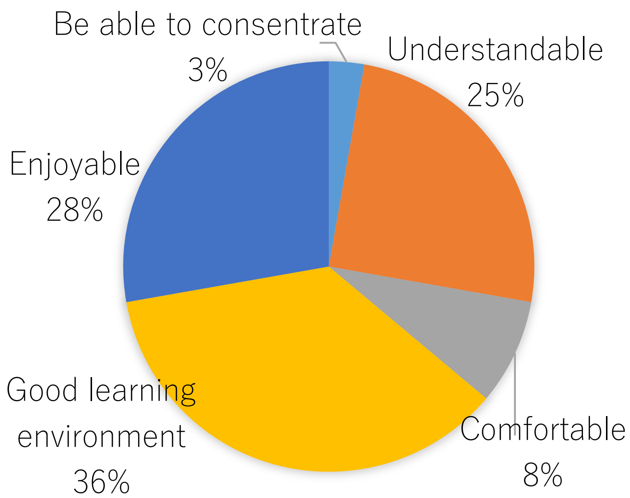

Figure 5 Reasons why students preferred the active learning style.

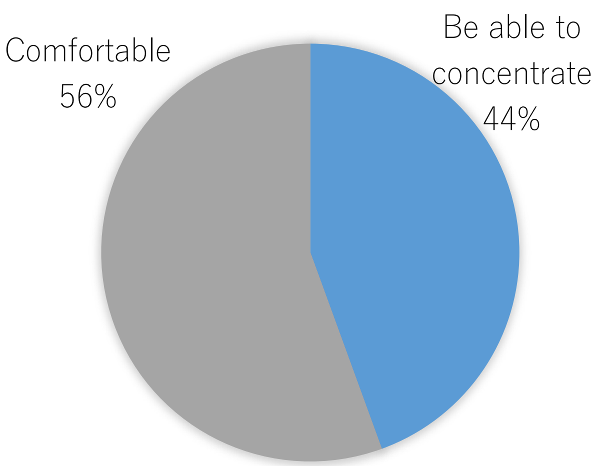

Figure 6 Reasons why students preferred the lecture style to the active learning .

the active learning style to teach Digital Circuits proved successful. We adopted a combination of an individual quiz, a short lecture, and group work during the lecture. According to the result of the survey conducted with students to determine their preferred teaching style, 62% of students preferred the active learning style whereas 25% of students still prefer the lecture style. This was first academic year where we attempted to replace the lecture style with the active learning style; therefore, we do not have sufficient data to support the fact that active learning style is a better way to educate students in special subjects. Conducting lectures using the active learning style needs appropriate preparation, for example, creating presentation slides for each short lecture and preparing handouts for the individual quiz and group work. Teachers may require longer time to make these preparations during the first year, but it is certain that students can learn independently through the active learning sessions. To prove that the active learning style is also effective in teaching special subjects to students, the survey will be continued in the future.

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IMPLEMENTATION STUDY ON E-LEARNING IN VOCATIONAL EDUCATION

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Abstract

With the evolving of information and communications technology, the new generation lives in the era of electronic information. Internet access is very easily available around the city and internet surfing has become a habit which permeates our daily lives. It is not limited anymore to emails, real-time chatting or filling online survey. In fact, it can help the user to acquire new ideas and knowledge. Online e-Learning is thus worth exploring to support teaching and learning in vocational education. In this paper, the authors will recount the first attempt in applying e-Learning to support learning. The initial study of the online e-Learning modes included webpage illustration, video coaching, and public video teaching materials via the Moodle platform. The assessment results of students adopting the above e-learning mode were compared with those of the control groups with face-to-face teaching.

In the second attempt, lecturers and the students or potential users evaluate the MOOC platform from one of the VTC institutes and another similar platform. The evaluation and review of their performance are based on some adjusted standard criteria. After the analysis of the findings, suggestions were proposed to improve the effectiveness of e-Learning implementation for engineering modules. The paper aims to share the findings in the first and second stage of the review. Suggestions for the implementation stage of e-Learning for vocational education at a department level are offered for discussion, inviting exchange and experience-sharing with conference participants.

Keywords: *e-Learning, Moodle, online video, MOOC*

Introduction

e-Learning is believed to have the potential to revolutionize teaching and learning. Over the past decade, it has certainly been having an impact on education and training at all levels, schools, post-secondary education and professional training. Its significant growth can be traced back to the introduction of the world-wide-web WWW in the 1990s, and the lexicon that ensued expands: computer-assisted learning, internet based instruction, web-based training, on-line learning, distributed learning and digital learning etc. To some, e-Learning is to facilitate the teaching, training and learning via the internet. From a formal education perspective, according to the Centre of Education Research and Innovation report (2005), "*E-learning refers to the use of information and communications technology (ICT) to enhance and/or support learning in tertiary education*". Equally significant is the adoption of e-Learning by corporations or organisations, like the BBC in the UK, the UK National Health Service (2009) and IBM's e-Learning portfolio is well documented. As ICT evolves, mobile learning, viewed as an extension to e-Learning, is in vogue. For teaching and learning, gamification could make learning more engaging, which no doubt appeals to a new generation of learners.

In Hong Kong, the universities have taken up e-Learning in different ways and forms, for instance, at the University of Hong Kong, a dedicated lab to develop e-Learning in their Electrical and Electronic Department and an 'E-learning Pedagogical Support Unit' was established in early 2012 by the university; at the City University of Hong Kong, a range of engineering e-courses is available, covering building services, computer animation and construction materials. On the main, some blended learning approaches were adopted. The Open University of Hong Kong, possibly a leader locally in the field of e-Learning provision, started with distance-learning and on-line learning programmes and now offering a number of e-Learning programmes at a Master degree level. In the school sector, there have notable efforts by the Education Bureau to promote the use of IT in education and in Education Bureau Hong Kong SAR report (2012) concluded that "*schools are ready for a paradigm shift towards the mode of student-centred e-Learning*." In the IVE Engineering Discipline, a task group was formed in 2014 to strengthen the e-Learning provision, which further explored the Moodle as the virtual learning environment to facilitate learning and its support via the computer, supplementing the traditional classroom teaching and learning. The experience is recounted in the following section.

Initial Study

In the initial attempt, the first stage is to use Moodle (an internal e-Learning platform) to facilitate the qualitative analysis of the e-Learning studies. The incentives and objectives were clearly delivered to the target students in order to collect timely and relevant data for analysis. The study of the online e-Learning modes included webpage illustration, video coaching, public video teaching materials and interactive MOOC platform. A popular and relevant existing webpage www.mathisfun.com was showed for basic mathematics. Videos were recorded by relevant subject lecturers to illustrate basic workflow procedures and calculations. Online teaching videos from YouTube were introduced to explain the detailed stepwise calculation.

The assessment results of students adopting the above e-Learning mode were compared with those of the control groups with face-to-face teaching. Special interests were paid to those capable students against those less capable students after the e-Learning assessments.

(1) Face-to-face teaching vs e-Learning

Two groups of Year 1 students from Campus A and Campus B were selected to study the same three topics: a) Reinforced Concrete Design – Basic Concepts, b) Reinforced Concrete Design – Design of a Simple Beam, and c) Construction Contract and Administration: Law of Contract. Results of 73 students from Campus A and 146 students from Campus B were investigated. Both groups were selected to have similar distribution of GPA. At the same time, Less Capable Students (LCS) from both groups, whose GPA were less than 2.5, were extracted particularly to study their behaviour.

1a) The same set of 50 multiple choice questions was delivered to the Control Group (CG) from Campus A together with the teaching, while the Experimental Group (EG) from Campus B had to go through the questions online by themselves. After the topic was delivered in lecture, the two groups were given a test in which 10 questions were selected randomly from the pool of multiple choice questions.

Table 1 Performance of All Students

Overall	CG	EG
Average	76.6	75.6
Std deviation	21.9	20.8

Table 2 Performance of Less Capable Students

Less Capable Students	CG	EG
Average	64.0	66.3
Std deviation	25.2	24.1

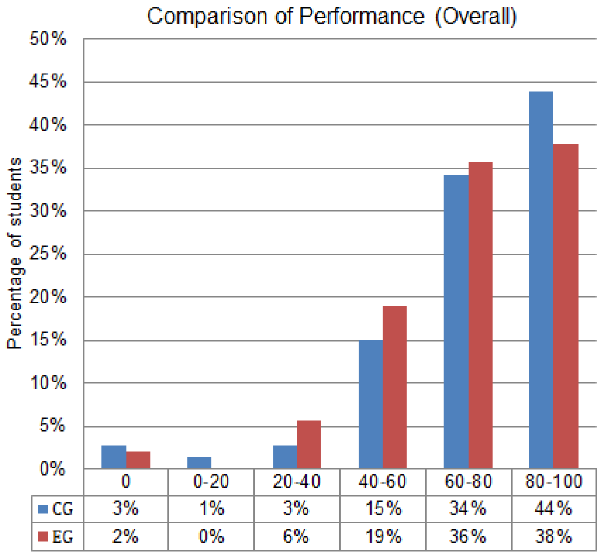

Figure 1 Performance Distribution

Both groups had similar results as shown from Table 1, Table 2 and Figure 1. Figure 2 below shows that access time of the Experimental Group which revealed a very high hit rate of the online question samples during the quiz period. However, the less capable students hit rate is very low.

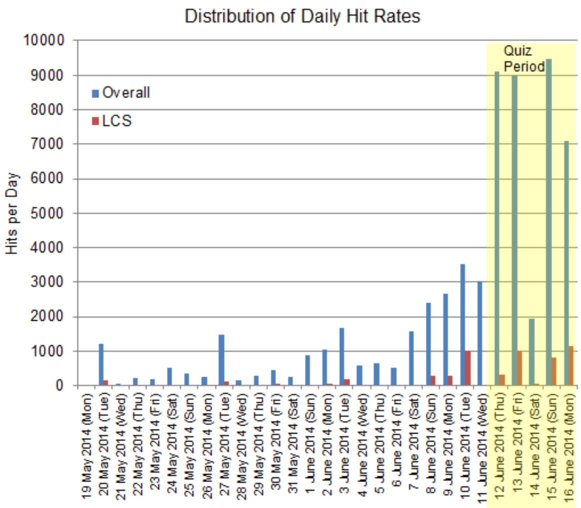

Figure 2 Daily Hit Rates

1b) The details of the simple beam design were calculated step-by-step for the Control Group from Campus A. On the other hand, 8 short videos of 8-10 minutes each and of similar calculation steps with verbal explanation were uploaded to the e-Learning platform for the Experimental Group from Campus B to access and revise on their own. A core question similar to the example was given to both groups as a test.

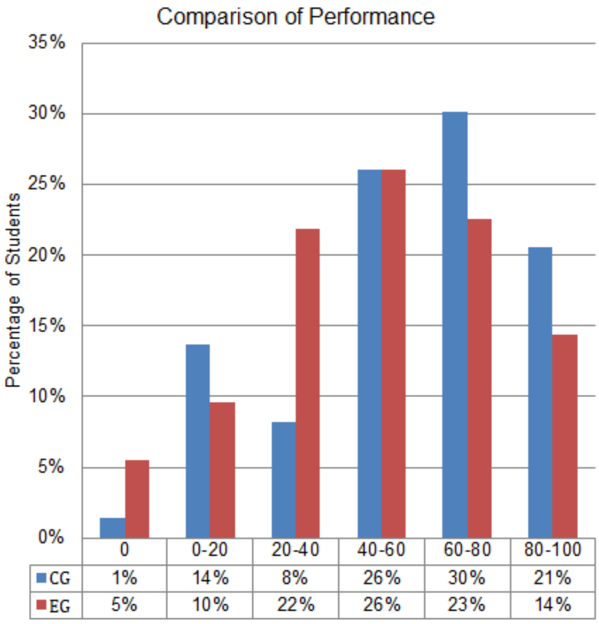

Figure 3 Performance Distribution

Table 3 Performance of All Students

Overall	CG	EG
Average	57.7	50.2
Std deviation	25.9	27.2

Table 4 Performance of Less Capable Students

Less Capable Students	CG	EG
Average	44.7	32.2
Std deviation	27.6	23.2

Table 3 shows that the Experimental Group from Campus B had a lower result than the Control Group from Campus A. Table 4 shows that the result was more significant on the LCS group. Figure 3 shows the performance distribution of all students.

Figure 4 below shows that the high hit rates near the test and exam period were also found in this test.

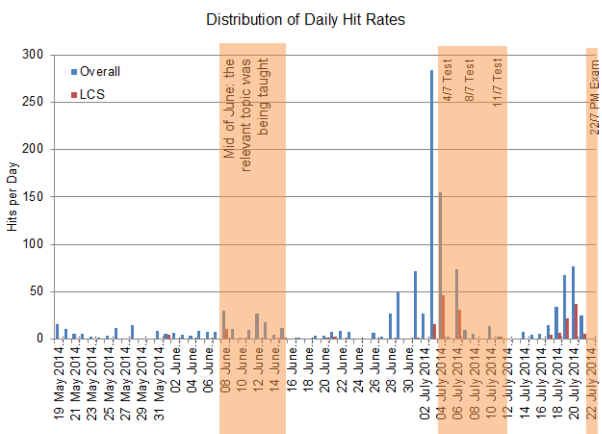

Figure 4 Daily Hit Rates

1c) The concept of law of contract was delivered to the Control Group from Campus A and 4 similar videos about 11 minutes each with English and Cantonese were prepared for the Experimental Group from Campus B. A formal test was also conducted with both groups. Similar results as previous section 1b) were found.

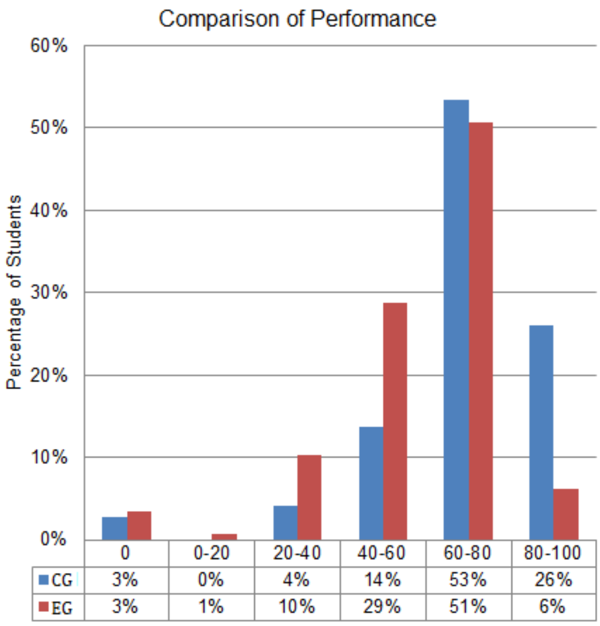

Figure 5 Performance Distribution

Table 5 Performance of All Students

Overall	CG	EG
Average	72.0	65.4
Std deviation	20.1	19.3

Table 6 Performance of Less Capable Students

Less Capable Students	CG	EG
Average	61.5	50.3
Std deviation	24.6	23.2

On the findings of the three tests, there was no significant difference on the results of the basic concept but the performance of Experimental Group from Campus B dropped slightly on the results of the other two tests which required complicated calculations and abstract concept. The drop was even more obvious on the Less Capable Student group. There was a significant Just-in-Time study behaviour where most of the students would study the learning content only few days before the assessments. Students were also found to have higher motivation and activity during night time 9pm-11pm where the hit rate was the highest. The next high hit rate would be the two hours before and after the lunch hour. A focus group discussion meeting was hold after the tests with Experimental Group from Campus B on the results. Students relied on their peer support very much especially on those complicated questions that required further explanations. Printed notes were preferable since this facilitated their discussion with their classmates on difficult questions. Online video on Reinforced Concrete Design was generally welcomed by students. However, students commented that it was time-consuming to watch the whole video and hard to scan through the video and make notes on the difficult areas.

(2) e-Diagnosis & Enhancement on Mathematics

A pool of 108 multiple choice questions on 9 fundamental mathematics skills was set in Moodle. Fresh Higher Diploma (HD) students from Mechanical Engineering (162 students) and Surveying (154 students) who had just registered were invited to join the tests. If the student failed in a specific topic, the students would be provided with relevant e-Learning resources and they can perform the enhancement module tests with 2 more attempts. Completion of all diagnostic tests or the relevant enhancement module tests would be considered as pass.

Figure 6 below shows that the attempt rate was low in the first week of the test. Since the fresh students were not familiar with Student email and Moodle system, the invitation had to be supplemented with personal email and three Short Message Service (SMS) so as to encourage more participation.

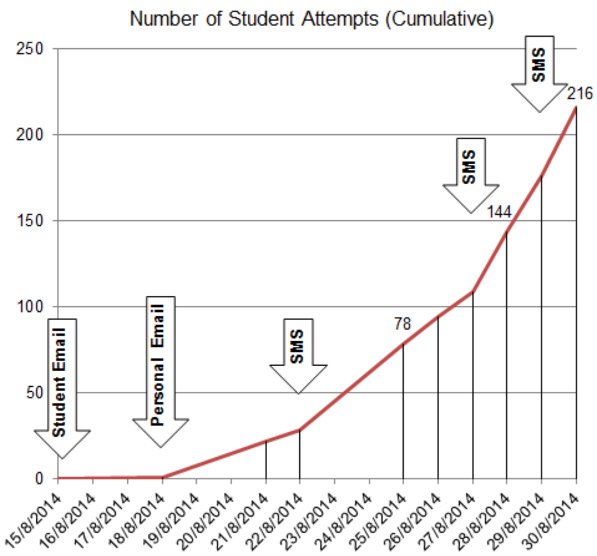

Figure 6 Cumulative Distribution of Student Number

The distribution of quiz attempt time of the fresh higher diploma students (Figure 7) had similar peaks at night, 2 hours before and after lunch when compared to those year 1 students.

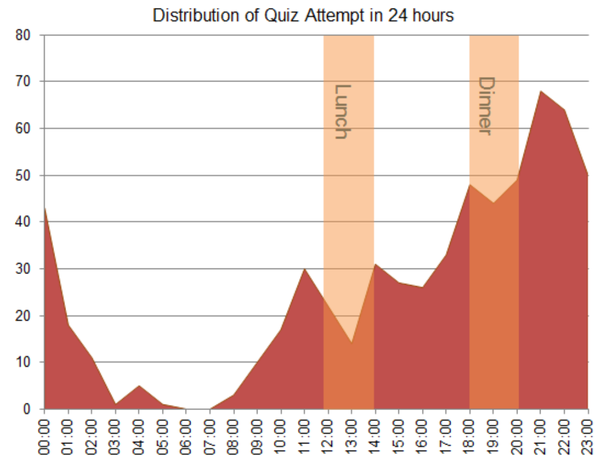

Figure 7 Hourly Hit Rates

The e-Learning resources for the related study content included (a) Graphical and text-based, (b) Video in English with English subtitle and (c) Video in English with Chinese subtitle. The view count of (a) is significantly lower than the other two which have similar view counts.

Table 7 Performance of e-Diagnosis & Enhancement

Item	Description	Number of Students	%
A	Total number of students invited	316	100%
B	Attempted	216	B/A = 68.4%
C	Completed the diagnostic tests	195	C/B = 90.3%
D	Passed all diagnostic tests	38	D/C = 19.5%
E	Requested to the enhancement modules	157	
F	Attempted enhancement modules	49	F/E = 31.2%
G	Pass the enhancement modules	20	G/F = 40.8%

The number of students who passed all the diagnostic tests (D) and enhancement modules (G) was relatively low. There were quite a lot of students who could not finish the test. A few phone calls were in fact received asking the helpdesk for the enrolment of the test and the instructions to carry on the tests. Combining with the low attempt rate and completion rate, it could be found that in order to conduct effective e-Learning, a clear instruction or user interface should be presented. The learning content and assessment workflow should be well designed in a sequential order and straight forward manner for easy following. It would be even more effective to have a briefing to instruct the students how to the deal with the test and make use of the online materials. More importantly, a strong motivation or well-defined incentive was required in order to stimulate the student participation.

(3) Piloting with Pearson

Subsequent to the test using our internal platform, existing well-developed e-Learning materials from Pearson was introduced as a pilot test to our higher diploma students. The platform included clear graphical presentation as well as video presentation to deliver the learning content. At the end of each topic, quiz would be given to the students to evaluate the performance. Step-by-step calculation would be provided if the student found specific question to be difficult to solve. The platform required a course fee. Although students were guaranteed to be refunded with the course fee, at the end, few students completed the course.

Current Attempt

The second stage is to evaluate the MOOC platform from one of the VTC institutes (QE) together with another well-known platform (KA) by lecturers and the potential users from a vocational education institute. Teachers and users were arranged to evaluate the performance of the two e-Learning platforms based on some standard criteria. After the analysis of the findings, suggestions were proposed to improve the effectiveness of e-Learning implementation in engineering modules.

A brief review on e-Learning quality aspects used in USA and Europe, (e.g. Joseph Grifoll (2010) *Quality Assurance of E-learning*, Stamenka Uvalic-Trumbic and, and Swedish National Agency for Higher Education (2008). *E-learning quality: Aspects and criteria for evaluation of e-learning in higher education*) was conducted before the current attempt. We found that the Quality Matters^{TM} (QM) rubrics stated by Sir John Daniel Ed. (2012) in *A Guide to Quality in online Learning* are appropriate for our purpose.

Results Review

After a brief review, the QM rubric is adopted. The unit of differential calculus of the two materials were under review by a group of lecturers and also students. Based on the adjusted QM Rubric items: Learning Objectives (Competencies), Assessment and Measurement, Instructional Materials, Unit Activities and Learner Interaction, Unit Technology, Learner Support, and Accessibility and Usability. The following table shows the average score for each item of the survey by lecturers. The scale is from 'strongly agree 1' to 'strongly disagree 5'.

Table 8 Average Score on Each Item

Rubric Items	QE	KA
1) Learning Objectives (Competencies)	3.96	2.42
2) Assessment and Measurement	3.68	2.38
3) Instructional Materials	3.27	2.64
4) Unit Activities and Learner Interaction	3.68	3.01
5) Unit Technology	2.80	2.64
6) Learner Support	4.00	2.82
7) Accessibility and Usability	2.69	2.14

The result shows that KA received more satisfaction in all items of the QM rubric. A focus group discussion with the lecturers and some potential users (students) was conducted after the survey. From the discussion, most of them prefer to use KA to learn the unit. It demonstrated that QM rubric is a useful tool for us to design our e-Learning materials. There are some sub-items which are ranked as 'Not Applicable'. That means they are difficult to be identified. The sub-items include '*The unit learning objectives describe outcomes that are measurable?*', '*The learning objectives are suited to the level of the unit?*', '*The distinction between required and optional materials is clearly explained?*', and '*The instructor's plan for classroom response time and feedback on assignment is clearly stated?*' We should pay attention to these items. Both platforms received a relative good satisfaction on item 'accessibility and usability'. Both platforms received a relative low satisfaction on item 'Learner Support'.

Discussions

From the initial study, the learning behaviour of vocational education students in e-Learning was understood. In addition, the current attempt found that QM rubric provides a practical framework for e-Learning initiatives. The following are some salient points considered for the implementation of e-Learning for vocational education at a departmental level based on the QM rubric.

Learning Objectives (Competencies) – Learning objectives should be stated clearly. Therefore, the learners can select units to suit for their own learning plan. Starting from 2012, the vocational engineering education in Hong Kong is using outcome-based approach. We can use the measurable intended learning outcome to help the design of the units.

Assessment and Measurement – To motivate learners, the evaluation of learner's work should be tied to the grading policy. In such case, the unit grading policy/rubric should be clearly stated.

Instructional Materials – Learners require a wide variety of instructional materials in the learning platform. e-Learning materials designer should think about providing different format of instructional materials, for example different languages. It should be clearly explained to learners which units are required and which units are optional materials.

Unit Activities and Learner Interaction – Online feedback should be provided during the assessment and measurement. Step-by-step online hints are desired by learners. Moreover, it is better to provide classroom response time for some learners, who need face to face feedback.

Unit Technology – It was found that interactive tools, e.g. 'calculator' and 'sketch pad', are useful for learners. Moodle is an effective tool for materials sharing and documents uploading/downloading but extra efforts are required to develop an attractive user interface to promote learner engagement and active learning. Since only basic functions are provided, the technologies involved are not the most advanced but ready to use without much difficulty. Platform supporting peer group study would attract students to use the e-Learning mode. To facilitate discussion between students, online chatting is worth developing.

Learner Support – Links about institution's academic support services and resources are easily overlooked. There are "eLearning Resources" links available to access the Moodle Community, Documentation and News in general but not specific to the target learning module due to the lack of resources. Support in academic services and student services still have rooms for improvement.

Accessibility and Usability – Both platforms can provide a satisfaction on accessibility and usability. It demonstrated that this is an essential factor for a successful e-Learning platform. More video introduction, graphical interfaces and sound effects could be supplemented to facilitate readability and usability.

On E-Learning evaluation, as summed up in the presentation title by Thomas C. Ouimet of Yale University: "Did they like it, did they learn from it, did they change?", which shows that the focus on the learner's perspectives is key to its measures. For the present work, our team would adopt a bottom-up approach building on the individual topics rather than module/course as the basic unit of e-Learning adoption. From that, we would gain more experience on e-tutorship, peer learning and self-assessment for further refinement of the approach. It is also apparent from stage 2 study that a rich digital media would be desirable but not a necessity, which would allow a less resource intensive start-up. At the on-set, it would be beneficial to establish advocacy groups, allowing like-minded lecturers and students to provide the necessary support to e-Learning, whilst the QM rubric would be the reference guide for the overall architecture for the different units of a module and eventually programme level development.

Conclusions

From the initial study, the learning traits of vocational education students in e-Learning were apparent: last minute learning, enhanced language support, detailed explanation requirements and a relatively low self-learning motivation. In the current study, it is found that the QM rubric is useful as a tool for the design as well as evaluation of e-Learning initiatives. To reap benefits for this learner group, a pragmatic approach would be adopted through reducing the learning unit scope, using a bite size approach as supplements to a topic of learning, say 10 minutes of digital media support. This would be conducted in a blended learning mode, which mainly relies on face-to-face teaching with e-Learning for enhancement of learning outside the class room. Furthermore, e-Learning advocacy groups, with users and teachers, would be formed to help the vocational education students to learn more effectively.

In short, to make a success of e-Learning initiatives, the learner's motivation plays a vital role, which is succinctly put in the Online Oxford Dictionaries, describes e-Learning as learning conducted via electronic media, typically on the Internet- '*successful e-learning depends on the self-motivation of individuals to study effectively*'.

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TRANSFORMATION TO PASSIONATE LEARNERS: A 21ST CENTURY APPROACH

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Abstract

The School of InfoComm Technology (ICT), Ngee Ann Polytechnic (NP) offers a specialization pathway in Infocomm Sales and Marketing (ISnM) for students taking the IT Diploma. This specialization started in 2010 and is unique among all the polytechnic courses in Singapore.

The design of this specialization pathway uses a framework of three innovative learning approaches supported by information technology. Students "Learn by Doing with Realism", "Learn with Increasing Autonomy" and "Learn with Others". Students are issued mobile devices (iPad) with access to specially designed multimedia lesson packages (iBook) and course content (iTunesU).

The authentic learning experience designed in the course allows students to experience "Learn by Doing with Realism" in a context that is aligned to what sales and marketing professionals do in the real world. In this way, students have a stronger appreciation of sales & marketing within the context of the Infocomm industry. The use of role-plays, exposure to real customers and use of real products during the course enables students to "Learn with Increasing Autonomy" as students seek their own ways to be familiar with the infocomm sales life-cycle, deliver impactful sales presentations and handle real customer objections, rather than rely on lecturers for information all the time.

The learning process is further enhanced by putting each cohort through the discipline of planning and executing a real infocomm marketing event via a team-based business case challenge. This enables them to "Learn with Others", learn experientially and apply what had been learnt previously but "with increasing autonomy".

The positive outcome of this learning design can be seen in the increasing number of successful internship placements for ICT's ISnM interns and the positive feedback from industry leaders on the performance of these interns. It is also evidenced by student feedback and high Module Experience Survey scores.

Keywords
Experiential Learning, Authentic Learning, Industry in curriculum, ICT-tools for Learning

Introduction

The School of InfoComm Technology (ICT), Ngee Ann Polytechnic offers a three-year course that awards the Diploma in Information Technology (IT). One of the specialization in this course is that of Infocomm Sales and Marketing (ISnM). This specialization was developed as a result of close collaboration with industry partners who identified a gap in IT graduates who need to be both competent in IT knowledge and have well-developed sales and marketing capabilities.

Hence, the objective of this specialization is to develop graduates who are specially trained to be Infocomm Sales and Marketing Professionals. This specialization consists of 4 core modules. These four modules are:

1) Infocomm Sales and Marketing (ISM)
2) Infocomm Sales Lifecycle (ISC)
3) Customer Decision Making and Negotiation (CDN)
4) Infocomm Business Case Challenge (IBC)

The aim of these modules is to allow the students to appreciate the roles and responsibilities of an infocomm sales and marketing professional. In order to do so, the teaching team needed to identify the signature pedagogy that would sharpen specific thinking skills, know-how and professionalism required in this industry. The signature pedagogy identified is the applied learning process which is industry-focused experiential learning.

The first module, ISM introduces students to the business of marketing, in particular, the key elements necessary to market products and services in the infocomm industry. The next two modules, ISC and CDN, introduce students to the infocomm sales life cycle that is more consultative in nature and also allows students to practice for sales presentations. Key topics that students would encounter in this module would include issues concerning customers such as how customers make decisions and how customer objections are best handled to close sales and maintain customer rapport. Finally, students get to put together what they learnt in the IBC module where students get to market a real IT product or service and compete in teams to present their proposals to a panel of ICT industry experts.

Materials and Methods

It is observed that the students that opted for this specialization have a narrow mind-set to learning and their sole objective to be in class is obtain a qualification for a job. This observation fits the profile of students described by John Biggs (2012) in that there is an absence of driving curiosity from the students towards learning. Faced with this profile of students, it is a challenge for the teaching team to plan a curriculum for the specialization that would increase student engagement with a view to bring about a conceptual change in the student to become learners passionate about their field.

One of the ways to increase student engagement is to raise students' intrinsic motivation to learn. Patterson (2012) proposed that more information technology should be used to customize learning and make lessons more learner-centric, and students would likely be more intrinsically motivated to participate in learning. To do so, the learning environment must be re-designed to "invite" students to be actively engaged and participating in the learning process

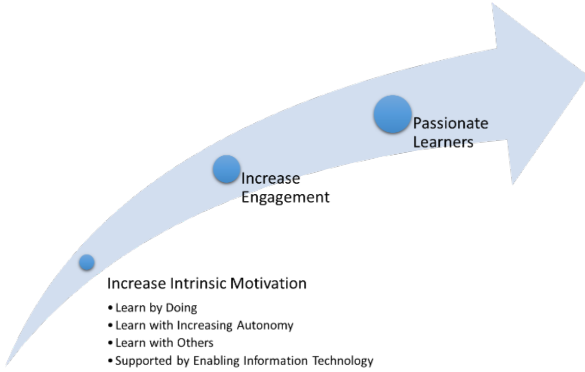

Figure 1: Steps to Passionate Learners

Figure 1: Steps to Passionate Learners describes the approach that the teaching team took when designing the curriculum. They wanted to create an environment where students were actively participating in learning through "doing", learning with increasing autonomy, have the ability to work in teams and learning from one another, and also be able to leverage on technology to enhance the learning experience so that students will be transformed from mere students into passionate learners.

To create such an environment where students are motivated to learn and become passionate learners, the first step would be to increase student engagement. The team sought to minimize a didactic approach (e.g. traditional lecture) to teaching and instead proposed a framework that adopted three innovative approaches supported by information technology. These three innovative approaches: "Learn by Doing", "Learn with Increasing Autonomy" and "Learn with Others" are supported by "Information Technology in Class". These approaches lay the foundation to "Increase Engagement" which leads to "Passionate Learners". These are explained in greater details in the following sections.

Increase Intrinsic Motivation: Learn by Doing

The ISnM curriculum has numerous activities that enable students to "learn by doing". This follows closely to Biggs (2012)'s "verbs that the students have to enact". These activities include devising a marketing plan and presenting this plan, not just to their lecturers, but to real customers who are likely to buy the products or services that they are marketing. This focus on getting students to "learn by doing" improves the level of intrinsic motivation (Abeysekera & Dawson, 2014).

Increase Intrinsic Motivation: Learn with Increasing Autonomy

In addition to the approach "learn by doing", it is important that students "do more with less". This means that as students mature in their thinking and learning, the guidance given in each activity by the tutor is reduced in tandem with the task becoming increasingly more sophisticated and challenging. The students are expected to be more autonomous about their own learning and be less reliant on tutors when faced with difficulties. They are expected to work through problems with minimal supervision, relying more on themselves and developing important 21st century competencies such as critical thinking and problem solving during this process.

Increase Intrinsic Motivation: Learn with Others

In order to promote peer discussion, the classroom selected for this module abandons the traditional row and column seating arrangement commonly found in Ngee Ann Polytechnic. Instead, cluster seating layout is used and this physical change in the learning environment encouraged peer learning as the layout now facilitates team discussions and helps to build team identity and camaraderie.

To leverage on the natural team cohesion formed by cluster seating, relevant team competitions (such as pop quizzes, discussion, debates, etc.) are conducted to encourage interaction among the different groups of students. The students become more socially active and cognitively engaged, leading to a setting where students are actively involved and passionate about the topics being taught as they become more engaged with content and with learning.

Collaboration between students becomes the norm in such a learning environment and "relatedness" is increased with students coming together to “make sense” and “construct meaning” from what they have learnt. Students then become more increasing motivated through this process of building team relations, learning from and with one another and just by being an active participant in this learning process.

Increase Intrinsic Motivation: Adoption of Information Technology in Class

Rosefsky & Opfer (2012) proposes several 21st century skills that students need to have for optimum learning. These are clustered as higher-order thinking skills, problem solving skills and communication skills which can be developed through the use of information technology.

The use of information technology to enhance student learning is well documented and much of the literature reviewed shows research that indicate that both teachers and students are users of technology, be it in face-to-face classroom sessions and outside the classroom. They are familiar with technology use in their daily lives. (e.g. Lin, 2011; Ng, 2010; Ting, 2010; Tomei, 2009). However, the use of technology and students’ familiarity with it, does not mean that they know how to use technology for learning effectively. It is suggested that technology ought to be used as a tool to inspire learning and to enhance learning with others. (Martinez, 2011)

Throughout the four modules in the Inforcomm Sales & Marketing (ISnM) specialization, information technology is heavily utilized to enable students to learn by doing and learn with others with increasing autonomy and collaboration. The teaching team explored a new pedagogy through the integrative usage of tablet technology and multiple wireless screen projections in the classroom to create a different learning environment for the students where learning is heavily supported by the use of innovative technology.

i. Uses of Technology in class : Access to technology

The students are issued with individual tablets (iPad) and each classroom is equipped with three projectors with wireless projection technology (AppleTV). During each lesson, the use of multiple projection screens deepens the learning experience where tutors make use of the three screens to show different slides wirelessly (students are able to compare and contrast different information shown simultaneously on different screens) and students witness the possibilities of presenting using multiple screens and in many of the students’ presentation, emulated the tutors.

ii. Uses of Technology in class : Ease of Collaboration

Lessons were also designed such that students would work on their tablets and share their work with each other seamlessly in an interactive, dynamic learning environment. This ease of sharing resources and information among team members with the use of technology tools increase the level of collaboration among students, allowing them to see the importance of learning from one another.

iii. Use of Technology in Class : Tracking & Evaluating learning

The use of digital books (iBook) allows students to be focused on topics and tutors to track students' progress through technology that allows them to track the amount of time students spent on reviewing the topics online. The use of iPad also allows for new methods to be used for assessment. For example, it is possible for students to record a video reflection after each class and submit each reflection as part of continuous assessment. This would benefit students who are more kinesthetic or are weak in their written expressions. Video recordings provide students with another avenue to express their understanding and learning.

Through this pilot, the tutors came to the conclusion that heavy use of technology tools in this pedagogical approach allowed students to leverage on their comfort in using technologies to enhance their learning. This improvement in their learning experience also increased students' motivation and engagement which can be observed through students' engaging presentations during lessons.

Increase Engagement: **Realism in learning**

Providing students with an opportunity to experience authentic learning is important to help them see the relevance of what they learnt in the classroom to the real world. By injecting realism into the classroom learning, students will have to apply their content knowledge in environments that is unpredictable. Students get to experience the challenges that they may face in the real world but within the learning context which will allow them to learn from each encounter. This realistic learning sales environment is created where the students have to "do" and perform. By them interacting with the real world in a safe environment, students' intrinsic motivation is increased.

i. Realism in Learning : Role Play

The specialization makes extensive use of experiential learning in the form of role play to increase engagement with the student. This approach enables students to experience how negotiation tactics taught in the classroom are applied which increases the likelihood of students using these techniques in real life settings.

ii. Realism in Learning : Real Products and Customers

Students are given real products, (e.g. Microsoft Surface Pro, Oculus VR etc) by industry partners and they are to develop a marketing plan and present this to the industry assessors. The students are exposed to numerous real customers and real products during their course. This exposure allows student to see the practical application of what they learnt in class and this realism increases their intrinsic motivation and engagement. The realism of the experience in using real products and the direct interaction with industry partners allow students to experience "learn by doing" and "learn with increasing autonomy".

Passionate Learners: Understanding the Industry

Guest speakers are invited to share with the students what the industry norms are and how problems or issues are handled in the real world. Field trips and learning journeys are also organized to bring students out of the classroom into the real world. They visit leading IT companies in their corporate offices, such as Salesforce and Microsoft. This exposure helps to expand students' horizon and allows students to visualize the real environment they may operate in upon graduation. These visits also show students the relevancy of what they are studying to what they see in the real world of IT, making them more motivated.

Passionate Learners: Development of Professional Skills – Presentation

Being able to make a good presentation in a highly stressful corporate setting is a core skill for an InfoComm Sales and Marketing (ISnM) professional. In preparation for this, ISnM students make as many as 4 times more presentations compared to students in other specializations in the IT Diploma course. Every presentation is intense and it is common for students to spend up to 2 weeks to prepare for a 30-minute presentation. During the presentation, the students are video-recorded and copies of the videos are given to each student for feedback. The students view their own presentation to identify their strengths and weaknesses and reflect on ways to improve their presentation skills.

In the first module of the specialization, emphasis is given to the design of the slides. After the students have mastered the basics of slides design, the next two modules focus on their ability to deliver a presentation. Once they have built up their confidence, the focus changes to the actual content of the presentation. With this scaffolding approach and increasing autonomy, the teaching team is careful to nurture the confidence of the students and to encourage the development of these very important soft skills. Creating this "safe" environment to learn allows the students to be comfortable with public speaking and discover their individual optimal presentation style.

Passionate Learners: Developing an Inquiring Mind-set

During each presentation session, students in the audience are to listen actively to their classmates and they are also expected to ask good questions during the question-and-answer segment. Marks are awarded for good questions asked by the student audience and for good replies by the presenters. In this way, a win-win situation is created in a positive collaborative learning environment. Students learn to listen actively as they follow their classmate's presentation and this also reinforces what they have learnt previously. Lessons become livelier as all the students participate actively. By creating a safe environment to ask questions, students build their confidence as they get used to asking and responding to questions in public.

Results and Discussion

With the change in curriculum delivery, students have been observed to be more enthusiastic and involved in their learning. The quality of their work has improved and this has been validated by industry partners who are invited to judge their work.

Ngee Ann Polytechnic conducts a Module Evaluation Survey (MES) every semester, where it is compulsory for every student to give feedback on the module they have taken for that semester. Feedback from the MES would indicate how well students think the design and delivery of the modules have helped them learn. Modules with an average score of 5.0 and above are considered as being well received. The four modules have consistently scored well in the past five years, with the latest MES (in 2016/2017) having an average score of 5.3. All four modules score higher than the School and NP average. This is another indication that students' learning experience has improved and the change has been a positive experience for the students.

Conclusion

The ISnM specialization is unique among the five polytechnics and is focused on its end objective of training IT students to be sales and marketing professionals in the IT domain. To say that some of these students are "unmotivated" may be true but not helpful (Biggs, 2012). By making the students learn by doing with increasing autonomy in a realistic environment, collaboratively learn from and with each other and through innovative use of information technology, the teaching team has improved the learning environment where motivation is a product and not a prerequisite for good learning. This brings the teaching team a step closer to making NP a great place to learn for the students and a great place to work, for the teaching staff.

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IS JAPANESE VERBAL APTITUDE RELATED WITH PERFORMANCE OF ENGLISH LEARNING OF JAPANESE?

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Abstract

English learning is a great concern for Japanese, especially students who are to do business in such a globalized society. The Top Global University Project was launched by the MEXT (the Ministry of Education, Culture, Sports, Science & Technology in Japan) in 2014, aiming at enhancing the international compatibility and competitiveness of higher education in Japan. The selected universities have carried out several projects to meet the expectations and Toyohashi University of Technology (TUT) is one of them.

Since being selected for the project, TUT has focused on an extensive English teaching to Japanese students and showed some successful outcome. However, not all students meet the requirements of the project, and there seems to be some factors that limit the improvement of English skills of some students. From practical point of view, we suspect it is Japanese verbal aptitude. Language can properly work on condition where adequate discourse is fulfilled and this requires general knowledge extending all languages in mind that coordinates a wealth of information about the world. So what if Japanese verbal aptitude is not good enough to attain the level of English required in the project?

Here we address the question by examining if English skill is indirectly affected by a training that aims at improving the way students express themselves in Japanese. The project has just started and the students taking the Japanese expression skills course are to take their first Japanese Verbal Aptitude test (Kokugo-ryoku Kentei) and the English Proficiency Test (Eigo Kentei) in July, 2016. In the project, we further compare the teaching effects of Japanese and English, and their combinations and teaching order, on improving English proficiency of the students.

The project could verify the importance of the quality of the students' first language for their learning of foreign/target languages and hence suggest a novel language teaching method where students are required to train their first language as well as their target languages.

Keywords: *Japanese Verbal Aptitude, English Proficiency, First Language Training*

Introduction

According to Golestani & Zattore (2009), there is huge variability in an individual's ability to acquire a second language (L2) during adulthood. The observation does empirically make sense to us. What then causes this to happen? It must partly be motivation that determines the results of learning as suggested by countless of studies and experiments (Maslow, 1970; Deci, 1975; Weiner, 1986). However, it is also obvious that there is a situation where some learners are successful in learning but the others not even with high motivation. This is where the learners' L1 comes in. Language transfer, referred to as the carryover of previous performance or knowledge to subsequent learning, often occurs positively or negatively from L1 to L2. In sufficiently broader sense, Kellerman & Sharwood Smith (1986) suggested the term cross-linguistic influence to additionally include avoidance, language loss and rat of learning as an effect of L1. Then L1 must somehow determine the outcome of L2 acquisition. How? The answer to the question is not necessarily clear. The language transfer and cross-linguistic influence show us how some aspects of L1 affect L2, but not how L2 development varies depending on individual learners.

Some neuroimaging technologies have recently become tools to break the barrier. The language network identified by resting-state functional connectivity show highly reproducible patterns that are consistent with those reported in task-based brain imaging studies (Tomasi & Volkow, 2012). Individual differences in resting-state connectivity have been associated with language learning abilities of L2 sounds (Ventura-Campos et al., 2013) and L2 words (Veroude et al., 2010). On L2 reading abilities for more general sense, Chai et al. (2016) found that pretraining functional connectivity within two different language subnetworks correlated strongly with learning outcome in two different language skills: lexical retrieval in spontaneous speech and reading speed where subjects were homogeneous in L1 (English) proficiency based on a subjective questionnaire. The work indicates that the human capacity to learn a second language can be predicted by an individual's intrinsic functional connectivity within the language network in the brain.

The work by Chai et al. (2016) reported no surface difference was found in L1 of the participants even with differences in the brain network connectivity. What does this mean? One possible answer to the question is that, in the experiment, the L1 proficiency was not properly assessed because only a questionnaire was used for the purpose. It seems possible to differentiate participants with regards to L1 proficiency if some proper ways of doing assessment are used.

To address the issue, here we designed an educational experiment to confirm that L1 (Japanese) proficiency predicts L2 (English) learning outcome and if L1 training further improves L2 learning outcome. In the experiment, L1 and L2 are Japanese and English, respectively. Once L1 is proved to predict L2 performance, L2 education should drastically be changed to introduce L1-L2 combined teaching methods in place of prevailing teaching only of L2.

Methods

Participants: Two sets of forty participants are recruited from the 3rd graders at Toyohashi University of Technology (TUT). The first 40 (Group 1) is the students who are to take the Japanese expression training course in the fall semester and the second 40 (Group 2) in the spring semester. Group 1 and 2 were designated 00 and 01, respectively, in Figure 1. The first digit indicates whether or not the students receive an English language training (ET) and the second digit Japanese expression skills training (JT). 00 therefore means the students receive neither ET nor JT and 01 students receive only JT.

Japanese expression skills training course: As shown in Figure 2, the class activity consists of three activities. First, students are given a instruction for 45 minutes on a topic with its background at the beginning.

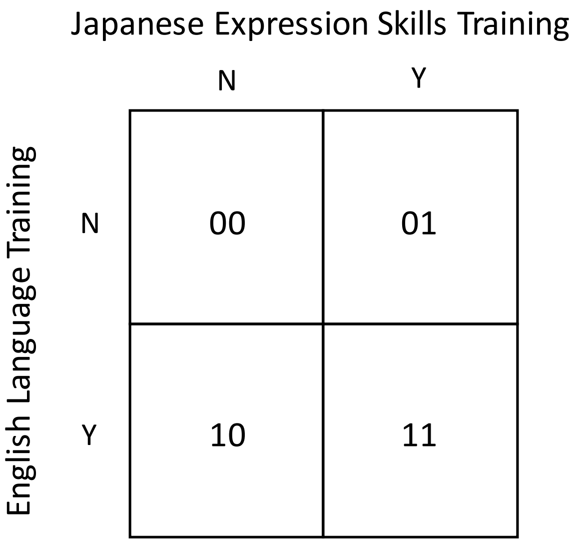

Figure 1. Classification of students on trainings received.

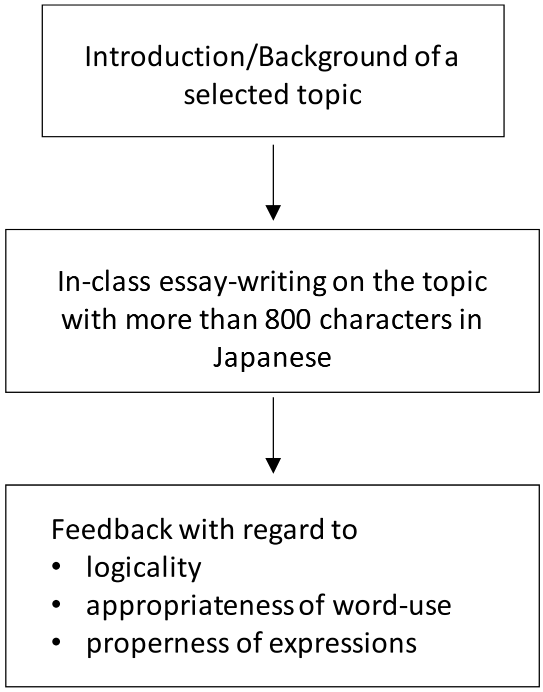

Figure 2. Activity flow of Japanese Expression Skills Course at TUT.

Then the students are given another 45 minutes to write an essay on the topic with more than 800 characters in Japanese. Finally the essay is checked and assessed by the instructor based on logicality, appropriateness of word-use and properness of expressions. The students are to receive such an activity 15 times during one semester.

English language training: The students classified 01 and 02 are required to recite and record a passage in two weeks selected from the TOEIC official test-preparation guide. The recorded recitation is scored out of 10 by Ikematsu and another instructor who is a native speaker of English throughout a semester. The score is only used for the feedback to improve students' English proficiency.

Assessment of language proficiency: Japanese verbal aptitude and English proficiency of the participants are assessed by the Kokugo-ryoku Kentei (Kokugo-ryoku; Z-kai Incorporated) and the EIKEN Institution Based Assessment (EIKEN IBA; Eiken Foundation of Japan), respectively.

Data analyses: Average scores of Kokugo-ryoku and EIKEN IBA before and after ET and JT are used to judge with a paired *t*-test if the changes in the average scores caused by the trainings are significant.

What to be confirmed

The present educational experiment is set up to confirm the following three questions.

<u>1. Could the Japanese verbal aptitude of Japanese students be improved through Japanese expression skills training?</u>

The Japanese expression skills course was primarily introduced at TUT in order to improve students' ability to effectively express themselves in Japanese. However, the effectiveness has not been assessed so far. We have several classes under the name of the course and the content varies depending on the instructors in charge. The present study selected a class that focuses on an essay writing and, probablly in the next step, would focus on other aspects that would be able to improve Japanese verbal aptitude.

2. Could there be any difference in achievement of English proficiency between the students with Japanese expression skills training and the others without it?

The focus is crucially on this question in the present study (Figure 3). If Japanese verbal aptitude has an influence on a learning process of other languages, the results of English proficiency test could differ depending on whether the students receive the Japanese expression skills training or not. If there found to be any difference between them, the current English language education should take account of the students' Japanese aptitude and take actions to be tied with some trainings where Japanese expression skills are to be improved.

3. What could the relation be like between Japanese verbal aptitude and English proficiency?

English is considered a logical language and Japanese is not. However, with regard to functional aspects like discourse, for example, which plays a crucial role in conversation, a certain universality such as a control of consistency holds for whatever the languages in use. Therefore, such a inherent knowledge of L1 could work in L2 or FL as well. The Kokugo-ryoku Kentei and EIKEN IBA are the ones that assess multiple aspects of skills such as basic verbal aputitude, reading, writing, listening, and speaking for Kokugo-ryoku Kentei, and vocablary, reading, and listening for EIKEN. What aspects of skills are correlated with each other is another question.

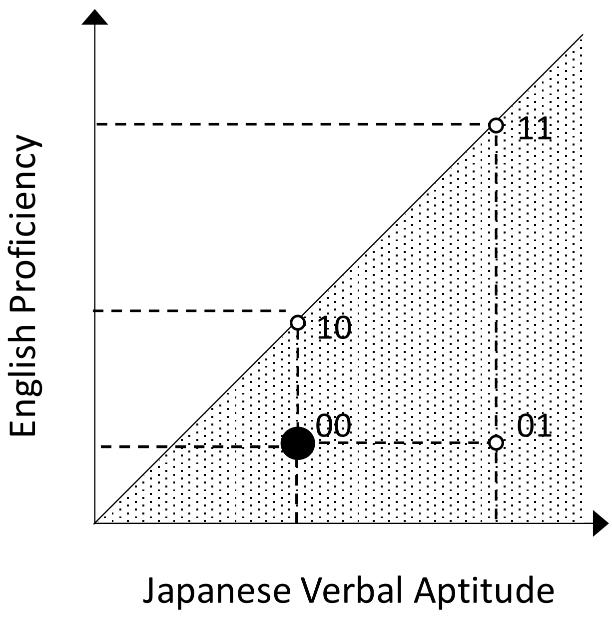

Figure 3. Hypothetical diagram showing English proficiency of Japanese never exceeds their Japanese verbal aptitude.

Conclusions

Here we designed an educational experiment to confirm that Japanese verbal aptitude predicts English learning accomplishment and if Japanese expression skills training further improves English proficiency in Japanese learners of English. Once Japanese verbal proficiency is proved to predict English performance, English education should drastically be changed by introducing something like Japanese-English combined teaching by changing our attitude toward English education where English proficiency of Japanese is considered to be improved at a similar rate as long as their motivation to learning is the same. Japan is struggling to increase the number of Japanese who use English without any barriers by setting up lots of programs including the one TUT was selected for. However, such a program would probably be a good news only for those who have already motivated enough to learn English. Thing is most Japanese are not motivated enough to learn English because they feel no need to use English in everyday life and lose confidence to be able to accomplish certain goals of English learning. The latter Japanese do not understand why they can't achieve the goals even with full motivation to learn. This is where the results of the present study give an answer. Languages a person use are intertwined with each other. One could help the other, and vice versa. But the first language could no doubt be the basis of the languages learned later. Japanese, the first language of us, could be significantly important even when English learning is in mind.

Acknowledgements

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AN ONLINE INTERACTIVE PLATFORM WITH GAMING FOR THE TEACHING OF THE LABORATORY SAFETY

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Abstract

Common practice for teaching and learning laboratory safety is normally through a briefing at the beginning of each subject. To leverage on ICT technology for enhancing the teaching methodology, we have developed an online interactive learning platform for the teaching and learning of the laboratory safety for all Year-1 students in the School of Chemical & Life Sciences of NYP. An online interactive platform that includes laboratory safety videos, animations showing proper laboratory safety practices and a game on the correct disposal of the laboratory wastes were developed. The effectiveness of the proposed platform for teaching laboratory safety was evaluated with two group of students: control group and experimental group. The experimental group of students that learned laboratory safety using the online interactive learning platform were found to achieve significantly better results than the control group that used the "Briefing" method. Both quantitative and qualitative feedbacks from students show that the proposed online interactive learning methodology is more effective, allows students with different learning pace to master the knowledge at their own pace, own time and venue, and the various activities were useful to enhance students' learning experience and outcomes. The proposed online interactive platform was found to achieve better learning experience and outcomes than the traditional "Briefing" methodology. It is recommended that the proposed online interactive platform be adapted to other Years of students in the School of Chemical and Life Sciences for better teaching and learning of laboratory safety.

Keywords: *laboratory safety, interactive learning, pedagogy, laboratory accidents, learning styles, interactive platform*

Introduction

Over the years, there were many laboratory accidents that were caused by the negligence of proper laboratory safety practices, as reported in newspapers. During the severe acute respiratory syndrome (SARS) outbreak in 2013, failing to meet the laboratory standards and practices led to three instances of laboratory related SARS cases in Singapore, Taiwan and mainland China (Lim, Ng & Tsang, 2006). In late 2008, a research assistant died from horrific burns in a lab fire at the University of California, Los Angeles (Van Noorden, 2011). The proper management of the laboratory safety therefore remains an indispensable aspect of the academic institutions.

In almost all the higher learning institutes, teaching of laboratory safety is usually done with the incorporation of the safety component into the module as a single 1-hour lesson per semester. These include an introductory presentation to laboratory safety rules during the first lesson, weekly presentation by instructors on experiment specific safety concerns and brief safety quizzes based on assigned reading (Miliszewska & Sztendur, 2011). Sometimes a standard video showing the laboratory safety rules will be shown to the students. Similar to many other higher learning institutes, the laboratory safety training in School of Chemical & Life Sciences includes a safety briefing at the beginning of a semester by the tutor, a standard laboratory safety video also shown at the beginning of each semester and additional briefing at the beginning of each laboratory session if there are specific laboratory safety requirements. In addition, a copy of general laboratory safety rules is included on the first page of the practical manual as a constant reminder for the students about the importance of following the laboratory safety rules. Email will be sent at the beginning of each semester to all students to remind them on the proper conducts in the laboratory.

Unfortunately, lapses in the general laboratory safety rules are still being observed occasionally despite the briefing and the constant reminders. The aim of this study was therefore to develop and evaluate the effectiveness of an online interactive learning platform with gaming for the teaching and learning of the laboratory safety to all Year-1 students in the School of Chemical & Life Sciences of NYP. This is done for the purpose of ensuring that laboratory safety awareness will be properly imparted among the students so that the laboratory safety will be followed by the students whenever they are performing the experiments in the laboratory.

Pedagogy

An interactive platform based on the setting of teaching laboratory in School of Chemical & Life Sciences was created. The commonly seen scenarios in the laboratory during practical sessions were included (Figure 1). Videos and animations in the form of pop-up messages were incorporated onto the platform to show the wrong and correct laboratory safety practices (Figure 2). Studies have indicated that games with a direct purpose of teaching about a specific topic allows for better learning of the desired content (Baid & Lambert, 2010). Proper integration of the learning content and strategies into the game-based learning environment also improved students' learning performance while maintaining the enjoyable nature of the games (Hwang, Wu & Chen, 2012). Therefore, a game was created and incorporated onto the platform for students to recognize the different types of waste bins in the laboratory (Figure 3). The platform was uploaded to the Blackboard Learning system for easy access of the students.

The learning outcomes were also identified. At the end of the study, students should be able to:

- demonstrate awareness of the general hazards in laboratory
- identify the incorrect laboratory safety practices and describe the correct safety procedures required in laboratory
- identify the proper disposal of various wastes generated in laboratory

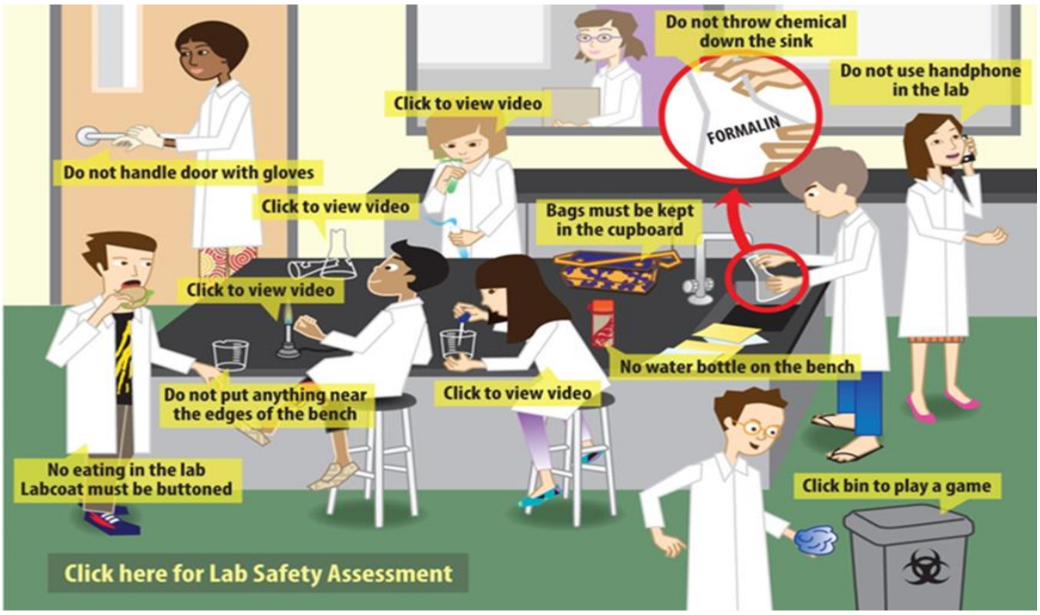


Figure 1: The laboratory-based interactive platform with videos, games and animation incorporated

Figure 2: Videos demonstrating wrong and good laboratory practices

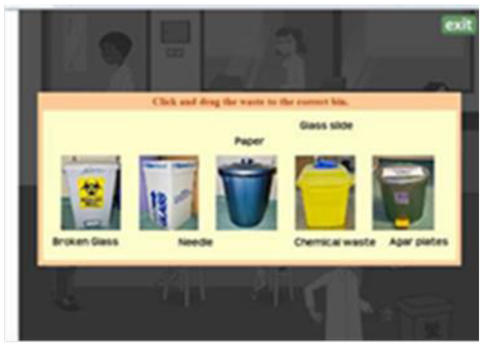


Figure 3: A drag-and-drop waste-bin game for the learning of correct waste disposal

The effectiveness of the proposed platform for teaching laboratory safety was then evaluated with two groups of students: control group and experimental group. The control group went through only laboratory safety briefing while the experimental group learned through only the interactive platform.

Data Collection

230 year 1 students in School of Chemical & Life Sciences had participated in the study. The control group went through laboratory safety briefing by an assigned tutor at the allocated time and venue. The tutor were instructed to go through the general laboratory safety rules with the students during the briefing. The briefing materials were presented using PowerPoint with diagrams and illustrations for proper laboratory practices. At the end of the briefing, there was a question and answer session to allow discussion among the tutor and students. The tutor was also instructed to ensure that the learning outcomes are achieved through briefing.

The students then took the assessment right after the laboratory safety briefing. For the experimental group, the students were instructed to go through the laboratory safety using the online interactive platform through Blackboard Learning system within a timeline. The students were allow to go through the online interactive platform as many times as they prefer. They then took the online safety assessment through Blackboard Learning system.

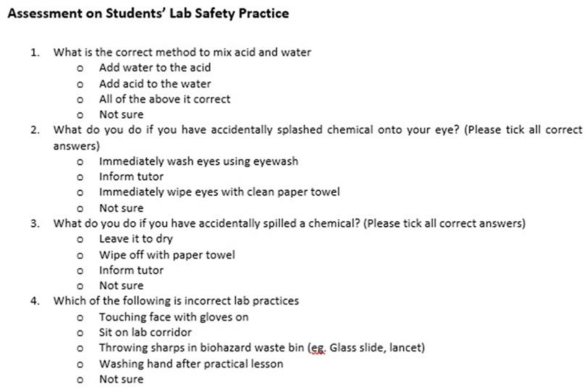
The questions of the assessment for both groups of students were the same (Figure 4). Those students who had scored below 50 marks were asked to meet their tutor to go through the briefing again and re-took the assessment until they scored 50 marks and above. However only the marks obtained during the first assessment were collected and analysed for this study.

Results

Marks Distribution & Mean Comparison

The lowest mark obtained in the assessment for the control group was 22 and the highest mark was 88. 49% of the students obtained below 50 marks while there were only 2% of the students who scored more than 80 marks (Figure 5). On the other hand for the experimental group, the highest mark achieved was 100 while the lowest mark scored was 72. 99% of the experimental group has scored more than 80 marks (Figure 6).

The marks scored by the students in the two groups were further analysed based on the mean. The mean marks for the control group was 52 (SD = 12) and for the experimental group was 95 (SD = 5) (Figure 7). The significant of the mean marks between the two groups was analysed through independent t-test. The results showed that the learning outcomes of the experimental group who has went through the laboratory safety through the online interactive platform has performed significantly better; t(318)=-48.68, p=0 (Table 1).



Assessment on Students' Lab Safety Practice

1. What is the correct method to mix acid and water
   - Add water to the acid
   - Add acid to the water
   - All of the above it correct
   - Not sure
2. What do you do if you have accidentally splashed chemical onto your eye? (Please tick all correct answers)
   - Immediately wash eyes using eyewash
   - Inform tutor
   - Immediately wipe eyes with clean paper towel
   - Not sure
3. What do you do if you have accidentally spilled a chemical? (Please tick all correct answers)
   - Leave it to dry
   - Wipe off with paper towel
   - Inform tutor
   - Not sure
4. Which of the following is incorrect lab practices
   - Touching face with gloves on
   - Sit on lab corridor
   - Throwing sharps in biohazard waste bin (eg. Glass slide, lancet)
   - Washing hand after practical lesson
   - Not sure

Figure 4: A sample of the assessment questions.

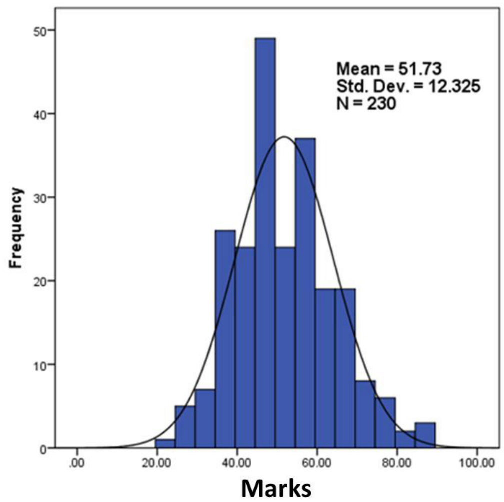


Figure 5: Marks distribution of the control group. Most of the students scored below 50 marks

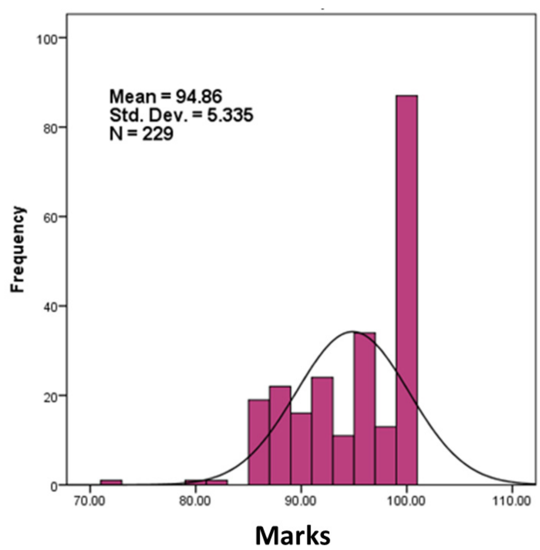


Figure 6: Marks distribution of the experimental group. In contrast to the control group, almost all of the students scored 80 marks and above

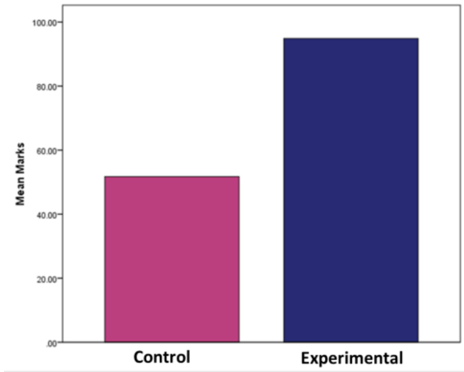


Figure 7: The mean marks for two groups. The experimental group has achieved better mean marks

Table 1: The independent t-test

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Marks	Equal variances assumed	102.565	.000	-48.613	457	.000	-43.12985	.88720	-44.87335	-41.38634
	Equal variances not assumed			-48.686	312.182	.000	-43.12985	.88588	-44.87290	-41.38680

Student's Feedback

The students in the experimental group has performed a survey after they went through the online interactive platform. 97% of the students agreed that they learned well through the online platform. Many students have also indicated they liked to view the videos (Figure 8) which helped them to identify the incorrect laboratory safety practices and describe the correct safety procedures required in laboratory more effectively. Students also mentioned that the waste disposal game has helped them to identify the proper disposal of various wastes generated in laboratory (Figure 8).

Students also mentioned during conversations with their tutors that they enjoyed learning through the interactive platform and they hope to continue to learn the laboratory safety practices through the platform. Many of them also said that the platform was easy to explore and the messages incorporated were cleared and easy to understand.

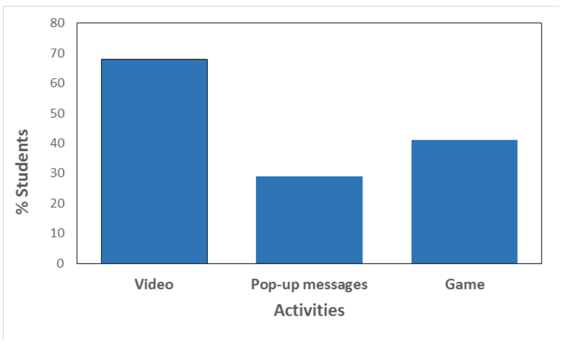


Figure 8: Popularity of the activities among students. 68% of the students preferred to view the videos and 41% of them liked to learn through the game

Discussion

Laboratory Safety – The Challenges

The principle behind the laboratory safety practices may be better communicated through the use of an active pedagogy that captures the attention of the students as suggested by Dewey as early as 1933. Educators agree that a pedagogy based on the lecture format is less effective than an interactive classroom (Johnstone & Percival, 1976; Burns, 1985; Fensham, 1992; Staley, 2003 cited in Blasco-Arcas, et.al., 2013). Students are generally pictorially oriented due to their experience of digital technologies and stylish diagrams in print (Miliszewska & Sztendur, 2011). In addition, these students have shortened attention spans and reduced interest in reading print (Miliszewska & Sztendur, 2011). This is especially true for the teaching of the laboratory safety as boredom has been identified as the greatest challenge for effective training of the safety (Hill & Nelson, 2005).

Quantitative & Qualitative Evaluation of the Platform

The online interactive platform developed in School of Chemical & Life Sciences has addressed the key issues and is effective in teaching the laboratory safety based on the results collected from the control and experimental group. The experimental group has demonstrated better performance as compared to the control group (Figure 5-8 and Table 1).

This has been also supported with the informal feedback gathered after the implementation of the online interactive platform from the 12 tutors who were teaching the practical lessons for Year 1. All the 12 tutors mentioned that they did not observed improper disposal of the wastes among the students after the implementation. And there was only 1 out 12 tutors has observed that student came in improper attire for the practical lessons. Three tutors have however occasionally observed improper laboratory behaviours such as opening door with gloves on and putting personal items on the bench.

Conclusion

The platform showing the typical laboratory setting with common scenarios allows the students to better relate to the real practical session. The platform was designed to be vibrant and colourful to satisfy the students' need of pictorially illustration for learning (Figure 1). The acceptability and the introduction of pictorial scene into academic curricula as medium for the teaching has already been demonstrated by Di Radio (2006) who used interesting and attractive comics to teach chemistry laboratory safety.

ICT allows the planning of fun, interactive activities keeping the teaching fresh, current, and interesting (Baid & Lambert, 2010). This can be enhanced by combining multiple forms of media together (multimedia) such as text, graphics, images, animation, audio and video (Eskicioglu & Kopec, 2003 cited in Baid & Lambert, 2010). Our online interactive platform has tapped on ICT to help to sustain interest among the students.

The pop-up messages narrated through the scene and the videos (Figure 2) incorporated offering a variety of learning methods that would attract the students' attention and interest. The game (Figure 3) on the other hand has certainly brought excitement among the students and further motivate them to learn laboratory safety more effectively. The platform also allows students with different learning pace to achieve the learning outcomes at their own pace, own time and venue. This may also explain the tremendous improvement in the assessment results for the experimental group. This group of students has the flexibility to learn at their own pace and convenience therefore achieving better learning experience and outcomes.

The proposed online interactive platform was found to achieve better learning experience and outcomes than the traditional "Briefing" methodology. It is recommended that the proposed online interactive platform be adapted to other Years of students in the School of Chemical and Life Sciences for the teaching and learning of laboratory safety.

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ENHANCING FLIPPED CLASSROOM LEARNING: VALIDATING AN EVIDENCE-BASED APPROACH

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Abstract

This paper summarizes the approach and outcomes of a flipped classroom teaching innovation using an evidence-based approach (Petty, 2009; Hattie, 2009; Sale, 2015) in a Digital Electronics module at Singapore Polytechnic for 3 consecutive years. The paper outlines both the rationale of implementing the flipped classroom format and the evidence-based pedagogic framework employed. It then shares the full instructional strategy, demonstrating how high effect teaching methods, calibrated to cognitive scientific principles, were combined with appropriate educational technology tools to create highly effective learning experiences for students. The outcomes of the innovation were evaluated based on 2 areas – (1) the subjective experience of the students in terms of how they felt about the programme and their learning and (2) actual attainment levels in terms of meeting stated outcomes. For the first area, initial data were mainly collected using student surveys. During the third year of implementation, more extensive evaluation methods such as using students as co-participants and evidence-based reflective practices were incorporated. Student feedback clearly showed that they were positively receptive to the flipped classroom format. In terms of attainment levels, comparison was made between the flipped classes and the entire cohort of students taking the same module, with overall results from both formative and summative assessments throughout the semester. Results showed a consistent improvement in student attainment for consecutive 3 years. From the 3 years' experience, it is suggested that the flipped classroom format, when underpinned by a strong evidence-based pedagogy, guiding both the learning design process and the selection and creative use of educational technology tools, can be an effective and efficient format for student learning. A key challenge will be in further developing the *creative teaching competence* necessary for expertise in designing and facilitating the student learning experience using the approach presented here.

Keywords: *flipped classroom, evidence-based, high effect methods, engineering education, educational technology*

Introduction

Educational Technology (EduTech) was identified by Singapore Polytechnic (SP) in October 2014 as one of the key initiatives to prepare our students to be life ready, work ready and world ready. The EduTech initiative has 3 focus areas, namely (1) to promote EduTech literacy of teachers, (2) to integrate the use of EduTech tools in large modules (more than 500 students), and (3) to cultivate an EduTech learning community through sharing sessions. At present, the flipped classroom is the most popular blended learning format used in SP when integrating the use of EduTech tools in the large modules (e.g. Lee, Ng & Quek, 2015; Chua-Moraes, Kee & Wah, 2015).

We have been flipping the Digital Electronics module in the School of Electrical and Electronic Engineering in SP for 3 years and the results have been encouraging (Teoh & Wan, 2014; Chong & Wan, 2015). This has led to a more substantive research approach to identify the critical success factors underpining the design and facilitaiton of the flipped classroom format.

From prior research, the students' ability factor has been explored (Teoh & Wan, 2014; Chong & Wan, 2015) and it was documented that weaker students benefitted from flipped learning and underpinning this success may have been the application of an Evidence-Based Teaching approach (EBT) (Petty, 2009; Hattie, 2009; Sale, 2015).

This paper documents our ongoing research project which is systematically employing and evaluating an EBT approach to flipped classroom learning. Key apsects of the approach and methodology are identified and illustrated, new findings presented and interpretations made, and a frame regarding the impact of using an EBT approach as a learning model underpinning flipped classroom practices is summarized.

Pedagogic Approach

There is much interest in flipped classroom among the academic staff in SP, which reflects the wider global activity in terms of delivery modes. The flipped classroom is essentially a blended learning format, and there is increasing evidence of its effectiveness over both fully online and face-to-face delivery modes (e.g. Means, Toyama, Murphy, Bakia, & Jones, 2010), as well as the obvious efficiency benefits of cost saving.

However, despite the buzz around the flipped classroom as an exciting new pedagogical approach, there is a lack of consensus on what exactly the flipped classroom is and how best to implement it, especially in pedagogic terms. Indeed, a major critique of flipped classroom in the literature is the lack of a learning model to base the learning design on. As noted by Picciano, Dziuban and Graham (2014)

> A prominent feature of much of *design* research to date has been a focus on surface features, or physical attributes (e.g. online, face-to-face), of the design without articulating clearly the core pedagogical attributes. (p.27)

> …the heavy focus in existing models on physical or surface-level characteristics rather than pedagogical or psychological characteristics is impeding progress. (p.29)

The original design of the flipped classroom for Digital Electronics (Teoh & Wan, 2014) was based on the 3 distinct stages proposed by Norrman (2014). This 3-stage flipped classroom design was enhanced pedagogically in 2015 through the application of key principles of an EBT approach documented by Chong & Wan (2015). For example, in the learning design process, high 'Effect-Size' teaching methods (those most likely to have high effect on student attainment - Hattie, 2009), were calibrated to cognitive scientific principles relating to how people learn best (Willingham, 2009; Sale, 2015). Furthermore, the selection of EduTech tools was based on their predictive capability to enhance specific aspects of the learning process. For example, the EduTech tool Kahoot was chosen for its capability, when used effectively (especially creatively) to get good student attention and engagement with the content learning, activate prior knowledge and check conceptual understanding. In the language of cognitive science, this had an excellent *von Restorff Effect* and hit the 'sweet spot' in terms of an appropriate motivation strategy for many students. The approach taken and research outcomes are more fully documented elsewhere (Sale, 2015; Chong & Wan, 2015). The aim is to create learning experiences that have high predictive outcomes in terms of students' attainment opportunities and an engaging learning experience. The design process is illustrated in Figure 1: EBT Design Process for Blended Learning.

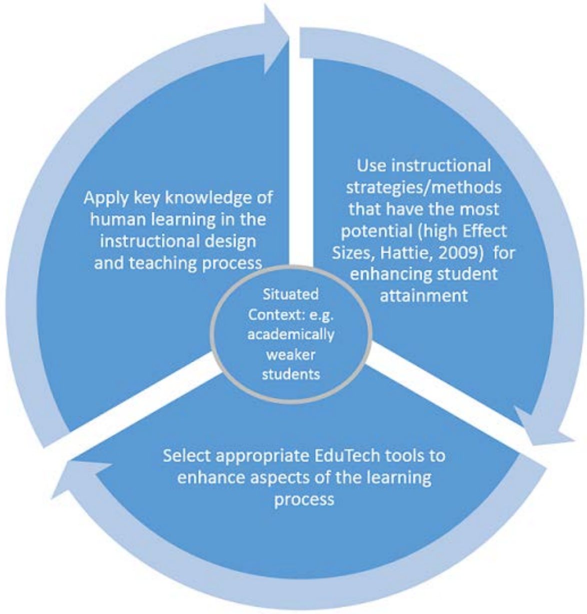


Figure 1: EBT Design Process for Blended Learning

In practice this design process is iterative, seeking to refine the blending of methods, cognitive scientific principles, and EduTech tools, to continually improve both the lesson design and teaching practices. The blending of high effect-size methods to create powerful learning experiences as been analogously referred to by Hattie (2009) as "Russian Doll" strategies. For readers not familiar with 'Russian Dolls', they are a set of different sized dolls, usually around 5, and they fit one inside another from the smallest to the biggest. Figure 2's illustration of Hattie's Russian Doll analogy provides a visual example of high effect method combination.

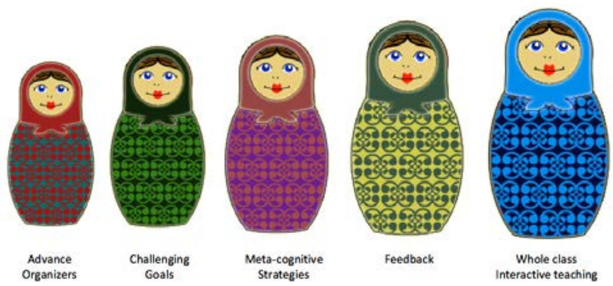


Figure 2: Hattie's Russian Doll Analogy

Hattie, for example, noted how a number of effective methods can be strategically and creatively combined to produce powerful instructional strategies that significantly impact student attainment. To quote Hattie:

> …some effect sizes are 'Russian dolls' containing more than one strategy. For example, 'Feedback' requires that the student has been given a goal, and completed an activity for which the feedback is to be given; 'whole-class interactive teaching' is a strategy that includes 'advance organizers' and feedback and reviews. (p.62)

In our approach, the Russian Doll analogy is further enhanced in terms of the blending process to incorporate those EduTech tools that have a best predictive outcome for supporting aspects of the learning process. As Sale (2015) highlights:

> In terms of Hattie's 'Russian Doll' analogy, the dolls are getting an added ICT 'makeover', so to speak. (p.141)

The ongoing professional development process is modelled on the long established Japanese method of *Lesson Study* (Stigler & Hiebert 1999), where groups of teachers meet regularly to work on the design, implementation, evaluation, and improvement of a specific lesson over time. In this process they observe each other teach, obtain feedback from students and seek to develop the most effective and efficient lesson for the particular topic area. For example, at the end of each lesson, feedback was obtained from the students using an exit poll and used as part of the evaluation approach for the next lesson design. Over time many modifications and refinements were made, which is to be expected in any new area of learning requiring good thinking and deliberate practice to achieve competence and, eventually, expertise.

The underpinning EBT principles are summarized below:

- The selection of methods are those deemed most suitable for promoting high attainment opportunities (e.g. high Effect Sizes) but contextualized to the situated context (e.g. learning outcomes, student profile and resource access and availability)
- Thoughtful application of the following cognitive scientific principles (e.g. Core Principles of Learning, Sale (2015)) as key guiding heuristics to design our flipped learning experiences:

1. Motivational strategies are incorporated into the design of learning experiences
2. Learning goals, objectives and proficiency expectations are clearly visible to learners
3. Learners prior knowledge is activated and connected to new learning
4. Content is organized around key concepts and principles that are fundamental to understanding the structure of a subject
5. Good thinking promotes the building of understanding
6. Instructional methods and presentation mediums engage the range of human of senses
7. Learning design takes into account the working of memory systems
8. The development of expertise requires deliberate practice
9. A psychological climate is created which is both success-orientated and fun
10. Assessment practices are integrated into the learning design to promote desired learning outcomes and provide quality feedback

- Selection and infusion of EduTech tools are based on the above EBT approach (e.g. EduTech tools that can enhance key aspects of the learning process in a given instructional design – lesson).

Implementation: Translating EBT into everyday practices

Digital Electronics (ET1003 and ET1004) is one of the fundamental core modules which all first year students in the School of Electrical and Electronic Engineering (EEE) have to study. The traditional class consists of 60 hours of instruction per semester of 15 weeks; divided into 30 hours (2 hours per week) of lectures, and 15 hours each of tutorial and laboratory sessions (2 hours per fortnight of alternating tutorial and laboratory lessons). The module was first flipped in 2004 and this is the third year we are flipping the module. For all 3 years, the 2-hour lecture was flipped.

There are 6 diplomas offered by the EEE. Table 1 below shows the breakdown of the pilot groups involved.

Table 1: Breakdown of Pilot Groups

Year/ Semester	Module Code	Diploma(s) Involved	No of students involved	No of lecturers involved
2014/2015 Sem 1	ET1003*	DCEP (2 out of 8 classes)	36 (motivated students)	1
2014/2015 Sem 2	ET1004*	DEEE (2 out of 24 classes)	35 (academic ally weaker students)	1
2015/2016 Sem 1	ET1003	DCEP (4 out of 8 classes) DEB (2 out of 2 classes)	112 (randomly picked)	3
2015/2016 Sem 2	ET1004	DASE (4 out of 8 classes) DCEP (1 out of 4 classes)	88 (randomly picked)	3

*ET1003 - Digital Electronics 1 (taught in semester 1)
*ET1004 - Digital Electronics 2 (taught in semester 2)

The implementation methodology was similar to previous pilots (described in Chong & Wan (2015)). Table 2 shows an overview of the flipped learning design:

Table 2: Overview of the Flipped Learning Design

Flipped Classroom Stages	Cognitive scientific principles	Key teaching methods used	EduTech tools used
Pre-Class	Core Principles of Learning by Sale (2015)	-Video lectures -Two-way feedback -Quiz	-Screen-O-matic -WhatsApp -Socrative
In-Class		-Mini lectures -Application activities -Peer instruction -Mid-point quiz -Learner support for weaker students	-Kahoot/ Socrative
Post-Class		-Exit poll -Two-way feedback -Question and Answer video	-Socrative -WhatsApp -Screen-O-matic

However, it is important to remember that even high effect methods or EduTech tools are likely to lose the level of attention or attainment impact if over-used. Quite simply, students will become habituated to them, even bored. As with our favourite foods, if we eat them too often and in too much quantity, they lose that 'wow' appeal. That's how the human mind works in this respect, and most vividly described by Friedrich Nietzsche:

> Against boredom even gods struggle in vain

Hence, over reliance on any particular EduTech tool is not advised and the same principle applies to method use. There is no one single 'silver bullet' method, just better methods in context. Fortunately, now, there are an increasing number of effective and interesting EduTech tools that can be blended into the instructional strategy to create sufficient variation to reduce habituation. In fact, creative blending, using the approach outlined in this paper, offers a practical metaphor for motivated teaching professionals to become 'Adaptive Experts' (Hatano & Inagaki, 1986) in *Creative Teaching Competence* as depicted by Sale (2015). Adaptive expertise is seen as the ability not only to solve routine problems, but also those posing novel and unpredicted features. In the same context, creative teaching competence refers to the ability to blend methods, EduTech tools and other resources into high impact instructional strategies and apply them effectively and creatively in practice.

Evaluation

The evaluation focused on two key areas: (1) the subjective experience of students in terms of how they felt about the programme and their learning and (2) actual attainment levels in terms of meeting stated outcomes.

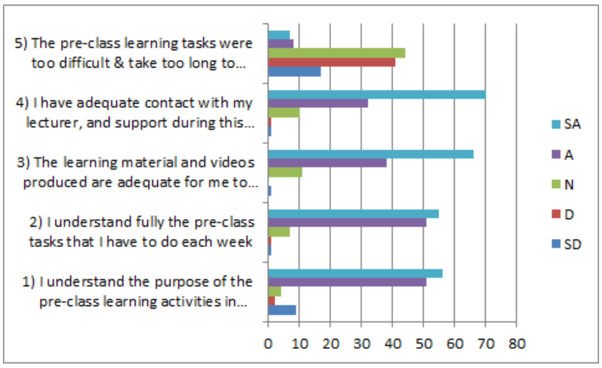
For the first area, initial data were mainly collected using student surveys. During the third year of implementation, more extensive evaluation methods such as using students as 'co-participants' (e.g. Lincoln, 1990) and a systematic Evidence-Based Reflective Practice approach (Sale, 2015) were incorporated. The use of student as co-participants in the research process proved invaluable as it meant we were able to explore in more depth how they were experiencing the ongoing flipped classroom activities and which aspects were more (or less) effective from their perspective.

For the pilot in 2015/2016 semester 2, 18 out of 88 students were involved in the research. It is to be noted that the students were volunteers (not 'conscripts') and expressed an interest in working collaboratively with the teachers towards enhancing learning effectiveness in this new flipped classroom environment. They were fully briefed on their role as members of the research team, which included conversing with classmates on the learning experiences, and recording key summaries at the end of each lesson. Finally, a focus group session was conducted at the end of the semester by an independent evaluator fully familiar with the flipped classroom format and EBT.

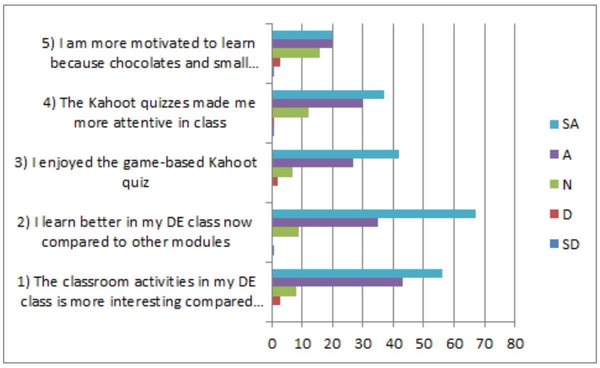
Results from Student Surveys

Student surveys were conducted at the end of each semester to identify key aspects of the subjective experience of the students. Figure 3 shows the consolidated responses over the 3 years. Altogether 118 out of 271 students responded to the survey. The questions were on a 5 point Likert scale from Strongly Disagree (SD), Disagree (D), Neutral (N), Agree (A) to Strongly Agree (SA). There was also a free response question at the end of every section for students to give their comments and views freely.

Pre-Class Phase



In-Class Phase



Post-Class Phase

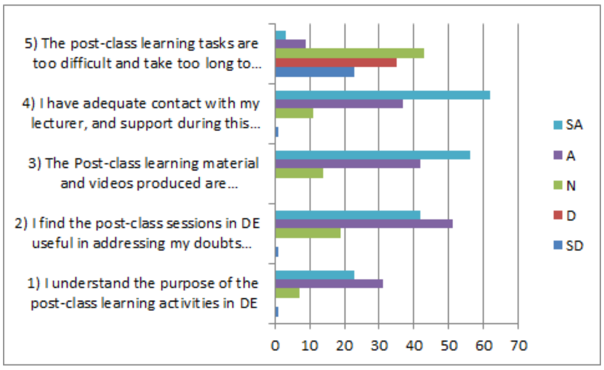


Figure 3: Consolidated Responses of Student Surveys

Data from Student Co-participants

The focus group of student co-participants comprised 11 of the class members. Based on agreed areas by the majority of students, the following inferences and interpretations were recorded:

- The anytime, anyplace and opportunities for repeated exposure received a strong majority affordance (which was to be expected).
- The use of the EduTech tools such as WhatsApp, Socrative Exit Poll and Kahoot were widely noted as supporting learning. Students found the provision of the short videos both supporting of content understanding and interesting. They also identified and confirmed the learning benefits of some of the key explicit EBT strategies employed (e.g. activation of prior knowledge, checking understanding, timely and quality feedback, and the creation of humour and fun as part of the learning experience).
- Of note, while the design of the instructional strategy is important, much of the feedback seemed to be contextualized to how individual teachers actually facilitated the learning process and interacted with students. In most basic terms the teachers' style, personality and competence are key components determining the success or otherwise of a flipped classroom approach. However, that applies to teaching in any context, which is widely documented in the literature (e.g. Izumi & Evers, 2002; Rowe & Rowe, 1993).

Overall, the students' reporting of their learning experience from the focus group interviews is consistent with the positive data from the student surveys.

Student Performance

Apart from what the students told us about their learning experience, we also wanted to find out the actual attainment levels in terms of meeting stated outcomes. We used both formative and summative assessment strategies to facilitate our learning goals and objectives throughout the semester.

Comparison was made between the flipped classes and the entire cohort of students taking the same module, with *overall results* computed using marks from general participation, continual assessment, laboratory tests, mid-semester test and final exam. Figure 4 shows the comparison of student performance over 3 years.

The results show better student attainment for the flipped classes as compared to school overall. Furthermore, there is a consistent improvement in student attainment for consecutive 3 years.

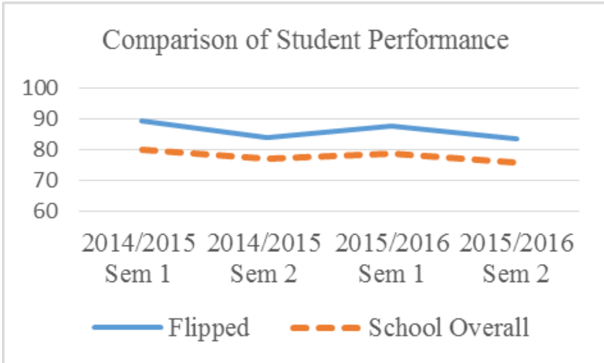


Figure 3: Comparison of Student Performance

Evidence-based Reflective Practice

During the pilot in 2015/2016 semester 2, we used an Evidence-Based Reflective Practice Approach (Sale, 2015), to structure our evaluation of the learning experience in terms of method effectiveness, compliance with Core Principles of Learning, and impact of the EduTech tools used. Reflective Practice is far from new in the literature and practices of teachers. However, as Hattie (2009) wrote:

> The current penchant for "reflective teaching" too often ignores that such reflection needs to be based on evidence and not post-hoc justification. (p.241)

The point is that reflection on practice, without a clear evidence-based framework for what one is seeking to develop and an effective mode of inquiry (good thinking), will likely result only in partial and limited improvement at best. Willingham (2009) made the key point concisely:

> Education makes better minds, and knowledge of the mind can make better education. (p.165)

Summary and Recommendations

The evaluation to date is proving a rich bank of data, both qualitative and quantitative, supporting an EBT approach for the design and facilitation of a flipped classroom format; indeed for blended learning per se.

In summary, from the 3 years' of implementation and ongoing evaluation, we conclude that the flipped classroom blended learning approach, when underpinned by an evidence-based pedagogy, is an effective and efficient format for student learning. A key challenge will be in further developing the *creative teaching competence* necessary for expertise in designing and facilitating the student learning experience using the approach presented here.

Finally, and perhaps the most significant finding, is establishing the basis for a high level of pedagogic literacy (Sale, 2015) which is essential for learning design, irrespective of delivery mode. Teachers need to be fully conversant with validated research on human learning and how this translates into effective and efficient instructional strategies. As Olbrish Pagani (2013) argued:

> Technology will change, but good design is constant. (p.8).

Acknowledgements

Special thanks to Dennis Sale who guided us in using the evidence-based teaching approaches to enhance our flipped classroom implementation.

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What math teachers at Kosen can do as experts in their fields

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Abstract

This paper attempts to explain how teachers at Kosen can adopt their own study to their classes or homerooms. Here, Kosen represents colleges of technology in Japan, five-year schools for students from 15 years old. Teachers at Kosen are also researchers in various fields of study such as engineering, mathematics, physics, literature, philosophy, etc. Since they check the newest or hottest research everyday via web news, preprint servers, journals, SNS or news letters from their societies, they can adopt such topics to their field of education before others. Moreover, they can explain the topics to students professionally, and students would be able to derive rich knowledge and motivation to learn. Now we need to discuss what exactly teachers at Kosen can effectively do as experts in their field of research during classes and homerooms in a limited amount of time. In this paper we report an effort in this matter by the authors working on mathematics. They held a supplementary lecture in which anyone in the college can participate with the theme of math games and linear algebra. They introduced a math game called Region Select which is based on a recent study of knot theory, which is a branch of topology in mathematics. Although one can play Region Select just as a puzzle game, the game can also be played using linear algebra. More precisely, we can find the solution to the game by solving simultaneous equations modulo 2, and we can also find that the number of the solutions is always just four by considering the rank of the coefficient matrix. The authors tried to make students aware of this fact through active group discussions about how to find the solution to the game.

Keywords: *Active learning, homeroom teaching, linear algebra, mathematics teaching, region select*

Introduction

Since teachers at Kosen are experts in various fields of study, they can adapt hot topics of the study to the fields of education. For example, the first author introduced three hot topics of mathematics to her homeroom students briefly; pentagonal tiling, the fold-and-cut theorem and knot theory. In particular, pentagonal tiling was a very hot topic in mathematics at that time because it was just after the discovery of a new important tiling. Some students checked up on the topics by themselves with interest, and they made posters and displayed them at a school festival.

Figure 1: Pentagonal tiling made of origami.

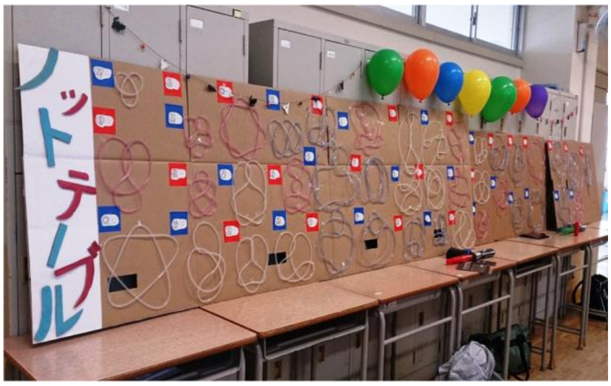

Figure 2: Knot table made of strings.

Knot theory, which is a branch of mathematics, is applied to fields of education positively and widely. For example, *Region Select*, that is a puzzle game based on knot theory created in 2011, is expected to apply to primary education making good use of the friendly design of the game without words or numerical equations. Also, there are efforts to apply Region Select to rehabilitations to train cognitive functions to recognize shape.

Figure 3: Region Select (Android app. version).

Materials and Methods or pedagogy

We planned a supplementary lecture which was open for every student in the college and was announced by the following poster.

Figure 4: The poster of the supplementary lecture.

The lecture consists of the following two parts:

Part I: ***Let's think with modulo!*** In this part we give a lecture about "modulo".

(a) The lecture starts with the following question:

<u>**Question 1**</u> *What day of the week is it today one year later?*

In fact, this question concerns with the concept of "modulo", which is a term in number theory in mathematics.

(b) Teachers introduce the definition of modulo as follows:

<u>**Definition 2**</u> Let m be an integer. We say integers x and y are *congruent modulo m* if $x - y$ is an integer multiple of m, i.e., the remainders of the division of both x and y by m are the same, and write $x \equiv y \pmod{m}$.

(c) Students try the following exercises:

<u>**Exercise 3**</u> *Prove the following:*
If $x \equiv y \pmod{m}$ and $x' \equiv y' \pmod{m}$, then (1) $x+x' \equiv y+y' \pmod{m}$ and (2) $xx' \equiv yy' \pmod{m}$.

<u>**Exercise 4**</u> *What day of the week is it today 34 years later?*

<u>**Exercise 5**</u> *Find the integer x ($0 \leqq x \leqq 6$) satisfying the following equations (1)-(3):*
(1) $8x \equiv 9 \pmod{7}$.
(2) $3x \equiv 1 \pmod{7}$.
(3) $7x \equiv 2 \pmod{7}$.

Part II: ***Let's play Region Select!*** In this part we play the math game "Region Select" with group-work style.

(d) Teachers explain about topology and knot theory quickly.

(e) Teachers introduce Region Select and show examples on a blackboard. Each pair of students play Region Select together with a small white board; One drew a knot figure and make a game, and the other try it.

(f) Students discuss how to find the solutions to Region Select and show it.

Goal: Students set up simultaneous equations modulo 2 to find a solution.

Results and Discussion

Eleven students, most of them are third grade, joined the supplementary lecture. They attended the lecture more actively than usual lessons, and could reach our goal. More precisely,

(a) A student answered the question quickly with the clear reason: "Because the remainder of the division of 365 by seven is one."

(b) The definition of modulo was well-understood by the students.

(c) **Exercise 3**: Some students succeeded the proof of (1) and one of them showed it using blackboard. A proof of (2) was explained by the teacher. And after that, a student found out another way of proof and explained it to teachers and students.

Exercise 4:Because it was running behind schedule, the formula "365×34+8" was given by the teacher in advance, and students found the answer by using properties of Exercise 3.

Exercise 5: From this question, this lecture tended to group-work style. All students discussed about the question for about 15 minutes, and three students explained it by using blackboard.

Figure 5: Part I.

(d) Students seemed to listen carefully. Some students took a memo.

(e) They understood the rule of the game and were trying it excitingly. They were also surprised when a teacher told them that the game can be solved for any knot figure with any initial condition.

(f) One of the students could set up simultaneous equations to solve the game, and explained it to the other students. Some students also challenged to find another way of solutions.

At the end of the lecture, the teacher added a comment that the Region Select game can be expanded to mod m for any natural number m.

Figure 6: Part II.

Students' comments

-We enjoyed a lot. (9 students)
-We would like to join again if we have a chance. (5 students)
-It was little bit difficult for me. (3 students)
-I hope the usual classes to be like this. (3 students)
-I like this lecture because we can relax and speak freely. (2 student)
-I could see how this topic and linear algebra relate each other and I think it is interesting. (2 students)
-I would like to use this topic in the future. (2 students)
-I want to share today's topic with my friends. (1 student)
-It is fun to listen the other's opinions and solutions. (1 student)
-Group work is fun and helps us to understand well. (1 student)
-Honestly, active learning style does not fit me because I want to listen to teacher's explanation carefully during class and think it over by myself later. (1 student)
-Topological thinking is interesting. (1 student)
-It is amazing that Region Select is well-defined and I want to make such games. (1 student)
-I got a new knowledge. (1 student)
-I think this lecture makes students like mathematics. (1 student)

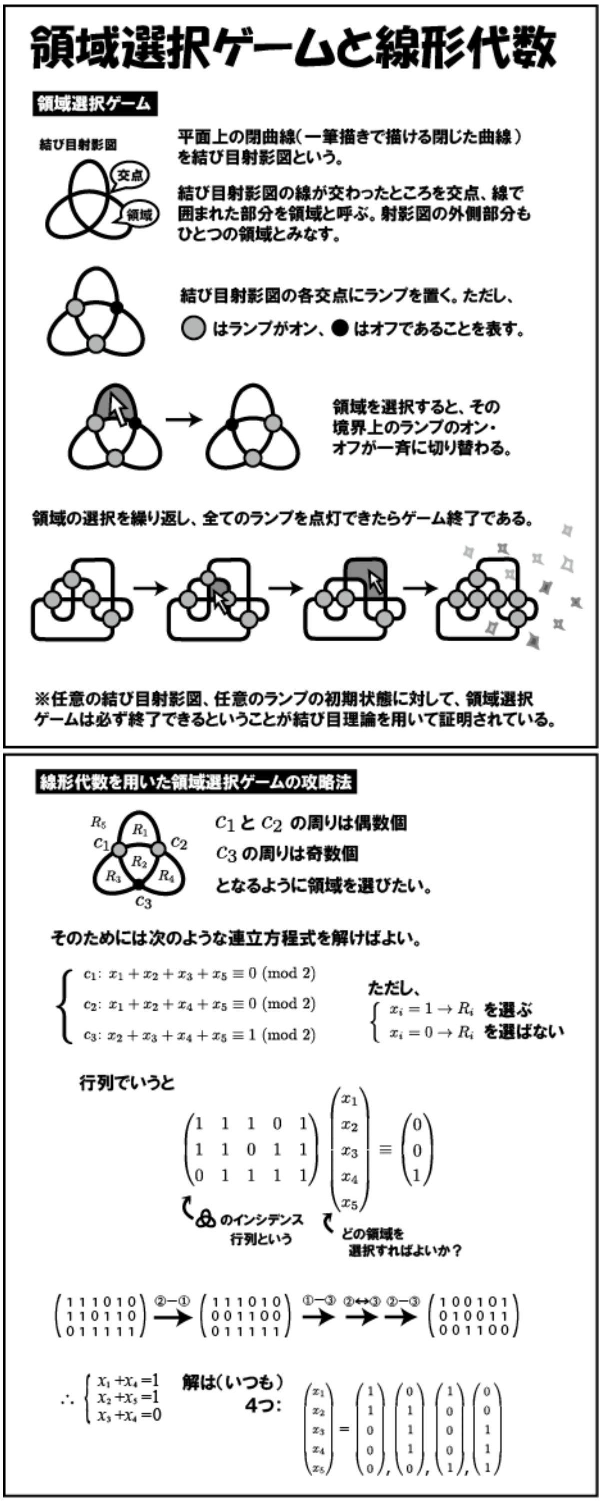

Figure 7: Handout for review.

Conclusions

Students seemed to have active and enjoyable time at the lecture and most of them spoke up their opinions during the exercises. Since it is difficult to estimate the right amount of time needed to the lecture, this style seems to be suitable for homerooms or supplementary lectures.

Acknowledgements

The authors thank Professor Han Yoshida for helping them at the lecture and taking pictures there.

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2203

USING APPS FOR LEARNING ASSESSMENT

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Abstract

The assessment of learning is a lifelong process that allows decisions and judgments about the achievements of a student before, during and at the end of the educational experience. In traditional school, teachers has chosen to evaluate learning with a only instrument, exam. This type of evaluation usually consists of a series of questions usually written and expects an open answer, an explanation that describes the solution to the question usually using memory, this practice is used to evaluate and qualify the knowledge acquired by student. The purpose of this paper is to demonstrate that the use of technology in the process of learning assessment helps to improve the educational experience, because it causes the student a better level of understanding of the contents evaluated, provides a playful atmosphere even competition among students, determine areas of opportunity for the teacher to develop strategies of feedback for concepts not included, consider the test only as a part of the integrated grade.

Introduction

Mexico is living a profound educational transformation, which sees the school as the center of public policies, looking for professionalisation of teachers, improving infrastructure and equipment, updating the curriculum, and the participation of parents family in the formative process, Constitution and laws was modified to addevaluationn of Education the term quality education, and the National Institute for Evaluation of Education was created (*INEE for their initials in spanish*) with assessment processes are:

- Improve the quality of education.
- To guide the formulation of educational policies.
- Measure the degree of learning alumnus.
- Improve school management.
- Promote transparency and accountability. (Nuevo Leon State Government, 2016):

This year, the Government of Mexico presented the Educational Model 2016, this document includes the evaluation as a process for improving students, being a factor that promotes the transformation of pedagogical practice and monitor learning during the educational path of students. In the 2016 model, the evaluation must be consolidated as a process that contributes to cognitive self-regulation through feedback and meaningful rather than rote learning. The evaluation must be the result of a variety of methodologies and tools and, being part of a teaching sequence should not be exclusively conclusive or summative. In that sense, it is necessary that teachers observe some essential methodological principles. First, they must conceive learning as a process that can learn, create an appropriate environment for learning and utilize ICT – Information and Communication Technologies- to support learning processes and assessment (SEP, 2016).

Assessment processes of learning at school are made in writing, with a series of questions that await an open response, that describe how memorized the answer, in the best case can be questions with multiple choice answers , true / false, fill related keywords gaps in the definitions. In my teaching experience, use of information and communications technology in learning and assessment processes have allowed me to improve the educational experience of my students, using various technological tools and systems for the management of learning such as Moodle, using applications of software for creating learning activities using JClic and games like Hot Potatoes, Organization of learning activities, assignments and assessments using Edmodo, and learning assessment with Kahoot and Socrative.

Using of Apps for learning assessment as Kahoot allows a playful learning and healthy competition through games, Kahoot is a platform for free based learning games (Kahoot Academy, 2016) using the term Gamification as the use of mechanical playing in recreational environments and not in order to enhance applications, motivation, concentration, effort, loyalty and other positive values common to all games. This is a powerful new strategy to influence and motivate groups of people. (Gamification, 2013)

Materials and Methods or pedagogy

The proposal applied in my group of students for learning assessment is the use of applications (Apps) as Kahoot.it, socrative.com or edmodo.com may also include the use of assessment tools that provide platforms the learning management system as moodle.com or blackboard.com.

For the group of students who I work consider using the App Kahoot.it, this tool allows the creation of quizes, discussions, and surveys, these can be answered using the smartphone, tablet or computer access to Internet.

The first step is to create an account in the address getkahoot.com and access to the system in which the test is created. Once you have your user account and password, you have access to the website administration panel Kahoot, the following figure 1 shows the screen Kahoot management.

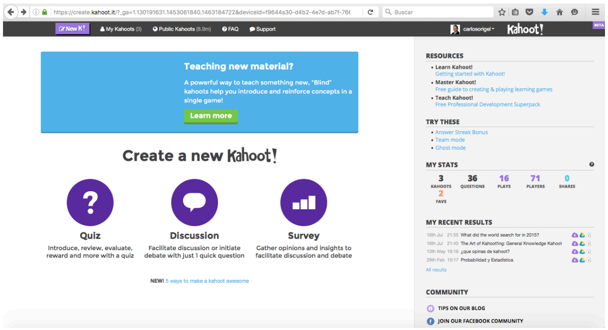


Figure 1. Management Panel Kahoot.

The second step is to create the test. In the figure 2, you can see three test options: quiz, start a discussion or survey. For our purposes of assessment learning we use the quick test Quiz. Figure 2 shows the screen in which the description of the test with title options is performed, the description, visibility, language and audience, you can include an image or video as the cover of the test.

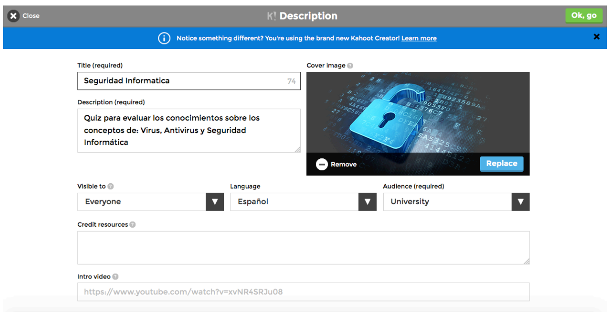


Figure 2. Page of options test description.

Once it has the description, the next step is to create the questions. Professor builds test, writing the question and add answers include multiple choice, true or false, or complete response, of which one is correct.

The professor gives the number of points that will add value to the correct answer and sets the time it will take the student to provide his response, the question may include images that support the description of the question and you can even add videos to improve the experience. Figure 3 shows the panel to create the question.

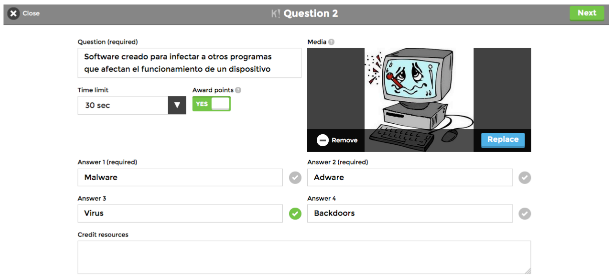


Figure 3. Panel to create questions.

Once you have the complete test, you can see the questions in the overviewing panel, each question can be edited, copied, deleted, or change the time limit for response, this can be seen in Figure 4.

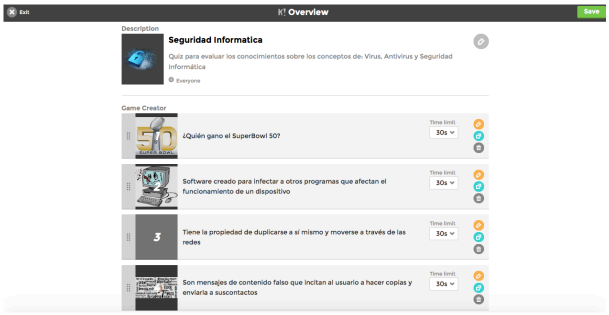


Figure 4. Panel overall view.

At the end of the design of the test, teacher launches the test and projects each of the questions, to start the game a PIN number shown, this number you should write the student in a web browser on your phone, tablet or computer in kahoot.it page, figure 5 shows the simulator game with the screen that projects the teacher and the screen shown to the students in his cell, this figure shows that the game can be done in two modes: classic and by teams.

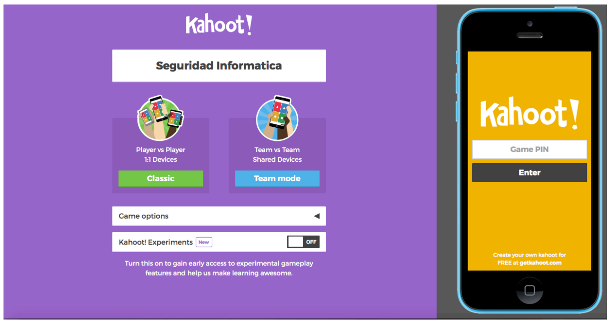


Figure 5. Simulator test.

Figure 6 shows the screen of the simulator in which the PIN is requested, once the PIN is introduce, it is asked students their name to register it as a player, so each student will add to the game.

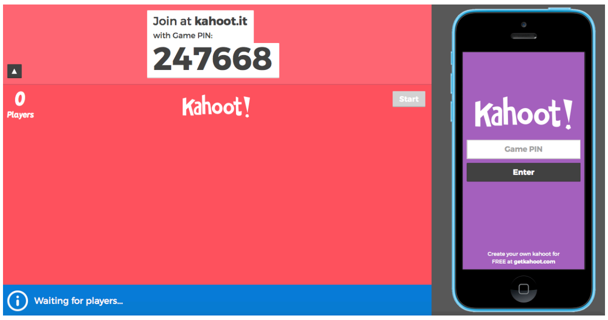


Figure 6. PIN to join the game.

In the projector the question is displayed, start to discount the time limit and expect the student's answer, in the electronic device or the student's computer just a series of geometric figures that correspond to each of the responses shown (Figure 7), the students should select the figure that corresponds to the correct answer within the granted time, when the time question expire, the application displays the number of students who answered correctly and the number of students who did not do so, so we can provide feedback on each question when the largest number of students do not answer correctly (Figure 8), after each question the application displays the ranking of the top 5 students answered correctly and in the shortest possible time (Figure 9), which makes it become a competition to respond as quickly as possible and correctly, in the team mode you can even compete with teams of students.

Figure 7. Panel questions projected by the teacher and answers panel that has the student.

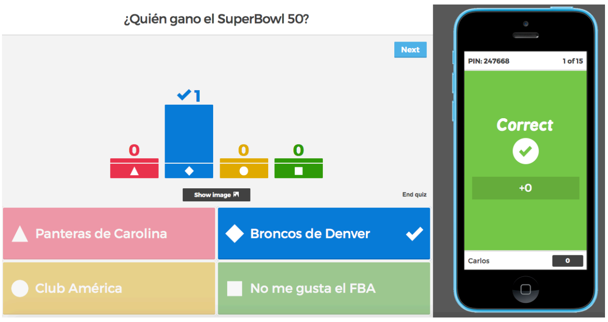


Figure 8. Bar graph with the number of students that answered correctly.

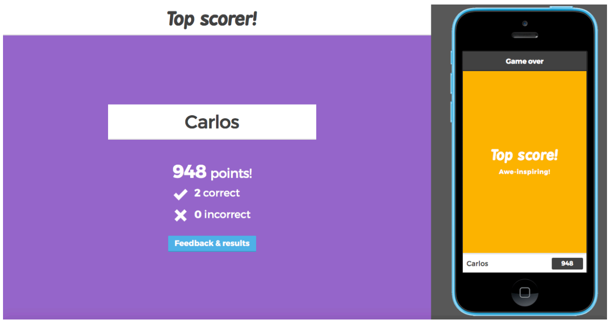
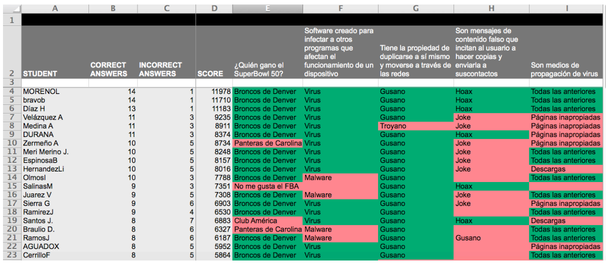


Figure 9. Top Scorer with the highest scores.

The test system provides an overview in Excel with the number of students and the answers that were answered correctly and that no, also provides a summary for each student, the time it took to respond and if he did so correct or not (Figure 10). With these summaries can determine what issues or questions need to strengthen knowledge and provide feedback.



STUDENT	CORRECT ANSWERS	INCORRECT ANSWERS	SCORE	¿Quién gano el SuperBowl 50?	Software creado para infectar a otros programas que afectan el funcionamiento de un dispositivo	Tiene la propiedad de duplicarse a sí mismo y moverse a través de las redes	Son mensajes de contenido falso que incitan al usuario a hacer copias y enviarla a suscontactos	Son medios de propagación de virus
MORENOL	14	1	11978	Broncos de Denver	Virus	Gusano	Hoax	Todas las anteriores
bravob	14	1	11710	Broncos de Denver	Virus	Gusano	Hoax	Todas las anteriores
Díaz H	13	1	11183	Broncos de Denver	Virus	Gusano	Hoax	Todas las anteriores
Velázquez A	11	3	9235	Broncos de Denver	Virus	Gusano	Joke	Páginas inapropiadas
Medina A	11	3	8911	Broncos de Denver	Virus	Troyano	Joke	Páginas inapropiadas
DURANA	11	3	8374	Broncos de Denver	Virus	Gusano	Hoax	Páginas inapropiadas
Zermeño A	10	5	8734	Panteras de Carolina	Virus	Gusano	Joke	Páginas inapropiadas
Meri Merino J.	10	5	8248	Broncos de Denver	Virus	Gusano	Joke	Todas las anteriores
EspinosaB	10	5	8157	Broncos de Denver	Virus	Gusano	Joke	Todas las anteriores
HernandezLi	10	5	8016	Broncos de Denver	Virus	Gusano	Joke	Descargas
OlmosI	10	3	7788	Broncos de Denver	Malware	Gusano		Todas las anteriores
SalinasM	9	3	7351	No me gusta el FBA		Gusano	Hoax	
Juarez V	9	5	7308	Broncos de Denver	Malware	Gusano	Joke	Todas las anteriores
Sierra G	9	6	6903	Broncos de Denver	Virus	Gusano	Joke	Páginas inapropiadas
RamirezJ	9	4	6530	Broncos de Denver	Virus	Gusano		Todas las anteriores
Santos J.	8	7	6883	Club América	Virus	Gusano	Hoax	Descargas
Braulio D.	8	6	6327	Panteras de Carolina	Malware	Gusano		Todas las anteriores
RamosJ	8	6	6187	Broncos de Denver	Malware	Gusano	Gusano	Todas las anteriores
AGUADOX	8	5	5952	Broncos de Denver	Virus	Gusano		Páginas inapropiadas
CerrilloF	8	5	5864	Broncos de Denver	Virus	Gusano		Todas las anteriores

Figure 10. Excel with the view of overall results and questions.

This ranking of scores we use to give qualification that will be part of the comprehensive evaluation, and the tool can be used for the three stages of assessment: diagnostic, formative and summative.

Results and Discussion

The results have been amazing. Students have fun with the assessment, now request that tests be made with this tool, an environment of healthy competition is created and causes the student is better prepared for the test. Enhances the experience of evaluation, various multimedia resources that support the understanding of the topic, question or problem raised are used. It provides a Excel summary of each group and compared to the diagnostic and summative evaluation to determine the level of learning. It is important mention that it is very useful to use other Apps for the evaluation of learning so that students have different experiences with the help of technological tools, this has a very good impact on how to assess and how as the student learns.

Conclusions

The use of technology enhances assessment processes of learning, makes learning more meaningful causes a fun experience and healthy competition, motivates the student to better preparation, recovering prior knowledge, qualifies and provides feedback as well as identify areas of opportunity to enhance knowledge.

Keywords

playful experience, gamification, learning management systems, apps, learning assessment, Kahoot, Information and Communication Technologies.

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Kahoot. Play your kahoo

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2204

An introduction of the experiment of the moment of inertia measurement to applied physics

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Abstract

For the students who major in chemical engineering, physics seems to be one of the difficult subjects to understand. The purpose of this study is to determine the effect of the introduction of the simple experiment for the improvement in the intelligibility in the lecture of applied physics.

The content of the experiment is a measurement of the moment of inertia of the disk. One class period is spent for this experiment. Concretely, the pulley, which is connected an end of the thread, is installed in the disk of the copper of the 300mm diameter in the axial state. And then, the weight is installed in another end of the thread and perpendicularly hung. By measuring the time in which the weight falls at the fixed distance, the moment of inertia of the disk is calculated and compared with theoretically calculated value.

Until now, in the lecture of the applied physics, much time has been spent for the description of the theory, and it seems to be quite difficult for the students without interest for mathematics to understand the principle of physical phenomena and to apply physical knowledge to the engineering. Furthermore, it was shown that the result of the examination was also comparatively low. By adding this experiment program, it is guessed that many students advance the understanding of the concept of the moment of inertia from the result of the questionnaire and the score of the examination tends to be also relatively improved.

For the student who majors in chemistry, physics is very important, but a relatively weak subject. In this study, it is confirmed that to introduce the experiment into the theoretical lecture of physics becomes very useful for the promotion of the understanding of the physical phenomena. The problem is that the time for the experiment is not sufficient.

Keywords: *Physics, Experiment, Dynamics, Moment, Inertia*

Introduction

Physics is one of the most basic subjects in the natural science and is also quite essential to science and engineering.

On the other hand, it has been pointed out that high school and college students tend not to be interested in the science subjects such as mathematics and physics. This tendency has been recognized as a very serious problem, especially for industry. As a solution to this problem, many teaching methods have been reported.

Recently, in the National Institute of Technology has conducted the achievement examination on the physical field in the third grade, in addition to mathematics, which evaluates the basic abilities related to the physics of technical college students every year.

From the results published by the National Institute of Technology, it has been shown that the accuracy rate about dynamics, which almost all national college of technology students in all departments tend to choose, keeps about 50%, though the level of the examination is relatively basic. This tendency cannot satisfy the teachers to teach physics.

Currently, the National Institute of Technology, Toyama College for Materials Chemistry and Engineering, students take classes in applied physics Ⅰ. The contents of this course are about dynamics. For students which belong to the engineering department of the colleges of technology, it is required to master the basic skills of dynamics. However, to study the dynamics, detailed knowledge on calculus and linear algebra is required.

Furthermore, since some students majoring in the chemical engineering tend not to be familiar with mathematics, physics has been regarded as one of the most difficult subjects to study.

In particular, physics has a category of rotary motion of a rigid body, which requires the knowledge of relatively high-level mathematics such as multiple integral, so this tendency seems to be remarkable.

On the other hand, for the students of the chemical engineering, this field is closely related to the motion of the molecule, which is related to physical chemistry and quantum chemistry.

However, to teach the concept of moment of inertia in the lecture, it is necessary to use the mathematical method described by formula, and this is the reason some students having no interest in this area.

Therefore, in order to have the students understand the nature of the moment of inertia, it is necessary for them to recognize a specific image of the moment of inertia by experiment in addition to the lecture.

Therefore, first, in order to understand the nature of the moment of inertia, it is necessary for students to recognize a specific image of the moment of inertia by experiment in addition to lecture.

Thus, the purposes of this experiment are to have them understand the concept of rotational movement of the inertia moments and rigid object by measuring the moment of inertia of the disk by using a simple experimental apparatus and to have them compare the experimentally obtained data with theoretically derived value.

In this study, the detail of this experiment and the effect of it on the degree of understanding the concept of the moment of inertia will be described.

Materials and Methods or pedagogy

1. The apparatus used for experiment of inertia moment measurement.

Schematic representation of the apparatus used for this experiment is shown in Figure 1. This system consists of the copper disc of doughnut state ① measures the inertial moment experimentally, aluminum pulley ② connected to disc, weight④ and thread③ which connects the pulley and weight.

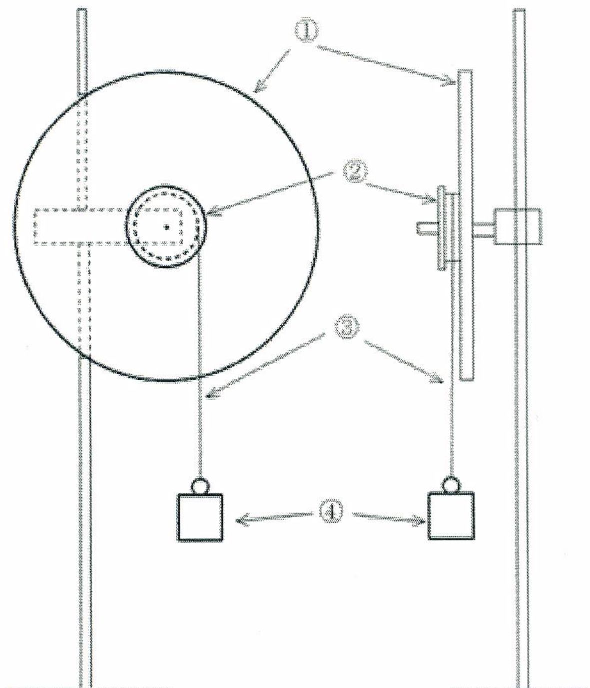

Figure 1 Schematic apparatus used for measuring the moment of inertia of rotating disc.

The dimension of the disc is shown in Figure 2. Outer diameter of the disc $2R_2$ is 250[mm] , inner diameter $2R_1$ is 16[mm] and the mean mass and thickness of the disc is 872.5[g] and 2.0[mm] respectively. On the other hand, the constant of gravitational acceleration g which is needed for calculation is 9.80665.

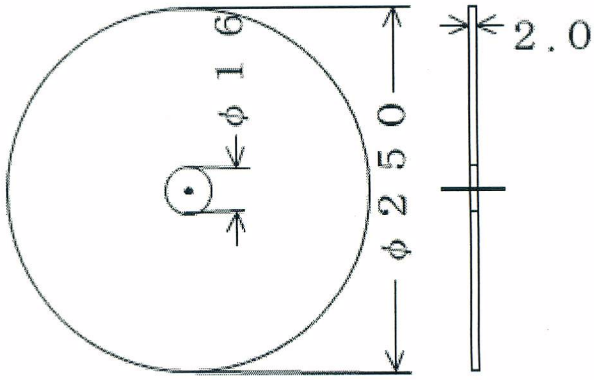

Figure 2 the dimension of the copper disc used for this experiment(unit:[mm]).

2. Experimental method

2-1 The principle of this experiment.

The method of the moment of inertia measurement is shown in Figure 3.

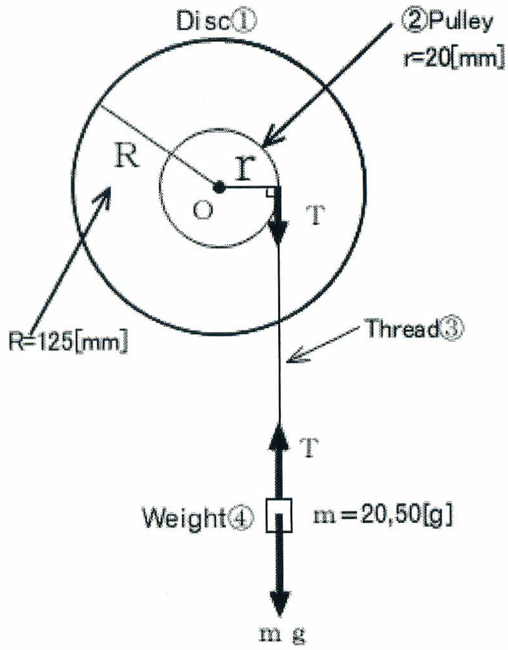

Figure 3 Schematic representation of the system consists of disc with fixed pulley rotating along the fixed axis and the weight which moves translationally.

After the restriction of the system is cancelled, the motion equation in rotational form for rotating disc is represented by eq.(1) and in translational form for the weight is represented by eq.(2), respectively. T is the tension exert on the weight. a is the translational acceleration of the weight and α is the angular acceleration of the rotating disc.

disc(①):

From

$$N = I\alpha,\quad \alpha = \frac{a}{r},\quad N = rT\ ,$$

$$rT = I\frac{a}{r}\ ,\quad T = \frac{I}{r^2}a \qquad \ldots(1)$$

weight(④):

$$mg - T = ma \qquad \ldots(2)$$

The eq.(3) is obtained by eliminating the value T from eq. (1) and eq. (2).

$$mg - \frac{I}{r^2}a = ma\ ,\quad \therefore \left(m + \frac{I}{r^2}\right)a = mg \qquad \ldots(3)$$

$$a = \frac{mr^2 g}{mr^2 + I}$$

shows a constant value while the weight is falling.

Therefore, by using the time t necessary for the falling of the weight by the distance L after the restriction of the system is cancelled, following equations are obtained.

$$L = \frac{1}{2}at^2\ ,\quad a = \frac{2L}{t^2}\ ,\quad \left(m + \frac{I}{r^2}\right)\frac{2L}{t^2} = mg$$

$$\therefore \left(m + \frac{I}{r^2}\right) = \frac{mgt^2}{2L}$$

Thus, the moment of inertia I is represented by the following equation by using m,r,L,t and g.

$$I = mr^2\left(\frac{gt^2}{2L} - 1\right) \qquad \ldots(4)$$

2-2 The experimental procedure

The number of students belonging to each experimental group is 4 or 5.

2-2-1 Assemble of the experimental apparatus
1. Measure the masses of disc and weight.
2. Install the rotational axis of the disc to support pole.
3. Anchor the support pole with disc to the stand
4. Connect a given weight of given mass to one of the thread and attach the other end to a point on the circumference of the pulley connected to the disc.

2-2-2 Experimental measurement process

1. Start the stopwatch at the moment of freeing the system after winding the yarn sufficient to pulleys.
2. measures the time required to given length descending of the weight.
3. Repeat these operations 10 times and calculates the average value of the measurement time.
4. Calculate the moment of inertia of the disc by substituting the given numerical value in the eq.(4).

Exercise
1. Find the formula of theoretical moment of inertia of the disc of doughnut state with outer diameter of $2R_2$ and inner diameter of $2R_1$ and mass of M.
2. Calculate the theoretical value of the moment of inertia and compare with the experimental value.

Theoretical moment of inertia of doughnut disc

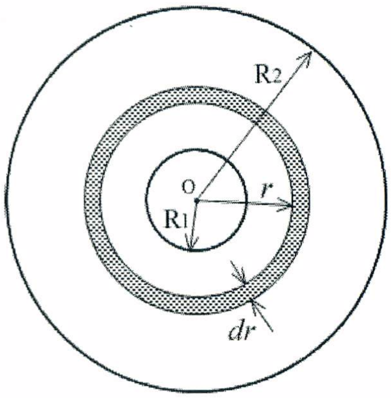

Figure 4. Schematic representation of the model used for calculating the moment of inertia of doughnut disc.

$$\sigma = \frac{M}{\pi\left(R_2^{\ 2} - R_1^{\ 2}\right)}$$ ...surface density of disc

$dm = 2\pi r dr \sigma$: mass of thin ring.

dI:Moment of inertia of thin ring of radius r and width dr

$$dI = r^2 dm = 2\pi\sigma r^3 dr$$

∴calculated value of moment of inertia of doughnut disc can be obtained as follows;

$$I_0 = \int_{r=R_1}^{r=R_2} dI = \int_{R_1}^{R_2} 2\pi r^3 \sigma\, dr = 2\pi\sigma\int_{R_1}^{R_2} r^3 dr$$

$$= 2\pi\sigma\left[\frac{r^4}{4}\right]_{R_1}^{R_2} = \frac{\pi\sigma}{2}\left(R_2^{\ 4} - R_2^{\ 4}\right)$$

$$= \frac{\pi}{2}\frac{M}{\pi\left(R_2^{\ 2} - R_1^{\ 2}\right)}\left(R_2^{\ 4} - R_1^{\ 4}\right) = \frac{M}{2}\left(R_2^{\ 2} + R_1^{\ 2}\right) \qquad \ldots(5)$$

The calculated moment of inertia obtained by substituting given values into Eq. (5) is 6.844×10^{-3} [kg・m^2].

Results and Discussion

Figure 5 shows the effect of experimental condition (mass of the weight) on the frequency distribution of the moment of inertia obtained by the experiment. From this result, the lower the mass of the weight is selected to, the narrower the dispersion of the obtained moments of inertia exhibits. In addition, the experimental data using the weight of m=20[g] shows a more closer to the theoretical value. Experimental error tends to depend both on the measurement time and the rotational resistance of the bearings mounted on the disc. Effect of rotational resistance of the bearing on the moment of inertia increases as the mass of the weight becomes light.

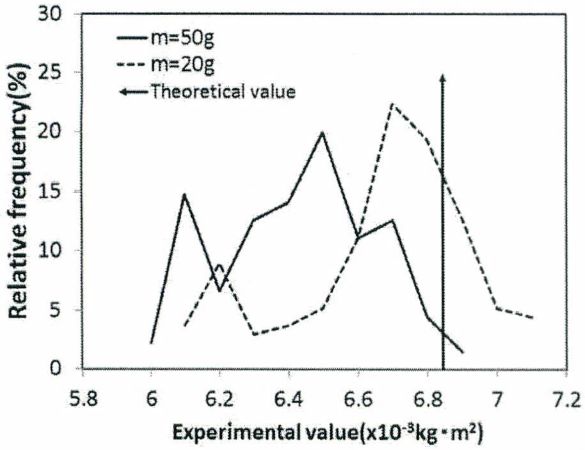

Figure 5 Histogram of the moment of inertia obtained by the experiment.

On the other hand, the effect of the mass of the weight on the error of the measurement time becomes smaller as the mass of the weight is light. In other words, the smaller the mass of the weight becomes, the longer the time that weight is descending along the certain distance, and this effect also gives small measurement error. Thus, in this experiment, as the cause of the experimental error of the measurement of inertia moment, it is found that the measurement time is greatly affected.

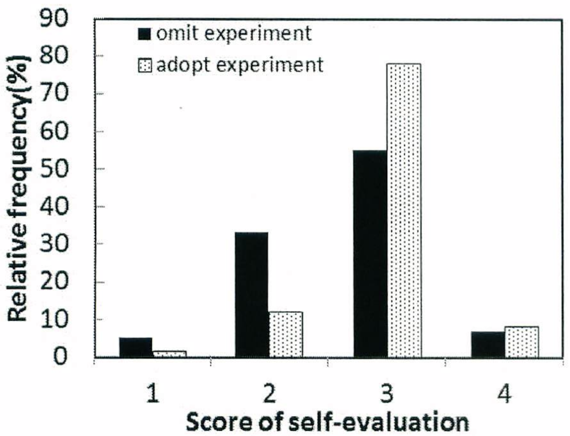

Figure 6 An effect of the experiment on the relative frequency of the self-evaluation score (1...Excellent, 2...Good, 3...Poor, 4...Insufficient)

The effect of the experiment on the distribution of self-evaluation scores for the field of rotational movement the rigid body in Figure 6.

The criteria for the self-evaluation for understanding are as follows;

Score4 Excellent
Score3 Good
Score2 Poor
Score1 Insufficient

In addition, this survey has been conducted after the lecture to students who belong to the fourth-grade of the department of Chemical Engineering for 10 years. As a result, compared with the case that the experiment has not been adopted, the score of self-evaluation for understanding shows a tendency to increase in the case that the experiment has been adopted. Therefore, by adopting the experiments in many fields of physics, the learning effect of this subject is expected to increase. However, the effect of adopting the experiment on the proportion of students who choose score 4, the highest answer for self-assessment, is relatively small. In addition, the effect of the experiments on the score of examination of this field is not clear.

Finally, two snapshots of the experiment are shown below.

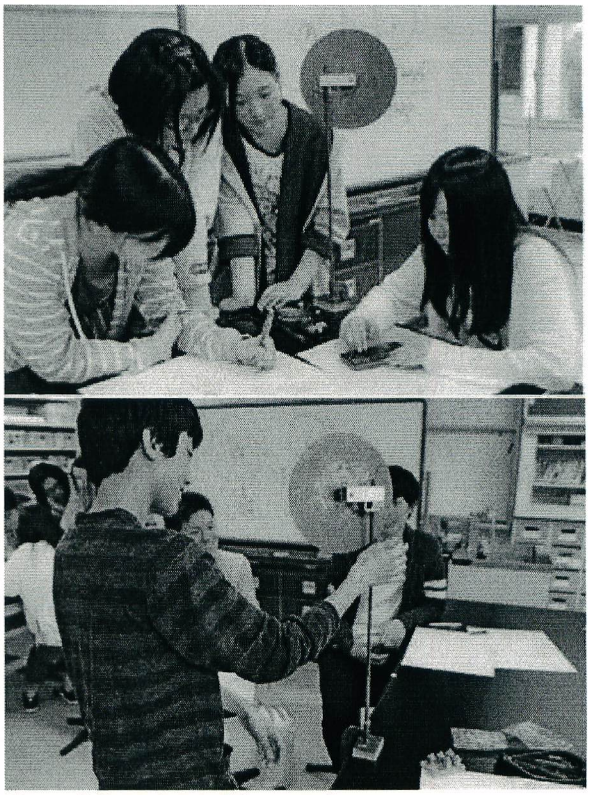

Figure 7 Snapshots of the experiment.

Conclusions

Until now, lectures on the field of dynamics have been widely performed by using mathematical tools, especially calculus.

And in the field of dynamics, the category dealing with rotational motion of a rigid body is recognized as one of the most difficult field to understand for students who major in chemical engineering because the detail of knowledge about calculus are required for them to study .

In order for students who major in chemical engineering to understand dynamics, it is not enough for them to learn by lecture only. Therefore, by introducing the experiment to the lecture, the effect of the adoption of experiment on the degree of understanding is effectively increased.

Although experimental system consists of relatively simple devices, the accuracy of the experiment is sufficient.

As a problem, in order to introduce an experiment in many fields of physics, a given time for the lecture is not sufficient.

Furthermore, it is also an important issue to prepare relatively large laboratory sufficient for carrying out the experiment.

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LEVERAGING ON 3D PRINTING FOR TRAINING OF BIOMEDICAL ENGINEERING PROFESSIONALS WITH BUSINESS PERSPECTIVES USING FLIPPED CLASSROOM PEDAGOGY

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Abstract

This paper describes our journey in using flipped classroom and 3D printing technology to inculcate active learning and design thinking in a 3rd Year Biomedical Project Module for the Diploma in Biomedical Engineering, offered by the School of Engineering at Nanyang Polytechnic. Flipped classroom was deployed to allow students working off-campus to carry out research, to empathise and define the problems they plan to work on. Teams were form with 2-3 students each to discuss on problem they plan to work on in a collaborative environment. 3D printers were used to build prototypes and facilitate testing and refinement of designs for best functional and design outcomes. Team then worked on business plans with inputs from lecturer as facilitator. Finally, the teams presented their solutions to their peers in a mini-seminar set-up, also attended by assessment panellists. Before Academic Year (AY) 2015, it was challenging for students to complete their prototypes in time, leading to failure in achieving the intended learning outcome of "Implementation and Testing" of products. With Flipped Classroom and 3D printers, students were able to spend quality and equitable time to achieve all learning outcomes. Assessment results were collected from 48 students for AY 2015 semester 1 (S1) and 32 students in AY 2014 semester 2 (S2). Out of 20 teams, 17 teams or 85% submitted completed prototypes in AY 2015/S1 as compared to 60% in AY 2014/S2. In terms of product functionality, 70% of teams were able to score 20 or higher, out of 25 marks allocated, as compared to about 55% scoring 20 marks or better in AY 2014/S2. The prototypes developed in AY 2015/S1 were also more complex than those developed in AY2014/S2. Both quantitative and qualitative feedbacks by students indicate the active learning approach adopted in AY2015/S1 is much better, where students have the opportunities to empathise and define their problems, solve a more complex real-life problems through a rapid 3D prototyping process, and validate their concepts and designs by testing the completed product iteratively. Lecturers' feedbacks show that students were more motivated in building their prototypes and engaged during the classroom discussion. They were also able to work in team and more confident in sharing their views with peers. The flipped classroom and 3D printing technology imbued active learning and design thinking in the minds of the students, enhanced their learning experience in designing biomedical products, and improved their academic performance and achievement of learning outcomes.

Keywords: *Design thinking, 3D printing, business ideas, active learning, and biomedical product design.*

Introduction

Nanyang Polytechnic in Singapore provides industry relevant education and training for our students, to prepare our graduates for the workforce and give them a competitive edge in the knowledge-based economy. Students enrolled in the Diploma in Biomedical Engineering (DBE) at the School of Engineering are given learning and development experiences that nurture their potentials and help them develop valuable attributes to excel in work, life and learning. Within the curriculum, practice-oriented project modules allow students to go through the process of ideation, designing and prototyping to hone their skills. In these modules, typically a few problems related to healthcare and biomedical engineering fields were given to students and they would form teams of two to three members to work on possible solutions. Students used to generate two to three ideas or designs and built prototypes using recyclable materials. Often it turned out to be a mere paper exercise where students shared their ideas through poster presentation due mainly to time-consuming prototyping processes that students had to go through if they were to fabricate slightly more complex prototypes. The limitations of such approach were obvious in that the students were not able to recognize and experience the true challenges in innovating biomedical products. They were also not able to empathise with the user's needs, appreciate the process in building and testing the functionality of the products and hence affecting their learning outcomes. From the Design Thinking perspective, students experienced the "define", ideate" and (to some extent on) "prototype" aspects of the process, lacking on the "empathize" and "test" aspects of the principle, where students need to experience in order to understand users' needs, solicit feedbacks from product testing, and iterate designs to better meet customer's needs. Due to these constraints, students' performance and feedback were not as good as we hoped to achieve at the end of the modules.

Methodology

To overcome the gaps identified, we reviewed our practices and implemented the Contextual Teaching and Learning (CTL) pedagogical approach (Robert and Patricia, 2001) in our diploma, which encourages lecturers to relate subject content to real world situations or context, and to motivate students to connect acquired knowledge to applications in real life environment by learning subjects in an integrated and multidisciplinary manner. In order for CTL to be deployed effectively, the Project-Based Learning ((Blumenfeld et al., 2000) teaching approach was introduced, where students are involved in problem-solving investigation, work autonomously to construct their own learning and build an innovative product through teamwork; just like any engineering professional would do in real world context. For the same reason, we embed the Design Thinking principle in the product development process to train our students with contemporary engineering design practices. The Design Thinking concept was first introduced by Peter Rowe, professor of Architecture and Urban Design at Harvard University, in his book Design Thinking (Peter Rowe, 1987) where he describes Design Thinking in the context of architecture and urban planning challenges. The concept was subsequently used and popularised by Tim Brown, the CEO of the design firm IDEO. He defined Design Thinking in his book (Tim Brown, 2009) as a collaborative process by which the designer's sensibility and methods are employed to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity. The design process of Design Thinking is depicted in Figure 1, we want to imbue this concept into students' mind through a learning model that combines practice-oriented project with opportunities to connect, contextualise and apply the knowledge gained in a team.

To address the constraints in traditional prototyping, which can be time consuming, we need to shorten the prototyping process so as to allow more time for product testing and improvements to be carried out. We evaluated 3D printing technologies and identified some cost-effective 3D printers for our laboratory. Through our review, we learnt that, in addition to be able to perform rapid prototyping, institutions exploiting 3D printing technologies also enhanced students' practice of visual spatial skills to perceive and visualize significantly more complex objects (Igor and Amir, 2015). The same technologies also allowed institutions to adopt the techniques of rapid prototyping engineering and fundamentals of engineering service processes in their curriculum (Lauri et al., 2010). More importantly, by incorporating 3D printing into the product development process, students are involved in an iterative and connected process that allows them to experiment their innovative design concepts and to experience various facets of engineering and design disciplines. Further to the emphasis on usability and functionality of engineering design, the students have to perform cost analysis, understand business entity and structure, business plan and intellectual property protection, to provide business perspective of product development. At the end of the module, each student team is required to complete a business plan to market their products.

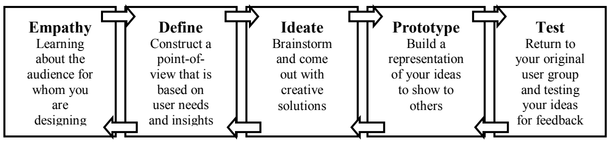


Figure 1: Typical Design Thinking Process

Constructive Aligned Curriculum Design

As part of the Outcome-based education adopted by the School of Engineering (SEG), we use constructive aligned curriculum (Biggs, 2003) model to design our curriculum. The module learning outcomes are constructed with student learning in mind and they are consistent with and aligned to the student learning outcomes and course educational objectives of the DBE programme. We formulate the module learning outcomes, design the learning activities and develop assessment strategies in an inter-related manner, as shown in Figure 2. In this paper, we'll be using the Biomedical Project module as the reference module to illustrate the implementation of the new approach in the DBE programme. For this Biomedical Project module, as learning outcomes, the students will be able to perform the following at the end of the module:

- design an innovative product
- identify and analyse design constraints associated with the product
- interact and collaborate with others in teams to complete the design of an innovative product
- develop a business plan

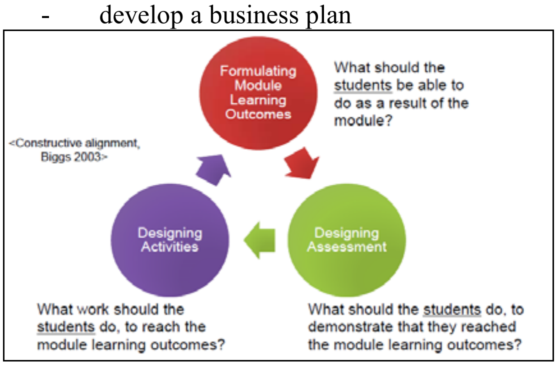


Figure 2: Constructive Aligned Curriculum Design

The learning activities are carried out in the form of lectures and practical sessions. Table 1 shows the instructional plan for Chapter 1 to 3 (part of the curriculum), where duration of the learning activities and the cognitive skills levels using Bloom's revised taxonomy (Krathwohl, 2002) to be achieved for each activity; such as Remembering (Level I), Understanding (Level II), Applying (Level III), and Analysing/Evaluating/ Creating (Level IV and above). The module is designed with 15 hours of lectures and 45 hours of practical sessions. Chapter 1 and 2 are conducted through lectures to introduce business concepts to students. Chapter 3 consists of 45 practical hours for students to work on product design and development, culminating to an innovative biomedical product at the completion of the module. The Design Thinking concept is emphasised to provide integrated, active and collaborative learning opportunities for our students, with the aims to develop skills in problem formulation, ideation and product prototyping and testing. To make more effective and efficient use of student learning time in acquisition of multidisciplinary knowledge concurrently with personal and interpersonal skills, we incorporated other active learning strategies in the module, including flipped classroom during lectures and a mini-seminar at the end of the semester for students to pitch their business ideas and products. Assessment of learning outcomes are based on both functional products as well as sound business plans. Rubrics of assessment for each component are defined as shown in Table 2. The assessment panel consists of facilitators and one independent faculty member who is not involved in delivery of this module, to give alternative views to the business plans and products.

Table 1: An excerpt of Instructional Outcomes (L-Lecture, T-Tutorial, and P-Practical)

No	Topics	Instructional Outcomes At the end of this topic, students will be able to:	L	T	P	Cognitive Skills Level*
1.0	**Introduction to Biomedical Project and Technopreneurship**		1	0	0	
1.1	Introduction to the module	• describe the objectives of the module • locate the linkage of this module to other modules in DBE course • state the relevance of this module to the industry				I
1.2	Introduction to Technopreneurship	• recognize the role of entrepreneurship in Singapore • assess one's suitability for entrepreneurship				III
2.0	**Business Ownership**		4	0	0	
2.1	Forms of business ownership	• identify different ways to start a company • identify different types of business ownership				II
2.2	Registering your business	• select an appropriate company name • write a mission statement • prepare company objectives				III
2.3	Marketing research	• identify targeted market				II
2.4	Feasibility study	• develop a SWOT analysis on one's business • prepare a feasibility study for one's business venture				III
3.0	**Product Development**		3	0	45	
3.1	Business product	• identify the product life cycle • recognize the importance of intellect property • recognize the importance of inventory management				II

Table 2: Assessment for Business Plan and Prototype

(a)

Category	Scoring Criteria	Score
Format	Business plan is prepared using appropriate format specified and details duly completed.	10
Content	Each topic is duly completed with appropriate and suitable content	60
Professionally prepared	Professional looking and accurate representation of the data in tables, graphs, and written form; graphs and tables are appropriately labeled and titled	20
	All appendices are properly referenced, labelled and appended at the end of the report	10
	Total	100

(b)

Category	Scoring Criteria	Score
Poster Information	Indicate name of invention, pictures of referenced product, indicate 2 extra features in the product, names of inventors	5
Poster Design	Engaging, visually simulating, aesthetically appealing use of colour, diagrams and text	10
Prototype	Complete Prototype	10
	Functionality	25
	Uniqueness	10
	Prototype is professionally done	20
	CAD model is professionally done	20
	Total	100

Lesson Delivery and Implementation Plan

The module is allocated 60 hours a semester, spreading over 15 instructional weeks (four hours per week). As time could critically impact the students' ability to complete their projects, we need to guide the students closely to achieve the learning outcomes. Learning from our past experience, instead of having one hour of lecture and three hours of practical lesson weekly, we felt that it is more effective to use different learning activities over a duration of 14 weeks, and the implementation plan is *two hours of lecture and two hours of practical lessons on odd weeks (1, 3, 5 …) and four hours of practical lessons on even weeks (2, 4, 6…).* At the 15th instructional week, students will spend the remaining four hours to prepare and present their business ideas and products in a mini-seminar setting.

For the first and third weeks, students will access and learn from module materials provided in our Learning Management System (LMS). The 2-hour lecture is conducted using flipped classroom approach, where students will read materials provided off-campus. We also encourage students to use this off-campus time to empathise problems by observing the environment and people in the communities. At the beginning of the product development phase, the class is organised into teams of two to three members. The teams are to plan and organise themselves autonomously for the tasks assigned. The face-to-face sessions on campus consist of group discussion, presentation, and brainstorming on product ideas. The lecturer, acting as facilitator, guides them in classroom activities and provides technical consultation on product designs. Student teams submit progress report weekly through LMS. Lecturer will monitor and provide feedback to the students on the work submitted, allowing them to make correction or further improvement. For instance, as part of learning activity planned, the teams discuss their products' strengths and weaknesses as compared to competitors' products. Based on the findings, they review their designs to improve their products. As students progressing on their design, the lecturer monitors and participates in their design evaluation and review process. The lecturer shares his or her experiences and provides insights to various design thinking principles. Once the product designs are ready, the students will begin constructing their prototypes using 3D printer.

From the 3D printed parts, students assemble and construct their first prototypes. Lecturer will share techniques in evaluating the prototypes, in particular the fit and functionality of the products. Often students are able to identify mistakes made from the first prototype and make changes to their design to rectify them. The benefits of this iterative approach are many folds. First, students are able to find the right context and connection between the knowledge acquired in other modules, integrate them and apply them in this practice-oriented project module. Second, students are able to acquire higher order thinking skills when they are evaluating and testing the prototypes. Third, students are more confident in marketing their works as they are able to complete and validate a functional prototype.

A student mini-seminar is organized during the last instructional week, allowing students to showcase their completed work. The platform allows the students to 'sell' their ideas and the completed products (see Figures 3 for pictures taken at the mini-seminar). In this mini-seminar, each team have 10 minutes to present their products to a panel of assessors. Following the presentation, an exhibition is organized for the teams to display their posters, business plans and products as well as to provide opportunity for the teams to hone their skills in seeking 'seed money' from the assessors who act as 'potential investors'.

Figure 3: Students sharing and presenting their concepts to panellist.

Results and Discussion

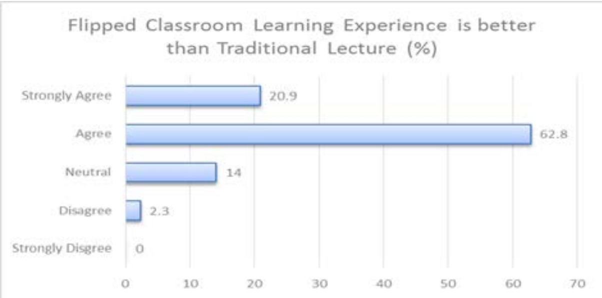
To measure the effectiveness of this new approach, assessment data was collected from an experimental group of 48 students who were enrolled in the Biomedical Project module in semester 1 of academic year 2015 (AY2015/S1), to compare with 32 student enrolled in semester 2 in academic year 2014 (AY2014/S2). Out of 20 teams formed in AY2015/S1, 17 teams or 85% submitted completed prototypes as compared to 60% in AY2014/S2. In terms of product functionality, 70% of teams were able to score 20 or higher, out of 25 marks allocated, as compared to about 55% scoring 20 marks or better in AY2014/S2. The prototypes developed in AY2015/S1 were also more complex than those developed in AY2014/S2. This is due mainly to the availability of 3D printers, where students were able to construct their prototypes rapidly, to visualize and validate their designs, and made multiple improvements to finalise their prototypes. An example of such complex product is shown in Figure 4, where all parts are fabricated using 3D printers. It was through this iterative process that most students were able to demonstrate a complete and functional prototype, leading to overall improved module grades performance.

In addition to academic performance, we also examined the data collected from the end-of-semester module feedback where students provide feedback on all modules they attended in a semester, covering module content, delivery and learning environment as well as equipment and facilities. We observed improvement in the module feedback of the Biomedical Project module as well, where ratings of "Agree" and 'Strongly Agree' showed an increase of 10 percentage points, from 85% in AY2014/S2 to 95.5% in AY2015/S1. These survey items include the clarity of module learning outcomes, the design and organization of module materials, the availability and quality of facilities and equipment, the e-learning components and the grading criteria. This improvement indicates a good acceptance of the new approach implemented in this module.

Figure 4: iWALK – a product that targets people with leg injuries or difficulties in walking

Finally, we examined the data collected from a survey that was specifically administered to students of AY2015/S1 to gauge effectiveness of the implementation and student's acceptance of the new approach. The results show that flipped classroom pedagogical approach gave them an opportunity to learn in a dynamic and interactive environment where module materials were read by students before the face-to-face session in the classroom. On-campus group discussion also allowed students to have more time to interact and collaborate with their team members leading to better learning experience and teamwork spirit for the students. The survey results are shown in Figure 5 where 83.7% of the students responded strongly

(Strongly Agree and Agree) to better learning experience through flipped classroom. In addition, 86.1% of the students preferred group collaborative activities (Strongly Agree and Agree) and able to work in team constructively.



(a) Flipped Classroom

(a) Group Collaborative Activities

Figure 5: Results of a survey carried out at the end of AY2015/S1.

Conclusions

The learning outcomes of the Biomedical Project are for students to produce an innovative, functional biomedical product with a sound business plan. The successful development of these products and plans required active participation of the students. To facilitate the learning process, active learning environment needs to be created for students to participate actively in a collaborative manner within a team. The higher level of active participation from students in the experimental group was seen from the completion of their final prototypes and business plans.

It is important to empower student on the development of the biomedical product. With the lecturer taking the facilitator's role using the flipped classroom approach, students are responsible for their learning and the deliverables. It encourages students to explore and discuss among themselves to find the best solution with the lecturer providing the necessary facilitation. They gain more valuable inputs by discussion and seeking inputs from their peers.

With the use of 3D printers, the realisation of finer details in the prototypes become achievable within the time frame given in the Biomedical Project module. In fact, many students in the experimental group were able to iterate their designs for more than 2 times to address shortcomings found in their prototypes. Through this process the students gained valuable experience in translating 3D models into actual functional physical parts which they would not have achieved if they were not able to build the complete prototypes. The students also learnt that features that they have created in digital models might not be translated successfully into a functional prototype due to issues such as space, assembly, materials, and many others that they discovered in this process.

The student mini-seminar, on the other hand, provides the students an avenue to hone their communication skills by marketing their ideas and products. The presence of 'investors' at the exhibition created an exciting and real-life environment for the students to showcase and sell their products. The environment also required the students to be creative in using various media to promote their products and be able to respond to queries quickly and confidently. Under such situation, the students need to demonstrate their ability to think and respond on their feet.

We conclude that leveraging on 3D printing, flipped classroom and active learning approach undertaken by this module improves the students' learning experience and increases their knowledge and skills in building and marketing their biomedical products. The use of 3D printing technology enhances the complexity level of the projects that students can work on. With this new approach put in place, we are moving closer to build a generation of future-ready graduates which are innovative and enterprising, producing biomedical engineering professional with business prospective.

Acknowledgements

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STUDENT-CENTRED PROJECT OFFICE AS A LEARNING ENVIRONMENT IN ICT ENGINEERING EDUCATION

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Abstract

In Engineering Education, it is important that students gain competences relevant for the requirements of the working life. Learning environments providing opportunities for active participation and facilitating the intrinsic motivation of the students are important tools when reaching this goal. In this paper, a learning concept and environment, "theFIRM", developed at the ICT Education and Research Unit of Turku University of Applied Sciences (TUAS) is described and discussed. "TheFIRM" is a student-driven project office that operates like a small company providing support services and development projects to both university internal and external customers. Typical assignments include website designs, small-scale database applications, and end user training sessions. The office has an internal organization that consists of students. The student CEO is responsible for general administration, staffing and selling activities, student project managers coordinate the assignments, and different technical student staff members focus on implementing their tasks. Naturally, theFIRM has responsible staff and faculty members who mentor the operations and who are responsible for both defining the learning objectives and assessing the students' results. Also the faculty's subject experts are available to support the projects when needed. However, all the activities are student-centred and they have a collaborative responsibility of the operations. The learning takes place in a real-life context while working with authentic customer projects and solving practical challenges connected to them. In addition, theFIRM is a platform for regional university-industry collaboration especially focusing on small companies and third sector organizations.

Keywords: *Active learning, Assessment, CDIO, Entrepreneurship, ICT, Project-based learning, Learning objectives*

Introduction

The CDIO Initiative (http://www.cdio.org) has defined general goals to engineering education. That is, the aim is to educate students who are able to: 1) Master a deep working knowledge of technical fundamentals, 2) Lead in the creation and operation of new products and systems, and 3) Understand the importance and strategic impact of research and technological development on society (CDIO, 2010). The ultimate goal is that the students gain competences relevant for the requirements of the working life and, thus, become able to aim at successful professional careers.

Reaching these goals is especially challenging in the fields that develop rapidly; Information and Communications Technology (ICT), for example. Significant tools and technologies may become obsolete and new ones emerge already during a student's study time. In 2015, several different approaches to address this challenge in Bachelor's level Engineering Education were discussed (Roslöf, 2015). These approaches included both curricular tools, different ways of university-industry collaboration, as well as faculty competence requirements and development processes.

In this paper, the focus is set to present a case study on utilization of active learning methods and environments. "TheFIRM" is a student-driven TUAS ICT project office that operates like a small company providing support services and development projects to both university internal and external customers. The learning happens in a real-life context when working with the customer projects and solving practical challenges connected to them. First, the generic factors behind student motivation and learning results are summarized. Thereafter the operational drivers behind theFIRM are discussed and, accordingly, the activities of theFIRM environment are described from different perspectives. Finally, the experiences on the past and current activities are discussed, and a set of future development thoughts presented.

Background on Student Motivation

Lim (2004) lists six types of motivation valid for studying the context of online learning. However, the categories can also be utilized to reflect the motivational settings in general:

- *Reinforcement:* Reinforcement maintains and increases the probability of the response it follows. Examples and tools of reinforcement are grades, teacher feedback and peer support.
- *Relevance:* Relevance refers to the value residing in the learning content as reflected in the learners' needs and expectations.
- *Interest:* Motivation promoting learner involvement also requires intrinsic factors to be present. The motivators include challenge, fantasy and curiosity. These elements are especially relevant when aiming to achieve a flow experience.
- *Self-efficacy:* Self-efficacy refers to students' beliefs and feelings of self-worth and ability-beliefs in how well they can perform and be responsible in a learning task. Students who are confident and motivated to learn will often spend more time and effort to gain better learning results.
- *Affect:* Inclusion, attitude, meaning and competence should be present in every learning situation. Affect describes the state of emotional feelings, concerns and passions of the individual while learning. Affect is influenced, for example, by organizational culture and climate, peer opinions, degrees of frustration or determination present, and attitude towards change.

Developing such learning environments in which all students could achieve a high level of motivation is an important goal. How can we mediate and reinforce the relevance of the different learning objectives, and facilitate interest in the different subjects and the future profession so that the learner could reach a proper level of self-efficacy and, furthermore, experience a positive attitude and climate?

Salonen, Lehtinen and Olkinuora (1998) have presented a model describing the mutual relations of the student/learner and teacher, as well as their potential to approach, explore and master the challenging aspects of the environment and turn this "curiosity" into learning outcomes. The model describes the core relationships between the student, teacher, the learning task, and the reciprocal effect of the task definition in a socially guided learning situation (Figure 1).

The model helps in the understanding and analysis of the different aspects of a learning situation and its dynamics. These relations present especially in customer-driven student projects have been discussed in more detail by Roslöf (2013).

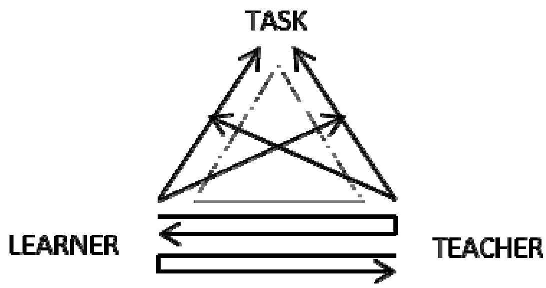

Figure 1: Student's and teacher's complementary motivational task orientation (simplified) (Salonen, Lehtinen, & Olkinuora, 1998).

Drivers Behind theFIRM

In addition to the global trend of facilitating active learning, and the support from findings in educational science, there are several operational drivers behind the development of learning environments like theFIRM.

Firstly, the Finnish universities of applied sciences shall provide education that is based on the requirements and development needs of working life and its development, as well as on research, artistic and educational foundation, aiming at professional expert tasks. Also, regional development is one of the central tasks of these higher education institutions (FINLEX, 2014a and 2014b). In other words, also TUAS shall maintain and develop a close co-operation with the industry and other organizations of the region. Especially fostering new innovations, start-up enterprises, as well as small and medium size companies (SMEs) has been considered main focus areas of our activities.

This mission is fulfilled, for example, by initiating and conducting applied Research, Development and Innovation (RDI) projects serving regional needs often connected to practical project and organizational development tasks. Many of these RDI projects have several different external partners and they are typically funded both by the partners themselves as well as different governmental and institutional funding agencies. However, the ICT Unit of TUAS gets often contacted by SMEs or other small organizations with requests to help them with different engineering challenges. Many of these requests deal with website design needs, small-scale software application development task, or practical problems with server configurations, for example. The assignments are important to the organizations but, in many cases, too small and research-wise too simple to provide enough challenge, content or volume for full-scale RDI projects.

Even though the requests are usually very well suited for student project assignments, TUAS did not have clear processes on how to answer these requests in a flexible way. The project-based courses and thesis assignments were (and are), naturally, possible tools to use but, still, we were too often forced to reject many of these requests – especially those that were presented late in the academic year when most of the courses had been planned and started already.

Secondly, also a challenge with flexible possibilities for students to progress in their studies was identified. There are continuously students who are able and willing to proceed faster in their studies than what is planned in the curriculum. Likewise, some students may have missed or failed some courses that are no longer available or that will not be provided before the next academic year. Many students have also gained compensation of certain courses based on their previous studies and competencies which produces “empty slots” into their schedules. In all these cases it was difficult to provide dynamic opportunities to the students in order to proceed and complete their studies without significant delays.

In other words, there was a clear indication to develop activities that would answer to the dynamic need of ICT-connected services of the SMEs and, simultaneously make it easier for students to complete studies in a flexible manner when the need, opportunity and/or desire emerges.

These challenges have been approached stepwise through several different pilots and phases including different types of project courses and student-driven helpdesk activities, for example. The following chapters focus on describing the current operations of theFIRM, one of the main tools to answer these needs at the ICT Unit of TUAS today.

Description of theFIRM’s Activities

“theFIRM” is a student-driven project office that operates like a small ICT solution provider that offers support services and development projects to both TUAS internal and external customers. Typical assignments include, for example, website designs, small-scale database applications, and end user training sessions. Customers can contact theFIRM directly or via the website (http://thefirma.fi/). Also TUAS service organization routes suitable customer requests received by other channels to theFIRM.

The office has an internal organization that consists of students. The student CEO is responsible for general administration, staffing and selling activities, the student project managers coordinate the assignments, and different technical student staff members focus on implementing their tasks. Depending on the individual interests and competencies, the students can focus on different ICT engineering topics. These topics include, for example, website design, graphics, network administration, and software testing. The topics can change from project to project in order to make it possible for the individual students to get familiar with different aspects of the field. The students apply to theFIRM via a light-weight recruitment process in the same way they would apply to any small company position. If the applicant is accepted to join theFIRM, the student can participate in one project only – or continue to work in several projects and tasks throughout the studies. After gaining some experience, it is possible to advance to more advanced tasks connected to technical topics, or to managing of the projects and people.

The customer requests and projects are implemented using predefined processes. The customers are provided an offer including an initial version of the project plan, staffing proposal and cost offer. Most of the projects have a price tag, i.e. the customers pay to TUAS an agreed fee after the project has been successfully delivered. This income is then used to cover some of the staff expenses and device updates. Most of the students do not get paid but they gain credits instead. However, some of the most senior students (the student CEO, for example) may get a limited number of hours per week salary in a student assistant role.

In the project contract it is also agreed what it means to work with students. For example, tight schedules are difficult to commit to, and the customer is expected to keep close contact to the students during the project and guide the work. Despite the learning by doing aspect present in all the projects, most of the assignments are completed as planned and with good quality results.

TheFIRM has own dedicated facilities at the campus. The current space consist of two old class rooms that have been refurnished into a collaborative office space that contains sections for different types of activities. Figure 2 illustrates the current working environment. TheFIRM’s “employees” can also use the other TUAS facilities, meeting rooms and computer classrooms for instance, when they are available.

Figure 2: Students working in the premises of theFIRM at TUAS.

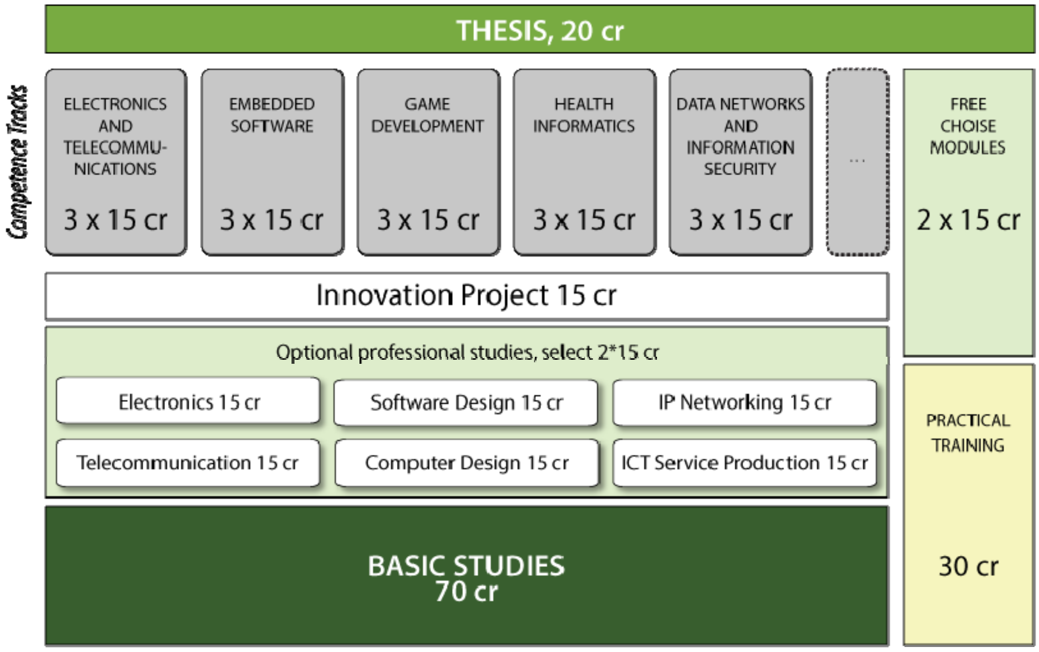

Figure 3: The curriculum structure of the Bachelor of Engineering in Information and Communications Technology at TUAS (TUAS, 2016).

Connections to Curricula, Learning, and Assessment

Although one of the fundamental goals of studying within theFIRM and its projects is to enable a high degree of flexibility, the studies are yet bound to the curricular framework. When the student starts working in theFIRM, the first module to study is called ICT Service Production. The extent of the module is 15 credits (European Credit Transfer System, ECTS) that is typically divided in three parts so that it is possible to gain the credits stepwise especially if the student only works for theFIRM part-time. This module belongs to the optional professional studies of the Bachelor Engineering in Information and Communications Technology program. These modules are typically studied during the second academic year (the program is a four years', or 240 ECTS credits, program) but this module can be started and studied flexibly whenever the student is willing and accepted to start. Thus, there is a clear connection to the curriculum.

In addition to the initial module, it is possible to study the free choise modules (30 ECTS credits) and to complete the Practical Training (= industrial placement, 30 ECTS credits) within theFIRM. However, it is recommended that a student should not invest all his/her optional courses or, especially, practical training to theFIRM in order to be able to experience also other environments and employers.

Those students that are interested and skilled enough to focus to the activities theFIRM has to offer, have the possibility to major in ICT Service Production. That is, they do not select any of the competence tracks presented in the curriculum structure (Figure 3) but, instead, a tailored path focusing of theFIRM's activities is provided for them. These students usually work on advanced positions in theFIRM, such as project managers, technical leaders. Finally, it is possible to complete a Bachelor's Thesis project on an assignment connected to theFIRM. These thesis assignments are typically advanced customer projects, or alternatively different development projects connected, for example, to the internal process development of theFIRM. In all, it is possible to complete 15 – 140 ECTS (almost 60 % of the degree at most) credits within this activity, although it has been very rare to fully use this opportunity. In practice, only the student CEOs and some of the technical expert students have reached close to the maximum.

The credits can be earned and completed in several ways. Participating in the project activities can produce credits but typically the directly project-based studies are integrated with theoretical content. TheFIRM offers a possibility to take official Microsoft Technology Associate certification exams. Thus, if the student's project deals with the technologies connected to these exams, usually some part of the credits are bound to completing a respective certification. For example, if the project utilizes HTML5, the total credits are partly based on the students' participation and performance in the project itself, and partly on the competence level demonstrated in the MTA HTML5 Application Development exam.

This integration provides a well-functioning combination of very flexible working-life-relevant project studies and a structured examination-based assessment of the gained knowledge and skills. If the student continues to work with more advanced projects within theFIRM, it is also possible to complete professional-level technical certificates. TUAS does not have a certified test center for these exams at the moment but they can be completed at a third party exam facility instead. The certification expenses are covered by the project incomes.

Figure 4: Recruitment advertisement of theFIRM [Finnish version of the bane: theFIRMA].

Teacher and Staff Roles

One of the central thoughts behind theFIRM learning environment is to keep allow the students be the active counterparts in all activities, also including the managerial roles and customer negotiations. Yet, it is equally important that TUAS staff and teachers are available to provide guidance and support when necessary.

Currently, there are three main staff roles at theFIRM. There is a staff project manager who has the overall responsibility of the theFIRM and its operations from official TUAS perspective. S/he participates also the customer negotiations and helps defining feasible project goals, pricing levels and formal contracts.

In addition, there is one teacher whose main task is to take care of the learning process. This lecturer defines the learning objectives for the students and projects, agrees on the number of credits connected to the project participations, and takes care of the assessment. Another important task connected to this is to ensure that the projects provide enough challenge and opportunity to learn. In other words, if a student participates in several projects during his/her studies, each new project should be more challenging than the previous ones.

The third teacher role is a technical consultant. If a project assignment contains so difficult engineering tasks that the students are not able to solve them by themselves, it is possible to consult any of the faculty subject experts and analyse the task together. This ensures that there will not be too many “deadlocks” in the process and makes is possible to accept rather challenging projects to theFIRM, too.

It is also important that especially the main staff members are continuously and regularly available for the students. Also, theFIRM needs human resource (HR) management activities, as any real ICT company, to ensure that there are enough resources and expertise available to complete the project throughout the year. In fact, it can be said that theFIRM has a continuous HR crisis because the best experts (graduating students) are all the time leaving it and new unexperienced ones (new students) are recruited and need to trained.

Discussion & Conclusions

In this paper, an active higher education learning enviroment for Bachelor's level ICT students has been described and discussed. The student-driven ICT project office theFIRM has been operating in its current form for about two years now and the experiences are promising. It seems that this type active and collaborative of studies fit very well to, at least, some of the students and encourage them to learn and develop their professional competences.

TheFIRM has answered rather well to its main operative goals, too. It provides opportunities for students to join the project activities very flexibly when they have time, energy and/or need to complete studies that are not bound to tight classroom schedules in the traditional way. Furthermore, theFIRM is already now playing an important role in serving the SMEs and other small organizations of the region. The students have completed more than 50 projects a year. Also those customers whose assingments have not been possible to be implemented by theFIRM have received a proper response and, often, proposals of possible other local vendors to discuss with.

Naturally, there are also development items to consider in oder to improve the activities of theFIRM even further. For example, there is a need to anchor the project-based studies even more clearly to the curriculum so that it is easier for the students to understand the opportunities and, on the other hand, communicate the continuum of stepwise increasing challenge level objective of these studies. Another development idea deals with the organization of theFIRM's steering as well as support of the student CEO and the other senior students. It has been proposed that theFIRM could have a board consisting of local entrepreneurs and industrial experts who would meet few times a year to review the activities, to propose business and process improvements, and to challenge both the senior students and the staff members.

To conclude, it is important to continue the development of innovative and collaborative learning environments in which the students can reach high levels of intrinsic motivation and achieve challenging learning objectives. As listed by Lim (2004), we need to be able to provide both *interesting* and *relevant* activities and, simultaneously, to create an athmosphere that provides *reinforcement* and strengthens the students' *self-efficacy* and *affect* experience. TheFIRM has potential to develop towards a fruitful learning community that is able to consider all these perspectives. Although theFIRM focuses on ICT service production, the experiences gathered so far can be easily utilized in other diciplinary contexts, too.

Acknowledgements

The TUAS Communication and theFIRM students and staff are acknowledged for providing the photographs included in this paper.

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Progress of Visualization of Learning Outcomes with Competence - Annual Report 2015 -

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Abstract

The National Institute of Technology, Anan College (NIT, Anan College) was selected by the Ministry of Education, Culture, Sports, Science and Technology for Acceleration Program for University Education Rebuilding subsidies in 2014. Many institutions of higher education in this country applied for this project, and after strict evaluation, the effort of NIT, Anan College was highly evaluated. Especially, in Theme Ⅱ(Visualization of Learning Outcome), NIT, Anan College was the unique College of Technology designated. We provide an environment where students can thoroughly study unsupervised. Of great importance for students is to evaluate academic results by taking notice of their daily learning process, to get in the habit of studying voluntarily, to visualize the competence of the student as an acceptable member of society and to fully utilize their capability for career planning.

Four programs will be the core of the approach: (1) Ensure the learning time by accumulating the Learning Portfolio. (2) Evaluate creative skills. (3) Implement student surveys to evaluate the actual learning situation. (4) Make an Academic Portfolio leading to improving education and developing skills of teachers. We describe the challenges concerning the above in FY2015. At the beginning of the fiscal year, all students set goals in three categories which consist of career, academic study and co-curricular activities, and they evaluate themselves at the end of the fiscal year. Trial evaluation of competency in fourteen regular curriculums through the second semester of FY2015 using newly developed rubric was conducted. In order to visualize the results of the student surveys, we made an illustrated sheet. All faculty have easily understood the major index of the student surveys at a glance. We investigate the correlation parameters which influence the satisfaction level of overall college life. We host a workshop for creating an Academic Portfolio as faculty development and also host a workshop with reduced hours in order for faculty to easily join.

In this paper, we describe the detailed achievements and results addressed up to now, and report the future plan of competence development within the visualization of learning outcomes.

Keywords: *Visualization of Learning Outcome, Management of Teaching and Learning, Career Design, Learning Portfolio, Competence, Student Survey, Academic Portfolio*

Introduction

The August, 2012 report released by the Central Council for Education, emphasized quality assurance. There were keywords listed: active learning and visualization of learning outcomes. The second Basic Plan for Promoting Education released by Ministry of Education, Culture, Sports, Science and Technology (MEXT) was approved in a Cabinet meeting in June, 2013. One of the basic policies is to promote university reform to increase the overall study hours of students. They have to acquire skills to continue studying by themselves throughout their career. Therefore, we have to improve our educational method in order to foster students to achieve their goal.

In 2014, MEXT selected our educational program as the Acceleration Program for University Education Rebuilding (AP). Our program is classified in Theme Ⅱwhich is aimed at visualizing learning outcomes and is characterised by focusing on competence. So we could gain insight into the educational improvement system based on the activities proven worth.

Materials and Methods or pedagogy

Recently, teaching portfolios have attracted significant attention as a key faculty development activity. Kurita (2013) arranged a teaching portfolio workshop suitable for Japanese. Though various faculty development activities have been conducted at NIT, Anan College, the portfolio workshop was held for the first time in 2010, with the aim of further improvement in the quality of teaching. Creating a teaching portfolio within the National Colleges of Technology has prevailed more-so than at universities and colleges. Eighteen workshops have been held both on and off campus with cooperation between the Colleges of Technology for three and a half years. More than 80% of NIT, Anan College faculty members created portfolios.

Saupe (1990) defined Institutional Research (IR) as "research conducted within an institution of higher education to provide information which supports institutional planning, policy formation and decision-making". IR has become popular at many universities in Japan. The use of IR is typically limited to teaching and learning. NIT, Anan College has implemented the use of IR for teaching and learning since 2010. We compile the survey targeted at first grade students as well as student body survey and graduation survey, these surveys share the importance and the method of using IR in the professional development workshop for faculty in which almost all faculty participate.

By these means, NIT, Anan College has fundamental understanding to improve teaching and learning. Quality assurance and teaching improvement using IR and TP at NIT, Anan College from 2010.

Program of visualization of learning outcomes

The overview of AP program at NIT, Anan College is shown in Figure 1. Our aim is to prepare educational circumstances which provide the ability to study by themselves. Then we improve educational management emphasizing the learning of students to visualize the learning outcomes. We think it better to put much value on the learning process in order to achieve an attainment target for students. Cloud-based Learning Management System (LMS) is one of the solutions. It can offer e-learning, so students study anywhere at any time. All students can access the LMS from anywhere that can connect to a network. Faculty can take care and maintain a connection students through the network anytime and anywhere.

Students have to learn practical expertise necessary in society. Recently, the competency to adapt socially and to get through life is also required. Therefore we prepare the visualization of competence that allows the student to get through their student life in our college and support their career formation.

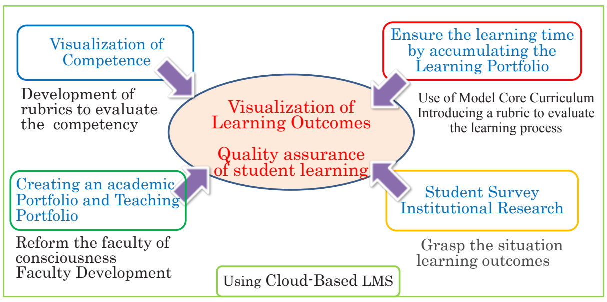

Figure 1 Overview of AP program at NIT, Anan College. There are four important approaches.

On-going activities

Our program started from the second semester in 2014. Office for Excellence in Teaching and Learning was newly-organized to carry out our program. At first, we prepared the LMS as educational infrastructure and carried out a survey to understand the trend of competence for all current students using LMS. Actually 97% of current students responded. Homeroom instructors returned the result report sheets to each student at a meeting and the students received the same result of PDF file on LMS. After that students recognized their own competence and they set specific goals for achievement within the year using learning portfolios on LMS. We expect students to set a goal by reflecting on themselves. Homeroom instructors have a regular meetings to help them achieve success. We expect students to have an attitude to achieve their goals to make an effort toward achieving their aims. In order to realize our idea, we allow students to begin with a set of goals and to analyse on themselves at the end of the fiscal year.

We investigate the relationship between the competence and each subject in the academic curriculum. Active learning is increasing in the classroom as well as developing competence. Then the competence should be embedded in an academic program. We recognize that co-curricular activities facilitate the development of various skills and want to evaluate the experiences. In order to evaluate the competence, we are discussing adapting the rubric reputation.

The Teaching Portfolio (TP) workshop schedule at NIT, Anan College is shown in Table 1. The workshop is held for two and a half days. Basically, the workshop involves three meetings between mentee and mentor, and activities are also set to motivate each other during the workshop: "Exchanging Idea", "How to be a Good Mentor", and "TP Presentation". During creating TP time, there is some conversation with visiting participants from other campuses when they receive hints and help reconsidering, finding, giving feedback to their educational philosophy, or getting new ideas. Furthermore, Academic Portfolio (AP) can reveal the effectiveness and balance of teaching, research, and services, which are recognized as the main components of higher education faculty, as results of their own reflection and evidence.

Table 1 Typical schedule of workshop.

	First day	Second day	Third day
a.m.		Follow-up meeting (2)	Follow-up meeting (3)
p.m.	Kick-off meeting Follow-up meeting(1)		Mentoring workshop Celebratory Graduation
		Get-together	

It is useful for both personnel evaluation and educational improvement. AP workshop is held in the same way as TP workshop, and is able to be held at the same time with TP. After the workshop, all of respondents felt that the workshop was useful and beneficial for their careers. The participants recognize that the workshop is significant for the faculty at the College of Technology, however, it costs much for a three day workshop. Then we hold a brief version of AP workshop for four hours in which documentation is minimized and much value is put on reflection. This short version of the workshop relates to academic portfolios is also useful for making participants think clearly about the work balance for faculty in the future.

Results and Discussion

At the beginning of the fiscal year, almost all students set goals in three categories which consist of career, academic study and co-curricular activities, and they evaluate themselves at the end of the fiscal year. The ratio of students who set goals of FY2015 is 96% and the ratio of students who evaluate themselves at the end of the fiscal year to students who set goals at the beginning of the year is 79%. There are three categories of goals which consist of career, academic study and co-curricular activities. Fig. 2 shows the status of the achievement of goals for career planning with self-assessment. The ratio of "achieved" increases with moving up to a higher grade from Fig. 2. Upperclassmen describe specific plans of getting a job or going on to universities. Fig. 3 shows the status of the achievement of goals for academic study with self-assessment. Lowerclassmen tend to set a goal of getting good study habits with concrete numerical targets concerning academic results. On the other hand, upperclassmen tend to set a goal concerning acquisition of academic credits like failing a test. Fig. 4 shows the status of the achievement of goals for co-curricular activities with self-assessment. Freshmen tend to set a goal of social common sense and common courtesy. Sophomore tend to set an example by their own behaviour and provide guidance for freshmen.

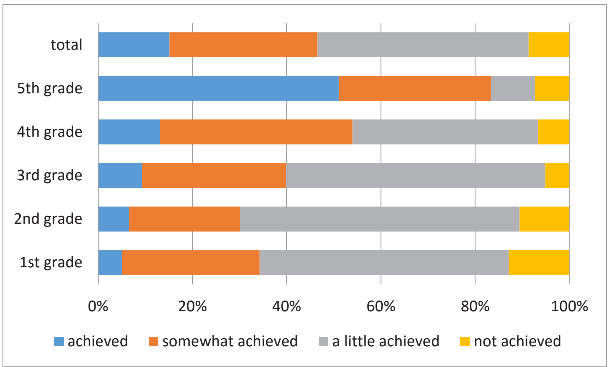

Figure 2 Status of the achievement of goals for career planning with self-assessment.

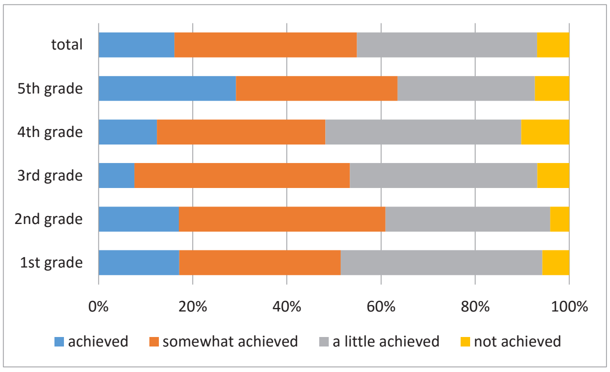

Figure 3 Status of the achievement of goals for academic study with self-assessment.

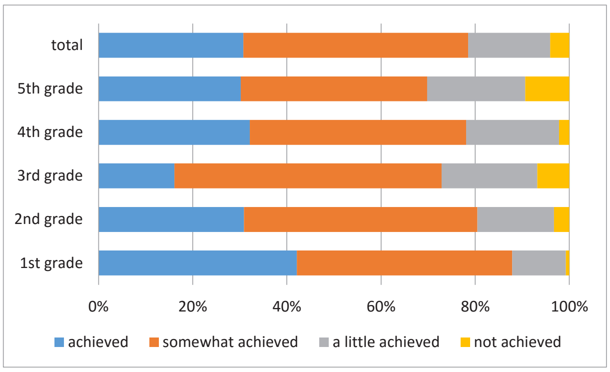

Figure 4 Status of the achievement of goals for co-curricular activities with self-assessment.

In order to analyse competency assessment of student survey, we conducted a PROG test as a competency assessment test for freshmen at FY2014, freshmen at FY2015 and sophomore at FY2015. We analysed the difference of achieving competency between day students and boarding students. Trend of the distribution for total level of competency from the results of PROG test are shown in Fig. 5 to Fig. 7. These figures show the results of freshmen at FY2014, sophomore at FY2015, freshmen at FY2015, respectively. From Fig.5 and 6 in which the subjects are the same, the rate of students gaining higer level increases. On the other hand, from Fig.5 and 6 in which the tests are the same, the rate of sophomore who achieve higher level is larger than the one of freshmen.

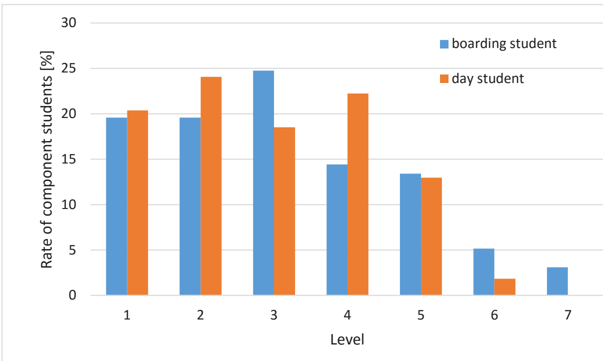

Figure 5 Rate of component of freshmen at FY2014. (n=151)

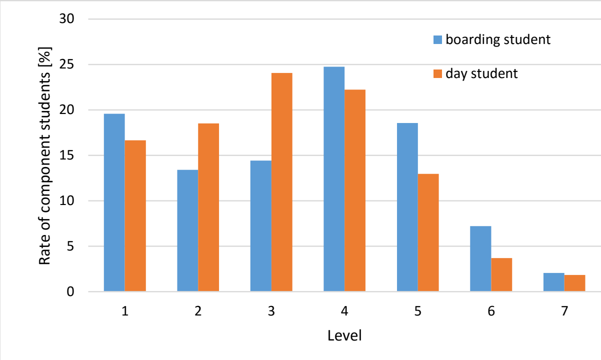

Figure 6 Rate of component of sophomore at FY2015. (n=151)

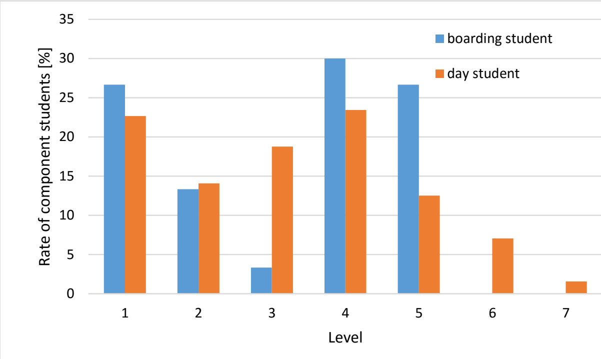

Figure 7 Rate of component of freshmen at FY2015. (n=158)

In comparison with average level, the results of boarding students are higher than the one of day students in both cases. It is considered that the trend of competency of PROG test has validity. Next, we analysed the correlation between academic results and competency. It is proved that some courses among thirteen analysed courses reveal a correlation. From these points of view, we can make students gain competency in the curriculum.

Trial evaluation of competency in fourteen regular curriculums through the second semester of FY2015 using newly developed rubric was conducted. Faculty using rubric gave us some feedback to make improvements. Furthermore, the guideline of competency in Model Core Curriculum of National Institute of technology will be revised. Then we are improving our rubric in order to test it for real.

In order to visualize the results of the student surveys, we made an illustrated sheet. All faculty have easily understood the major index of the student surveys at a glance. We put it on the web server in our college and share with faculty.

Conclusions

We expect students to make an effort toward achieving their aims. At the beginning of the fiscal year, almost all students set goals in three categories which consist of career, academic study and co-curricular activities, and they evaluated themselves at the end of the fiscal year.

Acknowledgements

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How Science, Technology, Engineering, Mathematics (STEM) Project-Based Learning Improves Student Learning

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Abstract

The purpose of this paper is to examine how extra-curricular and academic performance is affected by student participation in Science, Technology, Engineering and Mathematics (STEM) under project-based learning (PBL) activities. General observation and quantitative analysis was used to evaluate the two aspects. A solar car team project under the philosophy of STEM and PBL is developed and more than two hundred students from electrical and mechanical engineering field participated in the team project and learnt the STEM PBL core value. The team aims to develop a solar-powered vehicle to demonstrate the viability of a renewable energy through the use of green transportation, to promote the awareness of environmental sustainability among the public. It also provides students with an opportunity to put theoretical knowledge into practice, gain hands-on experience, and practice project management skills during development, and thus leading student to understanding science and new technology; and practising engineering skills and mathematics. Till now, six solar vehicles were built with the massive efforts of students. Moreover, design thinking process is adopted to engage and motivate students to learn and develop in the team. The entire process includes the following steps: ‘Empathize’, allowing students to learn about their audience for their designing process; ‘Define’, constructing a point of view that is based on user needs and insights; ‘Ideate’, brainstorming and coming up with creative solutions; ‘Prototype’, building a representation of one or more of student ideas to show to others and ‘test’, returning to original user group and testing their ideas for feedback. The team students showed significantly growth rates on research, planning, project implementation and reporting. The team also assists students’ further STEM studies and STEM career planning, and the nurturing of diversified talents with a range of capabilities at different levels in STEM knowledge development. In addition, the team organizes solar car workshops and demonstrations, and supervises group projects for secondary school students. Result of the study implied that STEM with PBL in school benefitted students in that they achieved a greater extension on extra-curricular and academic aspect, especially gaining more solid knowledge in technology and engineering.

Keywords: *STEM, PBL, design think process, integration, problem solving*

Introduction

According to the study from Anthony P. Carnevale (2015) that, the highest paying group after graduating from university in the United States is Science, Technology, Engineering, and Mathematics (STEM) group, especially engineering majors which followed by health and business. As a result, talented students in the United States compete for an engineering degree. The situation, however, is totally different in Hong Kong as it is found that science and engineering are considered “undesirable” for Hong Kong students. The 2014 Joint University Programmes Admission System data show that, the admission requirements for engineering and science degrees are significantly lower than those of law and medicine, even business programmes in Hong Kong.

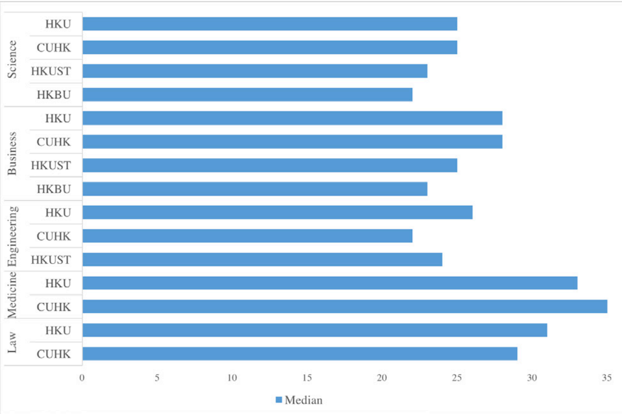

Figure 1. 2014 University Admission Median

In 2015 and 2016 policy address, Hong Kong Government stated that the Education Bureau of Hong Kong SAR will renew and enrich the curricula and learning activities of STEM, allowing students to fully unleash their potential in innovation. The critical problem is how STEM and students attracted each other. Lap-chee Tsui (2015) found that, the major challenge to Hong Kong's Innovation and technology advancement is STEM programmes face strong competition in attracting students with the best academic results.

To promote STEM and equip student with professional knowledge and practical skills, and to be work prepared, Vocational Training Council (VTC) already applied STEM PBL in Hong Kong Institute of Vocational Education (IVE) Tsing Yi, Engineering Discipline, the project is known as 'SOPHIE', a solar car project, and the result showing that STEM give a positive influence to students.

STEM PBL in VTC IVE

In 2010, the IVE Solar Car Team, a team that focuses on developing a solar-powered vehicle, was established by the IVE Engineering discipline of the HKIVE Tsing Yi under VTC. STEM PBL is one of the core values of the team in respect to educating students. The team consists of students from Electrical Engineering and Mechanical Engineering working together and aims to design an innovative and more sustainable vehicle called 'SOPHIE' to demonstrate the viability of renewable energy through using the green transportation. From 2010 to 2016, more than two hundred students learnt the core value of the team, among them, around fifteen students were selected to be the core team member every year. They learnt about solar power technology and advanced application, high-tech automotive design and fabrication, logistic management and team cooperation. The vehicle 'SOPHIE' allow students to learn by doing and applying ideas, which is the key feature of project based learning which discussed in Bulmenfed (2000). The principle is that students actively construct their understanding by working with and using ideas when they gain a deeper understanding of materials, for example, video camera is used as the side mirror in SOPHIE, responsible students were initiated that streamline shape cover shall be added on top to maintain the vehicle overall aerodynamic performance.

Till now, six 'SOPHIEs' were built under the massive effort of students. Three of them participated in three races under students' leadership, "Shell Eco-Marathon Asia 2012" with SOPHIE SEM, "World Solar Challenge 2013" with SOPHIE IV and "World Solar Challenge 2015" with SOPHIE V. In each competition, students demonstrated their telnets in building solar vehicles. Students have applied the knowledge learned in classroom to design and fabricate the solar vehicle for competitions and showed their confidence and interest in building the solar vehicle. These experience broaden their view in terms of problem solving, design concept and technology application, thus self-confidence was highly enhanced. From that, it is without doubt that STEM PBL has positively influenced student's extra-curricular performances. STEM PBL showed positive attitudes toward learning itself, team communication, and collaborative behaviour which were discussed in literature (i.e. Dominguez & Jaime, 2010; Kaldi, Filippatou & Govaris, 2011; van Rooij, 2009). Furthermore, STEM PBL was examined with respect to increasing students' interest, self-confidence, and self-efficacy, found by Baran & Maskan (2010), which was highly related to the components of STEM BPL such as collaborations in group work and contextual problems reflecting students' real world experiences.

In fact, design thinking process is also adopted to the team operation. The process is divided into five stages, including: Empathize, making use of the Internet, social media and local visits to under the design challenges to understand the way and why peoples engaging in similar projects, the needs are then identified; Define, through the empathizing stage, questions are uncovered and actionable problem statement of what needs to be built; Ideate, with the problem statement on hands, the team started to brainstorm and innovate on building the solar car; Prototype, these innovative ideas are realized by prototyping different parts of the solar car and were tested; Test, improved version of these prototypes were put together for testing (e.g. in campus parking lot), to realize the target product is finally delivered, and the project outcomes are being demonstrated.

Workshop to secondary school

To examine more on the extra curricular and academic aspects, a solar car workshop which is similar to the IVE Solar Car Team working operation is designed for senior secondary school students (i.e. S4 to S6). As junior secondary school students (i.e. S1 to S3) or even primary school students may not have the fundamental knowledge on STEM area, senior secondary school students were chosen.

The workshop introduces the basic solar car structure including solar panel working principle, energy conservation, and mechanical system to the participants, with the real product demonstration, (i.e. SPOPHIE) and divided them in group that hands on a project, a small scale solar car model. From the workshop, it is observed that there are positive effects for students in acquiring content knowledge and nurturing positive attitude toward learning. The primary reasons are the workshop contains hands-on activities and field-based contexts. Moreover, students' problem solving skills are improved since students were required to solve problems embedded in the project.

A set of pre-event and post event survey were conducted with the participants. The results are shown in the following:

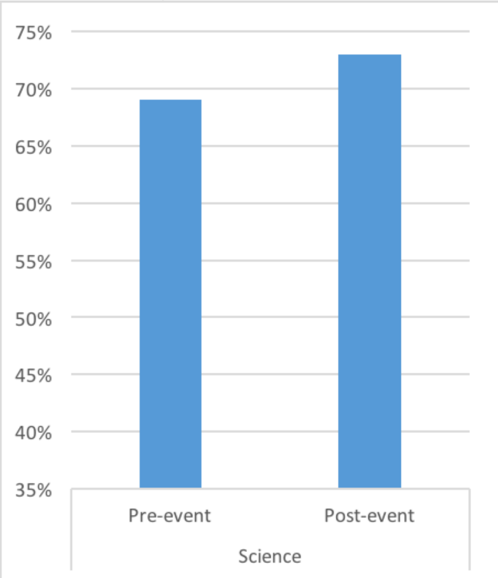

Figure 2. Survey score of Science session

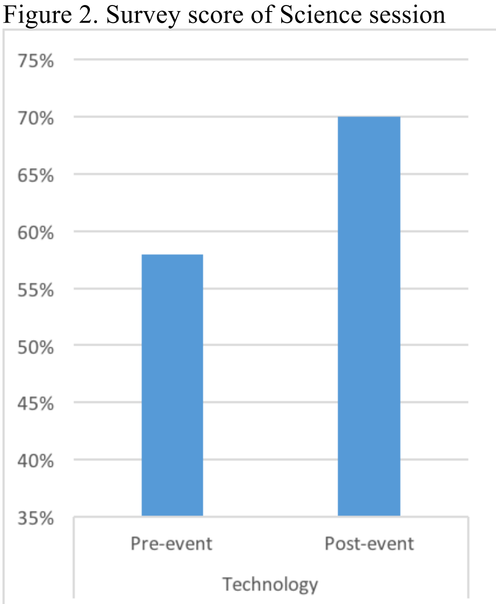

Figure 3. Survey score of Technology session

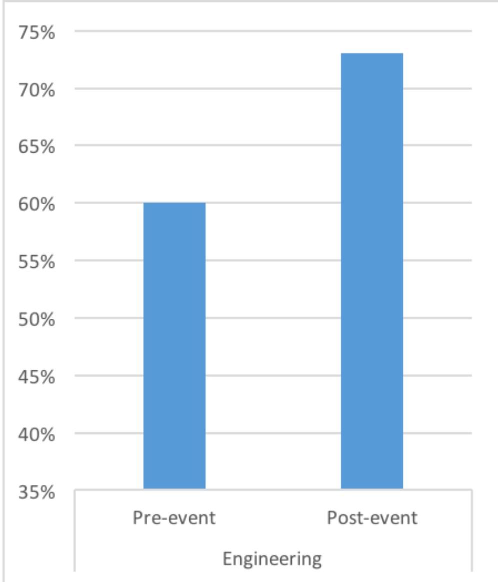

Figure 4. Survey score of Engineering session

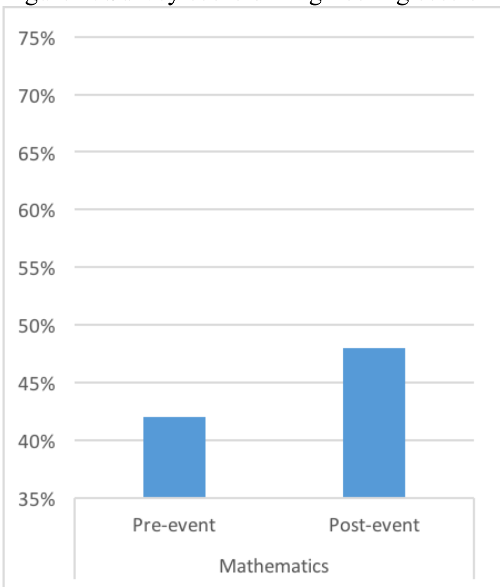

Figure 5. Survey score of Mathematics session

Result

The figures and the observation deliver that while STEM PBL was implemented, there is an expected positive growth rate in students' achievement especially in technology and engineering scopes (see Fig. 3 and 4), since these two area are not usually covered in classroom. Collaboration, group projects, ill-defined tasks, and student-centered environments all are inter-relationally function with each other. STEM PBL activities benefitted students in that more additional opportunities were given to students to communicate with peers and teachers than would traditional lectures. Teachers of the senior students appreciate that the workshop is interesting and helpful for students' learning. To increase the gaining of every STEM areas, the workshop would be further developed.

Conclusion

The effectiveness of implementing STEM PBL in terms of improving students' science and mathematics has not demonstrated as much improvement, however, the findings of this paper assists teachers to rethink how to promote STEM to students out of the traditional classroom and how the STEM PBL varied with the performance levels and benefit students by engaging in STEM PBL activities. STEM is an important key to nurture creativity, innovation, collaboration and problem solving skills of our next generation and to enhance the international competitiveness of Hong Kong.

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TEACHING AND LEARNING INTEGRATED ASSESSMENT FOR PROJECT (TLIAP)

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Abstract

Many engineering courses have a final year project as part of the course curriculum. This final year project or capstone is an important graduating experience for their students. However, commitment of the supervisors, subjectivity of the assessors, variations in assessment and evaluation methods, complexity of each project being offered and the different technologies of the projects, raise many questions with regards to how engineering schools manage such projects to ensure a credible and reliable assessment process.

This paper outlines the development and implementation of Teaching and Learning Integrated Assessment for Project (TLIAP), in two final year engineering project modules, Project Design and Development Part 1 (PDD1) and Project Design and Development Part 2 (PDD2) at the School of Engineering, Electronic and Computer Engineering (ECE) Division to address the problems as stated above.

The TLIAP Rubric is a demonstration of an innovative approach to assessment. The TLIAP Rubric revised the scoring rubric into a tool for structured teaching, learning and feedback, moving beyond the basics of being a tool for consistent marking. Its criteria focus not just on the end product but also on the development and learning processes e.g. prototyping, in completing the projects and 21st century skills such as collaboration. TLIAP also provides supervisors and students with easy to follow, clear and consistent guidelines to effectively monitor project progress.

The TLIAP Rubric criteria was carefully put together in consultation with students, project supervisors, technology cluster leaders and course leaders, and are aligned with the learning outcomes of the modules. It is a generic process-based, learner-centered teaching and learning assessment strategy that moves away from the more traditional supervisor-centered and end-product focused assessment.

The assessment criteria are tailored based on Structure of Observed Learning Outcomes (SOLO) taxonomy by John Biggs, assessing students' work in terms of its complexity and quality. Feedback have also been gathered at different stages of implementation and the results obtained showed a positive impact to student's learning. Supervisors have confirmed that the revised assessment process is easier to manage in the terms teaching & learning and assessment.

Keywords: assessment rubric, constructive alignment, assessment, SOLO taxonomy.

Introduction

Final year projects are common graduating requirements for many engineering students. In the School of Engineering, Electronic and Computer (ECE) Division, Ngee Ann Polytechnic (NP), students undertaking the final year project have to go through two modules in their two final semesters of their course. They are PDD1 (April semester) and PDD2 (October semester). Student's performance in these modules are often referenced by employers for employment or universities for admission into their degree courses.

In the recent years, there has been an increase in the complexity, diversity and depth of the projects that are being offered to students. This increase in options for students is also matched by the increased number of staff that are involved in project supervision and as moderators which can result is variation in supervisory styles, evaluation and assessment of the projects leading to inequality in the learning experience. There is a need to develop some level of consistency in assessment across the variety of projects.

Challenges in assessing Final Year Projects

Literature review has indicated that an increase in students and projects would also result in issues associating with assessing project submissions. According to Black (1975), wider range of topics, increase in scope, involvement of more staff as supervisors give rise to many issues such as ill-chosen topics, lack in clear objectives and poor supervision, resulting in frustrations and affecting students' performance. Black further argues that in most cases, marks awarded by individual supervisors are seldom challenged by external examiners which can lead to the notion of "unfairness" in evaluation.

In a similar study by Littlefair & Gossman (2008), they reported that there is significant discrepancy in assessment criteria amongst supervisors. Every supervisor seemed to have their own subjective views and students were often confused when supervisors and moderators have their own interpretation of the requirements which may conflict with one another. The lack of clear assessment criteria give rise to subjective assessment, lacking in transparency.

Jawitz & Moore (2002) did a comprehensive study on project management and assessment practices within University of Cape Town. Their study also concludes that there is large variation in project management and assessment practices within the same faculty.

Based on related studies and study conducted by the author, ECE also faced similar problems. These problems can be summarised as:

- Wide range of topics offered as projects
- Different approaches by supervisors
- Supervisors using own criteria for assessment
- Assessment criteria not communicated to students
- Lack of communications amongst supervisors

In order to ensure consistency in supervision and fair assessment across the wide range of topics and different approaches adopted by various supervisors, there is a need to develop an assessment tool that would ensure consistency in supervision and fair assessment. In addition, this tool must also be clearly communicated to students and supervisors.

Development of TLIAP Rubric for Engineering Project

Constructive Alignment and the T&L aspects

According to Biggs (2003), teaching and learning objectives, content and learning approaches must be aligned to the assessment criteria to achieve constructive alignment. This alignment optimizes the conditions that support higher order learning processes. To ensure constructive alignment in TLIAP, a rubric is designed using the learning outcomes as the assessment criteria. Andrade (2000) concludes that properly designed rubric can be used for teaching, assessment and also used by students to support self-learning.

Therefore, it is important to establish the learning outcomes of this engineering project first before the TLIAP rubric and assessment can be developed.

Establishing Learning Outcomes

For sound educational curriculum design, assessment criteria must be linked to module or course objectives (Jawitz & Moore, 2002). These assessment criteria should be based on a set of clear learning outcomes to be developed when students complete the module or course. The initial development of TLIAP rubric is the learning outcomes of the final year engineering project and these were derived from the project module objectives. These objectives become the assessment criteria for final year engineering project. Table 1 shows the module objectives and its learning outcomes.

While it is important that an engineer's primary concern is correctness of the final product but in reality the final product depends largely on the skills, approaches and management of the task (Littlefair & Gossman, 2008).These learning outcomes focus on project development processes and key graduate outcomes e.g. 21st century skills such as project management, working in groups and presentation skills.

Focusing on project development processes also gives supervisors the opportunity to show guidance, and thus integrate teaching into project development process.

Table 1. Module Objectives and its learning outcomes

Module Objectives	**Learning Outcomes (Assessment Criteria)**
Skills to manage a project i.e. able to work alone and collaborate with others. Skills to do an electronics/IT related project with a group of 2/3 students	**Project Functional Specifications:** Demonstrate understanding of the project requirements and able to describe the project objectives **Project Implementation (Before Integration i.e. work alone):** Demonstrate a range of practical skills that are used in project implementation **Project Integration (Collaborate with others):** Demonstrate a range of practical skills that is use in project integration i.e. combining each student's work into a final working project.
Skills to work effectively i.e. able to source for information using the internet	**Design and Analysis:** Demonstrate the ability to search for information and design that can be used to design a project that meets the functional requirements and specifications of the project.
Lifelong learning attitude: Able to initiate and plan own learning or self-directed learning	**Project planning:** Demonstrate the ability to do project planning by showing the overall plan, work breakdown, role assignment, timeline and milestones. **Project Management:** Demonstrate initiative and self-learning attitude.
Project presentation and report writing skills i.e. able to communicate effectively	**Report Writing:** Demonstrate writing skills in writing a project technical report **Presentation:** Demonstrate communication skills through project presentation
Possess good work habits and is professionally ethical	**Professional Ethics:** Demonstrate good work habits and professional ethics.

Classifying the Assessment Criteria

According to Thompson, the assessment criteria influence how students approach the project. Using a holistic set of assessment criteria encourages students to look beyond the bits and pieces of the project for which they think they can gain marks (Thompson, 2007). As the projects can become more complex as it progress, and it is important that TLIAP rubric is also able to reflect this increase in complexity. To do so, TLIAP criteria classification was developed based on SOLO taxonomy. SOLO, which stands for the Structure of the Observed Learning Outcomes, is a method that is used to classify learning outcomes in terms of their complexity and quality. This classification enables project supervisors to assess and feedback students' work in terms of its complexity and quality (http://www.johnbiggs.com.au/academic/solo-taxonomy/).

Besides assessment and feedback, SOLO is also useful in helping project supervisors scaffold their T&L around knowledge and skills required for the project in stages. At the initial stage of project development, supervisors can guide students to pick up only one or two aspects of the task required for the project (Uni-structural), several aspects, when the students have progressed (Multi-structural), integration of tasks (Relational), and finally, for the students themselves to design and develop untaught applications (Extended abstract). Appendix 1 shows the complete TLIAP rubric classification using SOLO taxonomy.

TLIAP and Project Development Cycle

The traditional engineering project development cycle and Design Thinking Process are defined in TLIAP rubric. The Table 2 summarizes the different phases that both processes go through to complete their project and also how the 2 different processes are "linked" through the T&L approaches used in each stage.

Table 2. Project Development Process and its T&L

Project Development Phases	Traditional Project Development Process	T & L Aspects	Design Thinking Process
Phase 1	Functional Specification	What need to be done?	Define
Phase 2	Project Planning	How to approach?	
Phase 3	Design and Analysis	Brain storming for ideas or find out how others have done it	Ideate and Research
Phase 4	Project Implementation (Before Integration)	Build the prototypes or go back to previous phase(s)	Prototyping
Phase 5	Project Integration or Final product	Integrate and test your project or go back to previous phase(s) if necessary.	Implement and Test

As there are common T&L approaches used, TLIAP rubric is thus applicable to both approaches. This is important to cater to the wider range of topics in projects, and the different ways in which students would take in the engineering project development process. For examples, the traditional approach using the five phases would be more suitable for a project if it has clear specifications, with defined steps and tools used to design and developed the final product. However, if the project requires students to modify either the current design or specifications, based on new findings or techniques that have become available, it may be more suitable to adopt the Design Thinking process where ongoing modifications are performed to remove discrepancies from the initial defined requirements or specifications. (Braha &Maimon, 1997 in Razzouk & Shute, 2012).

Project Standardisation and Moderation

One of the goals of TLIAP is to standardise the complexity of the topics being offered and its rubric is to ensure fairness in the assessment. All projects and supervisors are grouped into eight technology clusters. Each cluster is headed by a cluster leader with in-depth knowledge of the technology. The technology cluster leaders moderated the complexity of the projects proposed by supervisors in each cluster, ensuring all projects meet the predefined standard in depth and scope before being offered to students.

All student grades provided by supervisors within a cluster are first moderated by the cluster panels. After this, the grades will be moderated again by other cluster panels. Examiner Review panels consist of cluster leaders and three divisional deputy directors who will moderate when

- 'A' or Failing grade is awarded after moderation
- Moderated grade varies by a big margin.
- Disagreement with the moderated grade by supervisor

Implementation of TLIAP Rubric

Previously, one of the problems ECE faced when working with students on the final year project was the lack of clarity in the communications to students the project assessment criteria. With the implementation of TLIAP, all cluster leaders must brief all project students in their clusters in week 1 about the assessment criteria using the TLIAP rubric. The overall Assessment Schedule is shown in Table 3. Students are grouped in twos or threes to start on their selected projects. All supervisors are allocated three hours of contact hours with each group of project students which are scheduled in the students' time-table.

As students are aware that their supervisors and the different panels that would be assessing them using the TLIAP rubric, they can plan and monitor their own learning and manage their own progress using the rubric, and supervisors can also monitor, guide and scaffold teaching using the TLIAP rubric. These guidelines and schedule make it clear for both students and supervisors of the expectations of the final year project.

Table 3. Assessment Schedule

Project Design & Development (Part 1) Apr Semester (PDD1)			Project Design & Development (Part 2) Oct Semester (PDD2)		
Week 1	Assessment criteria briefing	Cluster leaders	Week 1	Assessment criteria briefing	Cluster leaders
Week 5	Formative Assessment	Supervisor	Week 5	Formative Assessment	Supervisor
Week 6	Moderation	Cluster Panel	Week 6	Cluster moderation	Cluster
Week 7	Feedback on performance	Supervisor	Week 7	Feedback on performance	Supervisor
Week 8-11	Student Evaluation	Student	Week 8 - 11	Student Evaluation	Student
Week 12	Final Assessment	Supervisor	Week 12	Final Assessment	Supervisor
Week 13	Moderation	Cluster Panel	Week 13	Moderation	Cluster Panel
Week 14	Moderation	Inter-Cluster Panel	Week 14	Moderation	Inter-Cluster Panel
Week 15	Moderation	ER Panel	Week 15	Moderation	ER Panel
Week 18	Module Review		Week 18	Module Review	

Note:
PDD1 assessment do not include project integration
PDD2 assessment do not include project specification and planning

Review of TLIAP: Supervisors' Perspective

Prior to the implementation of TLIAP rubric, the rubric was reviewed by all the technology cluster leaders for benchmarking against some selected A, B, C, D graded projects from previous semester, including the log books and project reports. There was general agreement after the weighting of the assessment criteria is adjusted.

After benchmarking, an online survey among the supervisors was also done to gauge their views of the revised TLIAP rubric. Feedback obtained from the supervisors were very consistent. Almost all agreed that the revised TLIAP rubric

- is clear, concise and easy to follow
- gives clearly stated assessment criteria for each grade

However, many supervisors also commented that the current workflow for TLIAP to collate the grades and tracking the grades with the hardcopy spreadsheets is a daunting task. Following this feedback, a web-based data entry system for project management and assessment tracking has been developed to compliment TLIAP rubric. This web-based database system simplifies assessment tracking processes.

According to Macías-Guarasa et al. (2006), administrative and teaching tools are important in project based learning courses with large enrolment. When information can be accessed easily, it can significantly reduce workload of project supervisors in monitoring students' progress. Figures 1 and 2 show two screenshots of this web-based system

Figure 1. Project groups tracking

PDD1 PR Assessment Marks Entry

Prj No.	Main Supervisor	Member	Sup	Pan	Ack Done	ER	ER Done	Title
P601	WIDJAJA FERDINAN		✓	✓	✓			Home Automation
P602	KIM CHEE WEE		✓	✓	✓	!	✓	Smart Classroom Attendance Taking System
P603	HUI TIN FAT		✓	✓	✓	!	✓	Smart Vending Machine
P604	TAI JIUN PINK		✓	✓	✓	!	✓	Crowd monitoring with Mobile Apps using Energey havastin
P605	TEY CHING SZE		✓	✓	✓	!	✓	WSS Mobile Robotics
P607	NG BENG KIAT		✓	✓	✓	!	✓	Line Tracer
P608	SUNARTO QUEK SIAW MIANG		✓	✓	✓			Robotic Arm Controller
P609	SUNARTO QUEK SIAW MIANG		✓	✓	✓	!	✓	Robotic Arm Controller
P610	LIM BENG SOON		✓	✓	✓	!	✓	Robot Colony
P612	NG BENG KIAT		✓	✓	✓	!	✓	Intelligent Robotic Contest
P613	WIDJAJA FERDINAN		✓	✓	✓			Guide Rail Gauge Inspection
P614	LIM BENG SOON		✓	✓	✓	!	✓	Humanoid Robot

Figure 2. Individual project group marks entry

	Enter all components based on 100%		Student No	Student No	Student No
1.	**Project Functional Specification** Demonstrate understanding of the project requirements and able to describe the project objectives	10%	75	80	80
2.	**Project Planning** Demonstrate understanding of project planning and management skills by showing the overall plan, work breakdown, role assignment, timeline and milestones	15%	77	75	80
3.	**Design and Analysis** Demonstrate the ability to search for information and design so as to implement functional requirements to meet the project specifications	20%	70	80	80
4.	**Project Implementation (before Integration)** Demonstrate a range of practical skills that are used in project implementation	25%	75	79	85
5.	**Presentation** Demonstrate communication skills through project presentation	10%	75	80	75
6.	**Project Management** Demonstrate initiative and self-learning	10%	75	80	80
7.	**Professional Ethics** Demonstrate good work habits and professional ethics.	10%	79	75	80

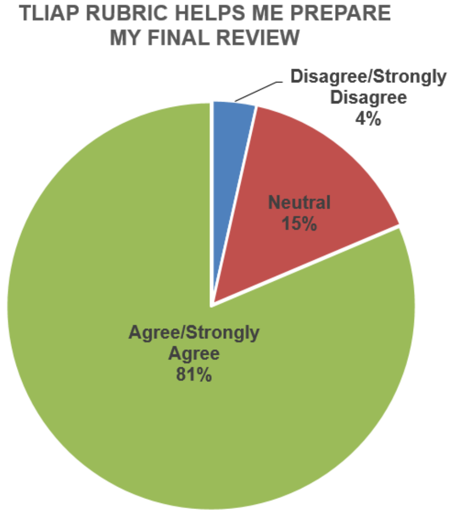
Review of TLIAP: Students' Perspective

Student evaluation is important and also essential for improvement (Rovai, 2003). Two student surveys were used to gather feedbacks on the value of TLIAP rubric to them.

Survey 1: Before Final Review of PDD1

In this survey, students were asked to rate how useful is the TLIAP rubric was in helping them to prepare for the final review, as well as comments for improvement in project management. Figure 3 shows the survey results with 81% of the students agreeing that TLIAP has been useful in their preparation of the project.

Figure 3



Survey 2 - Before Final Review of PDD2

In this online survey, the students were asked for specific areas in which TLIAP was useful to them. These included the TLIAP rubric criteria, using the rubric to set targets, overall project requirements, supervisor feedback and improvement. Figures 4, 5, 6 and 7 shows the survey results. The majority of students were positive about the TLIP criteria and requirements, and also acknowledged that TLIAP help them set targets and allowed them to better understand the project requirements. Students were also satisfied with the feedback provided during the project development process.

Figure 4

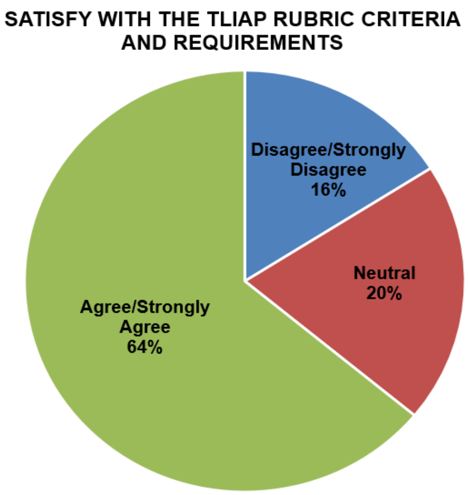


Figure 5

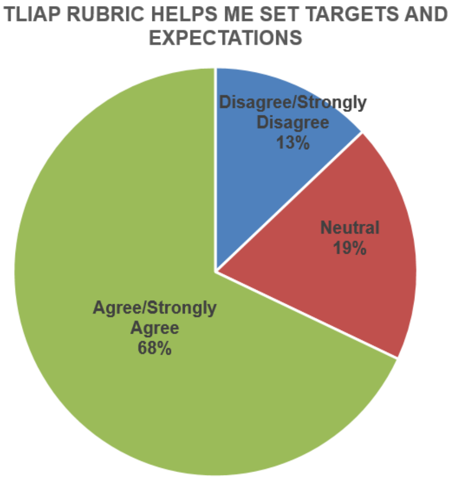


Figure 6

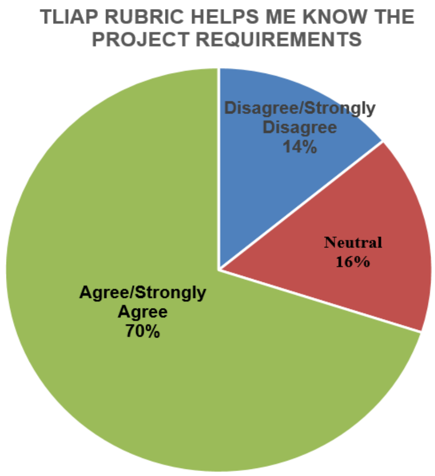
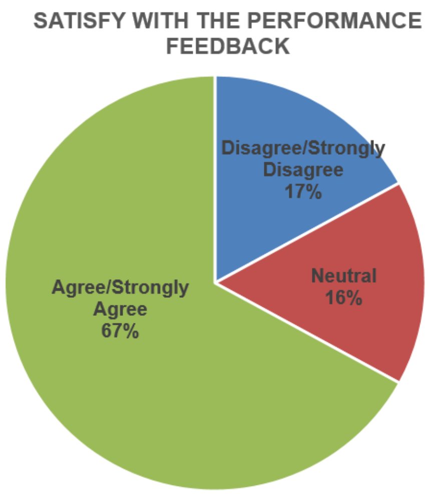


Figure 7



Conclusions

This study shows the development of TLIAP rubric that is directly aligned to the module and graduate outcomes. T&L is also incorporated into TLIAP which allows students to design and develop their projects using both traditional engineering project development cycle and Design Thinking processes.. TLIAP replaces a traditional approach that is subjective and open to challenge with a rubric that is clear in its criteria.

The development of TLIAP rubric involved feedback from project supervisors and the results showed that most agreed that the revised TLIAP rubric is clear, concise and easy to follow. It is able to communicate clearly to students what is expected of them, and supervisors are more consistent when grading different projects across different levels of topics and difficulty.

Technology clustering is used to overcome the problems related to diverse topics and three levels of moderation provide a fairer and more reliable assessment system. The daunting workflow of managing project and assessment is simplified using a web-based data entry and tracking system.

Student evaluation of the approach has also shown that it has achieved its objectives as the majority of students received feedback on their performance and indicated being able to set their own targets and prepare for the final project presentation.

This approach is by no means perfect to meet the expectations of all supervisors and students. However, it has enhanced student learning outcomes, reduce subjectivity in the assessment, and provided a more transparent and robust assessment system.

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Appendix 1: The TLIAP Rubric

Learning Outcomes	A - Extended Abstract	B -Relation	C-Multi-structural	D- Uni-structural
1. **Project functional Specification:** Demonstrate understanding of the project requirements and able to describe the project objectives	• Able to explain with a fully completed block diagram • Extended Application(s)	Able to explain with fully completed block diagram	Able to explain with partially (about 65%) completed block diagram	Able to explain with partially (about 50%) completed block diagram
2. **Project planning** Demonstrates understanding of project planning and management skills by showing the overall plan, work breakdown, role assignment, timeline and milestones	• Evidence of detailed work breakdown, timeline and role assignment. • Evidence of schedule being monitored. • Evidence of planning for Extended Application(s)	• Evidence of detailed work breakdown, timeline and role assignment. • Evidence of schedule being monitored.	• Evidence of detailed work breakdown, timeline and role assignment. • Some evidences of schedule being monitored	• Show simple work breakdown, timeline and role assignment. • Little evidence of schedule being monitored
3. **Design and Analysis** Demonstrate the ability to search for information and design so as to implement functional requirements to meet the project specifications	• Show application circuits/programs for use in the project + Extended Application(s) • Able to explain all parts including the linkage and relation	• Show application circuits/programs for use in the project. • Able to explain all parts including the linkage and relation	• Show application circuits/programs for use in the project. • Able to explain some parts and its linkage and relation	• Show application circuits/programs for use in the project. • Able to explain one or two parts but not the linkage and relation
4. **Project Implementation (before Integration)** Demonstrate a range of practical skills that are used in project implementation	• Evidence of building the prototypes or test programs + Extended Application(s) • Fully working and able to explain how it works	• Evidence of building the prototypes or test programs • Fully working and able to explain how it works including the linkage and relation.	• Evidence of building the prototypes or test programs • Partially working and able to explain how it works.	• Evidence of building the prototypes or test programs • One or two parts working and able to explain how it works.
5. **Project Integration (The whole project)** Demonstrate a range of practical skills that is use in project integration i.e. combining each student work into a final working project.	• Complete project is integrated and working • Able to explain how his/her parts in the integrated project+ the overall integrated project+ Extended Application(s)	• Complete project is integrated and working. • Able to explain how his/her parts in the integrated project + the overall integrated project	• Some integration and partially (about 65%) working • Able to explain how his/her parts in the integrated project	• Some integration and partially (about 50%) working. • Able to explain how his/her parts in the integrated project
6.**Report Writing** Demonstrate report writing skill through a project technical report	• Overall concepts are demonstrated • Block diagram with description of function block • Detailed explanation of individual block and linkage of each block+ Test Results with Analysis	• Overall concepts are • demonstrated • Block diagram with description of function block • Detailed explanation of individual block and linkage of each block	• Some concepts are demonstrated Block diagram with description of function block • Some detailed explanation of individual block and linkage of each block	• Basic concepts demonstrated. • Block diagram with description of function block. • Not detailed explanation of individual block and linkage of each block
7. **Presentation** Demonstrate communication skill through project presentation	• Audience can follow and understand • No clarification is needed	• Audience can to follow and understand • Need little clarification	• Audience can to follow and understand • Need some clarifications	• Audience has difficulty to follow and understand.
8. Project Management Demonstrate initiative and self-learning	• Complete task with no guidance • Able to provide assistance to others	Complete task with minimum or no guidance	Complete task with some guidance	Complete task with full guidance
9. **Professional Ethnic** Demonstrate good work habits and professional ethics.	• Observe all professional ethical guidelines • Full attendance, Reporting on time, Safety Rules + Good Attitude	• Professional ethical guidelines • Full attendance, Reporting on time, Safety Rules	• Professional ethical guidelines • 100- 80% attendance • Safety Rules	• professional ethical guidelines • Below 80% attendance • Safety Rules

2210

INTRODUCING MENTAL HEALTH SUPPORT IN ENGINEERING EDUCATION AT NIIHAMA COLLEGE

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Abstract

This paper reports the mental health education that we conducted at Niihama College. Cooperating with Saijo Public Health Center, we gave lessons to first-year students. These lessons aim to support students' mental health and to improve their communication ability. Our method is based on cognitive behavioral therapy. We also adopted the method of active learning in the class, such as group work and presentation. We believe this helps to nurture the ability of independent learning and communication. We carried out a questionnaire to receive feedback from the students and to check their level of understanding. This paper analyzes and evaluates our activity. We finally discuss the importance of mental health support in engineering education and recommend introducing it in the curricurum of National Institute of Technology.

Keywords: *mental health, cognitive behavioral therapy, engineering education, group work, presentation*

Introduction

Student Counselling Room in Niihama College made various efforts to support students' mental health. The Counselling Room has recently employed two school nurses and enriched the system of counsellor outside the college. As a result, the number of user of the Counselling Room has increased. This does not mean that the number of students who has troubles and worries has increased, but this does mean that students feel easier to consult. Consequently, we can grasp students' mental troubles and worries better, and now work on each case carefully. For the next step, we believe that it is important to improve self-control ability of emotion in order to keep fit mentally before serious troubles occur.

The Student Counselling Room had felt the importance of prevention before troubles occur, together with the traditional way of support which aims to solve worries and problems students have. While one of the authors was the head of the Counselling Room, we began to cooperate with Saijo Public Health Center in the eastern part of Ehime prefecture where Niihama college is located. Saijo Public Health Center launched a project to support the mental health of adolescents as one of efforts to prevent suicide in the year 2015. Niihama College become a model school for the project and we named the activity "Mental Skill-up Education."

We carried out the following two things. One is to carry out a lecture for teaching staff by public health nurses and to acquire the skill to give a lesson toward students. The other is that our teaching staffs actually deliver a class to support students' mental health. This class includes group works and presentations which are necessary for engineering education. The key feature is that our teaching staff especially homeroom teachers acquire the skill and give a class to students so as to maintain this education in the limited amount of budget. It is also meaningful to improve students' communication ability through group work and presentation in the process of learning the method of mental health.

In the following sections, we will introduce our method, then analyze the results of questionnaire, and finally discuss the importance of our activity and future issues.

Method

Out activity has two purposes. One is that both teachers and students learn the basic method of cognitive behavioral therapy that "emotion and behavior is affected by the way of thinking", consider the worries and situation that we face, and judge what we should do flexibly. The other is that teaching staff can deliver a class and continue our activity in the long term.

To accomplish our purposes, we first provide a lecture for our teaching staff and then give a lecture to 5 classes of 212 first year students. Out of 5 classes, first 3 classes were taught by staff from Saijo Public Health Center and teaching staff at Niihama College took charge of the other 2 classes.

1. Lecture for teaching staff

A lecture by two public health nurses at Saijo Public Health Center was held in July 2015, and 47 staff attended the lecture. We learned the basics of cognitive behavioral therapy that “emotion and behavior is affected by the way of thinking” and discussed how to deliver a lesson towards students.

2. Lessons towards students

We gave lessons towards 5 classes of first year students, 212 in total. The public health nurses carried out first 3 classes and our teaching staff learned by observation. Then, 4 staff took charge of the other two classes (2 teachers for each class). The lesson are 90 minute long and the contents of the lesson are as follows.

(1) Understand the basic idea of cognitive behavioral therapy

First, staff role-play the scene “A said ‘Good morning’ to B (A’s friend) but B did not reply”. Next, students imagine how A feels. Students choose their feeling from 5 choices (sorrow, anger, anxiety, composure and other) and raise a colored paper corresponding to their feeling (see Figure 1). At that time, staff tell students that perception and feeling vary and there is no right or wrong. Then, students consider the reason of their feeling, the cause of their feeling (i. e. the way of thinking) and the next action. Staff convey that “emotion and behavior is affected by the way of thinking.”

Figure 1. Student raise colored paper corresponding to their feeling

(2) Check their way of thinking

Staff introduce 6 patterns of way of thinking: “thinking ahead”, “obligatory thinking”, “subjunctive impression”, “thinking too much”, and “self-criticism”, “black and white thinking”. Students answer a small questionnaire and check features and habits of their way of thinking.

(3) Consider the relation of “incident (fact)”, “thought”, and “feeling / action”

Students consider the following case and classify into “incident (fact)”, “thought”, and “feeling / action”.
‘On Sunday, A wanted to play with B and sent a message on LINE. A sent massages several times, and the messages were already read but there was no reply from B. A thought that B went to play with C (another friend) and A felt left out. A got upset thinking that ‘I did something terrible to B’ or ‘B got into a serious trouble’. A got a stomachache and couldn’t work on homework that A had to do.’

(4) Discuss among group members and prepare for presentation

Students imagine how A thinks and how it affects A’s feeling and action. Students make groups of six and discuss advice to A within a group. Students decide a chair, a secretary, a timekeeper and speaker, and prepare for their presentation.

Figure 2. Group work

(5) Presentation

Each group gives a presentation for about two minutes.

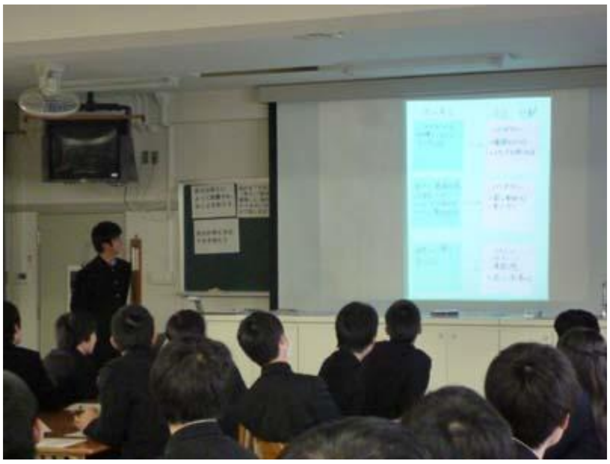

Figure 3. Presentation

(6) Sum up
Students review what they have learned and fill in a questionnaire.

Results and Discussion

This section shows the results of questionnaire we took. First, we report questionnaires of teaching staff after the lecture by the public health nurses at Niihama College. The reply to the question whether they already knew the cognitive behavioral therapy is the low 10.8%. However, 21.6% of the participants fully understand the content, and 70.3% understand the content. As these two replies are above 90%, we accomplish the aim to have our teaching staff understand the basics of the cognitive behavioral therapy. We also asked their willingness to adopt the cognitive behavioral therapy into education. 3% has already used the method, and the majority 75.7% are willing to work on it. This means that many teaching staff show positive attitude toward our project.

Now, we report the results of questionnaire of students after the class that the teaching staff of Niihama College give classes.

Did you enjoy the class?

Yes very	27.9%
Yes	70.9%
Not much	1.2%

Do you understand the idea that "emotion is affected by the way of thinking"?

Yes very	47.7%
Yes	51.1%
No	1.2%

Do you understand the importance of thinking "incident ", "thought" and "feeling" separately when you are worried?

Yes very	31.3%
Yes	62.9%
Not much	5.8%

Do you think this class would be useful for you?

Yes very	24.4%
Yes	65.1%
Not much	10.4%

Do you want to take this kind of class (mental health class) again?

Yes very	17.4%
Yes	61.6%
Not much	16.3%
No	4.6%

As you can see from the above results, most students show positive attitude towards the contents of the class. It turns out that our attempt was quite effective despite the first year of activity.

Conclusions

During adolescence, the body and mind go through many complex changes, and students tend to have many concerns. Therefore, it is necessary for students to learn how to deal with their stress and refresh their mind. It would be very effective to ask an expert outside of the college to give a talk, but it is difficult to continue in the long term in the limited amount of budget. Under these circumstances, we started the project aiming our teaching staff to acquire the skill of mental health and actually deliver a lecture. Judging from the results of questionnaire and reaction of students during the classes, we believe that we accomplish our aim. It is necessary to continue our efforts to understand the ideas of cognitive behavioral therapy and to learn the skill of giving a lecture. At the same time, we need to look closely at the circumstances of students and the number of consultation.

In 2016, we plan to carry out the similar lectures by homeroom teachers to first year students and start to give a lecture of assertion to second year students cooperating with Saijo Public Health Center.

Acknowledgements

We are grateful to public health nurses of Niihama and Saijo city healthcare center for supporting the classes that we carried out at Niihama College.

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2211

AN ATTEMPT AT GAMIFYING CALCULUS FOR STUDENT LEARNING

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Abstract

In his book Digital Game-Based Learning, education thought leader Marc Prensky argues that the pervasiveness of playing computer and video games has impacted current generations in the way they learn. In this light, he proposes that games are a good tool for learning. For one, its very nature arouses passion and involvement. Moreover, while rules give structure and context, goals provide motivation as learners push themselves to progress to higher levels of achievement through stages. Outcomes and feedback in games direct players towards improving their play and problem solving skills. Finally, interactivity in games allows learning to happen through doing, so that assimilation of information comes naturally.

In the School of Engineering at Temasek Polytechnic, Year 1 students need to take a core mathematics module in Calculus. With a wide range of student academic ability, inadvertently, a group of students will often lag behind because they could not grasp the basics. Due to the nature of the module, students need to be familiar not only with mathematical notation but also basic formulas and algebraic skills. Two online packages were designed to help students level up their basic skills in differentiation and integration by gamifying the learning experience. They supplement formal lessons by revisiting important calculus concepts. This allows students to have a gauge of their competence and the opportunity to improve on specific areas before sitting for formal assessments.

The differentiation online package was implemented during the Off Campus Learning Week in January 2016. A total of 1350 Year 1 engineering students took part in the exercise and were surveyed. Since it was a pilot run, the survey aimed to assess whether this form of learning was effective and what the experiences of students were like.

The majority of the students seemed to have enjoyed the experience, with 79% giving it a positive rating. As the details of the survey were unpacked, students' experiences and learning issues were surfaced that hint at some directions for future improvements.

As a follow-up, the integration online package was implemented at the end of the semester for students to attempt for their own review.

Keywords: *Calculus, Gamification, Learning through play, Self-directed learning, Motivation.*

Introduction

The phenomenal growth of the online gaming industry at the turn of the millennium, and its impact on student learning, are of great interest to both educators and employers alike. This is what Marc Prensky (Prensky 2007) cautions us about the Games Generations:

"Based on the latest scientific research and evidence in neurology, there is no longer any question that stimulation of various kinds actually changes brain structures and affects the way people think, and that these transformations go on throughout life."

In fact, Prensky suggests, approaches that dominate the education system now could actually retard learning for this group. For example, the Games Generations thrive on twitch speed, graphics, parallel processing of ideas and random access of content, whereas teaching in schools still resort to conventional speed, texts, linear processing of ideas and step-by-step instructions. Game-based learning, with attributes naturally suited to this group, could very well be a significant teaching tool in the future, although it has its limitations. One example stands out - reflection for critical thinking is not a skill usually associated with games. Nonetheless, certain genres, such as chess and military simulation games, are already integrating it into their game-play, indicating potential for game-design developments in this area (Prensky 2007).

Lisa Galameau and Melanie Zibit (Galameau & Zibit 2007) have similar views. They went on to assert that while current education systems are not preparing students with 21st century skills, online games are. In their view, the 21st century workers will need to collaborate with diverse teams of people, master knowledge by filtering through quasi-accurate information, and thrive on chaos to allow rapid decisions to be made in resolving new dilemmas. They call for the breaking down of barriers in the education systems to games by improving digital literacy and offering online learning environments. As young people embrace modern communication technologies and play in virtual environments, real-world capabilities can be developed organically.

More recently, gamification is a concept that is making headway in business, and trickling into the education arena. Defined as "the use of game design elements in non-game contexts" (Deterding et at 2011), gamification seeks to create target behaviours in the player towards emotional responses through game components (Hunicke et al 2004). Contrary to what some may believe, research shows that rewards such as points, levels and leaderboards do not actually harm the intrinsic motivation of the player to play the game for its own sake if the game is properly designed (Mekler et al 2013).

Gamifying learning content is gaining interest among schools and institutions in Singapore. A 2009 study of Singapore schools (Koh et al 2012) found that 58% of teacher respondents incorporated games in their teaching, though not frequently, and 16% of them firmly believed in the benefits of games. A similar study in a local polytechnic (Tan A. 2014) revealed that about 40% of the teacher respondents used games in their teaching and most were positive of its benefits despite its limited use. At the same time, game-based learning has taken on greater dimensions in some schools and institutions in the United States. Lee Sheldon discusses several case studies in his book *The Multiplayer Classroom* (Sheldon 2012). Notably, he commends Quest to Learn, an innovative high school in New York launched by Katie Salen in 2009, where the curriculum mimics the action and design principles of games.

These experimentations act as signposts pointing to much room for harnessing the power of well-designed games to engage students in problem-solving skills as we anticipate where game-based learning is going (Trybus 2014). Selecting meaningful game elements for the subject content is definitely an important consideration. For example, simulation with game elements has much to offer in engineering subjects. In the School of Engineering at Temasek Polytechnic, students who went through simulation-based learning in the subjects Machine Technology and Gas Turbine Engine were found to experience deeper learning than their counterparts in traditional classroom teaching (Fang et al 2008, Tan H. S. et al 2014).

For the semester spanning October 2015 to March 2016, the School of Engineering at Temasek Polytechnic made an attempt to gamify some of the learning of Calculus for Year 1 students. This paper discusses student experience and learning as fed back by the cohort of engineering Year 1 students of Calculus in January 2016.

Aims

Students who take up Year 1 Calculus at the School of Engineering in Temasek Polytechnic come from a wide range of mathematics background. About 30% of them are identified as students with poor mathematics skills and are required to take up compulsory remedial classes during their Year 1 first semester of polytechnic studies, with some continuing with remedial classes in their Year 1 second semester. There are also students (about 12% of the cohort) who not only took two mathematics subjects at high school level (GCE O-level Elementary Mathematics and Additional Mathematics), they aced the more difficult Additional Mathematics. Taking various factors into account, approximately 10% of the cohort would often be found struggling with the Calculus module.

The difficulty these 10% face is largely two-fold: while coping with new concepts and new mathematical notations in the module, they need to level up with others in algebraic manipulation skills. Tutorial classes, peer-tutoring among classmates, and tutor-led remedial classes are the usual avenues for their catching up. However, the need for countless basic drills is difficult to effect because the amount of individual attention needed to bridge large learning gaps is unrealistic. There is also the common understanding in the school that the teaching of the module should benefit most students, and capable students should be suitably challenged. While instructors try to pitch teaching to suit most students, there will always be students who inadvertently fall behind.

In attempting to gamify the learning experience of Calculus, a few aims were considered.

Firstly, the 10% struggling with the module need to find the activity meaningful. This means that the entry level of the game should be focused on drills in basic level Calculus that involve minimal Algebra. If they can repeat the activity sufficiently, they should be able to handle simple problems afterwards.

Secondly, the bulk of the students should be able to sharpen their skills in doing both simple and moderate level Calculus.

Thirdly, more exceptional students could be affirmed of what they already know, hone their skills, and nudged towards more advanced problems that go a little beyond the usual mathematics they see in class.

Additionally, the gamified learning experience should be an enhancement of what is already happening in class. Most questions should echo what they have seen in formal lessons, but broken down into smaller portions and then gradually brought to higher levels of complexity.

Lastly, the gamified experience should give the students a different yet pleasurable experience. Gamifying the learning hopefully brings fun and a fresh way of looking at learning, thereby giving students additional motivation to progress somewhat beyond what they are normally able to do in formal lessons. The game elements of levels (Basic, Intermediate, Challenging, Insane) and badges (gold, silver, bronze medals, or none) are meant to help students assess their competency and motivate them to acquire and polish more advanced skills.

Method

The attempt to gamify Calculus at the School of Engineering involves introducing two online packages into the module. Both named *Calculus Games*, the first package "Let's differentiate" focuses on Calculus differentiation, while the second package "Let's integrate" centres around Calculus integration. To ensure that students attempt at least one package intentionally, "Let's differentiate" was made a required task for these students during Off Campus Learning week from 9 to 17 January 2016. The week is designated once a semester for Temasek Polytechnic students to access online learning material from home for all their modules.

The game starts off with simple instructions with upbeat background music. Once the quiz is launched, sound effects enhance immediate feedbacks of their choices - a whoosh goes with a tick for the right answer, and a buzz goes with a cross for the wrong answer.

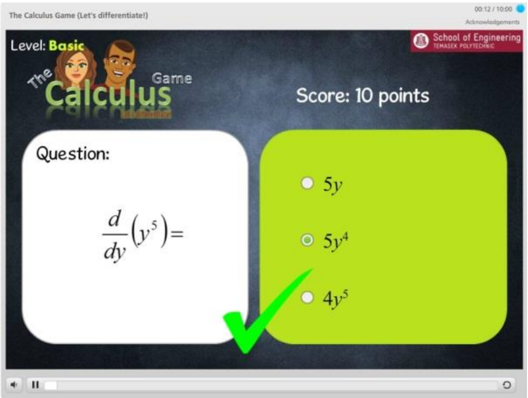

Figure 1: Screen capture of a Basic level quiz question when the correct answer was selected.

Students are able to repeat the quiz or move on to the next level provided minimal score is achieved. They can also review the quiz to see the right answers. The idea is that while students are motivated to do the sums quickly, they are also encouraged to improve their scores through repeated tries, and given the option to see the answers of their last try. A time limit of 10 minutes is allotted to each quiz.

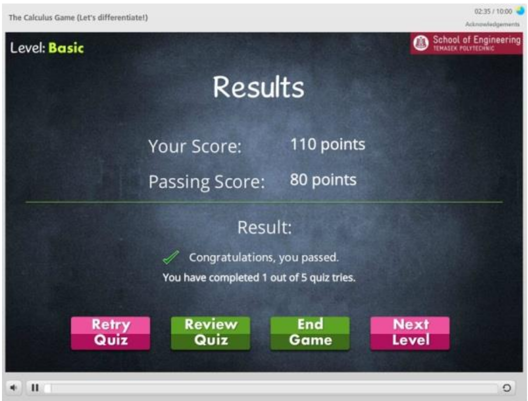

Figure 2: Screen capture of the Results slide at the end of the quiz with options for the next step.

In "Let's differentiate", students progress through four levels of quizzes at increasing levels of difficulty, starting with Basic level, and move on to Intermediate, Challenging and Insane levels if they meet minimal scores at each level. A final score together with a medal (gold, silver, bronze, or none) are displayed when the student either exhausts five given tries or chooses to end the game.

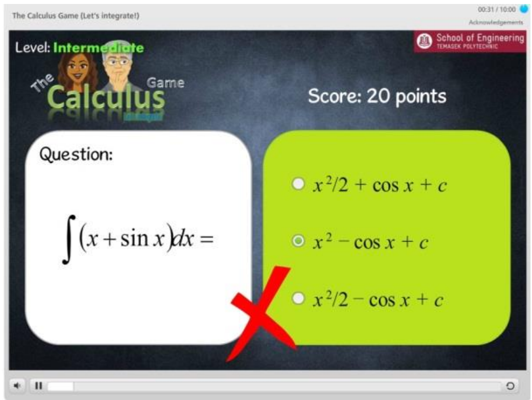

Figure 3: Screen capture of an Intermediate level quiz question when the wrong answer was selected.

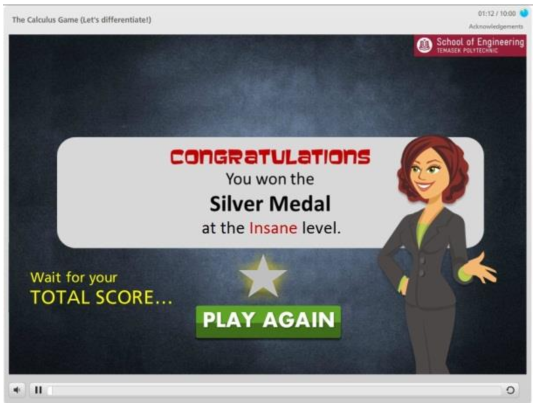

Figure 4: Screen capture of the medal slide when the student either exhausts all given tries or ends the game.

Created using the eLearning authoring tool Articulate Storyline 2, about 100 questions were randomized in the package so that repeated tries are still fresh experiences to students.

Minimal instructions were given and the interface is designed such that students intuitively know what to do, such as clicking a button, dragging objects, or just waiting for results to appear.

The whole environment of upbeat music, sound effects, levels, scores, and badges was crafted with the aim of making the experience more game-like, hence more enjoyable for students.

After going through "Let's differentiate" online, these students were asked to give feedback of their experience before working on the next online tasks of watching an online video lesson and doing an online quiz as required for the module.

Results & Discussion

A short survey of seven questions was conducted for students who played the *Calculus Game* "Let's differentiate".

In the first five questions, students gave an overall rating and feel of the game by choosing one out of four choices. All in all, 1350 responses were collated for the first five questions, corresponding to 89% of the cohort of 1520 students taking the module.

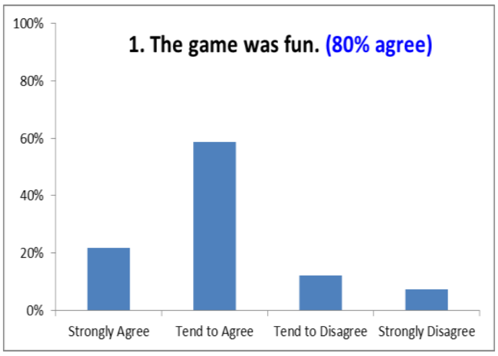

Figure 5: Survey response for Question 1.

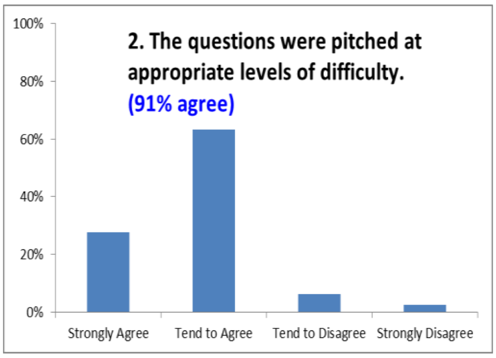

Figure 6: Survey response for Question 2.

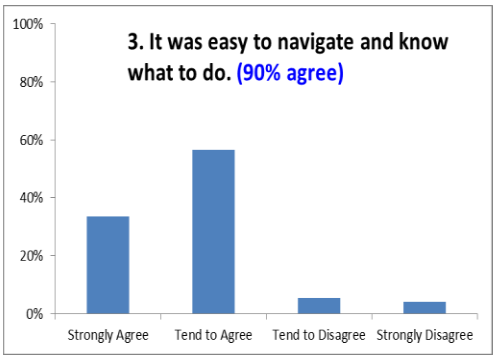

Figure 7: Survey response for Question 3.

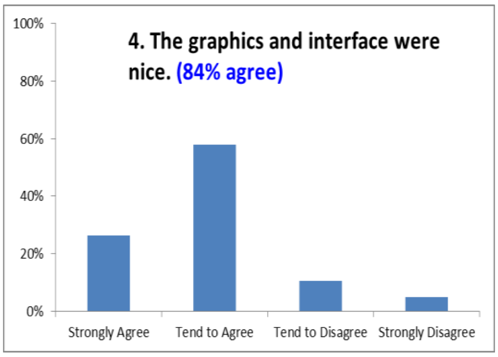

Figure 8: Survey response for Question 4.

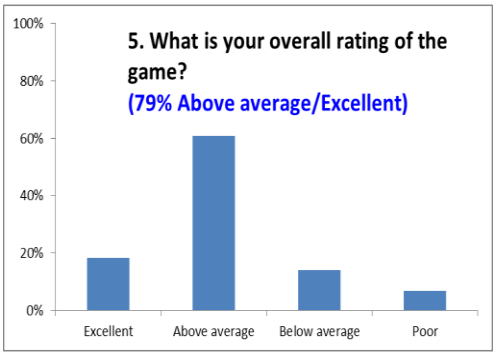

Figure 9: Survey response for Question 5.

The highest positive ratings were given to questions 2 and 3, where most students (90-91%) showed satisfaction with the problems posed and overall ease of use.

Students generally found the problems pitched at appropriate levels of difficulty. This could mean that they were able to do a certain amount of problems correctly, yet suitably challenged at some level. In written responses elsewhere in the survey, students mentioned being pleased that the problems looked similar to problems done in tutorial lessons, which they perceived to be useful in learning relevant concepts.

The game interface was also easy to navigate for the majority of them, indicating that despite minimal instructions, they knew how to progress to next steps intuitively. The simplicity of the game itself was also something appreciated by students as indicated in their written responses.

Questions 1 and 4 had to do with how students perceive the aesthetics of the game – whether the graphics and interface were pleasing to the eyes, and whether the experience was a pleasurable one. Despite the many suggestions for game improvement in question 7, a large portion of the students (80-84%) seemed satisfied with the aesthetic standards achieved for the purpose of mathematics drill. This was quite surprising considering the high quality of graphics and special effects that students, likely gamers themselves, are exposed to.

Question 5 was an important measure of how successful students deemed the game-based learning initiative was. It is heartening to know that students on the whole (79%) were satisfied with the activity through what they experienced.

In question 6, students responded freely on the strengths of the game, for instance, whether they found the experience helpful in their learning. In question 7, they gave suggestions to improve the game. Both questions drew written responses from about 60% of the cohort.

A frequent response for question 6 was that the game was helpful for learning. Several explained that it was a good after-term-break revision to go through virtually all relevant Calculus topics in anticipation of the scheduled quiz in the following week. Others were glad to find that simple formulas were edged in their minds after a few rounds of play, giving them a greater sense of competence in doing subsequent problems. Students also commented that the fast-paced game pushed them to think harder about their choices since it was not always easy to guess the answers. A pocket of them observed that the game-play enabled them to identify wrong concepts which had led them to make mistakes repeatedly. They were then able to brush up on those concepts through further self-study and practice. This feedback was a pleasant surprise for teachers.

Students who did not enjoy the game cited a number of reasons. Some could not make sense of the questions at all. Others felt that the game was not "game-like" enough as they expected better graphics, catchier music, livelier animation, or even an immersive experience. A few students expressed that gaming was not something they associated with learning. They preferred instead to do pen-and-paper assignments and attend formal lessons, where they felt "real" learning and teaching was taking place. Furthermore, some expressed that games did not appeal to them at all, as the anxiety of accumulating points under time pressure was too much for them. It was interesting to note that students' perception and preference of a game environment differed greatly across the cohort.

One area that affected students' experience significantly seemed to be related to software-hardware compatibility and connectivity issues. About a third of the students experienced severe hanging and system shutdown problems during game-play, particularly when they reached Challenging and Insane levels of the game. Unlike the ease of clicking multiple choice answers at Basic and Intermediate levels, they reported difficulties with keying in answers or dragging objects as required for some questions at Challenging and Insane levels. It is likely that the package is not compatible to touch-screen laptops or similar devices used by students. It is also possible that the school server was not able to support large numbers of students accessing it over the same period. In spite of the difficulties, many of them said they tried many times to re-play the game to get it to work. Fortunately, a third of the cohort did not experience any technical problems at all, while the rest of the third experienced one or two problems which they overcame after the second or third try at the game.

The responses for this question were also observed for students with different aptitude in Calculus.

Average performing students (those who received grades B and C eventually) seem to have gained most from the experience compared to their fellow students. They generally reported that the progression of difficulty across the levels was reasonable, and that they were able to learn something new from the answers' feedback.

High performing students (with a good grade A or a distinction grade Z) were pleased to have a review of the concepts learnt but wished there were more challenging questions for deeper learning.

Those who performed poorly (those who obtained a pass grade D or a fail grade F eventually) said that the game had clear presentation and that the fun experience pushed them to try harder. However, they also felt that the game only benefitted those who knew the answers or had some understanding of the concepts since the feedback did not give them the explanations they needed.

Question 7 of the survey attracted lively responses on how the game can be improved, some of which can be easily implemented. Suggestions include:

- Allocate more quiz tries per game and longer times per quiz to make the game more attainable.
- Improve the immediacy of the feedback by displaying the correct answer once they click the answer rather than reviewing all of them at the end of the quiz.
- Include a hint in each question, so that when the student chooses to read the hint and gets the correct answer, he or she would still get some points, albeit partially penalised.
- Display leaderboards for the highest scoring students.
- Display full working solutions at the end of each quiz.
- Increase or decrease the number of levels in the game.
- Make the problems easier or harder.
- Improve the graphics, music, and animation, perhaps even introducing immersive experiences.

A number of students commented that they were contented with the game if only the hanging and shutdown problems could be resolved. There were also a few students who suggested going back to pen and paper, instead of playing a game. Judging from the thoughtful suggestions from students, however, most of them were positive about learning Calculus through a game.

It would have been good to be able to say that students improved in overall grades following the implementation of the Calculus packages. Unfortunately, it is difficult to make such assertions due to the different spread of students and slightly different assessments on year. In fact, the cohort did improve on the previous year's cohort in terms of higher percentages of A's (a good grade) and lower percentages of F's (a fail). Instructors generally found that Year 1 Calculus students in the semester spanning October 2015 to March 2016 displayed better learning attitude compared to their counterparts in the previous year. This could have contributed to better overall grades among other factors.

Conclusions

The attempt to gamify Calculus for student learning began with the intention to motivate students in sharpening Calculus skills from the basics up. The gamified experience did seem to spur students to learn the concepts through trial and error, feedback, and repetition under time pressure.

On the whole, students liked the idea of a game-based learning environment and were willing to cooperate within the rules of the game. Most felt that the experience was helpful to them in learning, be it revising known concepts or learning new ones. What stood out in these feedback, however, was that a *meaningful learning experience* seemed uppermost on students' minds, not the fun of the game itself. Students, preferring the game or otherwise, always spoke from the perspective of how well their learning was progressing and how they liked it improved.

Given the readiness of students to experience game-based learning, there is much scope for implementing improved versions for Calculus or other areas of mathematics learning. Notwithstanding, future endeavours need to take into account students who have widely differing sentiments towards a gamified experience and those with different learning styles. Perfecting game elements and technical aspects to match expectations, while daunting tasks for educators, will not be as critical as crafting the right questions in the right way to facilitate helpful learning.

It remains to say that gamified learning experiences, while not able to fully replace the teacher as yet, could very well fill in some important gaps in large learning cohorts.

Acknowledgements

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ISSUES REGARDING ENGINEERING EDUCATION REFORM

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Abstract

Every country's development and competitiveness is dependent on the level of engineering education and its results.

The CDIO initiative[1], (Conceive, Design, Implement and Operate) has been gradually introduced into Mongolia from 2012. It is now broadly used in outcome-based training curriculums which prepare our new generation of engineers.

Understanding CDIO models, its fundamental theoretical and methodological backgrounds, the main goals are essential to determine the correct actions to be taken during the outcome-based training.

According to our paper, we studied CDIO's two main principles that have been accepted as the best and most efficient structure for engineering education. We also have developed human-based training guidelines and offered efficient methods tailor made for our country and our people.

Keywords: *engineering education, curriculum reform, outcome-based training, initiative*

Introduction

There are significant revolutions in the education sector throughout the world. Main reason for this revolution is emerged from world globalization, rapid reform in technology and transition process to the knowledge era. It leads us to understand the latest trends of higher education, learn about best international experiences, and make higher education more open, flexible and accessible.

In the recent years, there have been organized many jobs which are related upgrading higher education system in Mongolia. In particularly, to translate training program name and index according to the UNESCO classification and develop a human-based training curriculum frequently.

Due to updating engineering education curricula, content and methods in the international standards have following the outcome: engineering graduates will gain project based skills, complete engineering and operating capabilities.

Materials and Methods or pedagogy

Mongolian Ministry of Education has produced a document to develop Mongolian education to 2021 and it states that "to have training programs and curriculum that meet international standards". .

According to "Government action plan from 2012-2016", which talks about best initiatives, methods and implementing CDIO model in engineering curriculum which focuses on producing the next generation of engineers.

What is a "CDIO-Initiative"? In 1997, Edward F. Crawley, a professor of astronautics and engineering systems at Massachusetts Institute of Technology initiated the idea to strengthen training outcomes, make theory closer to industry, develop creative thinking and intensify research.

The initiative was named CDIO (Conceive, Design, Implementation, and Operation) and developed 4 levels of competencies that should have been acquired.

CDIO initiatives were accepted and implemented by the Swedish Institute of Technology, Omsk Polytechnic University and Cambridge University in 2000.

In 2014, CDIO association was formed which included the world's biggest universities. According to statistics (Asia region countries conference was held in China March 23-25, 2016) CDIO association has membership in the world's 129 top universities.

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[1] CDIO Russian : Современный подход к инженерному образованию
CDIO English : Conceive, Design, Implement and Operate

Figure 1. CDIO Initiative- Collaborating countries and institutions

According to figure 1, biggest CDIO members belong to regions such as North America and Europe. But there are only 20 CDIO schools in Asia (headquarter in Singapore). Mongolian University of Science and Technology joined CDIO Initiative in 2015. CDIO suggested member schools being managed by regions and each region is led by one or more regional leaders.

Why is CDIO initiative considered as "Best educational model to train engineers of new generation"?

CDIO model interprets engineering from a broad perspective. In this perspective, engineering is no longer limited to just technology, engineering combines closely with social development, market discipline, management model , history and culture, values, psychological, aesthetic and so on. CDIO model constructs the curriculum system based on such a large engineering concept. The CDIO model is not just to train technical experts, but also to train engineers who can engaged in system development of product under the modern organization and management models and market operation mechanism, but also the founder of engineering talent with a sense of social responsibility whose purpose is based on human well-being and social civilization. CDIO model is training engineering talent from a system macro perspective. The training objectives, the curriculum system and teaching mode are all under the command of such concept.

CDIO framework consists of two parts: CDIO syllabus and CDIO standards.

About CDIO syllabus and standards CDIO syllabus

CDIO syllabus is the preliminary list of training outcomes. On the other hand, syllabus indicates competencies that should have been possessed by students' end of the training. Competencies are given in 4 levels and marked as x, xx, xxx, xxxx. When levels increase, contents of competencies become more detailed and precise.

"X" level competencies determine main objectives of CDIO and it is divided into 4 categories.

The organization of the CDIO Syllabus can be described as an adaptation of the UNESCO framework to the context of engineering education.

1. Basics of science and professional general knowledge (Learning to know)
2. Personal and professional skills and attitudes (Learning to be)
3. Communication and teamwork skills (Learning to live together)
4. Systems of environmental and industrial thinking, planning and designing, operating and using (Learning to do)

These levels of classification models are useful for use as a list of learning outcomes of the program:

"X-level": List of learning outcomes are designed to determine the goals and objectives of the training program.

"XX-level": List of comprehensive learning outcomes are consistent with national standards, knowledge and skill sets of accreditation criteria that students should have adopted.

"XXX-level": List of performance indicators are defined more precisely.

"XXXX-level": Training outcome indicators are determined in a specific lesson.

X levels of competencies divided into XX levels, XX levels of competencies divided into XXX levels and XXX levels of competencies divided into XXXX levels. The following chart shows how CDIO competencies are divided general to specific.

Chart 1. Breakdown of 3rd levels of CDIO competency

x level	xx level	xxx level	xxxx level
3. Communications and teamwork skills	3.1. Teamwork 3.2. Communication 3.3. Communicating in a foreign language	3.1.1. Effective teamwork	3.1.1.1. Stages and cycles of team 3.1.1.2. Tasks and activities of team 3.1.1.3. Duties and responsibilities of team 3.1.1.4. Team goals, needs and characteristics 3.1.1.5. Pros and cons of team members 3.1.1.6. Team regulations and rules

CDIO standards:

In order to ensure training activities, there are 12 standards which are based upon the CDIO syllabus. The 12 CDIO standards address program philosophy (Standard 1), curriculum development (Standards 2, 3 and 4), design-build experiences and workspaces (Standards 5 and 6), new methods of teaching and learning (Standards 7 and 8), faculty development (Standards 9 and 10), and assessment and evaluation (Standards 11 and 12). Standards have the following objectives:

Chart 2: Standard objectives

	Standards:	Standard objectives
1	**Standard 1:** CDIO as Context	Adoption of the principle that product and system lifecycle development and deployment – Conceiving, Designing, Implementing and Operating - are the context for engineering education

2	**Standard 2:** Syllabus Outcomes	Specific, detailed learning outcomes for personal, interpersonal and product and system building skills, consistent with program goals and validated by program stakeholders
3	**Standard 3:** Integrated curriculum	A curriculum designed with mutually supporting disciplinary subjects, with an explicit plan to integrate personal, interpersonal and product and system building skills
4	**Standard 4:** Introduction to engineering	An introductory course that provides the framework for engineering practice in product and system building, and introduces essential personal and interpersonal skills
5	**Standard 5:** Design-Build Experiences	A curriculum that includes two or more design-build experiences, including one at a basic level and one at an advanced level
6	**Standard 6:** CDIO Workspaces	Workspaces and laboratories that support and encourage hands-on learning of product and system building, disciplinary knowledge, and social learning
7	**Standard 7:** Integrated Learning Experiences	Integrated learning experiences that lead to the acquisition of disciplinary knowledge, as well as personal, interpersonal, and product and system building skills
8	**Standard 8:** Active Learning	Teaching and learning based on active experiential learning methods. Active learning methods engage students directly in thinking and problem solving activities. There is less emphasis on passive transmission of information, and more on engaging students in manipulating, applying, analyzing, and evaluating ideas.
9	**Standard 9:** Enhancement of faculty CDIO skills	CDIO programs provide support for faculty to improve their own competence in the personal, interpersonal, and product and system building skills
10	**Standard 10:** Enhancement of faculty teaching skills	Actions that enhance faculty competence in providing integrated learning experiences, in using active experiential learning methods, and in assessing student learning
11	**Standard 11:** CDIO skills assessment	Assessment of student learning is the measure of the extent to which each student achieves specified learning outcomes. Instructors usually conduct this assessment within their respective courses. Effective learning assessment uses a variety of methods matched appropriately to learning outcomes that address disciplinary knowledge, as well as personal, interpersonal, and product and system building skills
12	**Standard 12:** CDIO program evaluation	A system that evaluates programs against these twelve standards, and provides feedback to students, faculty, and other stakeholders for the purposes of continuous improvement

Training activities for implementing, and evaluating programs will be organized in accordance with the objectives of CDIO standards.

Results and Discussion

1. **To determine the aim and objective of program and the result of training**

The aim and objective of program and the result of training should be determined on the base of Bloom system and its updated versions.

Educational aims now have become educational activities and as a result of it this system has become the base of CDIO model.

Also this complex system organizes the cognitive activities of students and leads from simple intellectual action to advanced cognitive level.

It provide opportunities to answer the questions such as how to work, what kind of cognitive actions must be done for students in each level of learning and what tasks should be developed and how they should be evaluated.

When the purpose of the training curriculum is determined depending on a country's labor market demand and interests, the objective is defined by competency based 4 types of above mentioned x level.

The most responsible part to develop curriculum is to define the training result.

There are many ways to determine it clearly. DACUM analyze is the most appropriate research method and it involves all participants.

2. **To develop curriculum:**

Curriculum is one kind of matrix that shows combination between subjects and result (PLOs[1]) during the training.

The matrix below indicates at what level and rank students must obtain CDIO skills depending on the final outcomes of subjects that are included in the curriculum.

Chart 3: Type of knowledge, evaluation rating and matrix of actions

Classification of knowledge	**Recall (knowledge)**	**Understanding (cognitive)**	**Application**
Facts	Listing	Expressing by other words	Classifying
Understandings	Recalling	Explaining	Proving
Actions	Mapping	Calculating	Creating
Activities	Producing	Giving example	Combining
Principles	Determining accurately	Converting	Solving
Knowledge transformation	Appropriate usage	Translating	Developing

Analyze	**Evaluate**	**Create**
Mapping	Classifying	Ranking
Comparing	Criticizing	Upgrading
Diagram	Finding solution	Thinking
Figuring out	Criticizing	Planning
Seeing differences	Evaluating	Controlling
Evaluating	Predictring	Implementing

3. **To develop lesson plan**

It starts with identifying the teachers and student's activities and results during classes.

Planning a particular lesson consists of defining aim correctly, choosing good methods and sequences as well as teachers creative activities of thinking and researching.

The aim of lesson plan should be focused on developing student's skills.

4. **Evaluating learning outcomes and developing methodologies**

This is the main part of the outcome based training curriculum. Assessment criteria, methodologies and planning are used to assess learning outcomes. However, evaluating process is very complicated and accurate**.**

How and what criteria should be evaluated? Many different replies are given on these issues: Some people say that learning results should be evaluated; others say knowledge, skills and attitudes should be evaluated and third ones say that learning strategies and observances are the key factor for the evaluation.

Assessing the student performance is more realistic than the above mentioned objects. The effectiveness of teaching and learning can be considered evaluation to assess student performance in conjunction with student behavior. Bloom's cognitive taxonomy gives a perfect answer for this.

Combinations of testing, interviewing, written exam, reports, doing experiment, organizing exhibitions can be used during the assessment of student performance. The right mixture and good harmony of these methods is essential.

The purpose of assessment is to define how well the students obtain the learning goals and results. Therefore, it requires much more methodologies and times from the lecturers.

According to Allan C.Ornstein, there are 4 basic forms of assessment: placement, diagnostic, progress and final.

Using the appropriate combination of assessment is the key for the evaluation and weaknesses could be eliminated by advantages of other assessment. Thus, understanding of each assessment's objective, intention, pros and cons are essential.

The assessment is not only done by teachers; students should be involved in evaluating each other when the student participation is ensured.

Conclusions

1. Developments of social and economic tendency have been changing in Mongolia. Especially, in the engineering education the latest and most efficient world frameworks has to be adopted. Learning about sets of 12 standards and its 4 syllabus of CDIO is important.
2. During the implementation of CDIO models, we suggest that **Bloom's taxonomy** the three lists cover the learning objectives in cognitive, affective and sensory domains are effective. However, the usage of improved versions of Bloom's taxonomy can be used in our school and in Mongolia as well.
3. When developing the curriculum, we have to consider all aspects in systematic way such as concepts, structures, updating contents and removing overlaps.

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Topic 4

Educational Models and Approaches

4101

ENHANCEMENT OF EDUCATIONAL AND RESEARCH ACTIVITIES BY "PRELAB" SYSTEM

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Abstract

The declining birth rate and aging population have caused decline of the national strength and international competitiveness in Japan. The Ministry of Education, Culture, Sports, Science, and Technology has been promoting "Regional revitalization strategy", and the ministry has demanded educational institutes to nurture human resources who can solve various issues with local companies. To respond to these demands, we NIT, Nagaoka College established the System Design Innovation Center (SDIC) in 2015. The center has nurtured innovative human resources using various measures such as engineering design education, cross-department education program named JSCOOP; job search for local companies based on cooperative education, and Prelab (pre-laboratory) system, which supports exploratory educational research. This paper describes the detail of Prelab system (Prelab), and discuss the ripple effect on the education and research activities of our KOSEN.

The basic philosophy of "Prelab" is to support faculty members' exploratory research and research activities for underclassmen who are equivalent to high school student. The Prelab consists of three major policies, which are "(A) Supporting exploratory research and realization of ideas", "(B) Holding various seminars", and "(C) Discussing new education methods". Also, all faculty members can propose any contents to all students and faculties. There have been 15 proposals raised in total since August 2015 in which the system was established. While there were only two research groups out of 15 proposals, the core member consisted of under the third-year students and a technical personnel participated in the lab group. The questionnaires showed that the students' motivation was improved, and also research motivation of them was higher than we had expected. We will strongly promote this system.

Keywords: *Project-Based Learning, Engineering education, High-school student, Prelab*

Introduction

Recently, the declining birth rate and aging population have caused decline of the national strength and international competitiveness in Japan. The Ministry of Education, Culture, Sports, Science, and Technology has been promoting "Regional revitalization strategy", and the ministry has demanded educational institutes to nurture human resources who can solve various issues with local companies (MEXT, 2015). Also, the Japanese government has been vigorously promoting the globalism in the field of education because of Japan's policy of accepting international students and acceleration of overseas transfer of Japanese factories. Therefore, educational reforms are demanded fundamentally to the field of education.

We NIT, Nagaoka College had performed to nurture having the practical and innovative-minded human resources since its establishment. However, these policies were not at all satisfied with current social demands. Therefore, to respond to them, we established the System Design Innovation Center (SDIC) in 2015 (Fig. 1). The center has nurtured innovative human resources using various measures (Toyama, S., 2015). Especially, the SDIC consists of three major policies such as Engineering Design Education (EDE), JSCOOP (Job Search for Local Companies Based on Cooperative

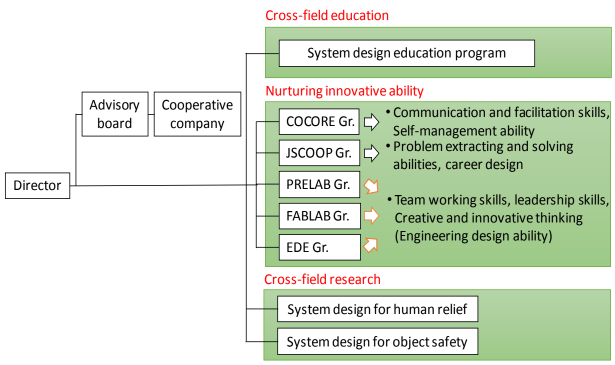

Figure 1. Organization chart of System Design Innovation Center

Education), and Prelab (pre-laboratory) system. EDE is a cross-department education program. The students learn about system thinking, design thinking and facilitation skill, which seem to be required for innovative personnel. System thinking means paying attention to the connection between each element and interaction related to the behaviour of the whole of system. Design thinking is a technique to develop products and service for social themes and needs and to explain their value as a story (Maeno, T., 2014). Facilitation skill is one of leadership to activate organization and participants with the support of consensus building and mutual understanding in meetings (Oishi, K., 2011). JSCOOP program is to nurture students' problem extracting and solving abilities with regional companies. The students go to regional companies to collect their information, and then they make public relations articles of the company. It is useful for nurturing abilities of carrier designing, collecting information, and information transmission. The Prelab system can support exploratory educational research of faculties and activate research of underclassmen. This paper describes the detail of Prelab system (Prelab), and discuss the ripple effect on the education and research activities of our KOSEN.

Outline of Prelab System

The basic philosophy of "Prelab" is to support faculty members' exploratory research and research activities for underclassmen who are equivalent to high school student. The Prelab consists of three major policies, which are "(A) Supporting exploratory research and realization of ideas", "(B) Holding various seminars", and "(C) Discussing new education methods" (Fig. 2). Also, all faculty members can propose any contents to all students and faculty members. When the proposers want to recruit the collaborators, they can announce it using a message board, email, and announcement by homeroom teachers. Usually, researchers who belong to general educational faculties and technical personnel are difficult to conduct research because of not having their laboratory and human resources in KOSEN so far, however, they can attempt to establish their own laboratory using this Prelab system. Also, all faculty members can discuss their ideas with all members. Therefore, it is expected that collaborative works and the number of grant application are increased by Prelab.

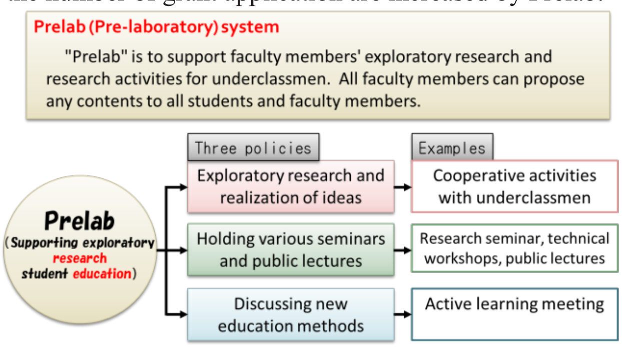

Figure 2. Enhancing research and educational activities using three major policies

On the other hand, underclassmen can participate in laboratory research using this system if they have an interest in research activity. Generally, KOSEN students like "monozukuri"; making something and experimental work (Fig. 3). However, underclassmen do not have a lot of experimental classes and opportunities for research activity. There are some reports that the study motivation of some students is to gradually decline for this reason (Yoshida, M., 2008). We have to make countermeasures against this rapidly. The missions of Prelab system are to prevent this issue and keep students' motivation for monozukuri. Actually, there are some reports that underclassmen research activity can prevent declining their study motivation (Yoshida, M., 2008, Miki, K., 2010). If we can use Prelab system effectively, there are many possible merits for faculty members and students. The Prelab system is one of the suitable tools for enhancement of educational and research activities.

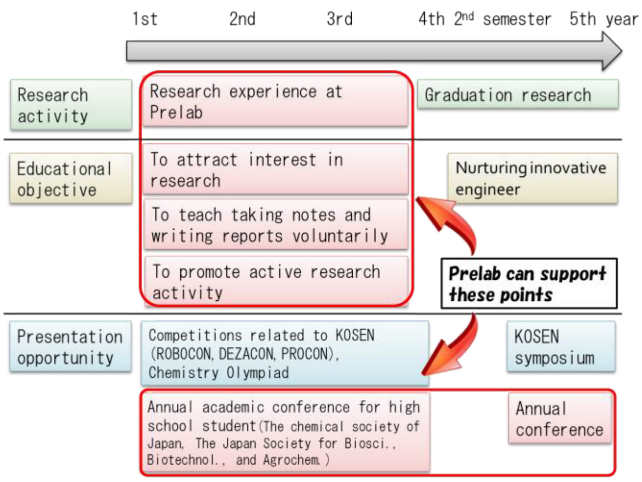

Figure 3. Research activity of students in KOSEN and supporting points by Prelab

Detail of Submitted Proposals

There have been 15 proposals raised in total since August 2015 in which the system was established (Table 1). Category A was four, B was five, and C was six. The results showed that faculty members and students had various needs, and also the category design

Table 1. Detail of all Prelab proposals

Theme	Target person	Category
SDIC seminar	All persons	B
Earthworms have unlimited potentials!-Introduction of earthworms' functions and Recruiting Prelab members-	All persons	A
Investigation of planarians in Nagaoka city	Under 3rd year students	A
Recruiting delivery lecture assistants of "Let's enjoy using Robots!"	All persons	C
Recruiting delivery lecture assistants of "Let's enjoy using Robots!"	All persons	C
PVRC solar car project -Solar cell production practice (1st term)-	All persons	A
Recruiting delivery lecture assistants of "Decode the optical signal of remote controller"	All persons	C
Encouragement in electrical working for girls	Female students only	B
Open class: "Mathematics using active learning"	Faculty and staff	C
Mathematics study meeting	Faculty and 3rd year students	B
Let's make the only one object in the world!	All persons	B
Practical learning of technology as a subject in junior-high school	Faculty and staff	B
Regional contribution activities using earthworms!-Recruiting Prelab members-	Under 2nd year students	A
Open class: "Mathematics (for 4th grader) using active learning"	Faculty and staff	C
Recruiting delivery lecture assistants of "Let's enjoy using Robots!"	All persons	C

was roughly suitable. Furthermore, there were three limited themes for faculty members. It was revealed that Prelab was beneficial for sharing information among faculty members (Fig. 4). For other examples, there were recruitment of assistants for public lectures and monozukuri seminar announcement (Fig. 5).

While there were only two research groups out of 15 proposals, the core member consisted of under the third-year students. One laboratory group consisted of multiple department students and a technical personnel. Prelab actually contributed to activate the activities of education and research in our KOSEN.

Figure 4. The open class scenery of "Mathematics using active learning"

Figure 5. The monozukuri seminar: "Let's make the only one object in the world!"

Detail of laboratory activity

1. Research theme and participating motivation of students

There has been a concern underclassmen can research continuously. Here, we introduce one case of the Prelab activities and discuss its educational effect for underclassman.

The theme is a "Regional contribution activities using earthworms". The participants were 13 students; four 1st graders, two 2nd graders, six 3rd graders and one 4th graders on 5th Feb. 2016. In addition, one technical personnel, whose research field was not biology but electrical and electronic systems engineering, participated in the same lab. group. They were divided into four small research groups since there were a lot of participants.

2. Actual activity

First-year students of our college start to take an experimental class from second semester, so we had to teach them how to take notes and use MS Office software before our research in order to start the activity at first semester. Since participants have a lot of classes and they belonged to various club activities as well, it was difficult to fix the research date. To encourage participants, we gave each group a small goal of research presentation, at an annual academic meeting for underclassmen and our college, for improving their research and presentation ability.

As a result, all research groups could summarize their research and present it at our College festival (Fig. 6). Furthermore, one of the groups presented their research at a high-school student category of annual academic conference (Fig. 7) (Saito, H., 2016). They explained their research to many people at the presentation diligently.

The students also attended at the symposium of novel prize winner. They listened to the lecture seriously and one of the students succeeded to get the

Figure 6. The poster display space at our college festival

Figure 7. The poster session at the 2016 annual conference of the Japan society for bioscience, biotechnology and agrochemistry

autograph of the winner.

The questionnaires after the conference showed that the students' motivation was improved, and also their research motivation was higher than we had expected. Currently, we try to raise the research to the next stage.

Promotion of Prelab System

The current problem of Prelab is the low recognition because of the poor information system. We have to improve advertising method for all students and faculty members. The Prelab-system survey results showed that the way that proposers' direct announcement got more participants than that by Prelab administrators. The number of proposal is two per month, and we must disseminate the system continuously to gain more recognition. We need to enhance the public relations and visualize various Prelab activities from now on.

Although Prelab has just begun, the system revealed that there were a lot of students who have an interest to research activities and monozukuri events. Furthermore, Prelab has contributed to encourage information exchange among faculty members. We strongly continue promoting this system for enhancing educational and research activities.

Conclusions

The basic philosophy of "Prelab" is to support all faculty members', including technical personnel members', exploratory research and research activities by underclassmen who are equivalent to high school student. Prelab can promote exploratory research and raise up the study motivation of underclassmen. Also, the system can contribute to exchange information efficiently among faculty members. It was found that Prelab could promote the educational and research activities.

Acknowledgements

We thank all SDIC members, the president, and administrative officials of National Institute of Technology, Nagaoka College: they supported us to establish the Prelab system.

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Project Based Learning: Case study in Chemical Engineering Plant Design

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Abstract

Chemical Engineering Plant Design is the last and one of the most important classes in Chemical Engineering degree program. In this class, students will work in a group of 5-6 to combine engineering knowledges learned in other courses in the general curriculum including economics, safety and environmental to design an integrated chemical process plant. At the beginning of class, small workshop in Leadership Compass (a Native American Indian–based practice): Appreciating Diverse Work Styles was introduced. This framework was designed to allow each student to dig deeper in their perceptions of self and team. The series of lectures such as principles of process design, selection of processes, material, and equipment, and cost estimation were given to provide fundamentals and techniques for students. The active learning tools such quiz game such as kahoot, group activities were used in class to enhance learning outcome. Students have to submit two progress reports and one final report. A preliminary report was including project title, objectives, market survey, process alternatives and selection, and simple profitability of each process. The second report was including a detailed process design and equipment and a result from process simulation program. The final report was including content in previous report, and economics evaluation as project and equipment cost, profitability. The three oral presentations were presented to a class and 4 of lecturers. During comments session, students was allowed and encouraged to comment and ask questions. After the oral presentation, the students have to make a correction and re-submit a report. From a series of lectures and oral presentation, students have developed their abilities to design an integrated chemical process plant. The comments from students were that they developed their abilities to work as a team, know their strength and weakness in each technical issue, and how to apply all knowledge to design an integrated chemical process plant.

Keywords: *Project Based Learning, Active learning, Chemical Engineering, Plant Design, Team Work*

Introduction

In the 21st century, the world has become more volatile, uncertainty, complexity, and ambiguity or VUCA. R. Berger (2016) explained about the trend compendium 2030 by such as demographics dynamics, globalization and future markets, scarcity of resources, climate change and ecosystem at risk, dynamics technology and innovation, global knowledge society, and sustainability and global responsibly are opportunities and also challenges for a new graduate in science and technology field especially chemical engineering. P21.org(2016) explained about Framework for 21st Century Learning The requirement for the 21st century skills such as Information, Media, and Technology skills, Critical thinking, communication, collaboration, and creativity, and life and career skills has to be well developed before graduation.

Chemical Engineering is one of seven disciplines of the Regulated Engineering Professions in Thailand under Council of Engineer, the Engineer Act, B.E. 2542(1999). Unlike the Accreditation Board for Engineering and Technology(2014) that established curriculum requirement for "(a) one year of a combination of college level mathematics and basic sciences (b) one and one-half years of engineering topics, consisting of engineering sciences and engineering design appropriate to the student's field of study, and (c) a general education component that complements the technical content of the curriculum"[2], The Council of Engineer(COE) in Thailand has established a very strict and detailed curriculum. The curriculum shall include at least 84 credits in fundamental and specific engineering, i.e, Fundamentals in science (18 credits), Fundamentals in Engineering (24 credits), and core course in chemical engineering (24 credits).

Chemical Engineering Plant Design, a one of required core course in chemical engineering curriculum from COE requirement. This projected based learning course is designed for the 4th year student to experience a conceptual design, general design considerations and selection, process design project of a chemical plant.

Pedagogy

During the first year in chemical engineering program, students will learn fundament course in science and engineering to gain basic knowledge. In second year, they will learn more sub-discipline in chemistry such as Organic Chemistry, Analytical Chemistry and fundamental course in chemical engineering such as Principle Calculation, Chemical Thermodynamics to gain deeper knowledge in chemistry and basic knowledge in chemical engineering. In third year, they will learn core course in chemical engineering such as Chemical Kinetics and Reactor Design, Unit Operations, Chemical Engineering Process to gain deeper knowledge in Chemical Engineering. During summer of third year, there is a 2 months industrial training class. Students will gain a hand on experience with staff in a real chemical plant. During a last year, they will learn the last three of chemical core courses; Process Dynamics and Control, Engineering Economics, and the last one, Chemical Engineering Plant Design.

Chemical Plant is an industrial scale plant that manufactures chemical/biochemical product via a series of process such feed preparation, reaction, separation, and etc. The projected based learning was chosen for teaching in Chemical Engineering Plant Design for students to experience in a conceptual design for a complex chemical plant and to develop the higher cognitive skills (analyzing, creating, and evaluating) as well as communication and collaboration skills.

The strategies to teach Chemical Pant Design class were similar to build a model from a Lego block. Students will learn how to do a conceptual design of a chemical plant task by task till the end. Students were given an instruction to form a team of 5-6 persons to work on a project to design a chemical plant to produce chemicals of their choice. They need to submit three reports, i.e., preliminary report, progress report and final report at week 6, 10, and 15 during 18 weeks of the whole semester. In addition, the week after report was submitted, groups required to present their work in front of instructor's panel.

The first stage: To help students to understand perception of team work, the small workshop in Leadership Compass (a Native American Indian–based practice): Appreciating Diverse Work Styles was introduced. This framework was designed to allow each student to dig deeper in their perceptions of self and team. Students learned about four work styles; North (Action preferred), South (Empathy preferred), East (Vision preferred) and West (Analytical preferred) from a team of instructors and performed a checklist to choose a work style that close to their style. After that they were participated in two round of 30 mins discussion among a group with the same work style and different work style to share and learn from individuals. Figure 1 show a picture during group activities on leadership compass. A week after they have to submit a project title, name of project manager and secretary, and other members.

The second stage: The further steps was a series of lectures such as principles of process design, selection of processes, selection of plant location, and simple cost estimation were given to provide fundamentals and techniques for students to fulfill a requirement of a preliminary report. The requirement of preliminary report is including project title, objectives, market survey, process alternatives and selection, and simple profitability of each process. A team has to submit a report at the week 6 and make a presentation in front of instructor panel. After each presentation, the open discussions were conducted for students to learn from other successful and failure. The example of preliminary report presentation was show in figure 2. During this learning process, students developed the deeper cognitive skills such as remembering, understanding, applying, analyzing, and evaluating from completing the task as well as communication, collaboration skills.

Figure 1 shows group activities on leadership compass.

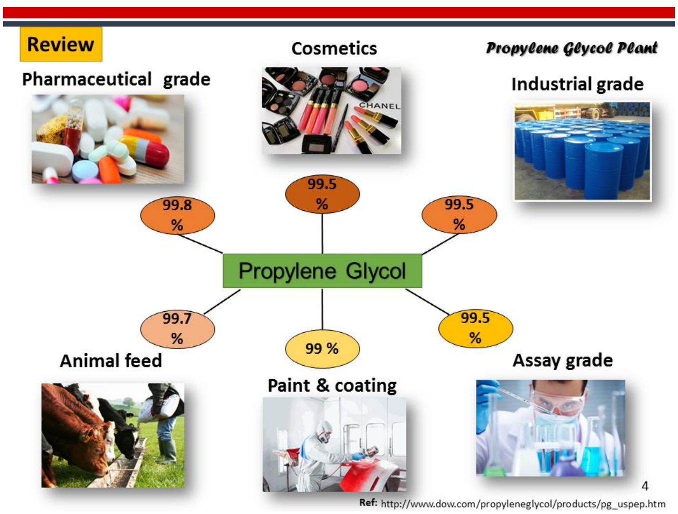

Figure 2 an example of preliminary report presentation of propylene glycol production team

The third stage: After presentation, a series of lectures such as selection of materials, equipment design were selected to lay down fundaments for students to finish their progress report. The requirement of progress report is including detailed process design, process diagram and results of process simulation. In this process, the knowledge that learned from the first three year and this class including the industrial training has been used to creating a new process that economical and sustainable. The all six of cognitive skills such as remembering understanding, applying, analysing, evaluating, and creating has been developed during this task. Again, team has to submit a report at the week 10 and make a presentation in front of instructor panel. The example of process diagram from a progress report presentation was show in figure 3.

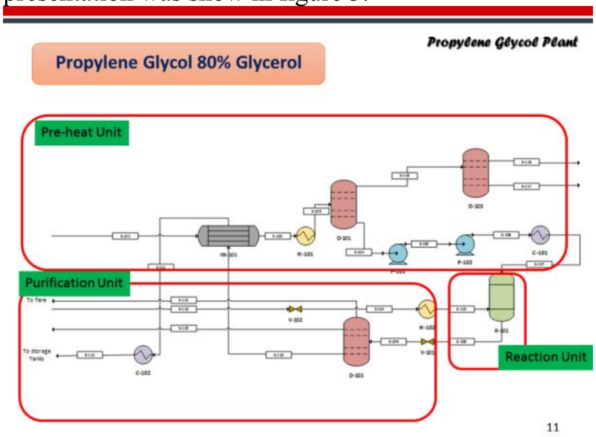

Figure 3. Process Diagram of propylene glycol production team.

During comments and open discussion of the progress report, students have learned from failure and misunderstanding. They realized their technical capability and weakness. The public quiz game, Kahoot, was introduced to the class to check students' core Chemical Engineering knowledge. Kahoot quiz game is a powerful that made students enjoy and more engaging. The example of kahoot quiz and score were shown in Figure 4 and 5.

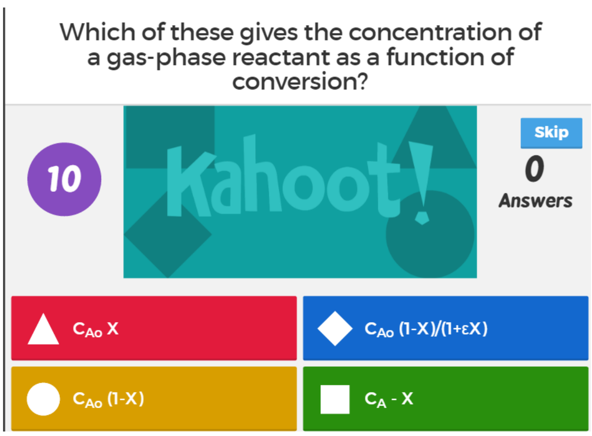

Figure 4 example of kahoot quiz that use in class

QUESTION	ANSWER 1	ANSWER 2	ANSWER 3
Which of these gives the concentration of a gas-phase reactant as a function of conversion?	"CAo X"	"CAo (1-X)/(1+εX)"	"CAo (1-X)"
- No.of answers	1	34	0
- Average answer speed	11.2	5.8	-
- % correct	97.14%		
STUDENT	ANSWER	TIME (seconds)	SCORE
A	CAo (1-X)/(1+εX)	4.0	901
AliZ	CAo (1-X)/(1+εX)	12.7	683

Figure 5 kahoot score of students.

The Last stage: A series of lectures that related to cost estimation such as equipment cost estimation, project cost estimation were introduced to student. The requirement for the final report was including all material from the first two reports and investment cost, operating cost, manufacturing cost, and profitable. In addition, a plant layout also presented. The breakdown of cost estimation, economics analysis, summary of the project, and plant layout of student project were shown in Figure 6-9, respectively.

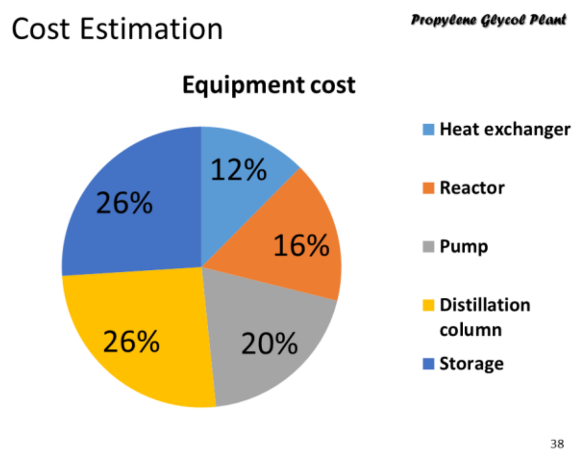

Figure 6 breakdown cost estimation of the propylene glycolteam

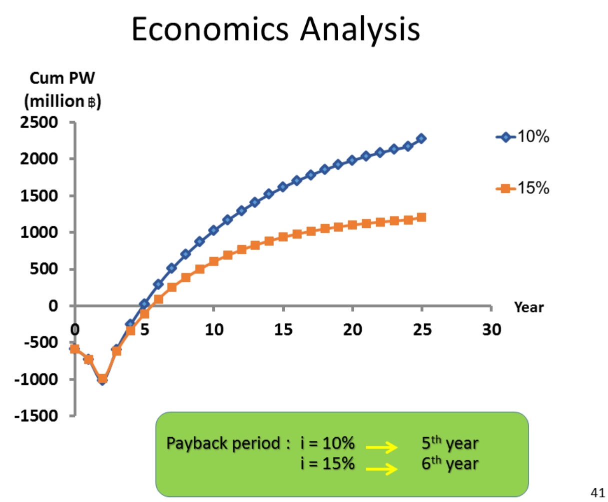

Figure 7 Economics Analysis of the propylene glycol team.

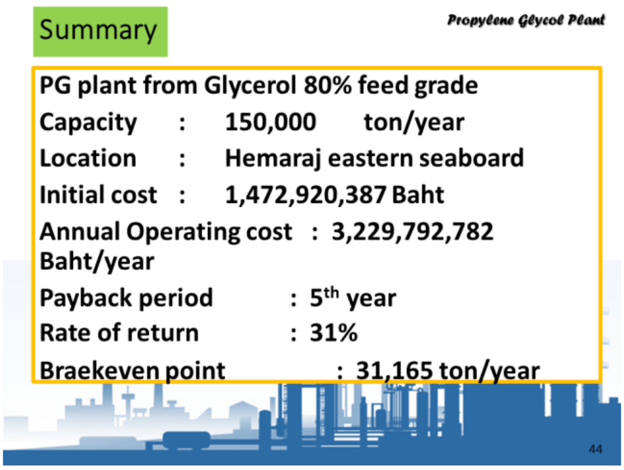

Figure 8 Summary project of the propylene glycol team.

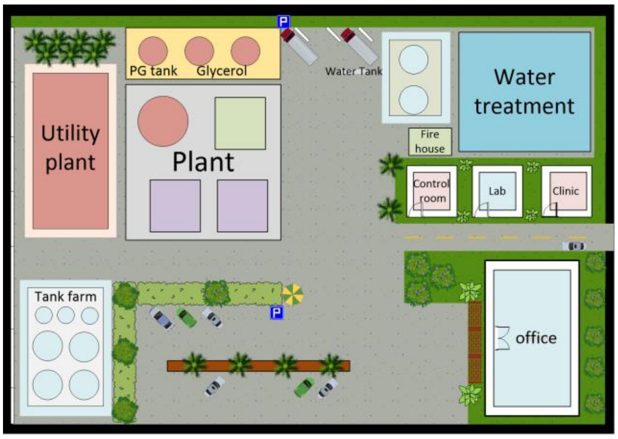

Figure 9 Plant layout of the propylene glycol team.

The grading of the class were evaluated from score of 4 parts, 10% from class participation, 30% from reports, 30% from presentation, and 30% from final exam. The reports and presentation was graded by using rubric score. The final exam was intent to check individual knowledge of chemical plant design, their project and their involvement in the project.

Results and Discussion

The project based learning that have been implement for teaching Chemical Plant Design class for 20 years was an effective learning method. However, the new requirement for 21st century skills challenged the instructors to use additional tools and method of teaching such as quiz game and a leadership compass tools to help students to develop their cognitive skills to higher level. The comments from students during a leadership compass activities, were very positive. They learn and understand the different of work style and will behave differently to make others to be happy to work with them. The quiz game made the students feel more enjoys and relax. The project assignments that challenge them to find a new process that economical and sustainable help them to use their critical thinking and creating. The reports and presentation helps the students to develop their communication skills.

Conclusions

The project based learning in chemical engineering plant design is a power tools to let student experience in conceptual design of chemical plant. Throughout a series of assignments and lectures, students have finished all tasks step by step like build a model from Lego block. They have been developed their abilities to design an integrated chemical process plant from the beginning to the end and prepare their higher cognitive skills as well as the 21st century skills.

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APPROACH ON PROJECT BASED LEARNING IN NATIONAL INSTITUTE OF TECHNOLOGY, ASAHIKAWA COLLEGE

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Abstract

Project-based learning (PBL) is one of the most important methods of engineering education at institutions of higher education. Students who study engineering need to have skills to solve problems under given restrictions as well as generic skills. In order to make the students to acquire problem-solving skills and to enhance creative ability, we carried out the education which we call "Instruction for Thinking." This program places great importance to each student's experience of problem-finding and problem-solving. It also aims to enable the students to get communication skill, team work skill, and practical technical skill as well as creative ability.

The Department of Electrical and Computer Engineering of National Institute of Technology, Asahikawa College has developed the subject named "Exercises for Creative Engineering Design" for the fourth year students since 2009. The theme of 2015 was "Let's explain the mechanism of electric power generation to the general public." The students worked in groups of 3 or 4 for a year. First they discussed which power generation to explain and selected four kinds of power generation: "Solar," "Thermoelectric," "Vibration," "Water." They designed and made original models to explain the principle of power generation by hands. The Instructors just pointed out some problems, but did not provide the students with any ideas. Finally the students made a presentation at a shopping mall after practicing many times.

As a result of our approach, most of the students who participated in this program improved their individual skills and felt great satisfaction. It was found that the education of "Instruction for Thinking" we conducted is an effective way to foster the students' creative ability and generic skills.

Keywords: *project based learning, presentation, power generation, engineering design, generic skill, creative ability*

Introduction

Project-based learning (PBL) has been taking place in the past ten years in Japan. Projects are based on challenging questions and problems, which involve students in design. Also, PBL gives students opportunities of problem-finding, problem-solving. The central activities of the project involve the transformation and construction of knowledge (e.g. John W. Thomas, 2000).

Recently, PBL is one of the most important methods of engineering education at institutions of higher education. Students who study engineering need to have skills to solve problems under given restrictions as well as generic skills (e.g. In-sook Kim. 2009; Y. Utsumi, T. Yonamine and Y. Kikuchi 2010).

The mission of the National Institute of Technology (KOSEN) is to foster creative and practical technical engineers. The KOSEN is conducting positive activities. The variety of career courses after graduation creates many possibilities for their careers, and leads to the production of excellent talents such as practical and creative engineers, managers, and researchers (e.g. J. Watanabe, 2009).

The Department of Electrical and Computer Engineering of National Institute of Technology, Asahikawa College (Asahikawa KOSEN), developed the new subject named "Exercises for Creative Engineering Design".

In this paper, we report an approach on PBL, i.e. the education called "Instruction for Thinking," to make the students to acquire problem-solving skills and to enhance creative ability. The effects of our approach are also discussed.

"Instruction for thinking"

The education called "Instruction for Thinking" places great importance to each student's experience of problem-finding and problem-solving. It also aims to enable the students to get communication skill, team work skill, and practical technical skill as well as creative ability. The key of "Instruction for Thinking" is that the instructors point out a few problems but do not provide the students with any ideas.

The Department of Electrical and Computer Engineering at Asahikawa KOSEN has developed the subject named "Exercises for Creative Engineering Design" for the fourth year students since 2009. The theme of 2015 was "Let's explain the mechanism of electric power generation to the general public." The number of the students who took this course was 15.

In the beginning, the students discussed which power generation to explain. They were divided into four groups, each of which included three or four students, and worked for over two semesters. After discussion each group selected four kinds of power generation: "Solar," "Thermoelectric," "Vibration," "Water."

The students constructed a model which explained the principle of power generation in order to make a presentation. First, the students drew their own ideas on a sheet of A4 sized paper as shown in Fig.1. They discussed the details and the problems of the ideas with the instructors as shown in Fig.2. The instructors only pointed out a few significant problems. They did not provide the students with any ideas so that the students could think the matters over by themselves.

After their ideas took shape, the students made a presentation of their original model to the instructors and the students of other groups. Figure 3 shows the example of presentation by the "thermoelectric" power generation group. The instructors made students elaborate plans of the purchase of goods. The students made their original model by hands.

Then the students made a first presentation to the first year students of the Department of Electrical and Computer Engineering of Asahikawa KOSEN at the end of the first semester. Figure 4 and 5 show presentations by the "vibration" and the "water" power generation groups, respectively. When the first presentation finished, instructors collected a questionnaire from the audience. In order to make the presentation better, following feedback or comments reflected as shown in Fig. 6.

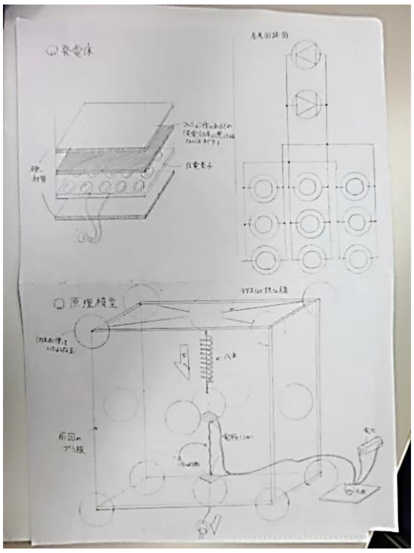

Figure 1: Diagram drawn with a pencil to explain an original idea.

Figure 2: Students discussing the original ideas to explain the mechanism.

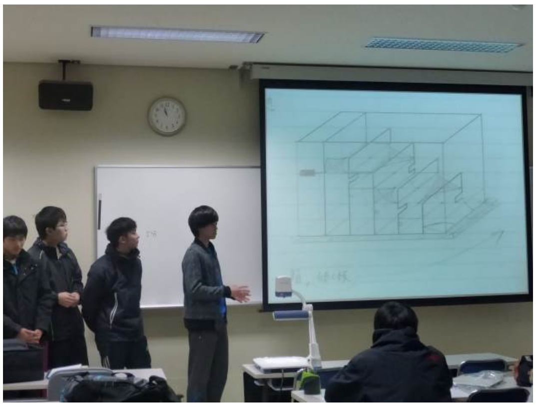

Figure 3: Presentation by the "thermoelectric" power generation group about the original ideas to the instructors.

Figure 4: First presentation of the original model to explain the principle of the "vibration" power generation to the first year students of the Department of Electrical and Computer Engineering.

Figure 5: First presentation of the original model to explain the principle of the "water" power generation to the first year students of the Department of Electrical and Computer Engineering.

Figure 6: Following feedback or comments from the questionnaire of the first presentation.

Figure 7: Students presenting their plan to improve their model.

Figure 8: Instructors and students discussing the submitted plan.

Figure 9: The "vibration" power generation group rehearsing the final presentation.

Figure 10: The "solar" power generation group rehearsing the final presentation.

In the second semester, the students made a plan to make their presentation better. In addition, the instructors made them to use the models which run on electricity. In the same way as the last time, the students made the ideas and discussed submitted plan documents to the instructors many times as shown in Fig.7 and 8. They also prepared three materials for a presentation: a revised model, a sheet of A0 sized paper and a handout, so that they could explain easily. Finally, they rehearsed the presentation again and again. Figure 9 and 10 show the rehearsal by the “vibration” and the “solar” power generation groups, respectively.

At the end of second semester, the students made a presentation at a shopping mall as shown in Figure 11 and 12. A girl, her parent, and her friends, who are the general public, attended our presentation.

After they finished this course, we surveyed how their individual skills improved and how satisfied they were with the course.

Figure 11: Presentation of the original model to explain the principle of the “vibration” power generation to general public at a shopping mall.

Figure 12: Students after presentation at the shopping mall.

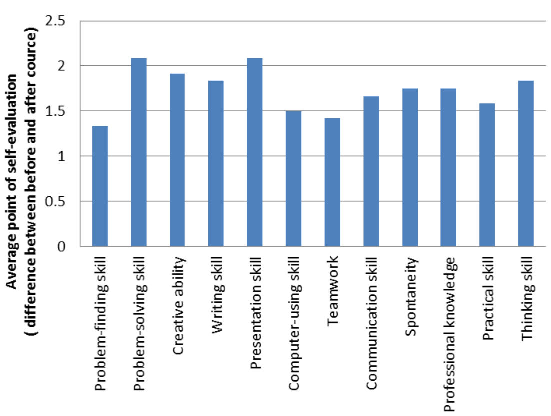

Figure 13: Individual skills after students finished this course.

Results and Discussion

In our approach, the instructors did not provide the students with any ideas. Insted, they made various “devices“ to guide the students to think by themselves. This is the most important point.

Our aim of this program was to get the students the following ability and skills: problem-finding skill, problem-solving skill, creative ability, writing skill, presentation skill, computer-using skill, teamwork, communication skill, spontaneity, professional knowledge, practical skill and thinking skill. Figure 13 shows a result of self-evaluation between before and after class on a scale of one to ten. The vertical axis of the graph is the students’ average point difference between before and after taking the course. All of their ability and skills were developed after they took this couse.

From the questionnaire, 100% students showed positive satisfaction: very much 58%, rather 42%, not so much 0% and Not at all 0%.

Conclusion

As a result of our approach, most of the students who participated in this course improved their individual skills and felt great satisfaction. It was found that the education of "Instruction for Thinking" we conducted is an effective way to foster the students’ creative ability and generic skills.

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A case study of the guidance for experiment with "Interactive Experiment Notebook" (II): Practical Training for Lower Graders of NIT and Improvement of Note-Taking Technique using Student's Self- and Peer Evaluation

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Abstract

In college or university, it has been made various student experiments in the region of Science and Technology. Evaluations of the student's efforts to experiments are made by mainly with report that student wrote. On the other hand, even if it understands that the guidance of the "Experiment Notebook" is important for a student, it is the fact that the teacher cannot start experiment notebook guidance by many enormous quantity powers. In the previous report, an attempt for guidance for experiment with "Interactive Experiment Notebook" in the subject of "Experiments in Electrical Machiner" that was made for fourth grade students was reported. In that trial, Notebook guidance was tried mentioned blow. Namely, 1) to all students, notebooks were distributed. 2) Template seals were also distributed and on which the table templates were printed and students had to fill the blanks with basic contents of experiments. Students learned how of basic data description. 3) Student drew actual wire-diagram of electric circuits for accurate record and practical understanding. 4) Another seal for notebook was made on which "consideration and idea on experiment" should be described. Students were faced with the need to consider the awareness and idea on experiment. 5) Effective use of "Inheriting sheet concerning know-how and instructions"; prevenient experiment student team recorded about "the notes (especially for safety)", "the idea", and "the advice" for a follower team.

In this report, in addition, an attempt of practical training of "Interactive Experiment Notebook" about "Applied Physics Experiment" for the 3rd grade students is reported. Firstly, to seize the trend of student's writing without preconceptions, the description of notebook without an indication of the format is allowed. Thereafter, the guidance of the description method is made to students; we examined the "change in the description of notebook" and "student of opinions and impressions."

In addition as a further attempt, students evaluate their notebook by themselves and do peer evaluation each other. So using obtained knowledge, it could be used effectively to further progress of the notebook description techniques. We can carry out the conversion of these attempts from "Passive Experiment" to "Active Experiment".

Keywords: *Experiment Notebook, PBL, Student's Self Evaluation, Student's Peer Evaluation, Interactivity, Technology Literacy*

Introduction

Following previous report (Koshiji, 2015), this paper also reports the effectiveness of guidance of experiment notebook, especially about student's self- and peer evaluation. Many Student experiments are performed at university and institute of technology etc. Usually, most of aims of student experiments were to understand of the theories and to learn experimental techniques. And most of evaluations of student's achievement are made by reports written by students. For paying attention to various aspects of experiment notebook such as "recording tools", "thinking tools" and "cultivation tools for science literacy", actual and intelligible Note-Taking trainings are very important for students belonging to the educational course of science and technology. As the first step of this attempt, analyses for state of student research were made by questionnaires for teachers belonging to NIT of Kyushu region. As a result, it was found that little guidance for experiment Note-Taking is made. In previous report (Koshiji, 2015), at the subject of "experiments in machine experiment", for 4th grade student of our department, guidance of experiment that mainly situated notebook training was tried and reported. In this report, the subject of "Applied Physics experiment" for 3rd grade students was added to this Note-book guidance trial. Further, in addition as a further attempt, students evaluate their notebook by themselves and do peer evaluation each other.

Methods

Then, in our school at the class subject of "Experiments in Electrical Machinery" for 4th grade students (Figure 1), and "Applied Physics experiment" for 3rd grade students (Figure 2), the guidance of experiment that mainly situated notebook training were tried.

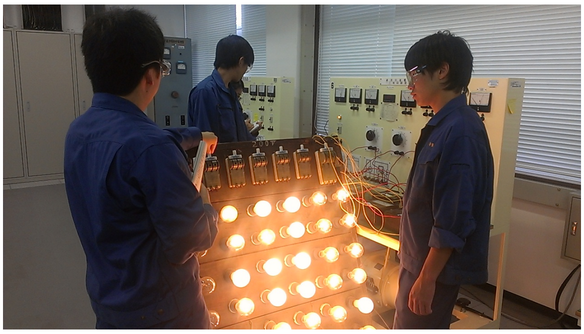

Figure 1 The states of the experiment "Experiments in Electrical Machinery"

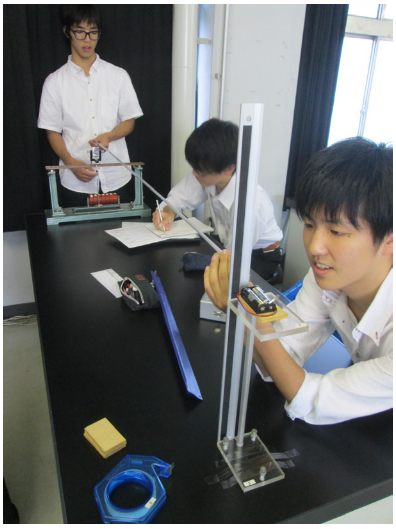

Figure 2 The states of the experiment "Applied Physics experiment" (measurement of "Young's modulus")

The methods used in this attempt will be described in detail below. Especially for 3rd grade student, to understand the student's idea about notebook without prejudice, at the start-up of this trial, there were no suggestions for note-taking method and we were allowed to students to freely note description. As a result, students were not carried out description of the organized laboratory notebook. In particular, no student has been described the figure and picture for explaining a state of the experiment. Moreover, by using the camera such as a smartphone, some students took photos of the described notes of their co-workers without their original note description.

Then, we tried to the attempt mentioned below (since the start of subject for 4th grade student and since after student`s free note-writing trial mentioned above for 3rd grade student).

(A) *Common attempt for two class subjects:*

1) Using commercial-available laboratory notebook: Commercial-available laboratory notebook that had adopted at many research laboratories and universities in Japan were distributed to all students (Figure 3).

Figure 3 Appearance of Notebooks used in these trial. "KOKUYO RESEARCH LAB NOTE (Entry Model) "for 4th grade students (left figure) and "KOKUYO RESEARCH LAB NOTE (type SD) "for 3rd grade students (right figure). The differences of the two notes are only the thickness of cover and the number of pages.

2) Using "Table-type template seal" and "Subject title seal" : As shown in Figure 4, Table-type template seal was employed to learn how to record basic information about experiments (i.e. Date, Title, Collaborators, Experimental equipment's details and so on).

Date			Time : ~ :	
Weather	Temp.		Humidity	Check☑
No.	Name of Experiment			
Name				
Collaborator				
		Equipment		
Symbol	Equipment Name	Number	Specification	
Sketch	Awareness:Discussion1		Awareness:Discussion2	Awareness:Discussion3
DATA1	Experiment Description:			
DATA2	Experiment Description:			
DATA3	Experiment Description:			
Experimental Outline				

Figure 4 Table-type template seal using in this trial. Original type of template which student used is written in Japanese.

Students cut the seals and attach them to notebook and fill in the blanks (Figure 5). It was possible to learn the contents of the format to be referred to the notebook through this work. In addition, there were "Subject title seal" and it's items of "Awareness and Discussion" in the seal and gimmicks such as students should wrote "Thinking" and "Awareness" in the notebook spontaneously. This allows the students began to actively description of "Awareness of the experiment" and “Attention and advice from the education staff” (Figure 6).

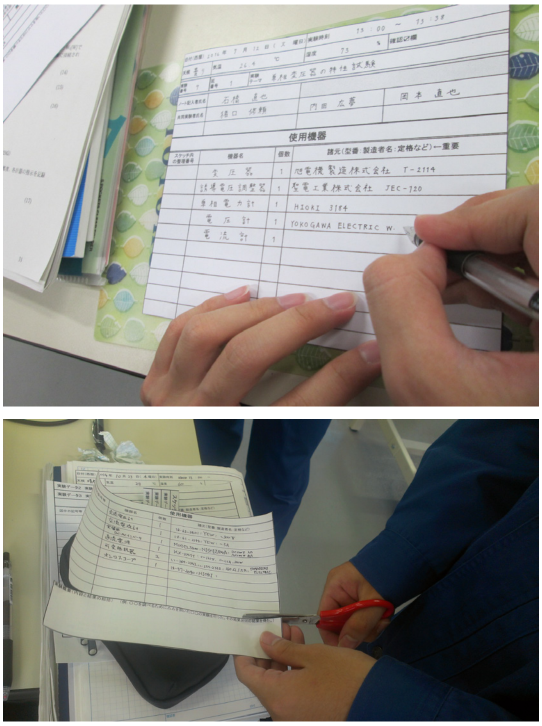

Figure 5 Student filled in the blanks of table and cut and pasted the seal on notebook.

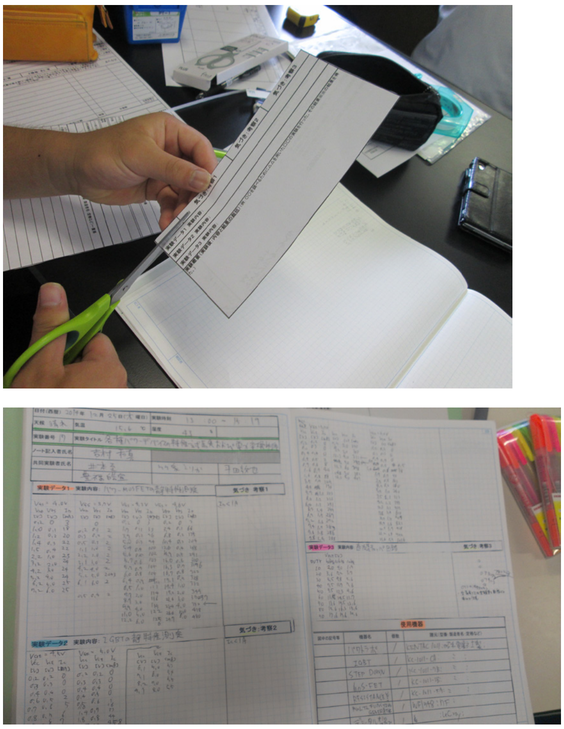

Figure 6 Student cut and pasted the “Subject-title seal”.

3) Sketch of practical wiring diagram or the arrangement of the experimental device: For the student’s specific understanding about electric circuits and the arrangement of the experimental device, students had to draw freehand drawing (Figure 7&8).

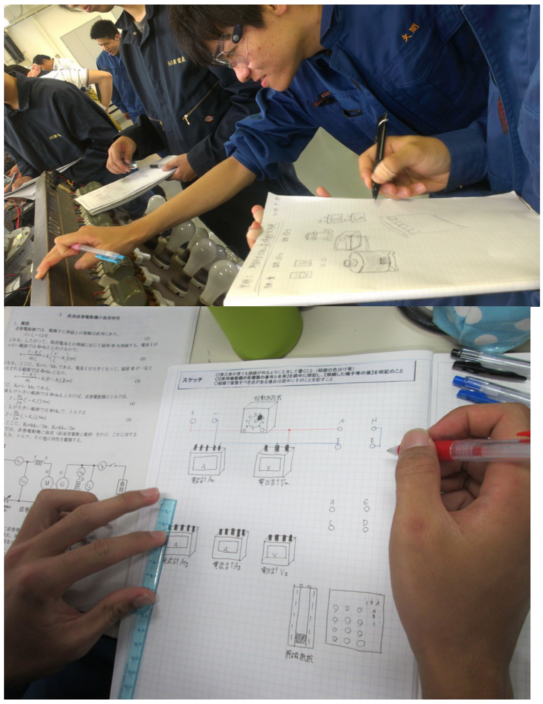

Figure 7 Examples of “Sketch of practical wiring diagram” which written by freehand. (by 4th grade student at the subject of “Experiments in Electrical Machinery”). Drawing situation (above) and an example of sketch (below).

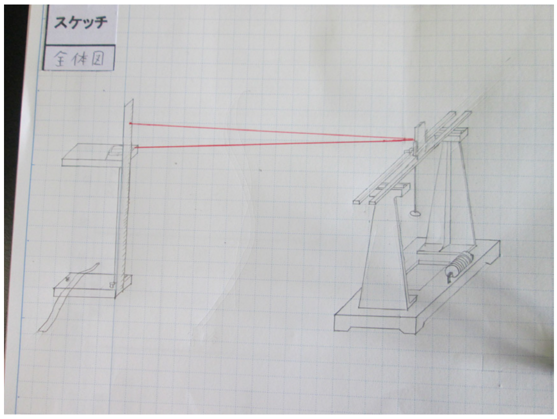

Figure 8 Examples of “Sketch of experimental situations” which written by freehand. (by 3rd grade student at the subject of “Applied physics ”). It was drawn about the experiment of “Measurement of Young's modulus” that shown in Fig. 2.

(B) *Specialized attempt in relation to the subject of “Experiments in Electrical Machinery” for 4th grade student*

1) Prewriting an experiment report before experiments: The contents written in a report are “Subject”, “Date”, ”Collaborators”, ”Aim ”, “Method”, “Data analysis”, and “Discussions”. Students should be written in report until “Method” before doing experiment. Students can understand the details of experiment in advance throughout description of experimental report.

2) Using “The hand-off memo about technical know-how and knowledge”: In this subject, fourth-

grade student are learn and perform experiments with transformer, synchronous machine, induction machine and so-on. Four or Five students formed a group and conducted different experimental theme in every week and finally carry out twenty themes of experiment for one year. At the most of the conventional student experiment, there was little transition from predecessor team. As mentioned before in this paper, students recorded “Precaution”, “Awareness of the experiment” and “Attention and advice from the education staff” on notebook and student team reproduced “technical know-how and knowledge” to next team. By using this approach, education staff now need not performed by repeating the same attention and guidance to each team. By reading this memo at the beginning of the experiment, Students also were able to obtain in advance a wide variety of knowledge (especially about safety) regarding the experiment (Figure 9&10).

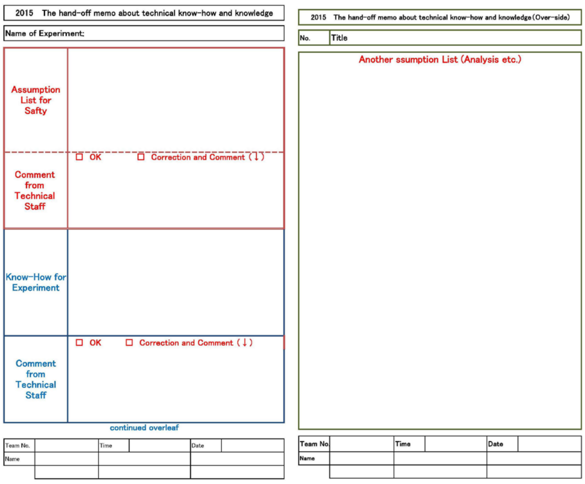

Figure 9 The hand-off memo about technical know-how and knowledge (front and rear view).The Original memo is written in Japanese.

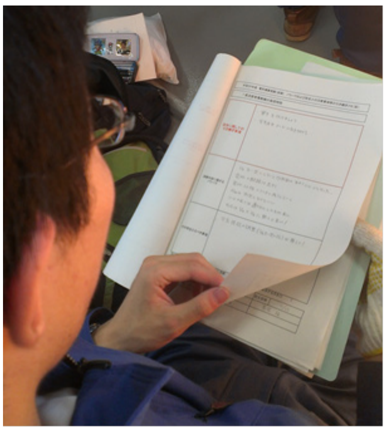

Figure 10 Snapshot of when the student have checked “the hand-off memo” prior to the experiment

3) Additions: For teaching staff and students, it adopted the cover that has been different color-coded for each experiment type in order to facilitate the sorting work (Figure 11).

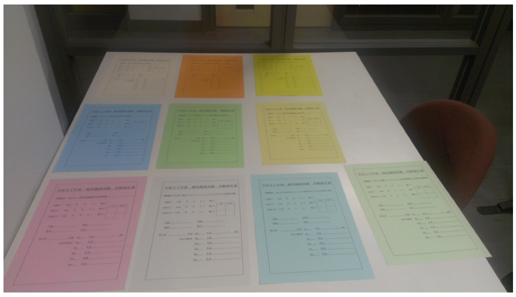

Figure 11 Color-coded cover sheets of report

Results and Discussion

Conventional, “Experiment Notebook” for students was “A Personal Memorandum Existence”. Under the influence of this idea, the contents that described in the experiment notebook are a good thing as long as it only students themselves can understand. Then, in addition as a further attempt, students evaluate their notebook by themselves and do peer evaluation each other. So using obtained knowledge, it could be used effectively to further progress of the notebook description techniques.

1) *Self-evaluation of notebook by themselves*: After the end of each of the experiments, student did self-evaluation about their notebook description using a check sheet shown in Figure 12.

Self-Evaluation of Experiment−Note (2016/ /) Title of Experiment( )

Subject	Table-type template seal	Sketch	Experimental data	Notice	Experimental Outline	Overall
Five levels evaluation (1~5)						
Reason						
Point that reflect previous note evaluation						
Point that reflect findings obtained in the previous peer evaluation						
comments						

Figure 12 Self-evaluation Sheet and snapshot that student was filling in the blanks of the table. Original type of template which student used is written in Japanese.

Through these efforts, students did objectively evaluate the descriptive content of their own experiment notebook, and was able to take advantage of the result to the next of the experimental notebook description contents. Although many of the students felt that it was possible to objectively evaluate their laboratory notebook, there were also students who feel the difficulty of objectively evaluate their own notes. Then, as the first attempt, students check the experiment notebook of one another, began to Peer Evaluation to evaluate and confirm the good points and the required improvements.

2) *Peer-evaluation of notebook*: These experimental subjects are carried out in half of the schedule of the one-year academic calendar. In the middle of the half a year of the experimental period, the students attempted to peer-evaluation of each other to check the experimental notebook of one another. As mentioned above, the conventional notes are those that belong to the individual students as a reminder of the individual students. Student didn't have an idea and chance that the peer-evaluation each other's notes to share the know-how of how to write. Therefore, although this attempt was a challenging one for students, on the other hand, it was also seen slightly bewildered student.

Figure 13 Snapshot of student's peer-evaluations of experiment notebook. Arrangement (above) and the actual state of the Peer Evaluation (below). Details of "Student Peer-Evaluation table" is shown in Fig. 14.

This is a future task as will be described later. Actually peer-evaluation will be described below : As shown in Fig. 13, each experiment notebook placed on each table and students checked one by one, and filled out the results in the peer-evaluation check sheet shown in Fig. 14. Students write improvement and enhancement point to "Improvement and enhancement Sheet (shown in Fig.15) "and it was used as a guideline for the future of notebook description.

Attendance number ( ) Name( )

No.	Corresponding item (Circle to those applicable)	good point and devising point Specific comments on the point you want to incorporate into your notebook
	Table-type template seal Sketch experiment data notice others	
	Table-type template seal Sketch experiment data notice others	
	Table-type template seal Sketch experiment data notice others	
	Table-type template seal Sketch experiment data notice others	
	Table-type template seal	

Figure 14 Details of peer-evaluation Sheet. Original type of template which student used is written in Japanese.

2016/07/05 Improvements and enhancements after Peer-Evaluations

subjects	comments
Table-type template seal	
Sketch	
Experimental data	
Notice	
Experimental Outline	
Overall	

Figure 15 Details of "Improvements and Enhancements after Peer-Evaluations Sheet". Original type of template which student used is written in Japanese.

3) *Questionnaires and Discussion*: Near the end of the experimental period, questionnaires for students both in the third grade and fourth grad were held. The results of Questionnaires are analysed and discussed below.
Firstly, It was conducted a questionnaire for the degree of help about "Table-type template seal", "Sketch of experiment situation","Column of Awareness and Discussion" and "Column of Experiment outline" and the results are shown in Figures 16 to 19, respectively.
In each grade, even though the experimental contents are significantly different, data distribution of each item shows a similar trend. The majority of students are answered that these are helpful.

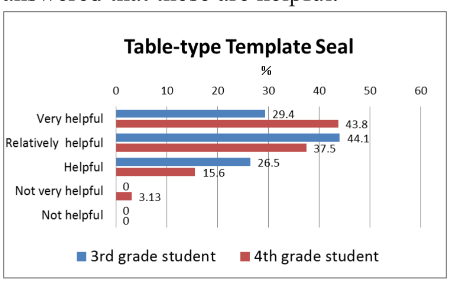

Figure 16 Q1: Was "Table-type template seal" helpful?

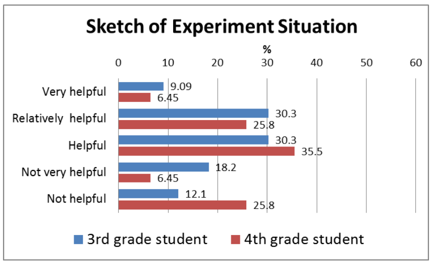

Figure 17 Q2: Was "Sketch " helpful?

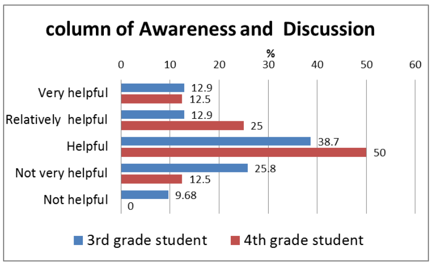

Figure 18 Q3: Was "Column of Awareness and Discussion" helpful?

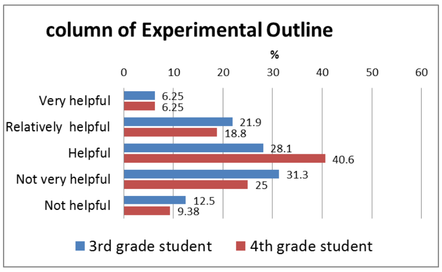

Figure 19 Q4: Was "Column of Experimental Outline" helpful?

The questionnaire results on the extent of the help of self-evaluation and peer-evaluation for the experiment notebook were shown in Figure 20 and Figure 21, respectively. Different from the previous questions, it was seen a large difference to the distribution of answer by student grade for this two items.

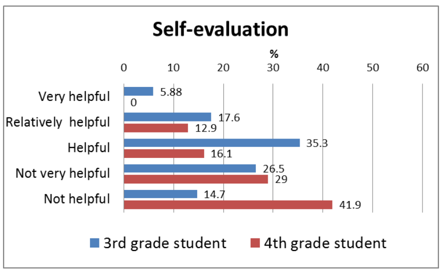

Figure 20 Q5: Was "Self-evaluation" helpful?

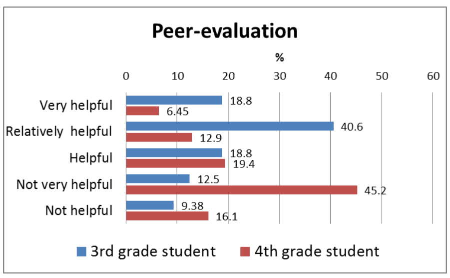

Figure 21 Q6: Was "Peer-evaluation" helpful?

Although the reason for the difference is a need for further comparison, it is mentioned that the higher grade students already had more knowledge about the laboratory notebook. In this time of the questionnaire were using the keyword "helpful" as a keyword in question. However, when taking into account the purpose of this initiative is better to using the "there is educational effect" is thought that it was good. Finally, the questionnaire results about "Overall for this trial" were shown in Figure 22. Most of the students responded that this attempt was helpful for them.

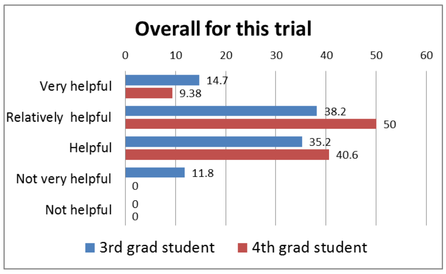

Figure 22 Q7: Was "this attempt " helpful?

Attempts of this self-evaluation and peer-evaluation had the implications of the trial. So, at the next trial, there are going to perform in mind the following points like as "Description of adequate purpose before trial" and "careful selection of words with respect to the questionnaire", etc.

Conclusions

To student experiment, by using the interactive approach, it was possible to stimulate a positive attitude and awareness of students. Also it was possible to carry out the cultivation of science literacy through these attempts. On the other hands, for the purpose of achievement, Self and Peer-Evaluations are unfamiliar for students, it is important to explain its purpose and meaning, etc. We can carry out the conversion of these attempts from "Passive Experiment" to "Active Experiment".

Acknowledgements

I am particularly grateful for the assistance given by the co guidance staff for this student experiment. This work was supported by JSPS KAKENHI Grant Numbers 23650521, 25560096 and 15K12401 (Grant-in-Aid for Challenging Exploratory Research).

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INFUSING ENGINEERING DESIGN THINKING & DESIGN PRACTICE MODULES IN ME DIPLOMA

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Abstract

The 21st century, marked by technological revolutions, has significantly shifted the type of skills required in the engineering workplace. Future engineers will need to be equipped with 21st century skills and have abilities to innovate with user-centric designs. To develop these competencies in students, Ngee Ann Polytechnic, School of Engineering, Mechanical Engineering (ME) Division infused Engineering Design Thinking (EDT) and Design Practice (DP) modules into the ME Diploma curriculums in order to:

a. Introduce design thinking processes and opportunities for the students to develop empathy for real world issues and to practice design earlier in their courses.
b. Strengthen students' understanding of basic principles and concepts by relating to real world applications.
c. Scaffold and stack the design curriculum to create connections to other modules and put together a complete picture of design to the students.

Based on the learning theory of constructivism (Gagnon, Jr & Collay, 2008) (Keller, 2011), EDT and DP were introduced with the objectives of developing student's engineering design and design thinking skills. Together with the use of project-based approach (Moalosi, Molokwane, & Mothibedi, 2012), the two design modules enable the transfer of design and engineering content knowledge into practice with an emphasis on engineering design.

In the EDT module, students work in teams and use a five-stage engineering design thinking process to solve course-related design problems. Critique from lecturers and peers, during the design and mock-up stages, provide constructive feedback for the project teams to improve on their projects. Students translate their conceptual designs into working prototypes, and apply iterative improvements to their prototypes to meet the design criterions.

The DP modules introduce enhanced or more complex design problems, which further deepen the students' design and hands-on skills. Students are assessed using a mixture of assessment activities like course level competitions, showcases, poster presentations and viva voce examinations. These activities further hone their interpersonal skills, teamwork and competitive skills.

Keywords: *design thinking, engineering design, constructivism, active learning, experiential learning, project-based learning*

Introduction

As part of the annual course review in 2012, Ngee Ann Polytechnic School of Engineering, Mechanical Engineering (ME) Division reviewed their ME diploma courses against the skills required in the 21st century engineering workplaces, which are marked by technological revolutions and evolving demands of skills (National Academy of Engineering, 2004). The four ME diploma reviewed in 2012 were:

a. Automation and Mechatronic Systems (AMS)
b. Aerospace Technology (AT)
c. Mechanical Engineering (ME)
d. Marine & Offshore Technology (MOT)

The review examined the relevance of the teaching and learning pedagogies used in developing engineering students, against a backdrop of issues like decreasing level of interest and motivation in engineering courses and wide variations of academic abilities in larger cohort courses like ME and AMS.

The review identified the following areas that required strengthening.

(1) "Scaffolding" and "stacking" of the design curriculum is weak.
While all the four courses have aspects of "Design" in the curricula, the scaffolding of the design modules was not strong for all the three-year courses. The core engineering modules also have weak or no connections to the design modules; which cause students to have fragmented ideas about how engineering principles can be applied into design applications.

(2) Lack of design thinking process and opportunities for students to encounter practice design earlier.
Another finding from the review indicated that there was a lack of user-centred engineering design thinking process. Typically, integrative design projects only occur during the final years, where students create engineering designs with their technical skills and knowledge, rather than in the earlier years, where students can have more time to hone their creativity and engineering design thinking skills. There were also limited opportunities for students to practice and develop critical thinking earlier in their courses, which can enhance students' design thinking experience.

(3) Student's inability to see relevance of concepts in real world applications.
Many students' understanding of engineering principles and concepts were weak and many could not see the relevance of what they learnt in the classroom to the real world. Students were learning in a surface manner which resulted in weak retention of knowledge and skills and inability to apply concepts practically.

The result of this 2012 course review prompted a design-centric curriculum recalibration and the introduction of two new design modules in 2013, namely Engineering Design Thinking (EDT) and Design Practice (DP) modules.

This paper describes the design and implementation of the EDT and DP modules to provide early and additional opportunities for students to practice engineering design thinking. This paper also describes the implementation of Design Thinking as a Teaching and Learning (T&L) strategy that is useful in driving engagement and deeper learning amongst the engineering students.

Infusing Engineering Design Thinking & Design Practice Modules – An Initial Experience

Design is embedded in the engineering curricula of AMS, AT, ME and MOT in ME Division. Design knowledge is scaffold and the complexity of problems students have to work through is increased as they progress through their years in the course (Table 1).

Yr	Modules	Competency
1	Innovation Toolkits 1 & 2	• Innovative mind-sets and creative thinking • User-centric approach in general applications
2	Engineering Design Thinking & Design Practice	• Engineering design • Engineering focus • Domain applications
3	Final Year Project / Internship	• Capstone projects in real world context • Professional development

Table 1. Scaffold of design curriculum in three-year diploma courses

The EDT and DP modules are two sequential modules taking place in the second year of the three-year diploma courses were students are expected to have some foundational knowledge and ability to solve simple engineering problems.

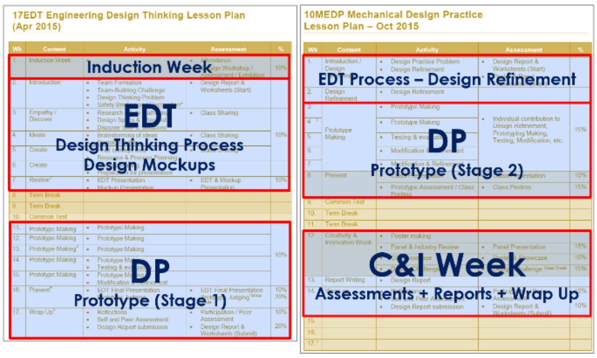


Figure 1. Overview of EDT-DP modules in the second academic year

At the beginning of the second academic year, the entire cohort of students goes through the Induction Week programme. The week-long programme provides students with community-based learning situations, where students will experience issues and challenges faced by certain groups in the community. This creates the opportunities for students to encounter the "needs of the user" and develop "empathy" for them. This initial encounter with "Empathy" will also set the foundation for students as they embarked on their design projects in EDT and DP and other domain-focused modules. The students will then seek to solve the issues with design applications and engineering solutions.

During the Induction week in 2015, ME Division students were committed to the community service of beach cleaning along the recreational beaches of Singapore in 2015 (Figure 2).

Figure 2. Community service of beach cleaning

Through research, cleaning activities and interactions with community partners and members of public, students experience and understand the problems of coastal pollutions that affects islands like Singapore. This understanding of the problems and the users allows students to work towards designing course-related solutions using their engineering knowledge learnt in their first and second years' modules with an additional dimension of "user" in mind.

For example, AMS students were required to design and build autonomous machines to retrieve objects from the beach (Figure 3). They were required to apply foundation mechanical engineering knowledge (e.g. Applied Mechanics, Engineering Materials, Strength of Materials, Electrical Technologies and Electronics, Fabrication and Manufacturing skills) and mechatronics domain specific knowledge (e.g. Arduino micro-controller, sensors and computer programming) into their design projects, with consideration for how the machines would be practical to the users.

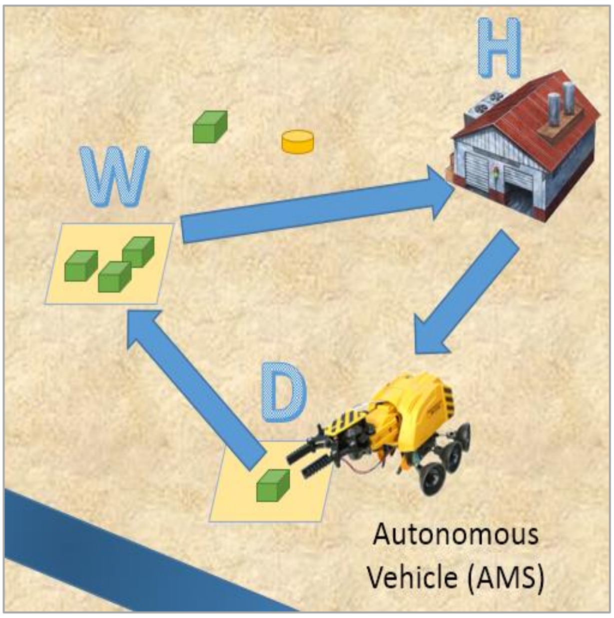


Figure 3. Autonomous machines to carry out missions of retrieving objects on the beach by AMS students

Engineering Design Thinking & Design Practice Modules – Design & Prototype

With the design problems and context defined through the Induction Week activities, the students commence their design activities in the EDT module, where students are introduced to a five-stage engineering design thinking process (Table 2) which helps the students conceptualise and find solutions to the design projects. Students are required to build physical mock-ups and prototypes to demonstrate the working principles of their designs in this module.

Stages	Description of Stage
Empathy	To analysis and understand the roots and needs of the problem.
Discover	Discover feasible solutions to address the needs and find opportunities for ideas creation.
Ideate	Ideas are formulated and analyzed. Chosen ideas are developed into the final conceptual product.
Create	Resources and processes are planned and prepared for mock-up and prototype making.
Realize	Physical development of working prototypes. Iterative testing, evaluation and modification are used to realize the designs successfully.

Table 2. Five stages engineering design thinking process

Measurable design criteria are given to the students along with the design problems. During the engineering design process, students will have opportunities to design and develop solutions that would meet the needs of the problems (including those of the users) against the measureable criteria. These criteria allow the students to strategize their design approaches and validate the effectiveness of their prototypes.

For example, three measurable criteria are used to assess the capabilities of load-carrying vehicles of the ME course, namely Load, Timing and Accuracy (Figure 4). These criterions serves as goals for design teams to validate and optimize their vehicle designs.

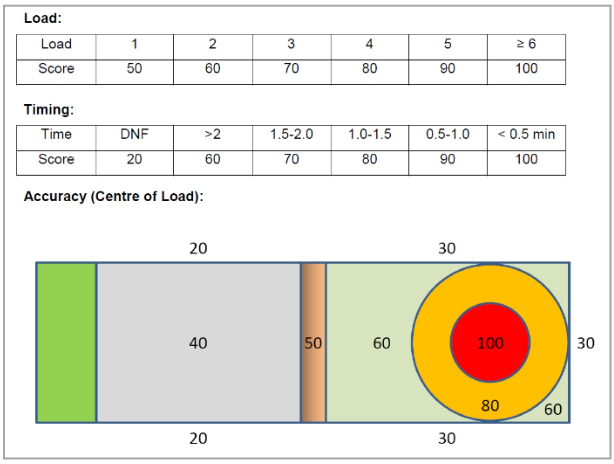


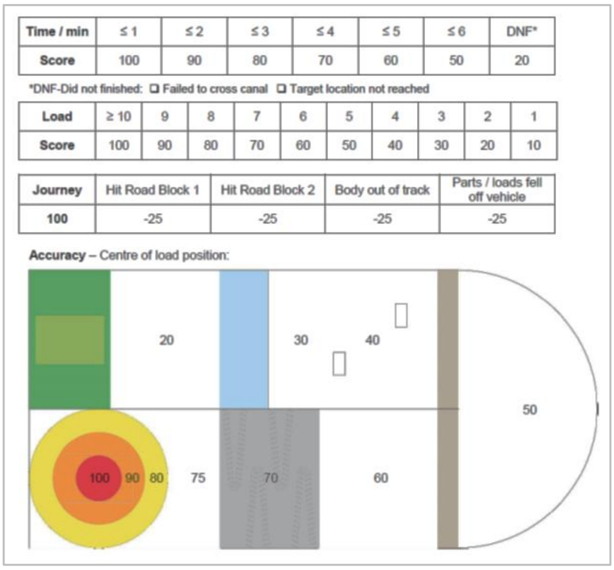
Figure 4. Design criterions for ME in EDT module

Throughout the engineering design thinking process, students will also learn how to manage their own resources and time to ensure that they are able to present their best prototype to be assessed at the end of the semester. Feedback provided by their lecturers and sharing among the peers allow students to refine their design and rework their prototype.

Upon completion of the design and prototype development in EDT, students will proceed to the DP module where they will be expected to do further refine their design and manage more complex design criterions.

Engineering Design Thinking & Design Practice Modules – Deepening of Learning

The DP modules build upon the EDT design thinking process to solve enhanced engineering design objectives (Figure 5), which are more complex and challenging. These enhanced objectives further stretch the students to deepen the design, technical and hands-on skills. Students will continue to refine and improve their prototypes, but with more constraints and considerations.



Time / min	≤ 1	≤ 2	≤ 3	≤ 4	≤ 5	≤ 6	DNF*
Score	100	90	80	70	60	50	20

*DNF-Did not finished: ❑ Failed to cross canal ❑ Target location not reached

Load	≥ 10	9	8	7	6	5	4	3	2	1
Score	100	90	80	70	60	50	40	30	20	10

Journey	Hit Road Block 1	Hit Road Block 2	Body out of track	Parts / loads fell off vehicle
100	-25	-25	-25	-25

Figure 5. Enhanced design criterions for ME in DP module

The DP module ends with Creativity and Innovation (C&I) Week, where students are immersed in course level competitions (Figure 6). The students will compete against their peers for class rankings – corresponding to marks added to their assessments. The course level completion and class rankings gamify the assessment process which aims to motivate the students to collaborate and work closely with their teammates and peers from their own classes. The students' projects are also reviewed in viva voce examinations, as well as demonstrations to their peers in poster showcase and exhibition. (Figure 7). These activities enable students to further hone their interpersonal skills, teamwork and competitive skills which are essential for their final year capstone projects and industry attachments.

Figure 6. Course level competition during DP module

Figure 7. Posters and prototypes showcase during DP module

Impact of Engineering Design Thinking on Teaching & Learning in ME

The infusion of EDT and DP modules have resulted in paradigm shifts in the Teaching and Learning (T&L) practices in ME. The design-centric curriculum rejuvenation had also brought about many opportunities to try out new ideas in pedagogies and adoption of technologies in the courses:

(1) From Teaching to Facilitation

The teaching staff moved from traditional teaching to facilitation of learning. The facilitation approach enables greater interaction and engagement with the students. The lecturers' role now is to facilitate the learning process by getting students to think through the issues themselves rather than just teach content and giving answers. They serve as design critiques and mentors, guiding and assisting students to seek their own solutions and methods. By doing so, the lecturers are also giving students more space to explore, learn, and apply their knowledge in a practical and useful manner.

(2) Creating more Opportunities for Student Engagement with Content

In the DP module, students can put their designs through iterative prototyping, testing, analyzing and refining to achieving their desired design goals. By testing their prototypes against the design criterion, they get immediate feedback on how well their designs are. Every failed attempt in achieving the goal becomes an opportunity for students to reflect on their designs, in terms of what they have learnt and how they can improve on their shortcomings. When faced with contradictions, students have to analyze alternative solutions, make decisions and trade-offs all while ensuring that the design and users requirements are met.

(3) Development of 21st Century Skills : Critical Thinking & Collaboration Skills

Students are stretched in their inquiry and critical thinking skills through the engineering design thinking process. Using pen and paper, sketching, making mock-ups and prototypes, students are engaged with practical hands-on experiences used in design thinking methodologies.

Collaboration and working in teams enable students to learn from one another (Figure 8) and develop critical 21st century workplace skills, such as teamwork, communication and interpersonal skills. As the student groups take ownership of their designs and project timelines, they become active and independent learners in the process of finding and achieving their own project goals.

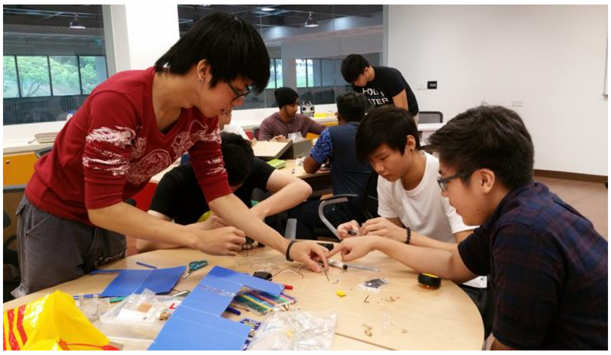


Figure 8. Collaboration or working in teams enable students to learn from one another

(4) Learning by Doing – Applied Learning

Workshops were designed to create spaces to foster creativity, creating, building and experimentation. Machining and fabricating equipment like 3D printers, laser cutting machine, electronics and soldering equipment, etc. were made accessible to the students during the prototyping stages. These workshops spaces promoted peer interactions and allowed sharing of ideas and knowledge between student groups (Figures 9 & 10).

Figure 9. Students creating prototypes in design workshop

Figure 10. Interactions and sharing of ideas amongst students

Students welcome the opportunities to make design decisions and develop the prototypes on their own. Students were more engaged and take greater ownership of their own learning, skills developments and project deliverables as a result of these opportunities. Some of the students furthered their involvements by incorporating what they did in their EDT-DP modules into their final year projects, where they continue to develop user-centered projects that are technologically more diverse and complex.

Conclusion

The revision of the ME diplomas towards more design-centric curricula by infusing Engineering Design Thinking and Design Practices modules has changed the way teaching and learning takes place within ME. The alignment between engineering modules that are used in the design projects has enabled ME to better prepare their students for 21st Century innovation-driven workplaces (Design Masterplan Committee, 2016). The students are more engaged with the learning and during the design thinking process, they are also developing critical skills that are essential for their future work. Lecturers are also engaging students in a different manner and have created more opportunities for the development of students' higher order thinking skills in addition to exchanging content knowledge.

The different pedagogical approaches to teaching and learning engineering have obtained positive feedback from both lecturers and students:

"I like that we are actually building our ideas. It is really awesome that we are putting all of the things we learned into practice." - AMS Student.

"The building of the glider was the highlight in this module, we have the freedom to think out of the box for the design of the glider it was very interesting as a student to apply what we have a learned in the past years to build the glider." - AT Student.

"We get to create structures for the first lesson which enhanced our thinking ability and through the weeks of presentation, our communication skills increased!" - ME Student.

"I enjoy the process of building a ship. The hands on approach is fantastic as it is not boring. The greatest form of success for this module comes when my team's ship floats and is able to carry out tasks assigned by the lecturer." - MOT Student.

The EDT and DP module development team will continue to review and improve the modules and design projects so that the diplomas are able to develop students that are both competent in their engineering design and knowledge, as well as being relevant to the needs of the community and industry.

Acknowledgements

This paper and project was competed with the strong support from Ngee Ann Polytechnic.

We are thankful to our Mechanical Engineering Division colleagues who had provided expertise that greatly assisted the development and operations of the EDT and DP modules.

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Attempts of the Project Based Learning in the technology development program for the decommissioning of Fukushima Daiichi nuclear power station

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Abstract

One of the most severe technological issues of the recovery from the damages by the Great East Japan Earthquake in 2011 is the decommissioning of the Fukushima Daiichi nuclear power station, including the restoration of contaminated environment.

NIT Fukushima College (one of the most closely located national engineering and technology colleges), therefore, started an education and technology development program funded by MEXT contributing to the decommissioning project under the collaboration of the nationwide NIT colleges, universities, national institutes and local private companies. The program (started last December) contains the activities for the development of (i) Physical and chemical probes to estimate the damages of the reactor buildings and the in-vessel components, (ii) Methods and devices for sampling and analysis of the "debris", for the storage of heat-generating nuclear wastes, and (iii) Social science approach to reduce the labor accident risks focusing on the motivation of the employees. Also, (iv) Education course to introduce the decommissioning technology, such as "Reactor decommissioning engineering" and "Decommissioning and the society", including "the students' competition on the decommissioning robotics" is a vital part of the program for the development of students with visions. The course also includes international internships.

A variety of technologies are required to be developed in the program. Some of the targets are the development of prototypic ones so far, and are rather suitable for the subjects of the "Project Based Learning"; for example, the basic technologies for the sampling and analysis of the "debris". Attempts and the prospects of these PBLs are introduced.

The education program contains lectures and internship on nuclear safety and decommissioning. In addition, the Creative Robot Contest for Decommissioning as part of the expansion of interest of students in research and development activities. An overview of these progress and future developments will be presented.

Keywords: *Educational program, Decommissioning, Nuclear power, Basic research program*

Introduction

Decommissioning of Fukushima Daiichi nuclear power station is a national challenge. Mid-level engineer training from a medium- to long-term perspective on to proceed with decommissioning is a pressing issue. A training of practical engineer is the theme of technical college as institution of higher education of the National. In particular, National Institute of Technology, Fukushima College (NIT, Fukushima College) is located in the most close to the Fukushima Daiichi nuclear power station in the higher education of the National. Therefore in NIT, Fukushima College, a position to lead the national colleges across the country in the field of decommissioning education has been required.

Students of NIT Fukushima College have an interest in decommissioning technology. Some students choose nuclear power-related companies in place of employment. In order to meet the medium- and long-term theme of the region, incorporate the decommissioning basic research in graduate research and special studies carried out human resource development through research.

The establishment of decommissioning human resource development consortium

NIT, Fukushima College had been submitted as a business representative on the public offering of Education, Culture, Sports, Science and Technology Ministry. As a result, our application has been adopted by the business for one year as a feasibility study. Application title was "Human resources training on the decommissioning of nuclear power plant, based on study for graduation --- interdisciplinary challenge from Fukushima".

In the wake of this adoption, "Decommissioning human resource development consortium" was established in 2015 March 17 by NIT, Fukushima College. In this council, the nationwide technical colleges, universities and research institutions pursue together human resource training in the medium- to long-term perspective. Place the Council of the Secretariat in the Fukushima College, Takayuki Nakamura Fukushima College president was appointed first chairman, and Tetsuji Choji Kagoshima college president was appointed vice chairman. 2016 April at 34 technical colleges, 9 universities, 3 local government relationship, 6 private companies have joined.

Education program on decommissioning

This educational program is designed to correspond with the "human resource development and cooperation between higher education and research institutes in the medium-and-long term viewpoint" which is related to a governmental medium-and-long term roadmap for TEPCO's Fukushima Daiichi Nuclear Power Plant. This education program is constituted by three pillars; research and development, education and the facilities available (Japan Atomic Energy Agency Naraha Remote Technology Development Center).

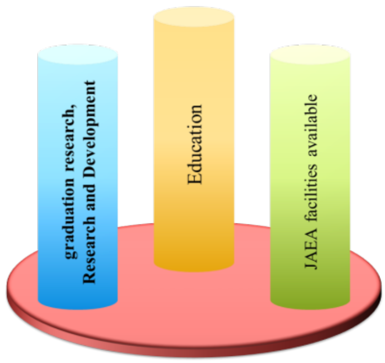

Fig. 1 Three pillars of education program on decommissioning

In 2015, classes on decommissioning have been offered in two subjects new.

Classes are "decommissioning and Society" of the 3-year target, a "decommissioning engineering" of the 4-year target, any one credit, was carried out in the intensive course format.

In 2016, internship programs for decommissioning and the two new lectures have been started. At the same time, the Technical College has promoted the cooperation in graduate research and special research.

In 2017, by starting classes on decommissioning in first grade and fifth grade, education program on decommissioning will be completed.

Internship is carried out complexly at two locations of companies and municipalities. In the company learn the decommissioning technology. In the municipalities understand the duties as a government on decommissioning.

Overview of "Decommissioning Engineering" and "Decommissioning and Society"

"Decommissioning and Society" will learn the basic knowledge that is required, including social aspects towards the decommissioning of the Fukushima Daiichi nuclear power station.

It shows the syllabus in Table 1. Prior to the decommissioning, it was also with the contents to think about radiation, decontamination and the interim storage facility. In addition, it was carried out basic lectures, such as history of the earth atmosphere formation, uranium resources formation, biology, physics, robots and waste management. Work group for understanding the communication techniques with the local residents towards decommissioning was also carried out.

Table 1 Syllabus of "Decommissioning and Society"

Period	Course content
1	Overview of nuclear fission reactor
2	Decommissioning overview of the nuclear power station
3	Social infrastructure of modern society
4	Nuclear power generation and nuclear fuel cycle
5	Radioactivity and radiation
6	The Earth's history, the global environment and the formation of iron and uranium resources
7	Selection of global warming and global warming countermeasures
8	Decommissioning and biology
9	Decommissioning and physics
10	Decommissioning and public communication
11	Decommissioning and robot
12	Decommissioning and sociology
13	Decommissioning and waste
14	Decommissioning and decontamination technology, interim storage facility
15	Overview of the Fukushima Daiichi nuclear power plant decommissioning

Lecture on decommissioning of the nuclear power station, the structure of light-water reactors and the nuclear accident of Chernobyl and TMI in the "decommissioning engineering" had been carried out.

In 2016, to start the "Introduction to Radioactivity and Radiation" for the second year and the "Introduction to Decommissioning robot" for the third year. In addition " Creative Robot contest for Decommissioning " is started.

Overview of Creative Robot Contest for Decommissioning

In order to get interested in the decommissioning to the young generation believes that education through the robot is effective. In addition, a variety of practices, such as PBL education and active learning lesson can be seen in each technical college. This Robocon also carried out by such PBL and active learning. It is the purpose to have an interest in decommissioning to the student through the manufacturing of robot. At the same time, it aims to cultivate the contributing to the "creativity education" "problem-solving ability" and "ability to identify challenges" students.

Overview of the competition challenges are as follows.

1) Field

To select the playing field in each team from the two fields of the following assumes the reactor building.

a) Mock-up stairs

b) Standard step field

2) Field environment

a) Mock-up stairs and b) standard test field have a common environment for the following.

a) It is no darkness lighting

b) Not be able to face up to the body to operate the robot by remote

c) Radio wave does not reach because there is a thick wall of concrete

3) Challenges of robot

a) Mock-up stairs

- Carry the luggage of weight 5kg to the second floor from the first floor. And come back to its original location by placing the luggage.
- Examine the thing that is put on the second floor. It should be noted that the location is undefined.
- Other issues related to decommissioning.

b) Standard step field

- Examine the field of shape (such as area and irregularities).
- Check things that are located in the field. It should be noted that the location is undefined.
- Other issues related to decommissioning.

There were submitted from all over the country in the national and public technical colleges of the 13 colleges 15 team in this contest. Results of document screening, was observed participation of 15 teams.

Introduction of Research

Considering that educational institutions such as Technical Colleges can accommodate, the development of large-scale equipment for melting and solidification fuel removal is difficult. Therefore, it considered appropriate to be centered on the fundamental issues regarding the construction of remote technology. Research themes, such as the following has been set.

(1) Development of remote control equipment in a nuclear reactor towards such sampling techniques for the situational awareness in the nuclear reactor

(2) Development of remote control equipment related to the analytical technique of radioactive material

(3) Waste treatment and disposal research for the safe storage technologies for heat-generating waste.

In addition, as a basis regions of these challenges,

(4) Property analysis and development of remote control infrastructure technology.

(5) Estimation of product material in nuclear reactor.

Additionally, as one of the social-scientific approach,

(6) Analysis of the relationship between work safety and motivation.

Conclusions

Last year, in the first year of this program, it was carried out basic research and development. We were able to build a research network between the National Institute of Technology. The education program was lectured as "decommissioning and Society" of "decommissioning engineering" to about 150 students. In the future, At the same time increasing the students with an interest in decommissioning, we want to nurture students who can compound eye thinking by composite type internship

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AN ATTEMPT TO IMPROVE OF UNDERSTANDING IN ENGINEERING LECTURES BY ACTIVE LEARNING APPROACH

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Abstract

This report describes an attempt to deepen understanding of mechanical engineering education, especially tribology lectures by active learning approach.

Various teaching methods were used in tribology lectures in Yuge College since 2010. For example, group discussions, video/presentation media or handouts were used to make interactive lectures and to control classroom.

CompTIA CTT+ techniques were applied to activate and to control classroom since 2014 in tribology lectures. In the presentation skills in the CTT+ techniques, the talking accents, intonations, speeds and eye contacts were intended to present in the lectures.

In the communication skills, open and closed questions were used according to the needs. And in the instruction skills, the pair and group discussions were applied.

When the students said their opinions or answered some questions in the classroom, sometimes they speak with a quiet voice before implements of the CTT+ techniques. This causes no problem in the lecture because every student was copying the blackboard and they kept quiet in the lectures. More I used to talk something small stories to change of the feelings in the classroom frequently.

From questionnaires for five years, before and after the implements of the CTT+ techniques, the students become busy and they have to concentrate their work in the lectures after the techniques. And they have to speak with a larger voice when they answered the questions in the classroom. More, the results of the regular examination are slightly better than before the implements of the CTT+. In particular, the students who marked bad results are decreased.

Keywords: *mechanical engineering education, active learning, lecture method, education effect, tribology education, CompTIA CTT+*

Introduction

The improvement of the education by the active learning approach becomes more common. Technique of the active learning is carried out in many universities and technical colleges. And the active learning method is carried out not only in problem based learning or in creative engineering class but also in good old style lectures.

Mizokami (2007) investigated actions of the improvements of learning in the universities in Japan according to discipline. He reported that many improvements for the good old style lectures are reported, problem solving types are popular in the seminar classes and the improvements are for the contents and the qualities

Students works the lectures actively and higher learning effect of the lectures are obtained by the active learning.

There are many reports that an understanding of the student deepened by the active learning. In addition, it is analysed about an effect and the problems of the active learning by various point of view.

Sunaga (2010) analysed the aim and the concepts of active learning and he points importance of the management of the curriculum.

Ohashi (2010) analysed the effects and the problems based on the Mizokami's report, and he mentioned the need of the consciousness change of the teachers and connection with the other subjects.

Oyama (2013) classified into six types according to the active learning styles, and she noticed the importance of the pre/post tasks of the students.

There are various understandings for "Active". For example, some students regard the copy of the blackboard is active job enough.

An affirmation for lectures and the tasks are important to lead the activate the students and to control of atmosphere in classes is also important for the activeness.

CTT+ technique have been introduced as one of the style of the active learning on "Tribology" lectures in Mechanical Electronics Engineering Department, National Institute Technology, Yuge College since 2014. Questionnaires were conducted before/after the introducing the CTT+ technique to evaluate the atmosphere in the classes.

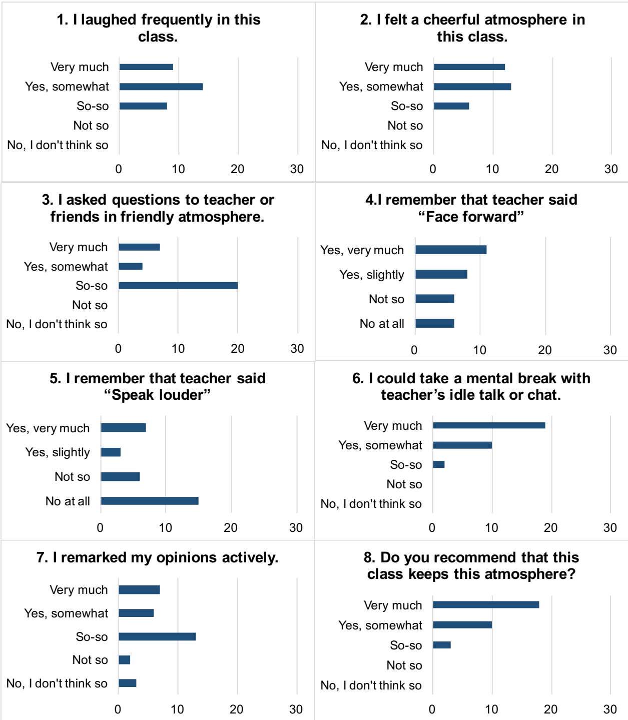

Figure 1 The results of a questionnaire on tribology in 2010 before the implements of the CTT+ techniques.

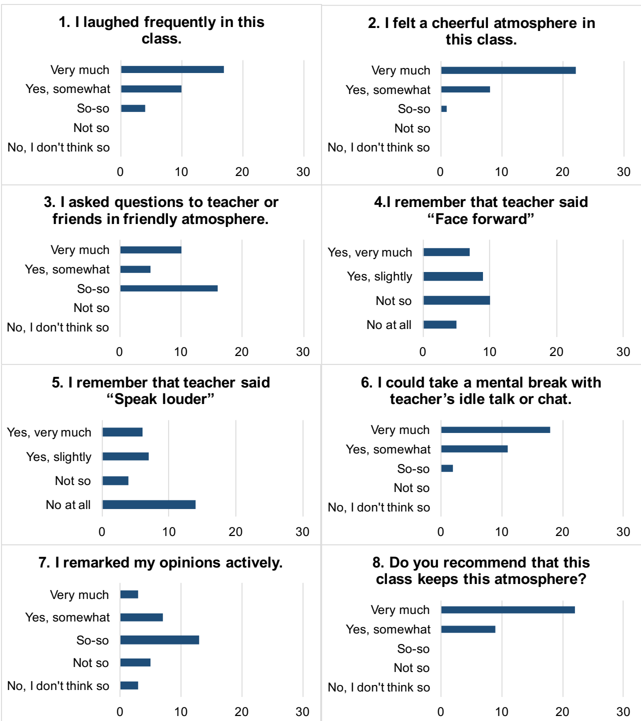

Figure 2 The results of a questionnaire on tribology in 2011 before the implements of the CTT+ techniques.

Methods and questionnaires

In order to grasp the purpose attainment of the subject, a questionnaire was conducted to the students. The items questions are as follows.

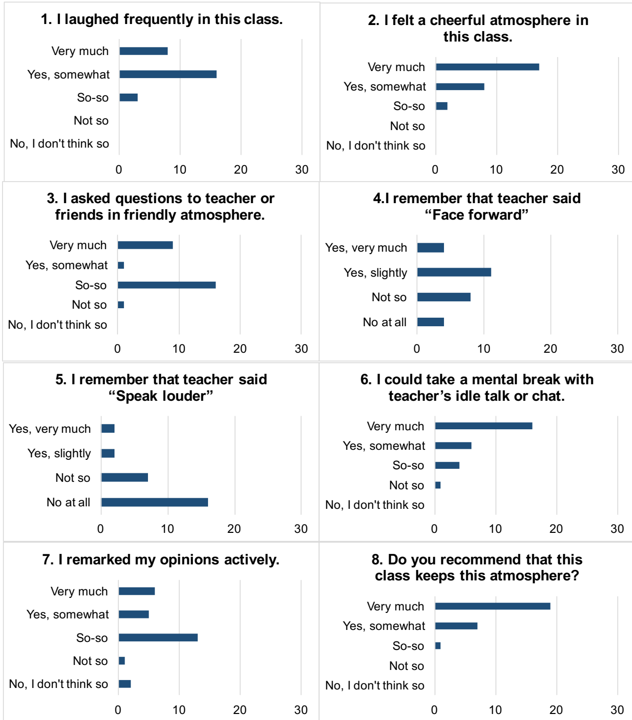

Figure 3 The results of a questionnaire on tribology in 2012 before the implements of the CTT+ techniques.

Questions:

(1) I laughed frequently in this class.
(2) I felt a cheerful atmosphere in this class
(3) I asked questions in friendly atmosphere.
(4) I remember that teacher said "Face forward"
(5) I remember that teacher said "Speak louder"
(6) I could take a mental break with teacher's idle talk or chat.
(7) I remarked my opinions actively.
(8) Do you recommend that this class keeps this atmosphere?

It is important to be make the brightly atmosphere that is easy to participate for students to get their higher activity.

Therefore, the questions mainly ask the atmospheres and easiness to participate to the works in class.

Results and Discussion

Figure 1 to Figure 3 are results obtained from the questionnaires before introduction of CTT+ technique to the tribology lectures.

The Figure 1 shows the results obtained from the questionnaire in tribology lecture in 2010. From the question 1, 2 in Figure 1, it can be seen the class could keep brightly atmosphere. From the question 3, no students have the sense of psychological resistance with ask questions to teachers or their friends in the class. From the question 4, just some students were warned to look at the teacher.

From the question 5, they do not have to speak louder when they answer something questions because the

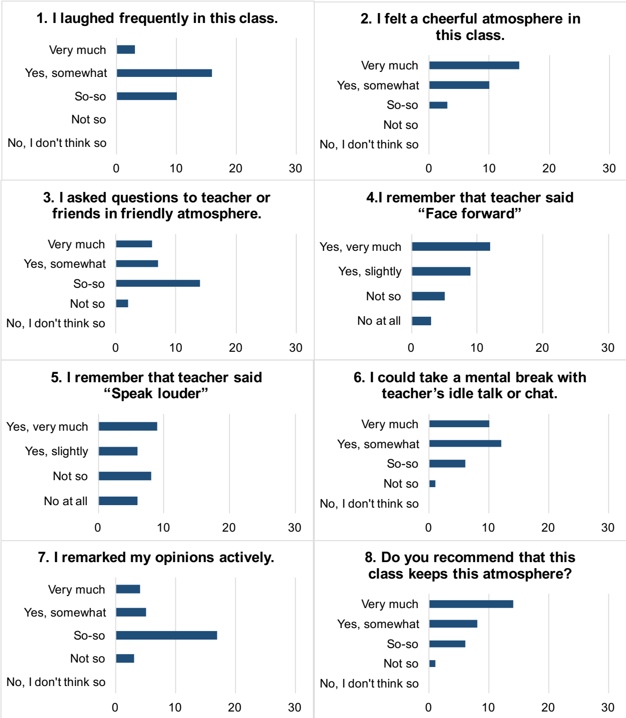

Figure 4 The results of a questionnaire on tribology in 2014 after the implements of the CTT+ techniques.

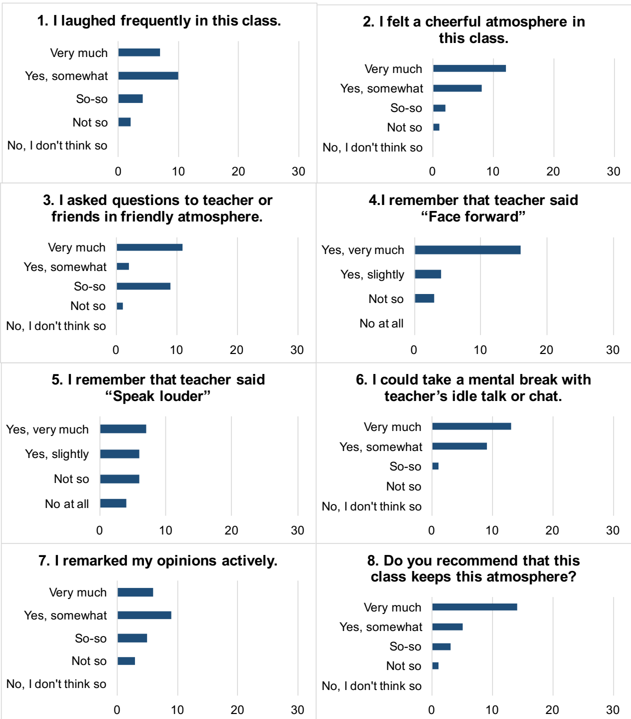

Figure 5 The results of a questionnaire on tribology in 2015 after the implements of the CTT+ techniques.

students copied the blackboard during the lecture and keep silent.

In the other, they need something to change their mood frequently during the copy job of the blackboard because of the monotonous job. And the teachers have to make a chat or idle talk to change their mood and to lead next theme. From the question 6, it can be seen the chat

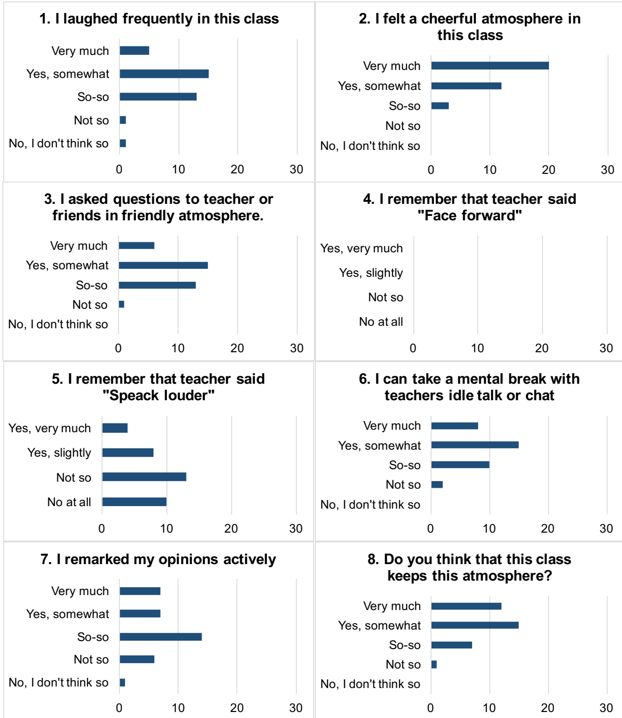

Figure 6 The results of a questionnaire on applied physics for another class of Figure 5 in 2015 after the implements of the CTT+ techniques.

is useful enough to take their mental break and to change a feeling in the classroom.

Furthermore, many positive answers can be seen from the question 7, that is they can remark their opinions in front of the classmate without mental blocks.

It can be seen that the management of the class is going well and many students have favorable reviews to the lecture from the question 8.

Figure 2 shows the results obtained from the same questionnaire in 2011. It has a similar tendency with Figure 1.

Also, Figure 3 shows the results in 2012. The students do not have to speak louder from the question 5 and the chat is important from the question 6 as same as Figure 1 and Figure 2.

Figure 4 shows the results obtained from the questionnaire in 2014. Since this year, the CTT+ technique was introduced in the tribology lecture. The tendencies in the question 4, 5 and 6 in the Figure 4 are different from the Figure 1, 2 and 3.

The question 4 is an instruction to look at the teacher or a blackboard. It is also an attention to be quiet for the students who talked with the friends or to make their concentration for the students who are scatterbrain before the CTT+ technique was introduced. However, after the CTT+ technique was introduced, it is an instruction to make an end of pair works or group works, so that many students answer for the question 4 with Yes.

From the question 5, they make discussions within the groups and make sounds in the classroom. They have to answer to the questions something with louder voice. And sometimes a teacher had to cause them to become aware that their voice is not louder enough to inform their opinions to the whole of classroom.

The question 6 is about the teacher's chat to change their mood or to lead next theme. It was important to change their mood and remake their concentration to the next theme for the students before the CTT+ technique was introduced. However, the numbers of students become decrease who answered with "Very much" after introducing of the CTT+ technique. It seems that a part of the chat to change their mood is decreased. This is because that they are changing their concentrations to pair works, group works, open/closed questions and so on in turn frequently.

The Figure 5 is the results obtained in 2015 and it shows similar tendency with the Figure 4.

The Figure 6 shows the results obtained from the similar questionnaire from Figure 1 to Figure 5 for the "Applied physics" lecture. Where, seven questions were conducted except the question 4. It can be seen the similar tendency with the tribology lectures for the question 5 and 6.

Table 1 shows the results of the average and minimum marks of examinations in the tribology lectures.

Table 1 The results of the examinations of the tribology

Year	**2010**	**2011**	**2012**	**2014**	**2015**
Average	80.6	82.1	84.7	84.4	89.0
Minimum	58	60.5	47	62	67

The average marks in 2015 is slightly better than that before the introducing the CTT+ technique. And the minimum marks after the CTT+ technique was introduced is better than that before the CTT+ technique was introduced. It is assumed that the students who have passive attitude become to be interested in the lectures more, after the introducing the CTT+ technique.

Conclusions

CTT+ technique have been introduced as one of the style of the active learning on "Tribology" lectures in Mechanical Electronics Engineering Department, National Institute Technology, Yuge College since 2014.

Questionnaires were conducted before/after the introducing the CTT+ technique to evaluate the atmosphere in the classes. The conclusions are as follows:

1. The students copied the blackboard during the lecture and keep silent before the introducing the CTT+ technique. And the teacher's chat is important to change their mood and to re-concentrate next theme for students.

2. The students have to speak louder to inform their opinions to whole of classroom. And the role of the chat becomes not so important because they change their concentrations frequently to pair works, group works and so on.

3. To control the atmosphere in the class is also important, especially, the students who have passive attitude become to be interested in the lectures more.

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A CASE STUDY ON THEME-BASED APPROACH IN HEALTH TECHNOLOGY ENGINEERING EDUCATION: PHYSIOLOGICAL MEASUREMENT TECHNOLOGY

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Abstract

There were radical curriculum changes in Metropolia University of Applied Sciences (MUAS) Information Technology Programs including Health Technology in 2014. This paper introduces the curriculum changes and experiences especially from student perspective. Instead of having fragmented curriculum including dozens of courses, the new curriculum has formed around larger thematic parts. In Health Technology, students learn not only technology but also business, operating environment and users, related to health technology utilization. Broad area of the curriculum magnifies the importance of integrated curriculum, for example, because teachers are from not only ICT but also from social and healthcare sectors. After the curriculum change, the core of Health Technology is based on three 30 ECTS themes: Physiological Measurement Technology, Customer Oriented Software Applications, and Health Technology Devices and Solutions. Themes are one semester in length and they have a common operating principles, integrated timetable and tools. Students have three simultaneous tightly integrated courses. Weekly timetable includes slots for lectures, assignments, independent and guided group work. Students work in small groups. Student centred approach is a vital in new curriculum to enable learning and fulfill needs of working life. The key is that students work actively and take responsibility of their own learning. Lectures and introductions are kept short and the focus is on guided practical assignments and projects done mainly in small groups. Teachers carefully plan and have weekly meetings to enable synchronization between different courses inside the themes. This paper focuses on Physiological Measurement Technology theme that was implemented first time in autumn 2015. Student feedback related to timing, synchronization, workload, and pros and cons is presented in this paper. Results were good. The goal is to provide students an integrated learning experience where they can deepen their knowledge and skills related to specific theme for the whole semester. Results imply that we are on the right track.

Keywords: *engineering education, integrated curriculum, learning methods, learning experience, teaching methods*

Introduction

Student centred learning is a significant issue in modern engineering education. Working life is changing to ever faster paced and work is done mostly in various projects. Tasks, employers, industry and teams are changing between the projects and during a career many times. Working life expects professionals who can solve problems, work in challenging projects and operate successfully with different kinds of people. Geven and Attard (2012) presents that students have to take responsibility and fully participate for their own learning to be able success in their later career.

Based on the Confederation of Finnish industries (2011) working life expects that future education will focus on skills in addition to knowledge and working in groups instead of working in isolation. Report also predict that fragmented curriculums are replaced by problem and phenomena based learning.

Attard, Di Iorio, Geven, and Santa (2010) define student centred learning: *"Student-Centred Learning represents both a mindset and a culture within a given higher education institution and is a learning approach which is broadly related to, and supported by, constructivist theories of learning. It is characterised by innovative methods of teaching which aim to promote learning in communication with teachers and other learners and which take students seriously as active participants in their own learning, fostering transferable skills such as problem-solving, critical thinking and reflective thinking."*

Student centred learning is key in Metropolia University of Applied Sciences' (MUAS) Health Technology engineering education. Health Technology is one of the major's in Information Technology Degree Programme. To enable student centred learning pedagogical choices and curriculum development are needed. Based on Attard, Di Iorio, Geven, and Santa (2010) students' different learning styles, needs, backgrounds, interests and choices have to be taken into consideration as well as communication between students and staff, ongoing reflection on learning and teacher's role as an enabler of learning.

Project based learning is one of the methods that is used in student centred learning. In project based learning, projects are typically quite long, problems are solved in small groups, and themes are multidisciplinary and broad. Learning is active, diverse and student centred. Goal-oriented and systematic work with deadlines and different tasks is important in project based learning. Students manage their projects by themselves, and agree with their individual tasks, phases and roles inside the project. The results are shared with others and evaluated by students themselves and others.

According to David (2008), the basic idea of project based learning is that real problems from real world capture students' interest, motivates and causes serious thinking as the students acquire and apply new knowledge in a problem-solving context. Larmer and Mergendoller (2010) list the following seven building blocks in project based learning: need to know, driving real world question, student voice and choice, 21st century skills, inquiry and innovation, feedback and revision, and a publicly presented product.

Pucher and Lehner (2011) stress that challenges in project based learning are students' ability to manage projects, students' variable motivation, communication between students and teachers, and authenticity of the project. According to Fincher and Petre (1998), the amount of teacher's resources for materials and guiding projects, and complexity of multidisciplinary implementations are challenges of project based learning in engineering education.

In addition to pedagogical choices, curriculum development is important to enable student centred learning. A fragmented curriculum including dozens of courses distributed to study path can be challenging. The main issue is how these courses can be integrated from student, planning and implementation point of views. In MUAS Health Technology, students learn issues related to technology, business, health and social care environment, and users and customers. This broad curriculum emphasise the importance of integrated curriculum, for example, because teachers have multidisciplinary background.

There were radical curriculum changes in MUAS in 2014. Previously, there were tens of 3 ECTS (European Credit Transfer and Accumulation System) courses along student 4-year study path. ECTS is a standard of higher education in the European Union; 60 ECTS credits (1600 hours) corresponds one academic year. 4-year study path include 240 ECTS in 8 semesters; one semester is divided into two periods. Earlier, there were courses that ran whole semester or one 8-week period. Student had 5 to 10 simultaneous courses. 3 ECTS equals to 80 hours of work and thus time per course was 5-10 hours including 2-4 hours of contact per week.

After the curriculum change, discussed thoroughly in Björn and Soini (2015) the core of Health Technology Major is based on three 30 ECTS theme-based semesters: Physiological Measurement Technology, Customer Oriented Software Applications and Health Technology Devices and Solutions.

Table 1 presents the structure and content of Health Technology Major at MUAS. Each Block is one period (8 weeks) in length and 15 ECTS in size. Each theme includes two one period modules and each theme module includes three 5 ECTS courses.

Table 1: MUAS Health Technology curriculum.

	1st period	2nd period	3rd period	4th period
1st year	Objects Module	Devices Module	Games Module	Networks Module
2nd year	***Theme 1***		***Theme 2***	
	Physiological Measurement Technology I	Physiological Measurement Technology II	Customer Oriented Software Applications I	Customer Oriented Software Applications II
3rd year	***Theme 3***			
	Health Technology Devices and Solutions I	Health Technology Devices and Solutions II	Elective ICT/Health Technology studies	Elective ICT/Health Technology studies
4th year	Innovation Studies	Work Placement	Work Placement	Thesis

Even after curriculum changes, MUAS Information Technology Programs are still 4-year and 240 ECTS programs. First year includes four 15 ECTS modules (Objects, Devices, Networks and Games) that all last one period. After the first year students choose their major. This paper focuses on Health Technology Major and especially on the theme 1 Physiological Measurement Technology.

Theme 1: Physiological Measurement Technology

Health and wellbeing can be measured with various methods. Applications measuring human functionality and living environment are developing and becoming more common. These applications are essential part in disease cure and prevention, and in health and wellbeing promotion. When utilizing measurement technology it is important to take issues related to human body and functionality into consideration - what can be measured and how this measured information can be utilized. There is an extensive set of sensors that can be used to gather data from a human body and functionality. To be able to use this data, it must be processed and analysed, in other words transformed into information. Health related information is necessary when building solutions to various customers and users.

The goal of Physiological Measurement Technology theme is that student knows products, applications and business related to human functionality and living environment measurements. Student knows phenomena measured from human body and their utilization opportunities. Student recognizes main physical principles of biomechanics and solves problems requiring mathematical skills, and performs practical measurement and analysis. Student understands physiological signals and uses physiological signal measurement devices and methods, and understands principles of digital signal processing. Student understands wireless communication principles. Student builds simple measurement system, connects sensors to measurement system, understands sensor operation and manages measurement data processing and storage. Student knows basics of team and project work, and applies these skills and the knowledge and skills learned in this theme to the project.

Theme 1 include six 5 ECTS courses. Courses and their main content are as follows:

Physiological Measurement Technology I (PMT I)

Intelligent Environments and Applications (5 ECTS)
- Measurement applications and business environment
- Products, services and applications related to measurements
- Intelligent living environment measurements
- Wireless communication
- Wireless sensors and sensor networks

Applied Anatomy and Physiology (5 ECTS)
- Basic structure and functions of musculoskeletal system
- Structure and functions of cardiovascular system
- Structure and functions of respiratory system
- Basic functions of nervous system and sensory system
- Practical measurements and analysis

Biomechanics and Motion Measurement (5 ECTS)
- Statics and equilibrium
- Rigid body dynamics
- Equipment for motion measurement
- Principles of motion analysis
- Senses and motion

Physiological Measurement Technology II (PMT II)

Physiological Measurements and Sensors (5 ECTS)
- Measurement of physiological signals
- Physiological signal measurement methods and devices
- Sensors
- Signal amplification and noise filtering
- Digital signal processing

Data Collection and Processing (5 ECTS)
- Labview programming
- Development of graphical measurement application
- Connecting sensors to system
- Data processing, analysis and presentation
- Storing data to database

Health Technology Project 1 (5 ECTS)
- Practice-oriented project
- Product and service development
- Team and project work
- Project management
- Project documentation

Implementation of Theme Based Curriculum

In this new thematic approach the themes are one semester in length and they have common operating principles, integrated timetable and tools. For example, each course inside the themes has similar structure including weekly schedule and goals, assignments and returns, and basis for evaluation and grading in Tuubi workspace (Metropolia's e-learning platform). Tuubi workspace is also utilized for course level communication and assignment returns.

Students have three simultaneous tightly integrated courses, time per course is around 16 hours including 7 hours of contact per week. Weekly timetable includes slots for lectures, assignments, independent and guided group work. Each students work in one small group, and the groups are re-assigned between semesters. The main idea is that students work actively and take responsibility of their own learning. Different learning methodologies are utilized such as project based learning presented earlier. It is essential that the students participate actively on their learning and therefore lecturer centred learning is reduced significantly compared to previous curricula. Lectures and introductions are kept short and the main focus is practical assignments done mainly in small groups. Students also widely evaluate their own and the group work during the themes.

Careful planning and weekly meetings are the tools to enable synchronization between different courses inside the themes. For example, biomechanics and motion lab measurements are tightly integrated to each other which enable student to understand the connections between practical human motion measurements and theoretical physical phenomena.

Feedback from the first implementation

It is important to gather feedback to enable continuous development. Physiological Measurement Technology theme was implemented first time in August-December 2015. This section presents the survey used to gather student feedback. Feedback was gathered at the end periods one and two of the theme. Similar survey is also executed after each period/module in the future. Obviously this survey in only one method to collect feedback. Feedback is also gathered during the courses, tutor discussions etc. The survey included following questions.

1) Assignments and timing of returns
2) How good timing and synchronization was in this period
3) How different courses supported each other
4) Amount of work: a) could have been more, b) suitable, c) too much
5) I worked: a) <30 hours, b) 30-40 hours, c) 40-50 hours, d) > 50 hours per week
6) What was good in this period?
7) What should be developed in this period?

Feedback Results: PMT I

This section presents the results from the student feedback survey gathered at the end of the first module of the theme 1. Results are divided into workload, what was good and what should be developed.

Workload (questions 4 and 5)

Figure 1 presents answers to survey question 4 related to amount of work. It can be seen that 85.7 % (N=24 out of 28) of the students estimated that the amount of work was suitable (option b), 8.9 % (N=2.5, note that some of the students selected two options: a/b or b/c) of the students thought that there was too much work (option c) and 5.4 % (N=1.5) of the students answered that there could have been more work (option a) during the first module of the theme 1.

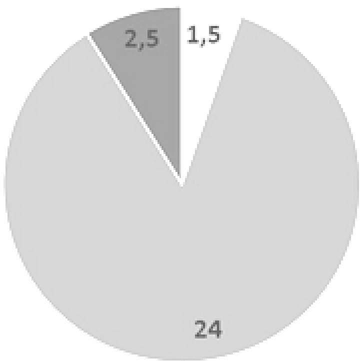

Figure 1: Amount of work in PMT I.

Figure 2 presents answers to survey question 5, how much students worked on weekly basis. The amount of used hours is based on student self-estimation. It can be seen that 64.6 % (N=15.5 out of 24) of the students worked 30 to 40 hours (option b), 25 % (N=6) of the students worked under 30 hours (option a), and 10.4 % (N=2.5) of the students worked over 40 hours (option c) per week. Thus 75 % of the students estimated that they worked over 30 hours per week. The ideal amount of workload per week is 40 hours.

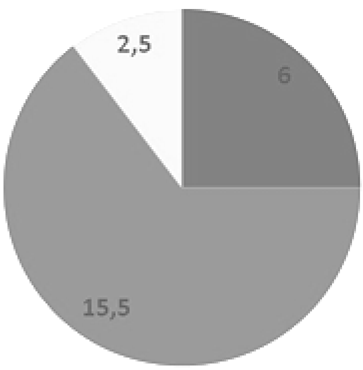

Figure 2: Working hours per week in PMT I.

What was good (questions 1, 2, 3 and 6)

Practically all students were satisfied with timing of the assignment returns. Most of the students that is 67% (N=18 out of 27) wanted assignments to be spread out to the whole period instead 33% (N=9) of the end of the period. Most of the students, that is 93% (N=25 out of 27) were satisfied how different courses supported each other.

Students were especially satisfied to practical assignments and research. Examples from these were practical measurements at the motion lab, personal ECG measurements and analysis, visits to the companies and also practical assignments done at the physics related to the motion lab measurements. Also versatility of the period was appreciated. This module included anatomy, physiology, wireless communication and biomechanics. High level of the teaching was highlighted in the feedback.

What should be developed (questions 1, 2, 3 and 7)

Students would like to have even more practical assignments instead of theory. Based on the survey more emphasis should be put to the instructions of assignments. Group sizes were 4 to 5 in the theme 1, students would have preferred smaller group sizes than these.

Feedback Results: PMT II

This section presents the results from the student feedback survey gathered at the end of the second module of the theme 1. Results are divided into workload, what was good and what should be developed.

Workload (questions 4 and 5)

Figure 3 presents answers to survey question 4 related to amount of work. It can be seen that 87.5% (N=17.5 out of 20) of the students found the amount of work suitable (option b), 7.5 % (N=1.5) of the students answered that there was too much work (option c) and 5 % (N=1) of the students thought that there could have been more work (option a) during the second module of the theme 1.

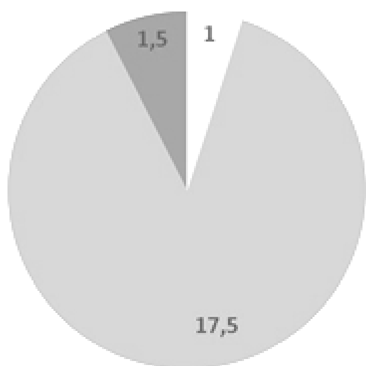

Figure 3: Amount of work in PMT II.

Figure 4 presents answers to survey question 5, how much students worked on weekly basis. It can be seen that 52.9 % (N=9 out of 17) of the students worked 30 to 40 hours (option b), 20.6 % (N=3.5) of the students worked under 30 hours (option a), 17.6 % (N=3) of the students worked 40-50 hours (option c) and 8.8 % (N=1.5) of the students worked over 50 hours per week. Thus 79 % of the students self-estimated that they worked over 30 hours on weekly basis.

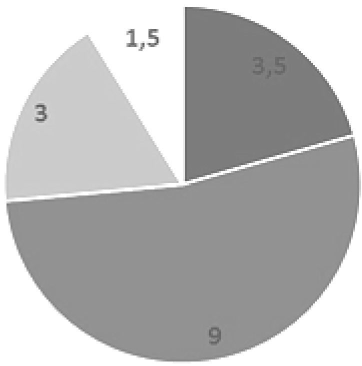

Figure 4: Working hours per week in PMT II.

What was good (questions 1, 2, 3 and 6)

Students were satisfied for timing of the assignment returns. They were also pleased versatility of the theme. Students were especially satisfied to practical assignments also in this second module of the theme 1. Based on the feedback there were less theory in the second module that satisfied students. Students also liked project and project based learning.

What should be developed (questions 1, 2, 3 and 7)

Students hoped for more materials from the teachers and more practical examples about subjects discussed. They also wanted clearer articulation related to course evaluation and how the grades are formed. They also pointed out the importance of distinct instructions the different course assignments. One practical example is that students were little confused the use of different learning platforms used in different courses.

Conclusions

Previous sections presented the feedback from the students. This section discusses the results and how they have been and will be used in the following implementation in 2016.

It is quite difficult to estimate weekly hours without precise documentation but it can concluded that workload in the first implementation was good, there might be possibility to increase the workload slightly.

Students were satisfied for timing of the assignment returns. From teachers' perspective there are some adjustments to be done in the next implementation. Students were pleased with practical assignments and measurements and these should be developed even more. Theory lessons are important and they cannot be omitted but rather they should be developed and matched even better to practical assignments. Versatility of the period was appreciated which was nice to notice because this is one of the building blocks of the theme-based curriculum. Students were ready and eager to work in groups and in project based manner, this was also important because this was another building block of the new curriculum.

In the following implementations the small group size is three and groups are decided by the teachers. This was also students' preference. More emphasis will be put to the homogenous instructions of assignments and grading in different courses. Tuubi e-learning platform will be utilized. Teaching materials will be developed for the coming implementations.

The goal of theme based integrated curriculum with student centred learning is to provide students an integrated learning experience where they can deepen their knowledge and skills related to specific theme for the whole semester. Based on the results presented and multiple discussions with teachers we are on the right track.

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Introducing Active Learning into Social Studies for Engineering Education

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Abstract

This paper aims to show the effects of introducing active learning into social studies for Engineering Education and to reconsider the possibility and the implication of social studies in Engineering Education.

For this purpose this paper reports some class examples which introduced the method of Oral History and Gamification.

Through these cases, this paper discusses effectiveness of introducing active learning into social studies.

First, the method of interviews or oral history is effective in a point to be able to realize the multi-faceted aspects of working and the important qualities of an engineer.

Second, the method of Gamifiacation is effective at improving the learning motivation of the students.

Third, social studies can be as a part of the classes teaching communication skills.

Fourth, the developing the class in collaboration with teachers of other fields is significant.

Fifth, it is enable to provide opportunity when student oneself notices importance of the knowledge of history.

Keywords: *Active Learning, Oral History, Engineering Education, Social Science*

Introduction

Generally, social studies in the College of Technology is not high in importance in comparison with engineering subjects.

The consciousness of the students is similar. For example, self-evaluations regarding Humanities and Social Sciences of graduates is low according to the results of questionnaires of the National Institute of Technology (NIT, 2012).

I heard things such as "I am weak in Social Studies" often from students. But according to this questionnaire of graduates, many of them answered that the subjects of Law and Economics will be necessary in the future for Engineering Education (NIT, 2012).

The results of this survey indicate that the teacher of social studies must devise classes so that students can be interested in this subject. And then, the teacher must think about educational policy and method.

Active learning is the method of learning in which the teacher provides his/her students lessons which are more interesting by providing contents that are easier to understand. It is the general term for the teaching method that incorporates the participation of the students who learn actively, in contrast to the form of teaching by one-sided lecturing from the teacher. (Central Council of Education, 2012). Specifically, it includes such learning as learning by discovery, problem-solving learning, learning by experience, and learning by investigation, etc., but group discussions, debates and group work in class are also effective methods of active learning. As active learning promotes the subjectivity and the participation of the students in this manner, it is considered an effective form of teaching. (Central Education Council, 2012) .

However, in the contents of social studies subjects, such as civics, geography and history, there are a few themes for which questions with more than one answer can be given. For these themes, rather than teaching the answers to the relevant problems, teaching that focuses on the process, such as relying on the discussion of problems by the learners is often done.

Having such a background, social studies education had a great deal of teaching materials and teaching methods that included the elements of active learning, before the appearance of the term, "active learning". Therefore, the environment of the teachers of social studies is easier to introduce the method of active learning compared to that of other subjects.

In such situations, I have been trying to introduce the method of active learning in social studies for the purpose of enabling students to take greater interest in class.

In this paper, I report some class examples which introduced the method of Oral History and Gamification in the social studies.

Through these case studies, this paper discusses and considers the possibility of introducing the method of active learning and the implication of social studies in Engineering Education.

Methods

1. Learning Oral History

Oral history is interviewing individuals about important events or everyday life and using the material which was collected with interviews for the study of history (Sakurai, 2010). Oral history is opened and used widely, for example sociology, psychology, political science etc. It is evaluated that through the interview, experiencing an another person's career indirectly is effective as higher education or career education (Umezaki, 2010)。

In this section, I will report two examples as the trials that introduced oral history into social studies education.

Thinking about "working" through interviews

In the class of politics and economics, I introduced the method of interview. I gave students an assignment for summer holidays. In this assignment, students had to interview people who have work experience and to hear *how he works*, *what does he get by working*, *what does he work for.* Further, students had to consider what his way of thinking and his values about his career were. In this assignment students often interview their parents or relatives during summer holidays. In some cases, they also go to their workplace to observe them at work. After interview students wrote a report, summing up what they have learned.

After the summer holidays, in the class students engaged in group work. First, students presented their reports which they prepared with each group. After presentation each group engaged in brainstorming about career or working by using a tag. Finally students summarized in one sentence or one phrase the meaning of "working" and presented it to the class. For example, "working" means "living", "enriching one's life", " bringing comfort to one's family", etc.

Through this group work students came to know the meaning and the significance of "working".

The description to be seen in their reports frequently is "until I conducted my interview, I had thought that 'working' was only to 'earn money' or 'to persevere', etc. But after the interview, I learned that 'working' was not merely to earn money, but to also engage in one's work, while enjoying what one is doing at times, thinking of one's family, as well as perceiving the purpose of life. I came to realize how limited my thinking had been."

The objectives of this assignment and group work are to enable the students to acquire communication skills, writing skills, interviewing, logical thinking, and brainstorming. However, the most important things are that the students cultivate a positive awareness on careers and realize the multi-faceted aspects of "working".

Learning the oral history of a sailor for Engineering Education.

In the subject: Modern Society and Law, which was held in the advanced course after the college of technology, we introduced the method of oral history (Takehara & Hino 2014). This class was conducted in cooperation with a teacher of material science, Dr. Takanori Hino. In this class, students learned the oral history of "*Seikan*" Train Ferries, *Yotei Maru* which ran between *Aomori* and *Hakodate* in 1965-1988, and recorded this oral history in cooperation with students from other departments. They made a DVD by creating a script and editing the video.

They wrote an impressionistic essay about the process of this class at the time of the semester test. From these essays we found that, consequently, students learned important qualities for engineers such as safety awareness, teamwork, and mastering skills. Moreover, they came to recognize the importance of knowledge based on experience and history.

I carried out a questionnaire after this class. It revealed that the satisfaction of the students was high from this survey (table 1).

	YES	N/A	NO	Total
Q6 Whether it is devising a means and method of teaching ?	10	0	0	10
Q7 Did teacher go with a serious and passion?	9	1	0	10
Q8 Are you interested in the course content?	9	1	0	10
Q9 Did you understand the lecture?	7	3	0	10

Table 1: the questionnaire after class (excerpt)

Moreover, the script and edited video became an important material for labor history and engineering history.

2. Gamification into Social Studies Education

High motivation of students toward class and study is essential for active learning in education. Gamification is one of the ways to increase the motivation of students. Gamification is to apply a game concept to non-gaming contents.

In this section, I report two examples of Gamification in social studies education.

Quiz with ranking for student's motivation

In this case I collaborated with the teacher of computer science, Dr. Hidetake Uwano and a student of the advanced electronics and information course in NIT Nara College, Yuki Tanaka. We introduced the element of Gamification into the class of social studies and summarized the result in an article (Tanaka, Uwano, Ichinose, Takehara 2016).

In the lecture of "Politics and Economics" we carried out the quiz to check the students' degree of understanding. At that time, we used the ranking for the student's motivation. The ranking is often used in Gamification.

In this quiz we used Moodle, a web-based open source platform for education as an e-Learning system.

The quiz was carried out on a Moodle quiz module at the beginning of one lecture. The quiz consisted of 15 four-choice questions with an eight-minute time limit.

After finishing the quiz, the ranking was displayed on the system with each student's ID. Each ID was given as a well-known person in Japanese history for the student's privacy.

Some students made comments such as "I want to get a high score worthy of my user ID." When displaying the ranking to the students, they talk about the name and their rank, especially about two clan masters who fought in a historical battle. The user ID was treated like the real name on the e-Learning system. Therefore, appropriate user IDs were an impetus for student's motivation.

After the quiz we carried out the questionnaire. The results revealed that many students answered in the affirmative about the quiz and ranking (table2).

Q7 Do you think you want to do a quiz with ranking next time?

NO ... YES

1	2	3	4	total
2 (6%)	6 (18%)	7 (21%)	18 (55%)	33

July, 23, 2015
3rd grade students, Dept. of Information Engineering

Table 2: the questionnaire about the quiz and ranking (excerpt)

We also measured the effect of the ranking on the motivation toward preparation and the quiz score. We defined three classes (104 students) as a ranking group, and the other two classes (82 students) as non-ranking group. Both groups were informed that the quiz would be performed two weeks later. In addition, the ranking group was informed that the quiz score would be open to other students with their ID through an e-Learning system.

As the result of the experiment, 44% of the students answered in the questionnaire that their motivation toward the preparation for the quiz had increased. There was no significant difference between the quiz score of the ranking and non-ranking groups. Analysis of the relation between a competitive-mind and motivation for quiz preparation shows that less competitive-minded students tend to have low motivation and scores (Tanaka, Uwano, Ichinose, Takehara 2016).

English Conversation in Trading Game

In this section, I will report the cases that I have developed social studies lessons for the purpose of improving the students' communication skills.

Specifically, by using the teaching materials that took advantage of the existing game-type materials, we devised a situation in which the students were compelled to speak English. The materials I used were called "trading games." This is a game that simulates trading, one in which the students are divided into multiple groups (representing countries) and vie with each other, having been given an unequal quantity of paper, (representing resources) and equipment (representing technologies). It was created as a teaching material for developmental education in Britain. Its translation in Japanese has been published and is being used in Japan

Before starting the game, the students are divided into 6 to 8 groups, each of which is given its resources and raw materials. By using them, each group creates products and sells them in the market for making profit. In this game, the group that acquires most profit is the winner.

When the students are divided into groups, unequal initial conditions are established from the beginning, reflecting the realities of advanced countries and developing countries.

Through the experience of real-like trading, the students became to understand how economic disparities are being increased.

Generally, the learning of English in Japanese schools is centered around lecture classes where students learn English grammar and get training in listening comprehension. Therefore, they receive few opportunities to practice conversation. By using these teaching materials and with the collaboration of English instructors Dr. Sachiyo Nisikawa, I devised the lessons to supplement the training in communication in English for learners, by preparing the environment in which they were compelled to speak English.

In this game, its "facilitator" could, in the middle of the game, change the rules to provide changes in the situations. In the middle of the lesson I decided to implement the rule that players had to speak English, when going to the market to sell the products. I prepared in advance a set of English examples, consisting of the questions and the answers that will be needed by the person in charge of the market. The learners would then try to somehow speak in English, but no words would come out of their mouths. They found out how difficult it was to communicate in English. They realized the necessity of learning English actively, rather than passively.

Summary and Conclusions

To conclusion, I will summarize the results and consider the effectiveness of introducing active learning into social studies for Engineering Education.

First, the method of interviews or oral history is effective in a point to be able to realize the multi-faceted aspects of working, for example, "working was not merely to earn money, but was also the means to enrich their lives" and the important qualities of an engineer, such as being aware of safety, of teamwork and of mastering the skills in his field.

Second, the method of Gamifiacation is effective at improving the learning motivation of the students. Many students answered in the affirmative in the questionnaire after the quiz with ranking. From the analysis of the questionnaire data, it was revealed that the students who were highly motivated in their studies and had higher competitive spirit became even more so, as their ranking was shown.

Third, having created situations in which communication in English was required can be as a part of the classes teaching communication skills.

Fourth, the developing the class in collaboration with teachers of other fields is significant in recognizing each other's education method or object rather than taking advantage of the professional knowledge of the experts in the respective fields.

Fifth, active learning brings the positive influence for social studies education itself. Because it enables to provide the opportunity when student oneself notices importance of the knowledge of history. And if the script and edited video became an important material for labor history and engineering history, the students may come to be interested in social science.

In a conventional way, social studies education in college of technology is centered on teaching knowledge which is provided by an individual subject such as History, Politics and Economics, Ethics and Geography etc.

In contrast, introducing the method of active learning into social studies education provide the opportunity when the students oneself notice the importance of learning social science.

In other words, through the experience such as interviewing people who have work experience or ship sailor, trying to sell the products they made with in English, the students oneself become aware of safety, teamwork, mastering skills in their fields and importance of communication.

So introducing active learning into social studies education is effective for Engineering Education in a point to be able to earn ability for self-study and become aware of the important qualities of an engineer.

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IS A FLIPPED LEARNING APPROACH SUITABLE FOR PART-TIME ENGINEERING STUDENTS AT TERTIARY LEVEL EDUCATION?

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Abstract

In a flipped learning model, teachers shift traditional educational arrangement outside the classroom and make teacher-driven instruction to student-centered learning. Meanwhile, students are the agents of their own learning and typical lecture and homework elements of a course are reversed. Very often, flipped classrooms are designed for secondary schools and for full-time courses and programs. As there has been growing interest in incorporating flipped learning into higher education, this calls for more high quality researches to inform practitioners on the use of flipped learning in different study modes. Rarely have they been examined in tandem with part-time study mode, this paper provides information on previous research studies and outlines benefits and major challenges of flipped learning particularly for this study mode. An investigation of a part-time higher diploma engineering course at Hong Kong Institute of Vocational Education (Tuen Mun) has been conducted. It reveals the learning needs in which flipped learning approach would have benefited their studies somewhat. The results of this investigation have been used as the basis for developing the course to allow a more effective flipped style. Pedagogical implications are drawn from the analysis and the way forward.

Keywords: *flipped learning, part-time, engineering study, tertiary education, vocational education*

Introduction

Pedagogical approaches such as Problem Based Learning (Kelly and Lesh, 2000), Model-Eliciting Activities (H. A. Diefes-Dux et al., 2004) and Peer Learning (H. A. Diefes-Dux and M. A. Verleger, 2009) have been introduced for teaching engineering students at tertiary level education. Recently, flipped learning approach has been the subject of much popular attention, however, very little research has been undertaken into these approaches.

In a flipped classroom, the information transmission component of a traditional face-to-face lecture is moved out of class time and in its place are active, student-centered and collaborative tasks. Before class, students have to prepare for class by engaging with resources that cover what would have been in a traditional lecture. After class, they could follow up and consolidate their knowledge. Notably, flipped learning has proven to be effective in secondary schools and in freshman engineering level (Yelamarthi et al., 2015). While past research studies have addressed many benefits of implementing flipped learning in full-time study mode, the flipped classroom approach in part-time study mode is under-evaluated, under-theorized and under-researched in general. Despite popular enthusiasm and a somewhat reasonable rationale, flipped classroom approach could not yet be considered an evidence-based (Pawson, 2006) approach, especially in consideration of different level of commitment by part-time students.

Vocational Training Council (VTC) is the largest vocational and professional education and training provider in Hong Kong. In academic year 2015/16, VTC has offered about 44,900 full-time and 21,500 part-time study places through its member institutions. Aiming for high quality researches to inform practitioners on the use of flipped learning in part-time study modes, the purpose of this study can be defined as the followings: 1) To provides information on previous research studies; 2) To address benefits and challenges of flipped learning for part-time students; 3) To propose best practices to design and implement flipped learning.

Research Questions

Part-time programs have a very different level of commitment than full-time programs do. Full-time students are expected to treat their studies as the main focus while part-time students might take one class a week, requiring only a couple hours of out-of-class study time.

From a cognitive load perspective, self-paced preparatory work might better manage working memory than traditional lectures (Clark, Nguyen, & Sweller, 2005). According to Andrews, Leonard, Colgrove, and

Kalinowski (2011), many of the learning difficulties experienced by students in higher education courses can be attributed to the passive role played by them during traditional lectures.

Flipped classroom approach wagers the success of in-class activities on the likelihood of students completing their pre-class assigned work and this leads to the perennial problems of student preparation. More troubling are issues of student motivation and imagine a flipped classroom where none of the students have completed their pre-class work. Based on such circumstances, how do teachers ensure students have prepared, and if the preparation in a flipped learning approach is useful for part-time engineering students at tertiary level education?

Research Methods

In academic year 2015/16, flipped learning approach was introduced to two compulsory engineering science modules, namely ENG3012 Engineering Science B and CON3301 Engineering Science for Construction A. The class of former one was in full-time mode of 28 students, while another was in part-time mode of 20 students. Both modules were foundational modules in the engineering curriculum and similar flipped learning approach was adopted in both classes such as the progress, the implementation, the physical setting, and the interface with Moodle-based resources.

Two study modes distinguish the two modules with different curriculum hours. Given the same qualifications framework level 3, ENG3012 has 45 hours including 25 hours of lecture, 15 hours of tutorial and 5 hours of laboratory, while CON3301 has 26 hours including 13 hours of lecture, 9 hours of tutorial and 4 hours of laboratory. Video lectures in English were available on Moodle platform and ENG3012 was considered as a control for gauging the discrepancies between both groups of students about flipped learning approach. A questionnaire survey was done in both classes to collect students' feedback, problems encountered, and the way forward.

There are five key questions to collect students' valuable views on the implementation of flipped learning approach. Key question 1 asks whether students watch the video lectures before the class or not. If students have watched the videos, the questionnaire asks whether the videos helpful for them to understand the topics in key question 2. If students have not watched the videos, the reasons of why they do not watch the videos are asked in key question 3. Key question 4 asks the students' opinions on the effectiveness of flipped learning approach than that of traditional lecture. Last key questions addresses what are the possible activities in the class session. The students' feedback is analyzed for the comparison of impacts on flipped learning approach towards students in different study modes. However academic result is not used as an indicator because of different learning contents. Minor changes will be made to ensure equivalence between other factors.

Results and Discussion

A big difference is found between part-time and full-time students on the actual preview rate of video lectures in a flipped learning approach. Almost no part-time students watched the video lectures while around three quarter of full-time students watched that. Key question 3 also shows the same situation in which part-time students considered there was no enough time to watch the video lectures, in contrast to full-time students who did not view the video lectures may be activated by modification of video lectures.

The results echo with previous research findings that level of commitment and motivation are two important factors that drive the effectiveness of flipped learning approaches. Among these two factors, level of commitment was more applicable to part-time students and motivation was more applicable to full-time students in this survey. For all students who watched the video lectures, majority of them agreed that the video lectures were helpful in understanding the topics.

Comparing traditional lectures, both classes agreed the flipped learning approaches were more effective while full-time class yielded a clear result. If flipped learning approaches were adopted, most of the students would prefer to have game-based activities in its place. Small-group and large-group discussion were second and third preferable options in their point of views. The summary of results is tabulated in Table 1.

The move from a traditional lecture to presenting that same lecture online is unlikely to result in learning differences if nothing else changes. Comparing full-time students, part-time students have more difficulties in finding time to watch video lectures because of their works. In this study, although part-time students also recognize the benefits and effectiveness of flipped learning approaches such as manipulating the pace of learning by pausing, rewinding, fast forwarding or skipping any parts of lecture videos, the constraint of tight study schedule is the largest hurdle in applying flipped learning approaches for part-time students.

The information-transmission component of a traditional lecture is moved out of class time if possible and replaced by a range of interactive activities designed to entice active learning. However, in most cases, engineering subjects are not solely information-transmission but require deeper understanding of concepts and skilfully practice of calculation. Unless a lecture has the sole goal of transmitting information, flipped learning is probably not the best approach (Bligh, 2000). Further researches should be done in order to identify the content to be delivered.

A Call For Further Research

There are many factors that play key roles in the effective use of flipped learning approaches. Only time and further researches will tell if flipped learning approach yield predictable, repeatable increased performance. A limiting factor in this study was its small sample size of 48 participants. A larger sample size and perhaps a same modules study would be

Table 1. Summary of survey results for both full-time and part-time classes.

	Full-time Class		**Part-time Class**	
Key Question 1. Have you watched the video lectures before the class?	**Yes**	**No**	**Yes**	**No**
	71.4%	28.6%	5%	95%
Key Question 2. If you have watched the video lectures, do you find it helpful in understanding the topics?	**Yes, it can.**	**No, it can't.**	**Yes, it can.**	**No, it can't.**
	80%	20%	100%	0%
Key Question 3. If you have not watched the video lectures, why?	**The video is in English and I don't understand**	**I forget**	**Too busy and I have no time to watch them**	**Others**
	75%	25%	84%	16%
Key Question 4. Comparing traditional lectures, do you find flipped learning approaches more effective?	**Yes**	**No**	**Yes**	**No**
	71.4%	28.6%	55%	45%
Key Question 5. If flipped learning approaches are adopted, what activities can make your learning more effective?	Small-group discussion: 14.3%; Large-group discussion: 7.1%; Game-based activities: 53.6%; All of the above: 14.3%; Others: 10.7%		Small-group discussion: 20%; Large-group discussion: 15%; Game-based activities: 40%; All of the above: 25%	

informative. A same modules survey would also be helpful to identify any disparities that are not affected by subject contents. In general, it is important to ensure teachers have the skills and pedagogical understanding required to embed constructively aligned active learning within the approach. In particular, future efforts will focus on how to modify the current flipped approaches to suit the needs of part-time students. Perhaps shorter videos will be used and incentives should be added to attract students to preview the videos.

Conclusions

Flipped learning approach are being adopted with much enthusiasm despite the paucity of specific evidence about their efficacy. In the absence of evidence of the efficacy of flipped classroom in general, the findings should encourage the practice of flipped learning approaches in the future, and support future research into exploring the adaptation and development of flipped classroom as an innovation educational pedagogy.

This paper outlines a study of the flipped learning approach with part-time and full-time engineering students at tertiary level education. The flipped classroom is a new pedagogical method, which employs video lectures, and interactive activities in the classroom. The results between part-time and full-time students are very different in some senses. Using full-time class as a control point, a survey was conducted in two engineering science courses at Hong Kong Institute of Vocational Education (Tuen Mun) during the spring semester of academic year 2015/2016. All students were asked to complete video lectures outside the classroom and full time students were considered as a gauge against part-time students. The two groups were compared using a same questionnaire addressing 5 key questions.

In conclusion, part-time students found it difficult in fitting flipped learning structure due to different level of commitment than that of full-time students. The biggest hurdles to achieve full effectiveness of flipped learning approaches for part-time and full-time students were busy work-study schedule and motivation respectively. Despite the difference in programme nature, both part-time and full-time students agreed that flipped learning approaches would have benefited their studies somewhat. If flipped learning approaches are adopted, game-based learning activities and small-group discussion should be in its place of the class session. Three implications should also be highlighted in this study during applying flipped learning approaches including 1) to move most information-transmission teaching out of class, 2) to use class time for learning activities that are active and social and 3) to adjust the length and language of video lectures whenever appropriate.

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PRACTICE OF LECTURE COURSE "APPLICATION OF ELECTRICAL AND ELECTRONIC"

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Abstract

The authors have conducted a lecture course "Application of Electrical and Electronic" by adopting active learning (AL) methods from FY2015 in National Institute of Technology (NIT), Nagano College. This course is an optional course of half-year to learn by utilizing knowledge of electrical and electronic engineering which students have learned at college in the past. In this course, students will learn photovoltaic power generation system, lighting design, electric heating equipment, air-conditioning equipment, electric railway, application of motors, electrochemistry, and smart grid and micro-grid. Also, in this course, we have partially adopted flipped classroom and conducted a test to confirm learning level at the beginning of a course. During school hours, students are doing the exercises on basic matters and designing electrical equipment by utilizing basic matters.

In the lecture course, students designed the photovoltaic power generation system of 10kW, and LED lighting equipment to be used in the classroom. In addition, students were exercises computational problems of the amount of heat generated from the electric heating equipment, capacity of air-conditioning equipment, output power of motor for elevator, and current efficiency in electrochemical, and so on. These designs and exercises were carried out in individual learning and group learning. In addition, students listened to lectures about the construction of the Shinkansen (bullet train lines) and conventional lines, and the configuration of the smart grid and micro-grid. Students who are interested in power engineering was the state that are working actively in home learning.

We conducted a questionnaire at the end of a lecture course. From the contents of the free description column, evaluation of students is likely that it was good. In this paper, we describe the course content and questionnaire results of a lecture course "Application of Electrical and Electronic".

Keywords: *Active learning, flipped classroom, applications of electrical and electronic, photovoltaic power generation system, lighting design*

Introduction

In recent years, active learning has been incorporated into courses in many college (example, Ogawa, N., et al. (2015)). Also, teaching examples incorporating the flipped classroom have also been reported (example, Inoue, H. (2014)).

In NIT, Nagano College, there were only a few courses that incorporated active learning seriously. The authors conducted a lecture course by using a teaching method that has gained experience in the experiment to nurture creativity (Watanabe, S., et al. (2005), (2008), (2011)). Therefore, we conducted a lecture course that incorporates active learning in order to have a deep understanding of the electrical equipments to the students. In this paper, we describe the course contents and questionnaire results of lecture course.

Contents of a lecture course

In this course, students will learn photovoltaic power generation system, lighting design, electrothermal equipment, air-conditioning equipment, electric railway, application of motors, electrochemistry, and smart grid and micro-grid. The contents that this course dealt with aimed at the technology close to that which is actually used in designing electrical equipments. This course was intended to be a course in which students actively collect information and learn on their own. This course is an optional course intended for the fifth grade, 26 out of 34 applicable students (76.5%) took it. In the end, it passed students of 25 (96.2%) in this course. Contents handled are as follows:

(1) Photovoltaic power generation system

The assignment about solar power generation equipment is to create a proposal to build a solar power plant of the total output 10kW at any location. The model of the power-conditioner used for the power conversion was specified in advance, but the students were required to choose solar panels and platforms, etc. Students were also required to predict the yearly amount of power generated by their proposed equipment, using the information from weather stations, etc. In a lecture course, only devices that constitute the solar power generation equipment and fundamentals of power generation characteristics were explained. For the students, it was instructed to investigate their own detailed matters necessary for the design. Students wrote a report by investigating the specifications of devices such as solar panels on the Internet and literature (figure 1 and figure 2). It is observed that interested students were actively gathering information.

(2) Lighting design of classroom

In lighting design, students were asked to calculate the number of light emitting diode (LED) lamps to illuminate the classroom used for this course if LED lamps are used to light the classroom. They were also instructed to calculate the illuminance on the desks in the case that LED lighting was used.

(3) Electric heating equipment and air-conditioning equipment

In electric heating equipment, students learned the principles of heat pumps and solved heat calculation problems. As for the calculation of the capacity of the air-conditioning equipment, students solved an example problem which asked for the heat needed for the room and chose what capacity air-conditioners are appropriate for the room (figure 3). For the results of solving were asked to describe in the blackboard to a representative of the students (figure 4).

(4) Electrochemistry, application of motors, and electric railways

In electrochemistry, students learned the principles of the primary battery and secondary battery, and went through the exercise of basic calculation problems. In the application of motors, students solved exercise problems about hoisting elevators. In the electric railway, it handled for the technology in Hokkaido Shinkansen which opened in March 26, 2016.

(5) Smart grid and micro-grid

Finally, we discussed about the smart grid and micro-grid that has been attracting attention as a power transport technology. After that, students studied the relationship between power demand and frequency variation and the problem of voltage rise due to the reverse power flow.

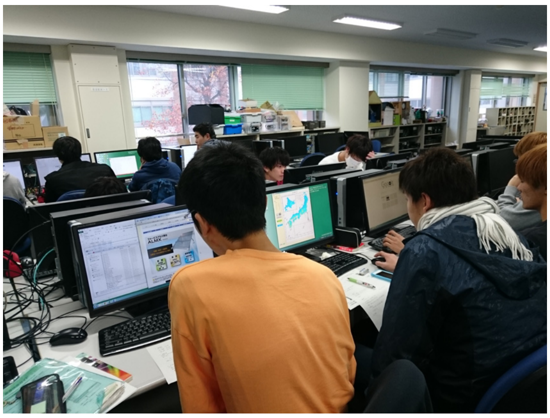


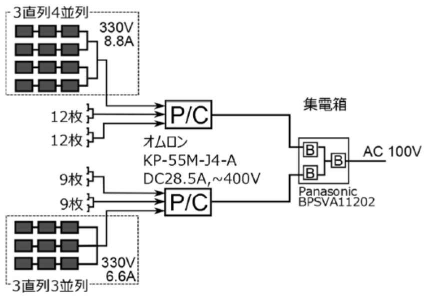
Figure 1. Appearance of students who are to search for articles about photovoltaic power generation system.

５年電気電子応用　第１回報告書（太陽光発電システム）　番号　　氏名

１．設置場所（おおよその必要面積と理由）
・場所：自宅(旧本屋)屋上、長野県長野市
・必要面積：100m²
・理由：それなりの面積を確保でき、頑丈であることから

２．太陽電池モジュール（メーカ名，定格，枚数，選定した理由）
・メーカ：ソーラーフロンティア
・製品：産業用 CIS 太陽電池モジュール SF165-S
・定格：165W、2.20A、110V
・枚数：63 枚　（
・出力 165×63＝10.395kW
・外寸寸法 977×1257×35
・選定理由：20 年保障である
薄膜系を利用してみたい、見た目が綺麗

３．接続系統図（直流側の電圧仕様，交流側）



(a) Location, the specifications of solar panels, et al.

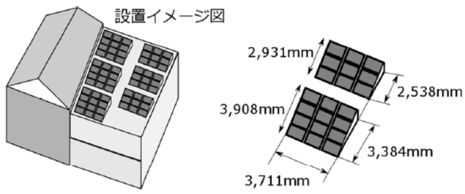
５．太陽電池モジュールの傾斜角（設定した理由）
・傾斜角：30°
・理由：NEDO 日射量データベースより、長野市における最高斜面日射量が得られる傾斜角である。

６．気象条件（考慮しなければいけない点，など）
NEDO　日射量データベース閲覧システムより
長野県長野市(傾斜角 30 度／方位角 0 度)　平均斜面日射量 3.96kWh/m²(日)
積雪若干あり

７．発電予測（年間どの程度発電しそうか）
年間発電電力量
＝斜面日射量×日数×出力×温度補正係数×パワコン効率×(1－その他損失)／標準日射強度
＝3.96(kW/m²*day)×365(day)×10.395(kW)×0.85×0.95×0.95／1(kW/m²)
＝11526kWh

但し温度補正係数 0.85、パワコン変換効率 0.95(仕様より)、その他損失 0.05 として算出した。

８．イメージ図



自宅事務所棟(旧本屋)屋上に設置、南向き

(b) Angle of inclination, weather conditions, et al.

Figure 2. Report on the design of photovoltaic power generation system.

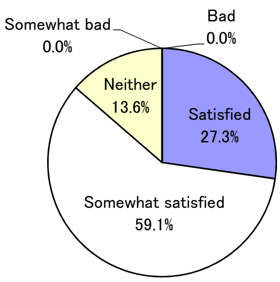
Figure 3. Appearance of students who are practicing in groups or pairs.

Figure 4. Appearance of students who are to explain the answer exercises.

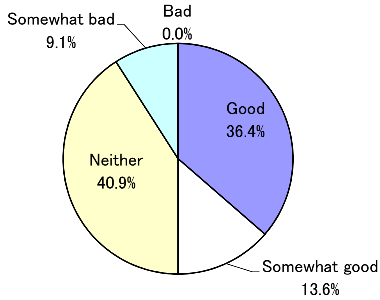
State of a lecture course and questionnaire results

This lecture course was half carried out. Interested students were observed to actively collect information and design equipment, but there were also students studying passively. The submission of assignments went well. At first, the contents in electrical equipment design by students was scheduled to provide the opportunity to present, but could not be carried out by poor health of the instructor. However, in FY2016, this plan is going to be put into practice.

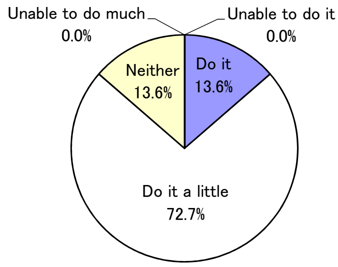
The authors have conducted a questionnaire survey on tuition to students on March 1, 2016, and obtained answers from 22 out of 26 attendants (84.6%). Questionnaire results are as follows: 19 students (86.4%) were almost satisfied with the contents of this course (figure 5(a)). Also, although 11 students (50.0%) were almost satisfied with the methods of this course, rest of students answered "Neither" or "Somewhat bad" (figure 5(b)). Students are considered to be not familiar with the flipped classroom. As for the efforts of problem, 19 students (86.4%) answered that they were able to make moderate efforts (figure 5(c)). As for flipped classroom, 6 students (27.3%) answered that they were able to do it a little, but 16 students (72.7%) answered "Neither", "Unable to do much," and "Unable to do it" (figure 5(d)). As for the amount of homework and reports, 14 students (63.6%) answered "Appropriate" (figure 5(e)). As for the knowledge about electric power engineering, 19 students (86.4%) answered "Somewhat master" (figure 5(f)). Students because it has mastered the basic knowledge of power engineering before taking this course, it is considered a degree of understanding has been improved.



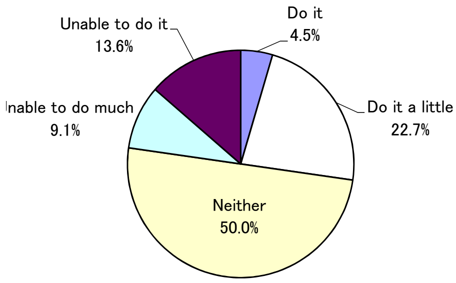
(a) Satisfied with the contents of this course



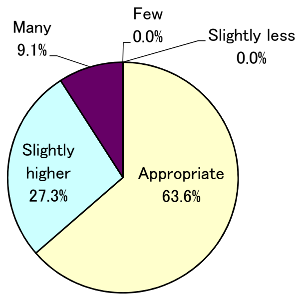
(b) Teaching style



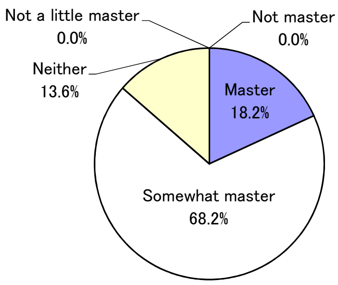
(c) Efforts to problem



(d) Approach to flipped classroom



(e) Amount of homework and reports



(f) Knowledge of electric power engineering

Figure 5. Results of the questionnaire survey.

In the free comment area, favourable comments like "The course was useful because I was able to learn electrical applications and practical things" were observed. On the other hand, there were opinions that there were too many handouts and that it was difficult to understand the content of the course, because the course dealt with various themes. It was also found that there were students who had difficulty preparing for the test because the range of topics for the test is wide. Some students were critical of the idea of flipped classroom itself, and some said that they could not learn deeply because the content of the course is wide. This year is the first year for this course. We will try to improve the method as to how to handle the class in the future.

Conclusions

In this paper, we describe the course contents and questionnaire results of a lecture course "Application of Electrical and Electronic" being implemented from FY2015. We conducted a questionnaire to students at the end of a lecture course. 86.4% of the students were almost satisfied with the contents of this course. Also, although 50.0% of the students were almost satisfied with the methods of this course, rest of students answered "Neither" or "Somewhat bad".

From questionnaire results, students in this lecture course is considered a heightened awareness to learn aggressively electrical and electronic engineering. However, since most flipped classroom not carried out in this college, students are considered not familiar with the flipped classroom and exercises. In the future, we need to devise the contents of a lecture course. In addition, it is important to increase the lecture that incorporates active learning and flipped classroom.

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TECHNOLOGY EDUCATION IN HONG KONG – TRENDS, CHALLENGES AND POTENTIALS

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Abstract

While education promotes technological changes, it also responds to technological changes. Technology education, with the concept of applying technology to solve problems and satisfy needs and wants, aims to develop individuals' knowledge, skills, attitudes and values in order to maximizing their adaptability and flexibility for future employment. As a field of study, technology education was internationally recognized in the 1980s, but the history of teaching craft-based and skill-oriented subjects in secondary schools in Hong Kong began in the 1920s. Students at that time were simply needed to acquire basic technical skills and gain practical experience to prepare for earning a living. Not until the mid-1970s was the higher order design element integrated into the curriculum of the local technology education to provide students with opportunities to practise problem-solving skills. Now, technology education is a part of general education in Hong Kong. In alignment with the global education trend, by combining science, technology, engineering and mathematics education, STEM education is currently being highly promoted in local schools. Besides, sustainability is a global issue of immense importance. Hong Kong, like many other cities in the world, has implemented various strategic measures to achieve sustainability. Theoretical perspectives on sustainable development under three topics, namely value position, nature of the proposed responses and structure of the proposed responses to this issue, as suggested in the literature, revealed that technology education can effectively contribute to education for sustainable development (ESD). A coherent and cross-curricular approach across all STEM subjects can be adopted in local secondary schools for ESD. This paper reviews the trends and challenges of technology education and STEM education in Hong Kong, discusses overseas experiences on integrating ESD through technology education into the school curricula, and describes case studies in the context of STEM education for introducing green design and green products as recommended in the literature to be beneficial to the future ESD.

Keywords: *technology education, STEM education, values, problem-solving skills, trends and challenges, sustainability, education for sustainable development*

Introduction

According to ITEA (2000), technology is defined as human innovation in action that involves the generation of knowledge and processes to develop systems for solving problems and extending capabilities. Technology education is a part of general education that is designed to develop technological literacy among students. The ultimate goal of technology education is to produce students with conceptual understanding of technology and its place in the society and thus grasp and evaluate new bits of technology that they may never have seen before. The definition of technological literacy is given as what every person requires to become an informed and contributing citizen for the present and the future. The scope and nature of technology education however vary in different places. In Hong Kong, technology education since 2015 has officially been integrated into STEM education, which is an acronym that stands for the academic disciplines of science, technology, engineering and mathematics collectively. This paper reviews the trends and challenges of technology education as well as STEM education in Hong Kong.

The concept of sustainability has sparked intense international debates since the early 1980s. Governments and non-government organizations all over the world have become aware of and expressed concern about the future of the mankind. The discourse took a pause when a common description of sustainable development was agreed: sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. The discussions about how sustainability can be achieved across a community however never stop.

Different cities empathize different areas and set out different ways for approaching sustainable development. In consideration of the strategic direction of Hong Kong, three areas were identified to exert impacts on the city's sustainable development. They are namely solid waste management, renewable energy and urban living space. Extra efforts are paid on these three areas in order to achieve sustainable development in the city.

One of the most crucial meanings of education is to empower people to contribute to environmentally sound sustainable development through their lives and careers. Whatever sustainable development is conceptualized, there is always a general agreement that education plays an essential role in this issue. As reported in the literature, theoretical perspectives of three areas: value position, nature of the proposed responses and structure of the proposed responses towards the issue, provide a clear interpretation of sustainable development. Launching education for sustainable development (ESD) through technology education is highly preferred because it has the particular capabilities for developing a moral value and solving authentic problems by using practical solutions and innovation designs. This paper discusses overseas experiences on establishing ESD based on technology education, and describes two case studies in the context of STEM education about promoting green design and green products which were suggested in the literature that they are highly effective to the future ESD.

Trends of Technology Education in Hong Kong

Technology education as a field of study was widely recognized by the end of the 1980s but the inclusion of technology education in the secondary school curriculum began much earlier. The teaching of traditional technical subjects in schools in Hong Kong can be traced back to as early as the 1920s (Feng, 2012). As a British colony at that time, the local education system was primarily modelled on that of the United Kingdom. Technology education at that time was mainly, formally offered at the secondary level. The title of these technical subjects, e.g. woodwork and metalwork, revealed that students at that time were only required to acquire simple technical skills and gain basic work experience for the preparation of earning for their own. Besides, the curricula of most traditional technical subjects in Hong Kong were copied directly from those used in the earlier days in the British schools, and had not been revised for many years.

In the late 1970s, Hong Kong economy undertook a major transformation, from manufacturing industry to services industry. To adapt to the changed economy, in the education system, a subject of different nature called Design and Technology (D&T) was introduced at that time to the junior secondary level as an attempt to get out of the traditional craft-based and skill-oriented subjects. This subject incorporates higher order design element into the local technology education curriculum, focuses on the thinking process and involves more design and problem solving components than any traditional technical subjects did. The intended learning outcome of this subject is that by the end, students should be able to obtain technological literacy through the development of design and technological understanding, knowledge and capacity, communication and problem-solving skills, and awareness of the relationship among design, technology and the society (CDC, 2015).

D&T provides a new direction in learning and a new learning environment for students such that they can have more chances to practise problem-solving skills. The reinforced subject of D&T, called Design and Applied Technology (DAT), was later made available for the senior secondary students. The success in developing D&T and DAT triggered the reconstruction of the other traditional technical subjects and the development of new technical subjects containing more design and problem-solving elements in the early 1980s. However, there was no more major modification in the local technology education over the following 20 years.

Challenges of Technology Education in Hong Kong

Before the year of 2000, all the technical subjects in the local technology education curriculum still remained using outdated teaching materials and teaching methods. The situation had a change in 2000. In order to match up to another economic transformation towards a financial centre, the "Reform Proposal for the Education System in Hong Kong" prepared by the Education Commission of the Hong Kong Government proposed that all the subjects in the curriculum should be reorganized and categorized into Key Learning Areas (KLAs) (CDC, 2015). Technology education is one of the KLAs.

Table 1 shows the existing technical subjects in the technology education curriculum at the secondary level in Hong Kong.

Table 1. Technology education at the secondary level in Hong Kong (CDC, 2015)

Junior secondary (Secondary 1-3)	• Automobile Technology • Business Fundamentals • Catering Services • Computer Literacy • Design & Technology • Design & Technology (Alternative Syllabus) • Design Fundamentals • Desktop Publishing • Electronics & Electricity • Fashion Design • Graphical Communication • Home Economics/ Technology and Living • Retail Merchandising • Technology Fundamentals
Senior secondary (Secondary 4-6)	• Business, Accounting and Financial Studies • Design & Applied Technology • Health Management and Social Care • Information and Communication Technology • Technology and Living

For junior secondary level, the latest curricula of the technical subjects in the local technology education were released in 2000 and implemented in the same year while those of the senior secondary level were released in 2007 and implemented in 2009, with minor updates in 2015. It is worthwhile to note that for D&T, the schools have a high degree of freedom to follow the curriculum of the 1983 version or that introduced in 2000. The objectives of the latest D&T curriculum at the junior secondary level are to help students to develop technological awareness, literacy, capability and lifelong learning patterns (CDC, 2015). The curriculum can broadly be divided into four areas of learning: nature and impact of technology for yesterday, today and tomorrow, tools and machines of technology, resources of technology, and design and communication. As for DAT at the senior secondary level, the objectives of its latest curriculum issued in 2015 are to provide students with fundamental knowledge and skills in design and technology and to cultivate them the attributes of innovation and entrepreneurship necessary to face the rapid social, economic and technological changes in a knowledge-based economy (CDC, 2015).

Over the past 30 years, technology education in Hong Kong has changed from skill-based teaching to teaching and learning for a balanced development of technological capability, understanding and awareness. Technology education provides broader chances to cultivate students' initiative, creativity, problem-solving skills and practical design competence. Technology education has developed to a high level between 1970s and 2000s in Hong Kong (Volk, 2003), but in the recent decade, the shift of the economy to finance and banking has caused technology education to struggle in a difficult situation. Besides, technology education is not officially offered as an independent curriculum at the secondary level in Hong Kong. Neither D&T at the junior level or DAT at the senior level nor any other technical subjects in the current technology education curriculum is recommended to be compulsory in the local secondary education system. Technology education in some local secondary schools has started to be cut back, suspended or closed, which leads to a significant decline in the number of students studied in the technical subjects. Today, only half of the local secondary schools offer D&T and less than 40 schools offer DAT (Feng, 2012). A comprehensive review of technology education in the local curriculum is therefore in great need.

STEM Education in Hong Kong

In Hong Kong, currently, there are eight KLAs in the school curriculum, namely Chinese language, English language, mathematics, science, technology, personal, social and humanities, arts and physical education. Every student should gain a balanced exposure in all these eight KLAs (CDC, 2015). However, when an educational system cannot satisfactorily achieve its goals, government and citizen groups will call for an educational reform.

In order to maintain the international competitiveness of and create opportunities for Hong Kong in national developments, the Hong Kong government is currently actively promoting innovation and technology across the city (CDC, 2015). Talents with different capabilities, at different levels are required to fulfil and contribute to the economic, scientific and technological developments of the city and the country. Although Hong Kong students perform well in science, technology and mathematics in international competitions, it has been criticized that they may focus only on individual disciplinary studies but not evenly participate in hands-on activities in schools. On the one hand, the current education curriculum may have failed to arouse all the abilities of students to solve daily life problems. On the other hand, it is widely agreed that knowledge learnt through the school subjects of science, technology, engineering and mathematics are most useful for people to live their everyday lives. Thus, a pedagogy, developed based on technology education and combined with science, mathematics and engineering education, is currently in need to strengthen the abilities of students in integrating and applying their knowledge and skills that they have learnt from different academic disciplines to provide practical solutions and innovation designs for their daily life challenges (CDC, 2015).

In 2015, when the school curriculum is under review, STEM education is notably introduced. The promotion of STEM education in Hong Kong is in alignment with the worldwide education trend. STEM refers to four subject disciplines, namely science, technology, engineering and mathematics. The differences between STEM education reform and other educational reforms rest upon three key factors: (i) STEM education responds to the worldwide economic challenges that many nations face; (ii) STEM education recognizes the demand for STEM literacy for solving the worldwide technological and environmental problems; and (iii) STEM education gives emphasis to the necessary knowledge and workforce skills required in the 21st century (Bybee, 2013).

The main objective of STEM education is to nurture students to equip with necessary knowledge, generic skills, values and attitudes in order to meet the increasing changes and challenges, and become effective lifelong learners. STEM education in Hong Kong is specifically intended to promote students' interest and develop their capacities to innovate by enhancing their creativity and problem-solving skills, through integrating and applying knowledge and skills across disciplines in solving real problems and promoting good citizenship. It also assists students' further studies and career planning, and allows teachers of different KLAs to work closely to enhance the overall learning and teaching effectiveness together. It is hoped that by adopting STEM education in local schools to nurture diversified talents of different capabilities can enhance the international competitiveness and social and economic development of Hong Kong.

STEM education is currently being highly promoted among schools in Hong Kong in a holistic and coherent manner through a variety of strategies, such as renewing the KLAs in the existing curricula of science, technology and mathematics education, enriching students' learning activities, strengthening project and experiential learning, providing teaching and learning resources, enhancing the teachers' professional development, partnering with key players in the community, and conducting reviews while disseminating good practices.

Besides, when promoting STEM education, five basic principles were identified by the Government for schools to follow. The ideas of these principles are summarized as follows: Each school is directed to build up on its own strength to provide students with STEM-related learning activities, diversified learning, teaching and assessment strategies in the way of continuous development process to answer students' needs and interest, where the learning activities and teaching strategies are most appreciable if they can balance the purposes, views and interests of the students and teachers and provide learning opportunities beyond classroom to the students so as to form a part of the essential student learning experiences (CDC, 2015b).

While STEM education is going to be adopted in local schools, five common confusions about STEM education must be highlighted: (i) it is not equal to a single scientific investigation; (ii) it is not equal to a single mathematics, science or technology competition; (iii) it is not equal to simply applying technology in the teaching of science or mathematics; (iv) it is not only suitable for a small group of elite science or mathematics students; and (v) it should be taught in an integrated, cross-circular manner, not just within the individual STEM subjects (Dugger, 2010).

The promotion of STEM education in Hong Kong started in 2015. It should take longer period of time to observe whether the outcomes of this new pedagogy can be effectively achieved.

Technology Education and Sustainable Development

Technology education is suggested to be an effective method of vocationalizing schooling. It is understood as developing an individual's capabilities and competences to empower the individual for his/ her future employment. One of the key features that appears to be common across technology education is the emphasis on problem solving.

Human has been living beyond the carrying capacity of the planet. Continuous degradation of the environment is adversely affecting the growth and development of our world. The future of the mankind and the quality of life for future generations are under threat. The concept of sustainable development emerged in the early 1980s as an attempt to bridge the gap between environmental concerns about the increasingly evident ecological consequences of human activities and socio-political concerns about the persistence of human development (Robinson, 2004). Measures are required to deal with this immensely important problem.

Education can make a significant contribution to the promotion of sustainable development. Sustainability is often described in curriculum documents as an issue that is intended to be integrated within design projects and activities, rather than being a lesson topic in a classroom (Middleton, 2009). Owing to the particular emphasis on problem-solving skills, in the recent decade, the issue of sustainability has been linked with technology education.

Pavlova (2009) studied the theoretical perspectives on sustainable development under three key areas: value position, nature and structure of the proposed responses towards the sustainable development issues.

When interpreting sustainable development comes to value position, the first question is often whether human should put more emphasis on human or the nature. There are frequent debates on philosophical and moral concepts of appropriate methods to conceive of the relationship between human and the nature. Huckle (2005) criticized that ecocentrism, i.e. the environmental ethics that human should live with reference to the nature, romanticizes the nature outside the society and fails to recognize that only human can value things; while if anthropocentrism, i.e. the environmental ethics that the nature should be used and managed, is too strong, it will allow the exploitation and oppression of the nature by treating it instrumentally or only as a means to human. Pavlova (2009) suggested that a weak anthropocentric approach that promotes mutual flourishing of human and the nature should be adopted as the value position to conceptualize sustainable development in order to provide a basis for education for sustainable development (ESD) via technology education.

As for the nature of the proposed responses towards sustainable development, Robinson (2004) identified two major approaches, i.e. technical fix and value change. It was highlighted that these two approaches of responses should be conducted in parallel. One major reason is that although technology has plenty of positive features for achieving sustainability, technological advancement is a subject of profitability. In economics, the Jevons Paradox teaches us when technological progress increases the efficiency with which a resource is used, reducing the amount necessary for anyone use, but the consumption rate of that resource rises due to the increasing demand. It is easily understood that achieving reductions in the environmental impacts of an economic activity does not necessarily translate into improvements in human living quality. The major goal of the responses to sustainable development is to achieve optimal performance by using the technological problem-solving skills with a change of the value learnt from technology education.

The responses towards sustainable development may contain several common goals or themes. With regard to the structure of the proposed responses, Pavlova (2009) responded to the three key areas of concepts for ESD, as identified in the International Implementation Scheme for the United Nations Decade of ESD, which are society, environment and economy. The three concepts establish the framework of ESD. Since these elements comprise an ongoing and long-term process of change in knowledge, skills, moral values, attitudes and behaviours, it is worthwhile to remark that achieving sustainable development is a dynamic action.

Theoretical perspectives that include value position, nature and structure of the proposed responses provide a clear interpretation of sustainable development. A weak anthropocentric approach together with an emphasis on value change and the issues on the ever-changing society, environment and economy build up the nature of ESD. Technology education which has the particular value and design and problem-solving components can effectively contribute to ESD. Currently as technology education is fused into the STEM education in Hong Kong, a coherent and cross-curricular approach across all STEM subjects can be adopted in local secondary schools for ESD.

Overseas Experience on ESD

The need to integrate ESD into technology education has taken on a new priority internationally in recent years. Governments of many countries in the world are working hard to include ESD in their curriculum documents. This paper overviews the experiences of the governments in Australia, Ireland and Sweden on promoting sustainable development through technology education.

Currently, there are two syllabuses about technology being used in Queensland, Australia (QSA, 2007). Both syllabuses have the requirements of delivering some ESD elements to the students. The junior students are required to work technologically and consider appropriateness in the social, environment and economic aspects before adjudicating on the sustainability of their design ideas, the processes and the products as well as their possible impacts on the users or the environment. During the process, appropriate knowledge, practices and attitudes can be developed in the students. This syllabus provides teachers with an opportunity to introduce the basic ideas of sustainable development. However, no guidelines on the concept about appropriateness leads to no mechanism to evaluate the education effectiveness of the teachers and students on ESD. This situation was criticized that in the context of the outcome-based education, the majority of teachers would not pay much attention to the sustainability aspect of the syllabus (Pavlova, 2009).

In the Irish education system (IESD, 2006), younger students study in the Junior Certificate programme, in which four technical subjects are elective. Material Technology, Technical Graphics and Metalwork do not have any element about technology and society. The remaining technical subject Technology was developed as a combination of the other three technical subjects but having a strong emphasis on the design and problem solving skills. The concern on the relationship between technology and society also features the syllabus. As for the senior level, the technical subject Technology and Society provides a context in which students can explore and appreciate the impact of past, present and future technologies on the economy, society and environment. Critiques however appeared around the Irish technology education. It was argued that although the focus of the technical subjects has moved from a craft-based model to a design-based model, simple passing-on of traditional knowledge and skills to students remains. Students are not required to understand the content (Owen-Jackson, 2000). While Technology and Society shows awareness of the environmental issues, the other subjects appear to operate without a real understanding about the complex economic and social effects that shape the technological development. The absence of a focus on these effects of technology on sustainable development across the suite of the Irish technology education also highlights a significant failure in ESD (McGarr, 2010).

In the current Swedish school curriculum, ESD is a requirement (SNAE, 2011). It is highlighted that every person working in the school should encourage respect for the intrinsic value of each person and the environment. In the Swedish education system, environment is one of the four perspectives, which states that teaching should illuminate how the functions of society and our ways of living and working can best be adapted in order to create sustainable development. Three goals in the curriculum are sustainability or a sustainable development approach. It is mentioned that the school is responsible for ensuring that each student on completing compulsory school has obtained knowledge about the prerequisites for a good environment and sustainable development. Sustainable development is explicitly written out as an important element in the syllabuses of eight subjects. In the subject of Technology, for example, its goal is clearly related to sustainable development: students should be given the preconditions to develop confidence in their own ability to assess technical solutions and relate these solutions to sustainable development. However, this curriculum of ESD also has shortages. It was criticized that knowledge about sustainability in the Swedish technology education is vague and teachers are mainly aware of the ecological and environmental aspects of sustainability but less on the social or economic parts (Inga-Britt, Gumaelius and Geschwind, 2013). Besides, the implementation process of ESD was complained since decisions and directives of ESD is taken at the organizational level with few chances for teachers to influence the what, when and why of ESD.

In looking back at the experience of integrating ESD into the school curricula in Australia, Ireland and Sweden, four strategies for developing ESD successfully in Hong Kong are proposed, (i) an audit should be conducted on the syllabuses of all the technological subjects to avoid sustainability blind spots; (ii) the assessment methods should align constructively with the intended learning outcome and the nature of the learning activities to enrich ESD learning experience; (iii) professional development opportunities should be offered to teachers for ESD; and (iv) a constant evaluation mechanism for ESD is needed (McGarr, 2010) .

Suggested Learning Strategies in the Context of ESD

The importance of ESD can be addressed via STEM education in Hong Kong. Case studies are usually good starting points for students to understand, analyse and brainstorm solutions for a daily life problem. Learning activities in ESD suggested in the literature for realizing green strategies and technologies are described.

Various problem-solving strategies can be used in the green design. Advanced Systematic Inventive Thinking (ASIT) is one of the strategies, which contains five tools: unification, multiplication, division, breaking symmetry and object removal.

A case study was proposed about a management company requiring a sustainable design to solve the problem of disposing sewage. Students can propose their own solutions to the above challenges with the basis of the knowledge they have learnt from the STEM subjects. For example, students can combine the knowledge learnt from Science with the ASIT tools of unification and division to assign worms a new use to break the sewage down to become humus. Students can combine the knowledge learnt from Technology with multiplication tool to slightly modify the existing worm farm technology to minimize the use of energy consuming power machines or probably toxic chemicals but deal with the sewage naturally. They can use the knowledge learnt from Engineering to speed up the rate of natural transformation. They can also use the knowledge learnt from Mathematics to determine the reduction of daily running costs, the negative costs to the environment as well as the ongoing maintenance costs. This ESD of green strategies in this way will create a win situation for all the parties, customers, students and the environment.

Different criteria for green product design have been developed all over the world, such as Datschefski's five principles of designing sustainable products, which require: (i) the products are made from organic materials and is recyclable or compostable; (ii) the products should use solar energy or other forms of renewable energy during manufacture and use; (iii) the products must be non-toxic in making, use and disposal; (iv) the products should consume less materials, energy or water; and (v) the products should be made under fair and just operating conditions for the workers and the communities involved.

A case study was proposed about an industry which recognizes the challenges posed by energy shortages, climate change and the necessity for energy efficiency in buildings. A green product is needed to reduce the energy consumption of the industry. Similarly, students can propose their own solutions to the above challenges with the basis of the knowledge they have learnt from the STEM subjects. For example, students can use the knowledge learnt from Science to identify, source and use new and more efficient materials for the green product to reduce energy consumption. They can use the knowledge learnt from Technology to design the green product to consume renewable energy instead of fossil fuel energy and consume less materials and water. They can use the knowledge learnt from Engineering to improve the energy efficiency of the green product. They can also use the knowledge learnt from Mathematics to evaluate the effectiveness of energy saving by using their green product across the industry.

At the end of the ESD class, teachers can introduce more methodologies of assessing environmental impacts of the existing and new products, e.g. Life Cycle Analysis (LCA). When LCA is applied in the ESD teaching, issues such as energy and water consumption, toxic emissions, transport problems and the health and safety of users and workers can be further discussed (Pavlova, 2009).

Conclusion

There are three aims of this paper: (i) to review the development and challenges of technology education and STEM education in Hong Kong; (ii) to study the overseas experience in integrating ESD via technology education into their school curriculum; and (iii) to describe some case studies that were proposed in the literature about the adoption of STEM education in promoting ESD.

Technology education began in the 1920s in Hong Kong. By integrating higher order design element into the curriculum, technology education becomes a part of general education for our students. In alignment with the global education trend, the local Government is pushing STEM education. Besides, sustainability calls for the global concern. Hong Kong has established a strategy direction for mitigating a number of environmental problems. Human resources with different capabilities at different levels are required to help to achieve sustainability in Hong Kong. Literature reveals the support of theoretical perspectives on sustainable development under value position, nature and structure of the proposed responses on technology education for its contribution to ESD as it provides a set of clear priorities for teaching and learning. Therefore, a coherent and cross-curricular approach across all STEM subjects can be adopted in local secondary schools for ESD.

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EVALUATION OF PROBLEM-BASED LEARNING TO SELF-MOTIVATION USING CUSTOMER SATISFACTION ANALYSIS

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Abstract

One-way type classes have long been emphasized in Japanese educational practice. To promote voluntary learning among students, problem-based learning (PBL), an active learning method, is regarded as being more educational than conventional classes. Several lecturers have adopted PBL-based assignments recently. Nevertheless, the outcomes of such approaches for PBLs apparently depend on both the lecturer and the class. It remains unclear whether all PBLs are educational and effective for students. Methods for quantitative evaluation of the educational value of PBL are also poorly established.

This study assessed the effects of a PBL-based assignment on students' motivation and outcomes by sampling a PBL-based assignment in a Food Engineering class at the National Institute of Technology, Miyakonojo College. This PBL-based food engineering assignment for groups (3-4 individuals per group) was conducted as one of the learning content. The assignment included studies of interesting food processing, preparation of a presentation about that food processing, and presentation in a class workshop. In addition to hearing other presentations in the workshop, students were instructed to evaluate other presentations according to certain evaluation criteria. This evaluation was intended to foster students' critical thinking through critical assessment of other presentations. After the workshop, a questionnaire survey was administered to elicit responses related to the challenge and meaningfulness of this assignment for students. To evaluate the effects of the assignment statistically, data from the questionnaire were subjected to customer satisfaction (CS) multivariate analyses.

Questionnaire analyses reveal that most students have experienced presentation-based classes several times in years 4–5 at this college. Results also indicate that they regarded other presentations as beneficial for themselves for future presentations and that they expected comprehensive classes including PBL-based assignments rather than one-way type classes. Although presentation-based assignments yielded qualitatively demonstrative benefits to students, the CS analysis clearly reveals that having the opportunity for a presentation itself was more important for students' effort and motivation than anything else. Considering questionnaire survey results, CS analysis is useful for quantitative evaluation of the PBL assignments. It can provide statistical verification of them.

Keywords: *educational style, active learning, presentation, critical thinking, statistical analysis, multivariate analysis*

Introduction

One-way type classes, during which students passively receive information from a teacher (Prince, 2004) via traditional lectures, have long been emphasized in Japanese education practice. Unfortunately, student learning retention rates by lecture are only 5%: far less than active learning methods such as discussion and practice by doing (Lalley & Miller, 2007) (Fig. 1A). Active learning has received adequate attention recently because it is regarded as being more educational than traditional classes (Yamaji, 2014) (Fig. 1B). To promote voluntary learning among students, several active learning methods including flipped classroom using e-learning (Hayashi et al., 2013), problem-based learning (PBL) (Ishii et al., 2011; Kawaijuku, 2011), and project-based learning have been tried (Sumino et al., 2011; Ohnaka, 2012). Actually, PBL-based assignments have been adopted in several classes. In practice, the outcomes of such approaches for PBLs apparently depend on both the lecturer and the class. Moreover, it remains unclear whether all PBLs are educational and effective for students and how the educational values of PBLs are evaluated quantitatively.

The author conducted a PBL-based assignment in a Food Engineering class at the National Institute of Technology, Miyakonojo College. The assignment included studies of interesting food processing, preparation of a presentation about that food processing, and presentation in a class workshop. This study investigated the effects of a PBL-based assignments on

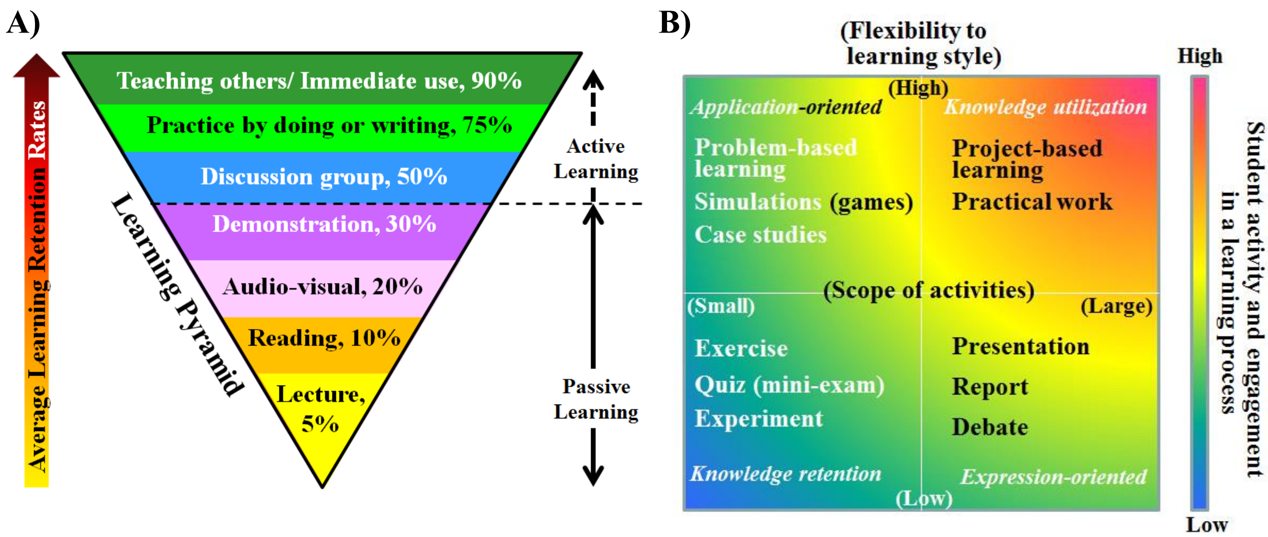

Figure 1 Instruction style and student engagement in a learning process. (A) The graph is a learning pyramid modified from an earlier report of the literature (Lalley & Miller, 2007). (B) The relation between scopes of activities and flexibility to learning style in a learning process was modified from an earlier report of the literature (Yamaji, 2014).

student motivation and outcomes by sampling the PBL-based assignment in a Food Engineering class. After the workshop, a questionnaire survey was administered to elicit responses related to the challenge and to assess meaningfulness of this assignment for students. To evaluate the effects of the assignment statistically, customer satisfaction (CS) multivariate analyses were applied to questionnaire survey data. Results reveal that students expected comprehensive classes including PBL-based assignments rather than traditionally one-way type classes. Moreover, CS analysis is useful for the quantitative evaluation of PBL assignments.

Pedagogy and Methods

PBL-based assignment: A PLB-based assignment was given to students of the Food Engineering class, taught by the author, at the National Institute of Technology, Miyakonojo College in 2014 and 2015 academic years. The numbers of students who took the class in 2014 and 2015 academic years were respectively 19 and 29. This assignment for groups (3-4 individuals per group) was conducted as learning contents of this class. The assignment included (1) studies of interesting food processing, (2) preparation of a presentation about that food processing, and (3) a presentation in a class workshop.

Critiquing other presentations in the workshop: In addition to hearing other presentations in the workshop, students were instructed to evaluate other presentations according to the following evaluation criteria: 1, abstract format of a presentation abstract (including figures and tables); 2, abstract contents; 3, quality of figures and tables; 4, presentation technique toward audiences; 5, visibility of their presentation slides such as font size and quality of figures and tables; 6, clear presentation and explanation; 7, punctuality of presentation time; and 8, adequate responses to questions from the audience.

Questionnaire survey after the workshop: After the workshop, a questionnaire survey was administered to elicit responses related to the meaningfulness and challenge of this assignment for students. The questionnaire survey asked students the following questions: 1 (designated as Q1), their experience of presentation-based classes at this College; 2 (Q2), their experience of reviewing other presentations; 3 (Q3), a question about whether students regarded other presentations as beneficial for themselves for future presentations; 4 (Q4), their preference for comprehensive classes including PBL-based assignments relative to one-way type classes; and 5 (Q5), the necessity of critiquing other presentations. Students responded to Q1-2 with “yes” or “no”, while they did Q3 with 3-grade evaluation or Q4-5 with 4-grade evaluation. Here, the answers for Q3 were “no benefit”, “beneficial for themselves”, and “beneficial as a negative example”. Moreover, this questionnaire survey allowed students multiple answers to the decision branch for Q3. Those decision branches for Q4-5 referred to Figure 3.

CS analysis for statistical evaluation of the questionnaire survey results: To evaluate the effects of the assignment statistically, data from the questionnaire survey were subjected to CS multivariate analysis, a data analysis method used to assess customer satisfaction using a several-point scale for store operation, business management, and product development in a marketing field. Data from Q3–5 above of the questionnaire survey were used for CS analysis in this study. Each answer for Q3, for instance, was categorized into three types: 0 points for the answer “no benefit”, 1 for that “beneficial as a negative example”, 2 for that “beneficial for themselves” and 3 for both “beneficial as a negative example” and “beneficial for themselves”. Each answer for Q4-5 was also categorized into four types: 0 points for the answer “strongly disagree”, 1 for that “disagree”, 2 for that “agree”, and 3 for that “strongly agree”. Scores 2-3 were regarded as positive answers in this CS analysis.

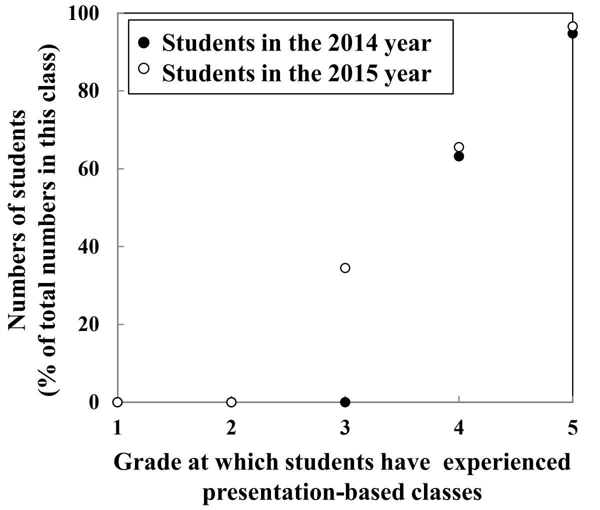

Figure 2 Student experiences of presentation-based classes. This is based on the result of Q1 in the questionnaire survey.

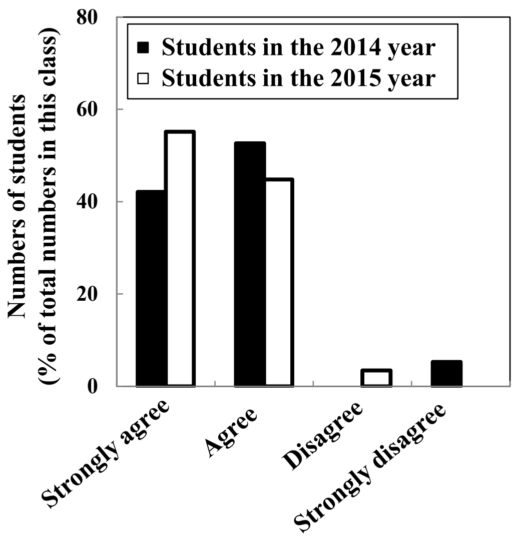

Figure 3 Student desires for learning processes. Students answered the question of whether they prefer comprehensive classes including own presentation such as PBL-based assignments rather than only the traditional lecture. This is based on the result of Q4 in the questionnaire survey.

The student scores for Q3-5 were calculated. The degree of importance and satisfaction derived from each question item was evaluated. It is shown graphically in Fig. 4.

Results and Discussion

Although active learning has received adequate attention for promoting voluntary learning among students, it is difficult to assess educational outcomes. This study was conducted to evaluate the educational values of PBLs for students using the questionnaire survey qualitatively and CS analysis method quantitatively. The questionnaire analysis (Q1) reveals that most Food Engineering class students had already experienced presentation-based classes several times during years 4–5 at this college (Fig. 2). In addition to their presentation in the workshop, students critiqued other presentations. This was intended to foster students' critical thinking through critical assessment of other presentations. The questionnaire survey results (Q2) reveal that students had experienced evaluation of other presentations (data not shown). Questionnaire survey results (Q3) also indicate that they regarded other presentations as beneficial for themselves for future presentations including a presentation for their graduation work (data not shown). Some students considered others' presentation styles and methods of presenting figures as good references. For others, for instance, presenters speaking from their notes gave a bad impression. Consequently, the behaviour was regarded as a negative example for other students. Moreover, the results (Q4) show that they clearly expected comprehensive classes including PBL-based assignments rather than just a traditional lecture (Fig. 3). Students, more than 80% of them, tended to respond positively about the necessity to critique other presentations (Q5) (data not shown).

Voluntary learning among students is apparently related with student satisfaction level to each educational method. To elicit responses related to the challenge and meaningfulness of this PBL-assignment for students, results from Q3-5 were subjected to the CS analysis (Fig. 4). The degree of satisfaction of the PBL assignment and the importance, which were correlation factors between each student's total scores and each factor from the questionnaire survey, were estimated

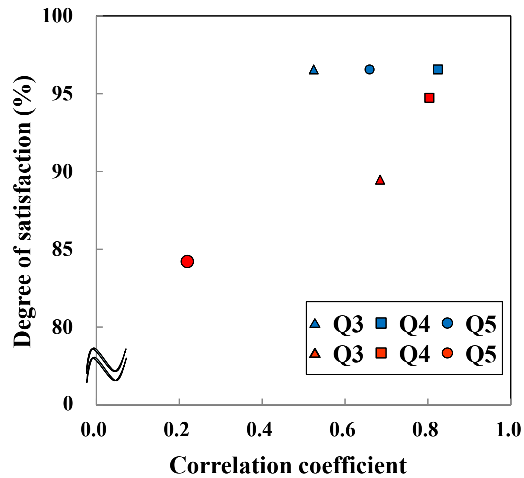

Figure 4 Results of CS analysis derived from a questionnaire survey (Q3–5) about PBL assignments. The degree of satisfaction of students with the PBL assignment about each question item from the questionnaire survey was estimated. The correlation coefficient between each student's total scores and each question item was calculated concurrently with the estimation of student satisfaction level about each question item.

respectively. Factors related to both Q3 and Q4 have a high rating for both the satisfaction and the importance of the PBL assignment. In contrast to the results from Q3 and Q4, the factor related to Q5 was split on both evaluations, particularly the importance (correlation coefficient) rather than the satisfaction, from students in the 2014 and those in 2015 (Q5 in Fig. 4). In addition to that presentation-based assignments yielded qualitatively demonstrative benefits to students (Q3 in Fig. 4), the CS analysis clearly reveals that merely having the opportunity for a presentation itself was more important for student effort and motivation than anything else (Q4 in Fig. 4).

A flipped class (Hayashi et al., 2013; Shigeta, 2014) has received more attention than other active learning typed-classes including PBL. The flipped class demands preparation using e-learning such as web schooling to students. The flipped class spends regular classroom time on related practice or higher-level education such as case studies and PBL. Consequently, the flipped class no longer spends classroom time on lecturing. Seeing the flipped class from other viewpoints, the class requires an educational situation in which both the teacher and all students become fully conscious of learning, irrespective of the student's habits of study in advance for the next lesson. The presence of students, who fail to prepare for the class and forget to do so, might trigger the flipped class to fail. Moreover, those students eventually fall behind others in the class. In contrast to the flipped class, a PBL-typed class, which this study also adopted, must spend some regular classroom time on lecturing and the remainder on PBL. Even if some students maintain a low level of consciousness related to learning, a teacher can manage a PBL-type class and also teach in flexible ways.

Even if a teacher decides what kind of educational method to use, it is important to evaluate the effects of the selected method and to perceive student's satisfaction level with the method. Although we can vaguely understand each student's behaviour and tendency from questionnaire surveys, which are a classical and standard approach, it is difficult to quantitatively ascertain the students' satisfaction level solely from questionnaire approaches. As a result of the application of CS analysis to this PBL-based assignment and the questionnaire survey, this study has demonstrated that CS analysis is useful for quantitative evaluation of the PBL assignments and that CS analysis can provide statistical verification of them.

This study adopted CS analysis to evaluate the effects of the PBL-based assignment. This study, however, included no plan to conduct CS analysis at the beginning of this study. For this reason, limited question items (Q3-5) in the questionnaire survey were subjected to CS analysis because other items were unsuitable for CS analysis. Therefore, the number of evaluation items might be insufficient for CS analysis. Adequate question items for CS analysis are also needed. At any rate, more evidence is necessary to validate the potential benefits of CS analysis properly to evaluate educational methods including active learning methods.

Conclusions

The PBL-based assignment as one of active learning methods was conducted in the Food Engineering class. This study evaluated the educational effects of the PBL-based assignment on students using the questionnaire survey and the CS analysis. This study reveals that students expected comprehensive classes including PBL-based assignments rather than one-way type classes. In addition to understanding student's behaviour and tendency qualitatively from the questionnaire approach, CS analysis is a workable method to quantitative evaluation of the PBL assignments. Thus, CS analysis can provide statistical verification of them.

Acknowledgements

This study conducted the questionnaire survey to students, which attended the Food Engineering class at the National Institute of Technology, Miyakonojo College in the 2014 and 2015 years. The author thanks the students for willingly consent to answer the questionnaire survey.

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EXPERIENCES OF TEACHING ENGINEERING AND ENGLISH IN COLLABORATION

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Abstract

The purpose of this paper is to study how the change in pedagogical principles has influenced the teaching methods of engineering studies and English communication with respect to first and second year IT students. Information Technology Degree Programme at Helsinki Metropolia UAS adopted a curriculum reform in 2014 and introduced team learning and student collaboration as well as team teaching in order to improve learning outcomes. Several studies have argued that foreign language communication skills, especially English skills, play a more significant role in today's working life. For example, an increasing number of technology companies use English as their working language and employees are expected to be able to not only read complex professional texts but also analyse them with insight.

The data for this study was gathered by analysing video recordings of team teaching and observing students' project presentations and writing process. Academic writing outcomes as well as other written assignments were evaluated from both language and content point of view by the teacher team. Students were also asked to give feedback on the English lessons.

Although the focus on English courses has already for years been on communicative competence and skills needed in working life, the change in the pedagogical approach was noticeable. The preliminary results suggest that the team-based approach to teaching engineering and English communication resulted in improved learning outcomes. Especially the students with weaker English skills succeeded better in their learning assignments than they did with conventional teaching arrangements due to the support of their team members and the teacher team. The presence of a multi-disciplinary teacher team clearly motivated the students to work harder on the assignments. Especially project presentations, practicing formal meetings and focused customer communication as well as the job application process were taken more seriously. Since feedback was received from the teacher team, the structure and content of the presentations and the reports clearly improved. Another significant finding was that not only did the students benefit from team teaching but team teaching provided an opportunity for the teachers to learn from one another.

Keywords: *Curriculum reform, team teaching, engineering, English communication*

Introduction

Although team teaching as a pedagogical method has been used for decades in Finnish comprehensive schools, it is not very common at university level. In 2014 Finnish Ministry of Education declared that team teaching should be used systematically throughout comprehensive school classes 1-9 from the beginning of 2016, because as a method it provides a pedagogically flexible, versatile and efficient learning environment (Opetushallitus 2014). In 2014 Metropolia UAS Information Technology Degree Programme adopted a curriculum reform and introduced team teaching in order to improve learning outcomes. The new curriculum was made quite flexible and teachers were given resources to enable joint teaching sessions.

This study aims at analysing how teaching engineering and English in collaboration and integrating language studies with professional ICT studies such as software development and web design, affect student performance. The study describes two team teaching implementations and compares team teaching with the more traditional way of teaching where a teacher is alone in the classroom with students. We also discuss the benefits of team teaching from teacher point of view and reflect on how team teaching has affected our way to plan the lessons, teach and evaluate student assignments. The research was conducted among first and second-year international and Finnish students at Helsinki Metropolia UAS.

Background

Because foreign languages are an essential part of working life competence for engineers (Charles and Marchan-Piekkari 2002; Huhta et al. 2006; Kantelinen and Airola 2009), they have traditionally been included in Finnish curricula in higher education. At university level students are taught that they should be able to communicate in English globally (cf. the goals for language learning presented in CEFR; Council of Europe 2001). Native speaker competence is not the ultimate goal anymore. Some interview studies carried out among employees of Nordic multinational companies (Millar and Jensen 2009) corroborate that indeed one does not need perfect language skills or sound like a native; it is enough to be able to communicate effectively in working life situations in an international environment.

The curriculum reform at Helsinki Metropolia UAS in Finland which started in 2014 has meant significant changes for teaching English and all other subjects as well. Previously the starting point was that each teacher is solely responsible for his/her courses. Teachers taught their courses and evaluated student work mostly alone. After the curriculum reform, there can be 4-6 teachers working and teaching in collaboration during an 8-week module. Also, the structure of the whole course module is different than before. In the old system, English courses were 3 credit units whereas now they are integrated into a 15 credit unit module. One module consists of engineering studies and so called general subjects such as mathematics, physics, Finnish and English. The teachers who are responsible for the module share responsibility for planning the module, monitoring student progress and evaluating student work. (For a more detailed discussion on the reform, see Hjort et al. 2015; Lukkarinen et al. 2015 and Vesikivi et al. 2015).

The new modules as well as student and teacher reactions have been described at least in three studies. Vesikivi el al. (2015) found out that significantly more students had completed 30 ECTS credits or more by the end of the first term of their studies. Hjort et al. (2015) and Lukkarinen et al. (2015) suggest that students were quick to adopt teamwork skills. Also, the students became quickly independent and were able to meet new challenges without much teacher intervention.

Material and Methods

This paper discusses two implementations of team teaching. In the first one, two English teachers analyse their experiences of teaching English together. In the second study teachers of engineering and English discuss their collaboration when English was integrated with two engineering courses, Application Development Methods and Software Structures. In both studies we wanted to focus on how the new pedagogical principles of Metropolia UAS have influenced the teaching methods.

We decided to use ethnography as a research method. Hammersley and Atkinson (2007) describe the key features of ethnography as follows:

1. Ethnography studies real rather than experimental social situations / events.
2. According to the ethnographic method, data may come from various sources such as participant observation, informal conversations and documentary evidence.
3. In ethnographic methodology, what will be studied has not been decided beforehand. Whatever catches the researcher's interest, is worth studying.
4. In an ethnographic study, there does not have to be a large amount of data because the purpose is in-depth study of a certain group.
5. Ethnographic study does neither focus on quantitative nor statistical analysis. The data is typically interpreted and explained by the researchers.

The joint sessions of the English teachers were video recorded to observe teacher collaboration and student response. The analyses of all the other joint sessions are based on field notes and student feedback. The findings presented in subsequent chapters are based on what we noted about our own behaviour as well as student behaviour in the data.

Research: Teaching English in Collaboration

In the first study two English teachers experimented with teaching together during an 8-week module called IT Orientation in September 2015. The course is intended for first year international students of Information Technology at Metropolia UAS. The purpose was to investigate the curriculum reform at Metropolia UAS just as Hjort et al. (2015), Lukkarinen et al. (2015) and Vesikivi et al. (2015) but from a language and communication point of view.

The module yields 15 credit units for students and the topics included English, Finnish, mathematics, photo-editing and software programming languages. Our students came from over 12 countries such as Nepal, Vietnam and Russia. All of them had completed secondary education and some also had university level studies. All students had studied English for several years but their skills varied a lot.

At the Metropolia UAS we have agreed on dealing with the following topics during the English classes with the first-year ICT students: presentation skills, job application documents and academic writing. The topics that we chose for our joint English sessions were important for an international group of first-year students: **integrity and honesty in academic writing and the job application process** in Finland and Europe. The joint sessions were video-recorded by another member of the teacher team.

Videos: For this study two English teachers analysed their collaboration during two joint English lessons. The topics of the lessons were academic integrity and applying for a job. We started the lesson about academic honesty by asking the students how they understood plagiarism. The discussion showed that different practices exist and many students were eager to tell what is considered as acceptable in their home countries. Since we had students from so many different cultures, the discussion was very interesting. After that we went through the conventions of our university which are similar to the practises commonly adopted in Europe (Swales and Feak 2004). We also had a workshop on a plagiarism prevention service called Turnitin used at Metropolia UAS and many other Finnish universities (Turnitin 2015).

The second lesson dealt with writing a CV and a cover letter for a job application. The students were divided into groups of 3-6 based on their nationality and linguistic background. We wanted to have students with as similar background as possible in the same group. This was important because we asked the students to demonstrate how a proper job application is written in their home countries. After each group presentation there was a lively discussion about the different ways of contacting an employer. It was interesting for all of us to see how different we are in terms of formality/informality and power distance. For example, according the Vietnamese students, a job applicant should not mention that he/she knows more about something than the employer. In contrast, the European students emphasised the importance of being self-assertive. The student presentations were followed by our lecture on Finnish and European conventions.

Discussion

For us these two lessons were the first were have ever held together with another English teacher. Even though we planned the lessons carefully beforehand, we still needed to learn in practise how to work together in front of the students. What added to our nervousness was the fact that the lessons were being video-recorded by a third member of the teacher team and later shared with all the teachers and students of this module.

In addition to describing our observations of the lessons we held together, we decided to analyse our collaboration through the recordings. We noticed that at the beginning of the lesson we kept to the roles and work division we had previously agreed on and although we established plenty of eye contact, there was little dialogue between us. Towards the end of the lesson when we were starting to feel more relaxed, there was a lot more dialogue. Another observation was that first both of us mainly communicated with the students but gradually we began to interact with each other and we even started to complete each other's speaking turns. The third teacher in charge of the video recording also began to participate in the conversation and we began to involve him. As a consequence, the students had a chance to hear three teachers' views on the same topic such as plagiarism. In hindsight, there could have been more dialogue from the beginning between the teachers.

Research: Teaching Engineering and English in Collaboration

The purpose of the second study was to find out how two second-year engineering courses, Application Development Methods and Software Structures and Models, could be integrated with an English course on Project Writing and Presentation Skills. The teacher team consisted of two English teachers and six engineering teachers. The implementation was carried out during two 8-week study periods in spring term 2016. Both international (23) and Finnish (13) IT-students participated in these courses and English was the language of instruction.

The course content and assignments for the both 8-week implementations were planned together with the engineering teachers and the English teachers. The idea was to have one joint 4-hour session once a week. The topics chosen for team teaching on the first course were **project presentations, practicing formal meetings and writing formal emails**. The second course focused on **writing an academic report** based on professional technical articles selected by the teacher team. The students were reminded that all these assignments would be evaluated by the whole teacher team.

Project plan: The purpose of the Application Development Methods course was to expose students to a typical process of designing and implementing an application that has a web user interface. For this purpose students worked both on individual assignments and, more importantly, on a small project in teams of three. Each group had to come up with a clear and concise project plan.

Each group made several project phase products, such as user persona descriptions, project plan, project presentations, and a final report which were evaluated from both language and content point of view. The evaluation of the phase products took place in a meeting room where two project groups gathered simultaneously with the English teacher and the engineering teacher. Altogether there were 6-8 students and 3 teachers present during the evaluation and feedback sessions.

The project plans and user persona descriptions were assessed during two team teaching sessions. Each session lasted for 45 minutes. The first drafts of the assignments varied a lot in quality. Some groups had almost finalised their work and produced thorough project plans written in good report style. However, some groups failed to produce any kind of written plan mostly due to poor team working and communication skills.

These were the first joint sessions for us teachers and we were all eager to contribute. As a teacher team, we were able to give effective feedback to each group from several points of view. When the project plans and user persona descriptions were shown on a large screen, all the teachers immediately started to correct errors both in language and content. Consequently, students were able to sort out multiple errors in a short time. There was a lot of dialogue and interaction between us teaches, for example we debated about the structure and content of the assignments. Based on our experience we would like to argue that academic debate between teachers in the classroom can be a positive thing; it encourages students to participate in discussions and learn how to argue for their opinions.

Presentations: When evaluating student presentations, the engineering teacher's long experience of giving and listening to presentations in working life proved valuable. He was able to spot weaknesses in the structure of the presentations and point out how to sound more convincing. In other words, he gave quite honest and pointed feedback on how a real client would react to each group's presentation and what should be done to improve content, delivery, and engaging the listeners.

The English teacher paid more attention to language use, but also delivery. Since presenting in front of an audience is quite stressful for many students, we all shared our experiences of feeling nervous during presentations and gave tips how to feel more calm and confident.

Business writing: Students practised writing formal style business letters such as a letter of apology for different recipients. They also practised negotiation skills and having formal project meetings. The purpose of these exercises was to prepare the students for working life and also pay attention to cultural differences in business writing conventions. Once again, it was interesting to discuss together how different we are in terms of formality/informality and directness/indirectness, for example in greetings and salutations. We also talked a lot about power distance which can be seen as an important cultural concept.

Written assignment: academic report: The final project in engineering studies is a written thesis. In order to prepare students for academic writing conventions well in advance, we required them to study one selected article each. Moreover, the students were instructed to search for at least three additional reliable sources and write a 3000 word formal style report based on the source material. We told the students that the teacher of engineering would grade the content and the English teacher the language of the reports. The students were instructed to upload their reports on the plagiarism checking service Turnitin which was already introduced to them during their first English course at Metropolia UAS (Turnitin 2015).

The students varied a lot in their English skills and were, therefore, given several opportunities for extra tutoring by both teachers. Some students took the opportunity to learn how to improve the grammar and style in their reports. Quite a few needed help with paraphrasing, in-text referencing and how to indicate sources in the list of references.

We decided that both the engineering teacher and the English teacher would read and grade the reports together because we wanted to discuss their content, style and grammar simultaneously. The reports were clearly better than expected; in several reports the language, structure and conventions of an academic report as well as content were of excellent quality. We were pleased to see that none of the students had plagiarised their text; all reports were properly paraphrased from source material. In other words, the students had absorbed the reference material and done their own thinking.

Results and Discussion

It seems that the presence of a multi- disciplinary teacher team which has expertise in both content and language made students work harder on the assignments. Also, the new curriculum offers possibilities for team teaching because of its flexibility.

Integrating English with engineering studies: In addition to analysing collaboration between English teachers, we found the collaboration between the teachers of engineering subjects and the integration of English into engineering subjects fruitful. As already pointed out, the IT Orientation course, its English lessons and course tasks were planned together. The students were told from the beginning that each task will be reviewed by the whole teacher team and that there is a common goal. To give an example, the students were asked to compile their up-to-date CV. The English teachers were interested in how well the students could communicate about their background and skills. The students were also asked to upload the CV to their homepage which they created with one of the professional teachers using HTML. What is more, each student included in the CV his/her portrait photo that had been taken and photo edited with the professional teachers. From a language point of view, this collaboration paid off. The students provided better quality CVs. The same phenomenon could be seen with other tasks that were assessed by several teachers.

Another benefit turned out to be an increased student retention rate. During the old curriculum sometimes only half of the students had completed all their English assignments by the end of the course. Several students used to submit the compulsory tasks even 2-3 years late. During the new curriculum only a few students had not completed all their assignments by the end of the English course. Also, no student failed to submit the remaining assignments by the end of the term. This finding clearly suggests that students take their tasks more seriously and engage themselves better when there are several teachers dedicated to one course. This finding is in line with Hjort et al. (2015), Lukkarinen et al. (2015), and Vesikivi et al.'s (2015) observations.

Conclusion

The purpose of this study was to analyse and describe our experiences of teacher collaboration and the integration of English and professional studies during a module aimed at first and second-year ICT students at Helsinki UAS in Finland. This was important because Metropolia UAS has undergone a major curricular reform in order to, among other reasons, increase the number of students who complete their studies and graduate with a Bachelor's degree. Because the reform meant substantial pedagogical changes for teachers and students alike, it has been important to evaluate the outcome.

First we analysed sessions which the two English teachers taught together and which a third member of the teacher team recorded. The analysis was based on video recordings of the sessions and our field notes. One difference with a traditional classroom setting with one teacher was that now we could provide the students with multiple views on the same topic. We believe this benefitted our students who have various cultural backgrounds and different learning styles. This was interesting as we have different teaching styles and typically emphasise slightly different angles. These joint sessions gave us all fresh ideas and served as a learning experience.

Secondly this study described collaboration between English teachers and teachers of ICT subjects. The course tasks we gave to the students were planned and evaluated together. Compared to our previous experiences of separate tasks for separate subjects, it was evident that the students now took the combined tasks more seriously. We were quite pleased to see that none of the second-year students had resorted to plagiarism when writing the academic reports. What is also noteworthy is that apart from one or two exceptions all the students submitted all tasks and passed the module by the end of the term. This is quite an achievement keeping in mind that the students had very different English proficiency levels.

In conclusion it can be argued that team teaching improves student motivation and learning outcomes. Because the students worked harder, the content and structure of their presentations and reports were clearly better compared with those before the curriculum reform. Finally, team teaching as a method has allowed us teachers to learn substantially from each other.

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EDUCATION OF PRACTICAL ENGINEERING SKILLS AIMING FOR SOLVING REAL PROBLEMS RELATED TO LOCAL AREA

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Abstract

The Department of Electrical and Computer Engineering in National Institute of Technology (NIT), Maizuru College offers practical engineering education that teaches how to utilize skills to contribute to local area in cooperation with local society. Based on investigation of real society, the students propose solutions to problems related to local area by fabricating prototypes using their electrical and information engineering skills in the lecture. For example, the students have developed a special controller for electric wheel chair with support from Maizuru Rehabilitation Center for Crippled Children. The prototypes fabricated by them actually contribute to solving the problems related to local area because the five-year course education system of NIT makes it possible for the students to develop advanced electronic devices and software for practical use. The involvement of the students in activities with local institution and city government has encouraged them to learn more diligently, and taught actual development process of devices and software related to regional contribution.

Keywords: *engineering education, practical skill, regional contribution, welfare, tourism*

Introduction

National Institute of Technology (NIT) is a higher education facility in Japan which fosters engineers with advanced practical skills and creative ability through a five-year course starting after graduation from junior high school. The five-year course makes it possible to design an effective curriculum which includes a wide range of engineering education from basic to advanced level. For example, in the department of electrical and computer engineering in Maizuru College, which is one of 51 colleges of NIT, the subjects of electrical engineering and those accompanying experiments and practical training are introduced in the first year in addition to liberal arts. The engineering education begins with very basic contents assuming low level mathematical skills of first year students. In the five-year course, the students achieve learning of advanced contents such as design and manufacture of electronic control system, measurement of properties of electric devices, producing of computer programs for various purposes, and so on. After completing the five-year course, the students acquire an ability to work as electrical engineers in a company.

The department of electrical and computer engineering in Maizuru College educates the students about the manufacturing skills in the subject “Creative Engineering” (Fukumura and Tange, 2009; Funaki, Tange, and Mihara, 2012). The subject requires the students to develop prototypes of electrical devices and/or software which propose a solution to a problem presented by a teacher. The students incorporate their creative ideas in the prototype with originality and ingenuity. Until three years ago, problems which the students addressed were chosen from general engineering or scientific issues. For example, the students assembled the inexpensive parallel computer while taking into account the budget to solve the problem with calculation speed of numerical simulation. One of the most important points in the lecture is the choice of the problems by the teacher. Although certain results were achieved by the lecture, further consideration to choice of problems is thought to be important in ensuring the students more interest in manufacturing.

NIT has 51 colleges which are located in various parts of Japan. One important mission of NIT is to provide the education/research results which is closely connected with the location of each college. There are a lot of examples of research which contribute to local area by solving the problems related to local area (Hama, Kobayashi, 2009; Satake, Tsukayama, Kamisato, and Noguchi, 2010). However, it is very difficult to contribute to local area directly by educational activity. The department of electrical and computer engineering in Maizuru College has been developing relationships with the local governmental agency, some local institutions and companies to provide the students with the opportunities for effective lecture in practical skills. In the lecture of the subject “Creative Engineering”, the problems which are solved by the students have been changed to those which are related to those agencies, institutions or companies so that the problems are more concrete than former ones. In the subject "Creative

Engineering", the students aim for solving real problems related to local area by fabricating prototypes which contribute to solving the problems using their practical engineering skills. The students can investigate the real problems related to local area by visiting those agencies, institutions or companies. In the development process of prototypes which are fabricated to propose the solution, the students can also investigate the feedback of real users to improve their prototypes. The student's proposal contributes actually to solve the problems related to local area because the students have advanced electrical and information engineering skills by the five-year course education of NIT. We provide very effective education of practical skills by making the students concern with real society.

This article reports the details of effective education of practical skills via the lecture of the subject "Creative Engineering" which is taught at the department of electrical and computer engineering in Maizuru College. The disability aid and the vitalization of local area (Maizuru-city) were chosen as the problems which the students addressed. The students developed the prototypes of support devices for disability person and the prototypes of electronic devices for vitalization of local area to propose the solutions to the problems. In the development process, the students visited Maizuru Rehabilitation Center for Crippled Children and Maizuru city government to investigate the problems and to obtain the feedback. The students have acquired the practical skills effectively by being contact with the local society, and have contributed to solve the problems related to local area.

Learning goals of the subject "Creative Engineering"

In the lecture of the subject "Creative Engineering", the students learn how their engineering skills contribute to local society. The small-group teams, each of which consists of four or five students selected at random, propose the solution to the problems related to local area. The significance and unique feature of the lecture is that the students are involved with real local society and collaborate with those. The students develop prototypes of electronic devices and/or software using their advanced engineering skills to solve the problems. The five-year course curriculum of NIT, starting after graduation from junior high school, allows the students to develop the advanced and practicable devices and/or software. The lecture is also effective for the contribution to local area as well as for the education. The details of the learning goals of the subject "Creative Engineering" are as follows.

< Educational goals >

1. The students are able to understand the development process (planning, design, prototype, survey, improvement, evaluation), which is started from investigation of the problems and is ended by completion of the devices and/or software, through involvement in local society.
2. The students are able to contribute to local society using their engineering skills.
3. The students are able to integrate their broad knowledge of electricity and information and to utilize those to fabricate devices and/or software.
4. The students are able to communicate and cooperate with group members to achieve project.

< Contribution to local society >

1. The proposals to solve the problems related to local area are advanced after the lecture by continuing the development of devices and/or software in the graduation work, and the achievement contributes to local area.
2. The development of collaborative relationships with local governmental agency, some local institutions and some companies contributes to the establishment of technological assistance system for local society.

Learning structure of the subject "Creative Engineering"

▪ *Lecture plan*

The subject "Creative Engineering" is designed for the fourth year students of the five-year course. The classes are scheduled once a week. There are 15 classes in half a year.

< 1st, 2nd week >	Explanation of the problems related to local area. Group discussion.
< 3rd week >	Presentation of the proposals to solve the problems.
< 4th to 12th week >	Fabrication of devices and/or software.
< 13th week >	Poster presentation. Demonstration of devices and/or software.
< 14th,15th week >	Report writing.

The teachers also give the students guidance about activities outside of school hours. The students visit local governmental agency, some local institutions and companies to investigate the details of problems related to local area after class or at convenient time for the destinations. The preparations for each classes by the voluntary effort of the students are required to proceed with the fabrication and their activities smoothly.

Although two or three teachers of the department of electrical and computer engineering in Maizuru College mainly teach the students, all teachers instruct the students in engineering technique in their respective specialized fields. In the fabrication process the students seek technical advice from the teacher familiar with the problem which they face.

▪ *Field investigation and proposal to solve the problem*

The students address the problems related to local area based on the investigation in real society. The students visited Maizuru city government and Maizuru Rehabilitation Center for Crippled Children. Maizuru Rehabilitation Center for Crippled Children is a public institute which teaches the skills required for independent living to the children with disabilities, such as cerebral palsy, spinal cord injury and hip joint disorder. The students investigated the problems related to sightseeing and public park in the visit to Maizuru city government. They also investigated the problems related to electric wheel chair for children in the visit to Maizuru Rehabilitation Center for Crippled Children. The investigation in real society encourages the students to learn the method to utilize their engineering skills for contribution to local society.

The students identify the problems based on the investigation, and make a presentation on how to solve the problems related to local area by fabrication of electronic devices and/or software. All student teams and teachers discuss about the proposals which solve the problems. After the review of the proposals by the teachers, the students can set a goal properly with consideration of their skills, the budget and the fabrication period, and can begin design of electronic devices and software.

- *Fabrication of the prototype*

The budget and fabrication period are restricted to make the students consider a schedule for fabrication. The budget is restricted to ¥5,000 (about $48) because the students are only required to fabricate simple prototypes to show their ideas. Actual fabrication is restricted to being executed at the laboratory so that the students fabricate the prototypes for just the time the laboratory is available. The students have to consider their plans of development. Some teachers teach practical fabrication skills in the laboratory in addition to giving advice outside the laboratory.

- *Poster presentation of proposal and prototype*

The students make poster presentations on the results of fabrication of prototypes, and explain details of their proposals to solve the problems related to local area in addition to the details of their activity. As shown in Figure 1, the students demonstrate how their prototypes solve the problems related to local area. The examples of posters are shown in Figure 2. The students prepare two A1 size posters for the presentation.

Figure 1 Poster presentation in the subject "Creative Engineering"

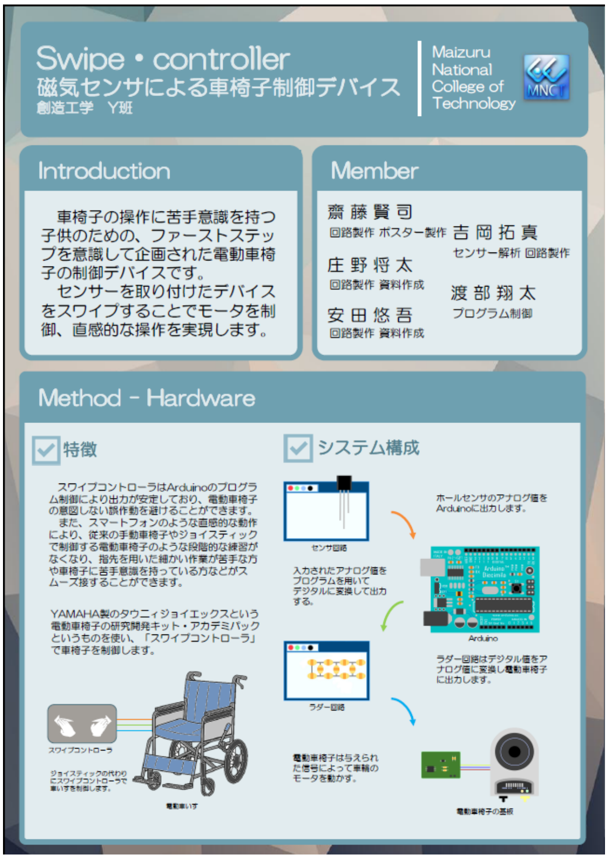

Figure 2 Example of posters in presentation of the subject "Creative Engineering"

Grading of the subject "Creative Engineering"

The activity in the fabrication process, the poster presentation and the report are graded. The students are evaluated with a focus on group activity except for the report.

The students are required to show their proposal and target achievement in the poster presentation. Although the high quality prototypes are not required, those have to be able to demonstrate how those work to solve the problems related to local area, and have to have functions enough to explain their proposal and their target achievement. The students are graded with a focus on their proposal because the development of the prototypes is taken over by fifth year students of the five-year course to work toward practical use of the prototypes in the subject "Graduation Work".

- *Grading for fabrication (group activity)*

In addition to giving technical guidance, all teachers grade the group activities of the students in the laboratory in which the students fabricate the prototypes. Cooperativeness, role and responsibility, positive attitude, planning, comprehension, originality, technical skills, and so on are graded.

- *Grading for poster presentation*

In the poster presentation the teachers ask the students from many different perspectives about their proposal. The teachers grade the posters (format, content, intelligibly), the prototypes (technical skill, originality, accomplishment) and the presentation skills (comprehension, clarity, attitude).

- *Grading for report*

All students are required to submit the report individually after the poster presentation. Some teachers grade the reports based on content (intelligibly, clarity), organization (proposal, planning, achievement, explanation of prototype, test results, future tasks), format, and observance of deadline.

Educational results of the subject "Creative Engineering"

- *Examples of prototypes*

In 2014 and 2015 the students proposed 11 solutions to Maizuru city government and seven solutions to Maizuru Rehabilitation Center for Crippled Children. The examples of the proposals which solve the problem related to the regional tourism and the electric wheel chair for handicapped children are reported below.

< The proposal solving the problem related to regional tourism >

"Decorative illumination placed in public space"

Maizuru city government needed a huge display which is placed in front of Higashi-Maizuru station and which illuminate night town. As shown in Figure 3, the students made the huge decorative illumination which illuminate about 20-square-meter of land. They had to take into account snow because it is installed in winter and it snows in our area.

Figure 3 Decorative illumination placed in front of Higashi-Maizuru station

"The Stamp Rally using NFC"

One of the problems related to regional tourism in Maizuru-city is that many sightseeing places are not introduced sufficiently. If many tourists would visit many sightseeing places in Maizuru-city, Maizuru city government could expect benefits from tourism. The students developed the "Stamp Rally" system for a smartphone to resolve the problem. The "Stamp Rally" is a Japanese game which participants collect stamps placed at various spots. Examples of the stamps are shown in Figure 4. Usually "Stamp Rally" uses special paper sheets to collect stamps but preparation and management of sheets and stamps are bothersome. The students replaced sheets and stamps with smartphones and Near Field Communication (NFC) tags. Participants collect stamp images stored in NFC tags by touching their smartphone to NFC tags. Figure 5 shows the screen of smartphone which the application program is executed. The stamp image (Figure 4(c)) is displayed at the location of the tag on the map of application program.

(a) (b) (c)

Figure 4 Stamps for "Stamp Rally"

Figure 5 Application software of "Stamp Rally" for smartphone

< The proposal solving the problem related to electric wheel chair for handicapped children >

"Swipe Controller for Electric Wheel Chair"

"Swipe Controller for Electric Wheel Chair" is the controller for the children who cannot use usual joystick controller because of the trouble in hand. Figure 6 shows the "Swipe Controller for Electric Wheel Chair". Even if children have a trouble in hand, they can use the "Swipe Controller for Electric Wheel Chair" because they can control an electric wheel chair only by putting their hand above the surface of the "Swipe Controller".

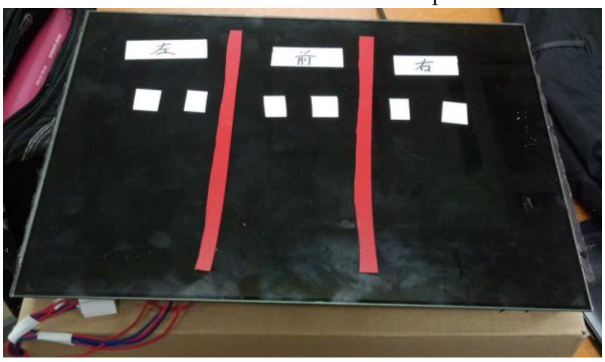

Figure 6 Swipe Controller for Electric Wheel Chair

The controller consists of a single-board computer (Arduino), magnetic sensors, and so on. Some magnetic sensors are arranged under the surface cover. As shown in Figure 7, we can control the electric wheel chair by putting the magnet above the surface of the "Swipe Controller". In the figure he puts the magnet on left side of the controller so that the electric wheel chair turns to the left.

Figure 7 Usage of "Swipe Controller for Electric Wheel Chair"

- *Demonstration Outside Campus*

In 2014 the prototype of electric wheel chair controller was shown at "Kids Barrier-free Festival" and "Welfare Festival in Maizuru" by the students. Those exhibitions were held in Maizuru city under the cooperation of many related organizations and companies. Many handicapped people, their families and welfare service workers attended the festivals, so the students were able to collect valuable information for practical use of their prototypes. As shown in Figure 8, the students were interviewed by local newspaper.

電動車いす 乗りやすく
舞鶴高専生 子ども向けに改良

舞鶴工業高等専門学校（舞鶴市白屋）の学生たちが、病気や障害のある子どものための電動車いすの改良に取り組んでいる。このほど市内で行われたイベントで子どもたちが乗り心地を確かめた。

文部科学省「地（知）の拠点整備事業」の一環で電気情報工学科の4年生が府立舞鶴こども療育センターと協力して開発している。

子ども向けの福祉機器展示会「キッズバリアフリーフェスティバル」（まいづる姿勢の学習会主催）で、車いすの試乗が行われた。操縦レバーを電車の運転台型にしたり、磁石入りのリストバンドをかざすだけで操縦できるようにしたりしており、子どもらが実際に乗って操作した。

開発メンバーの樋口拓海さん（19）は「突然動きだすのが怖いという意見があったので、ゆっくり加速するようにした。きょうの子どもたちの声を、今後の開発に生かしたい」と話していた。

（芝田佳浩）

舞鶴工業高等専門学校の学生たちが改良した電動車いす（舞鶴市浜・市商工観光センター）

おことわり 31日から1月2日までの休日トクターは30日付に掲載しています。

Figure 8 Article on student's activity in "Kids Barrier-free Festival"

As shown in Figure 9, many prototypes were shown also in open campus (open house) of our college by the students. Many junior high school students and their parents attended the open campus (open house). The students got a good opportunity for describing the prototypes from engineering view point because the participants in the open campus (open house) have a strong interest in engineering. The participants were able to know our education about practical engineering skills specifically by talking directly with the students educated in our college.

Figure 9 Student's activity in open campus (open house)

Those activities are very effective for teaching the method to utilize their engineering skills for contribution to local society. One of the most important points related to the education is that those activities encourage the students to learn more diligently.

- *Evaluation of lecture by students*

The evaluation of the lecture by the students is shown in Table 1. The students evaluated their achievement from the viewpoints of problem-solving skills, problem analysis ability, planning skills, ability to utilize knowledge, and presentation skills. The satisfaction with the lecture has been high. The students have been satisfied with being involved with real society in the process of fabrication of prototypes. They were able to learn sufficiently about the development process of electric devices and/or software, and able to propose the solutions to the problems related to local area by fabricating devices and/or software using their electrical and information engineering skills. They have actually felt the value in their engineering skills.

Table 1 Evaluation of achievement by students

Evaluation items	satisfied	neutral	dissatisfied
problem-solving skills	58.6%	42.4%	0.0%
problem analysis ability	42.4%	57.6%	0.0%
planning skills	66.7%	27.3%	6.0%
ability to utilize knowledge	54.6%	42.4%	0.0%
presentation skills	57.6%	33.3%	9.1%

Review of the subject "Creative Engineering"

- *Relationships with local society*

Cooperation of local governmental agency, some local institutions and companies is essential for the lecture. They offered the students valuable opportunities to relate to real society, so the students were able to propose practical solution to the problems related to local area through learning the method to utilize their engineering skills for contribution to local society. The proposals by the students in the lecture need further discussion so that local governmental agency, some local institutions and companies adopt those as practical idea. Some students should continue the development of prototypes in the subject

"Graduation Work" to contribute to resolving the problems related to local area.

- *Budget for lecture*

Electric wheel chairs were needed to develop controller. Two electric wheel chairs were provided by Kami Electric Corporation which is located near our college, and the others were purchased by the grant of "KYOTO KOSEN COC Project". If we developed more practical devices and/or software, the more budget would be required.

- *Grading*

Group activities, poster presentation and report were graded based on our evaluation sheets. The sheets have enough items to grade each skill but Rubric has not yet been introduced.

Conclusions

The department of electrical and computer engineering in Maizuru College educates the students about manufacturing skills in the subject "Creative Engineering" aiming for solving real problems related to local area. In the lecture the students learn how to contribute to local society using their engineering skills. They propose solutions to the problems by developing the prototypes of devices and/or software using their expertise in electrical and information engineering. The development, which is executed in cooperation with local society, teaches process (planning, design, prototyping, feedback, improvement, demonstration) to the students. The collaboration with local governmental agencies, local institutions and companies is effective for the education of regional contribution and practical skills. It is a very valuable experiences for the students to visit local governmental agency, some local institutions and companies to investigate the real problems related to local area, to collaborate with them to solve the problems, and to realize significance of regional contribution.

Some student's proposals to solve the problems are advanced to put prototypes to practical use by continuing the development of devices and/or software in the graduation work, and their achievement will actually contribute to solving the problems. The education also plays an important role in regional contribution because all colleges in NIT aim to contribute to local area where each college is located.

Acknowledgements

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DEVELOPMENT OF PROFESSIONAL COMPETENCIES IN POLYTECHNIC STUDENTS USING AN AUTHENTIC LEARNING STRATEGY IN THE HUMAN RESOURCE IN ACTION MODULE

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Abstract

To prepare students for the workplace, the polytechnics have to design curricula and adopt innovative teaching and learning strategies to make a difference to student learning outcomes. One of these is authentic learning. This paper describes how authentic learning was applied in the design of the Human Resource in Action (HRA) module to prepare students for work when they graduate from the polytechnic. In this module, students worked in groups of 5 to 6 to complete a real HR-related project for a company (also known as "the client"), which had specific deliverables determined by the client and students. The tutor and the client took on a coaching role to provide guidance and feedback throughout the semester to support student learning and to achieve the project outcomes. Students were assessed using defined criteria on the final deliverables and professional competencies by the tutor and the client. These together with the students' reflection journals showed that professional competencies, such as planning and organising skills, communication skills, collaboration, result orientation, analytical thinking and creativity, can be imparted and their importance emphasised through an authentic project that allowed students to be actively involved in their learning. Their involvement in a real-world project also led them to develop an interest in the subject matter and be responsible for their learning journey.

However, the development and implementation of this authentic learning experience does have its challenges. These included issues relating to assessment reliability, the client's readiness to coach, the tutor's workload and time pressure for the students to complete the tasks that met the client's expectations.

To further enhance the authentic learning experience for the students in the HRA module, there are plans to include deeper engagement with the industry partners in coaching and assessing the students and a review of the teaching load or tutor-student ratio to achieve optimal learning for the students.

Keywords: *authentic learning, real-world project, and professional competencies*

Introduction

Twenty-first century organisations are becoming more demanding places to work in because business is not always stable and sustainable, and jobs are becoming less defined and the workplace is constantly presented with uncertainty. To remain employable and appealing to multiple employers, employees have to possess 21st century skills that will enable them to engage in jobs that emphasise expert thinking or complex communication. These 21st century skills also include cross-disciplinary skills and competencies, such as communication, problem-solving, co-ordination skills, interpersonal skills (Garrick and Clegg, 2000) that will enable employees to collaborate with colleagues, not only with those in the same office location but also with peers who may be half way across the globe.

Confronted with a demanding workplace and uncertainty in the global market, the pressure is on higher education institutions to prepare students for work. A set of discipline-specific skills will not be sufficient because they get obsolete quickly in an increasingly knowledge-driven economy. The role of higher education institutions has to focus on students' employability and to kick-start their work readiness when they graduate. This is because employers expect the work-ready graduates to be competent in their specific discipline and be able to operate in ambiguous situations (Barrie, 2006; Bowen, Hart, King, Trigwell and Watts, 2000).

Business schools have to redefine their curricula to enhance student learning and adopt pedagogical methods, which will enable students to master the 21st century skills faster and allow for improved quality of learning. Learning activities must also allow students to transfer their learning to real world situations and measure their ability to interpret, analyse and synthesise information.

Purpose of Paper

This paper describes how authentic learning was applied in the Human Resource in Action (HRA) module at the School of Business and Accounting (BA) at Ngee Ann Polytechnic (NP) to prepare students for work when they graduate from the Polytechnic, and the professional competencies that they had acquired in performing authentic tasks that reflected the real world.

Literature Review on Authentic Learning

Authentic learning is a pedagogy that focuses on real-world issues where students are introduced to tasks that reflect genuine problems faced by experienced professionals at the workplace (Lombardi, 2007). It is a strategy that enables students to make connections of their classroom learning to real-world situations. This pedagogical approach provides a platform for students to acquire knowledge in the classroom and apply it to real-life tasks related to their professional fields (Donovan, Brandsford, and Pellegrino, 1999).

Many educational researchers have advocated the use of authentic learning in higher education to develop students' competencies through the integration of knowledge into real-life issues. The pedagogy has been used in many disciplines, including physics (Murphy, Lunn, & Jones, 2006), and product development (Hey et al, 2007). Adopting the authentic learning approach provides powerful learning environments for students to interact with rich contexts and authentic tasks, engage them in active, deep, independent and collaborative learning. Such an approach supports knowledge construction as students are required to construct knowledge rather than reproduce information that is taught to them in the classroom.

To maximise the benefits of authentic learning, Reeves et al (2004) suggested that the learning tasks must have real-world relevance, are ill-defined and include a number of sub tasks and complexity. The learning experience should also provide students the opportunity to investigate the tasks from different perspectives, allow students to collaborate and reflect, yield an end product that includes more than one iteration, and allow for competing answers or solutions, integrate across different subject areas, and include integrated assessment.

When adopting authentic learning, the role of the tutor has to change to that of a coach who will act as a sounding board, a facilitator, a counsellor and an awareness raiser to assist the students to deepen their learning and confidence. This practice is acknowledged as important for enhancing learning and the development of learners. Metzler (2000) argued that coaching will “promote more student thinking and creative exploration by posing questions and problems to students rather than telling (or showing) students how to move in a certain way”. Coaching is also an effective instructional strategy in developing problem solving, creativity and critical thinking skills (Entwistle, 2000).

Design of an Integrated Curriculum in HRA

The HRA module is taken by Year 3 students who specialise in the Human Resource Management Option in the Diploma in Business Studies. The pre-requisite for students is that they must have successfully completed four core HR modules, namely Compensation Management, International Employment, Industrial Relations and Training & Development before they are enrolled for HRA.

HRA is designed with the aim of providing students with an authentic learning experience to develop critical professional competencies and essential HR functional skills in a real-world setting.

The HRA curriculum incorporates a combination of Dewy’s cognitive processes orientation and Bruner’s self-actualisation orientation curriculum development principles. The cognitive processes orientation allows students to process and apply HR content into a real-world project and in so doing, they are able to use problem-solving and decision-making strategies to find solutions to address the issues on hand as well as develop their critical thinking skills. These cognitive skills are essential in one’s career because they are transferable in a wide variety of settings. Bruner’s self-actualisation orientation curriculum principle provides students with rewarding experiences to enhance their personal development because they are required to reflect how they have developed their professional competencies. It also aims to increase students’ awareness of workplace expectations. A curriculum that emphasises on practical application of concepts engages the students in deep analysis and critical thinking (Chonko, 1993).

The curriculum development is done in consultation with staff in the HRM section of BA, analysing feedback data from students, as well as learning from colleagues’ experiences in conducting an experiential module. There is also close engagement with employers and professional bodies to ensure current professional competencies and desired personal attributes are included into the curriculum. The competencies include planning and organising, communication, collaboration, analytical thinking, result-orientation, job-focused learning, creativity, and conflict management. These competencies are critical for a 21st century education, and educators are expected to develop students who can manage complexity, uncertainty and value conflicts (Dehler, Welsh and Lewis, 2001).

Authentic learning and coaching strategies are used to develop the professional competencies and HR functional skills by having students work on HR-related projects, such as recruitment and selection, training and development, manpower planning, and employee benefits. The tasks are self-directed, reflective and relevant to the students because students apply what they have learnt in the classroom to a real-world assignment in a company. The assessments in HRA focused on the “how to”, as well as the “what” and the “why”. The assessments help students build their confidence and interest in learning because the entire process emphasises the relevance of their learning to their employability rather than assessing on memorised theories and concepts.

Teaching Approach in HRA

There are no lectures and prescribed textbooks for the students in this module. Students are assigned four hours each week in their timetable to work on the project, which can include meeting the company or consultation with the tutor. An estimate of another two hours per week is required outside the timetabled hours for students to work on the project. The students are given 12 weeks to complete the project.

Students work in groups comprising 5 to 6 members each to complete a project of their choice from a list, which has been prepared by the tutor who has secured these projects from the industry. The tutor will also ensure that the project scope is manageable to be completed within the given timeframe and the assessment requirements meet the academic rigour and learning outcomes of the module.

In addition to the project work, students are also required to attend workshops, which are used to facilitate discussions on students' development and progress on the project. These workshops are less formal and encourage dialogue between the tutor and the students where the tutor takes on the role of a coach, a facilitator and an expert resource to guide and support each group as they progress with the project. During these dialogue sessions, the tutor promotes creativity and self-discovery among the students, and gets students to reflect on their development of their professional competencies.

Methodology

A study was undertaken to review the use of authentic learning in HRA to evaluate its effectiveness of learning and the development of critical professional competencies.

This study involved 17 students who took the HRA module. The 17 students were divided into three groups, comprising 5 – 6 students in each group. Each group worked on a different project for 3 different companies. Each group worked with the company (also known as "the client") to agree on the final deliverables and timeline. The students were assessed on an individual basis as well as a group by the tutor and the client on the final deliverables and the professional competencies.

For the purpose of this study, the tutor worked with the client in each company to observe and record observations of the students' behaviours at all the interactions. Students' reflection journals were also used as data points to validate the tutor and the clients' observations.

The qualitative data analysis was performed using thematic analysis. The analysis began by a coding phase to identify emergent themes and to search for commonalities and uniqueness (Tesch, 1990). After the coding phase, information with similar meanings was organised into more comprehensive themes.

Feedback from the module experience survey (MES) was also used as another source for data analysis. The MES examines students perception of their learning experience and has both quantitative and qualitative data.

Outcomes of Authentic Learning

After examining the data from the students' reflection journals, comments from the tutor and client's records, four themes related to authentic learning emerged. They were deep learning, enhanced collaboration skills, improved communication skills, and greater emphasis on professionalism through real-world experiences.

(1) Deep Learning

Deep learning was achieved through the project because the students participated actively at every stage of the learning process. The active learning process motivated students to learn and be interested in their own development because they were mentally challenged, and they were able to learn from various parties (the client, the tutor and their group members). Permanent learning can be achieved when students learn by doing the tasks and draw on their knowledge in other modules to support their learning outcomes.

The study showed that 14 students (out of 17) mentioned that the project had helped them apply their HR knowledge to a real-world situation and this had motivated them to think in depth about the practical application of concepts learned in the classroom. They also learned to set standards and measured them against the expected standards of the clients which drove them to take ownership of the project to make improvements if the standards were not met. This aspect of learning allowed them to hone the *Result-Orientation* competency which the module aimed to develop in the students.

The real-world project also gave students the ability to intelligently apply their functional knowledge to practice. At every stage of the project, students were assessed on their higher-order thinking skills because they were required to analyse and evaluate the suitability of the information to the issue on hand. At times, they were also required to create solutions by combining different pieces of information to present a coherent option to address a specific need in the project. Throughout the process, the students were able to hone their *Planning and Organising* competency, and develop their *Analytical Thinking* competency.

The following statements illustrate that the students were able to make connection with their learning to the real world:

- *I can see a connection between what I have been taught by my tutors and what is required in an organisation. My tutors always reminded us that HR is no longer just a department responsible for settling employee-related matters. They are also partners of the business.*

- *Dealing with a real client for this project had taught me to be more flexible in order to adapt quickly. It allowed me to think deeper to what I already knew.*

(2) Enhanced Collaboration

Collaboration is another outcome from authentic learning, particularly when students are required to work in a small group (Brown, Murphy, Nanny, 2003; Choo, 2007). As a group, the students practised problem-solving skills and learned how to collaborate to complete the project to meet the client's expectations. The students were able to develop strong and meaningful bonds with each other through their "substantive conversations" while creating solutions (Newmann and Wehlage, 1993).

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All 17 students reflected that collaboration skills were critical to their professional growth. The following statements demonstrated the value of working in a team.

- *The team learned to work with people with different strengths and capabilities. None of the team members knew each other at the start of the project. It was only after a few project meetings, team members knew what their own personal strengths and weaknesses were and started leveraging on each other's strengths to complete the project.*
- *I have also learnt that cooperation within a team is important. Each member played a part in delivering quality work and our combined effort is the result.*
- *In a group, I was able to solve an issue from different angles.*

When students are involved in authentic tasks, they learn the importance of collaboration to achieve a shared goal and they are able to strengthen their communication skills to apply in a business situation. Business partners, colleagues and customers often come together to discuss their perspectives on business issues (Lombardi, 2007; Soslau & Yost, 2007).

It is also essential for students to learn how to leverage on the collective wisdom in a team-based setting to arrive at an agreed decision through critical thinking and negotiating processes. It also fosters responsibility and commitment as a group member because everyone is required to share and contribute to the final outcome of the project. Working in collaboration, students are able to sharpen their problem-solving skill and *Analytical Thinking* competency by considering and synthesising multiple perspectives.

(3) Improved Communication

Thirteen students mentioned that the project had enabled them to improve their communication skills. They realised that communication style and language used in a business setting was different from their day-to-day communication with their friends. Students also learned how to communicate effectively in a professional business manner, paying attention to body language and how to engage the audience appropriately. The students' reflections on communication were as follows:

- *I learned how to conduct myself appropriately in official meetings with the client. This will help me in the near future when I enter the workforce because I will have to face clients on a daily basis. It has taught me the ability to adapt to different client's expectations and to act accordingly to suit their demands.*
- *It taught me the importance of communicating my ideas, opinions and thoughts clearly to my client.*
- *Communication is extremely crucial especially when working in a team because any miscommunication may snowball dangerously into something unconceivable and out-of-hand.*

Communication skills are critical in the current fast-paced global workplace because such skills have an important place in ensuring a more efficient process to reach effective solutions and strengthen teamwork. Being able to communicate effectively and knowing the nuances is crucial for HR professionals because they have to present HR initiatives and policies to the management and employees regularly. In today's workplace, HR professionals need good communication skills to interact with colleagues from diverse backgrounds within the location and across boundaries. Therefore, real-world projects provide students a good opportunity to learn valuable business communication skills and to develop their confidence in communicating with various stakeholders.

(4) Professionalism

The authentic learning experience through the project provided an effective way for developing professional competencies because the students were allowed to discover and develop these competencies through exploration within their learning context (Biggs, 1999).

In addition, authentic learning environment allows the development of certain personal attributes that are often referred to attitudes and values. Barnett (2006) refers to them as "certain kinds of human dispositions and qualities". In education, these personal attributes can be demonstrated as: (a) self-awareness and confidence, and an increasing motivation to learn and succeed; (b) an active, self-managed approach to life and work; (c) focus on achieving.

Employers and community value these personal attributes because they demonstrate professionalism in a person. Employers value employees who are focused and have the drive to achieve because it shows an employee's motivation and engagement on the job. Employees who have self-awareness and are confident tend to be more proactive in their learning and are more willing to apply their learning in different work situations.

Personal attributes, unlike skills and knowledge, cannot be taught as a subject but they can be learned when students are given the right support and learning environment. In authentic learning, the role of the tutor and the client play a critical role in helping the students to develop positive personal attributes.

The students' reflections on their learning about professionalism:

- *The team learned to conduct ourselves professionally in business meetings with the client. The team dressed appropriately and spoke in a polite and respectful tone so as to gain the client's respect and trust. This had helped us to build rapport with the client too.*
- *The first learning experience for the team was working with an actual company. Working on a real-world project required the team to adjust their working style in order to meet the needs of the company, for example in communication and planning the workshop.*
- *Despite the difficulties working with the client, I had to maintain my professionalism. It was new learning for me and it was important that we learned it as a student.*

Feedback for Learning

One of the key strengths in the module was the constructive feedback that students received from the tutor and the client. The four hours allocated in the students' timetable were meaningfully used for feedback and coaching. The sessions helped to build confidence when the students were told that they had done well. At the same time, these same sessions were also used to coach students to develop their professional competencies so that they can be ready for work. The client was also involved in providing formative feedback to the students. The clients' feedback gave a different perspective on the students' performance and this dimension added richness to the authentic learning approach. The students became more aware of the critical skills that would make a difference to work performance, and it helped to reinforce the importance of professionalism at the workplace.

Challenges in Adopting Authentic Learning

There were several challenges in adopting the authentic learning approach. Students faced time pressure to complete the project because they had to manage multiple projects from other modules simultaneously. As a result, work quality was compromised because they did not have the capacity to fine-tune their work. Some students also reflected that they had difficulty providing workable solutions to their client because they lacked experience and business knowledge. The ability to translate theoretical concepts to practical solutions took time and deeper understanding of a company's working norms and culture. It was also time intensive for the tutor because of the diverse requirements and expectations of each project. Depending on the readiness of each group to handle the client, the tutor had to spend time coaching the groups so that they felt a little more confident meeting up with the client.

As each project requirements differed, the learning from diversity and unpredictable events made it difficult to assess every student in a reliable manner. The knowledge gained from authentic learning may not necessarily match exactly the educational objectives of the planned curriculum. In many situations, the tutor and the client were not present to validate the learning. As a result, the tutor had to rely on the reflection journals as evidences of learning.

Another challenge was finding companies who were willing to partner with the Polytechnic to create the learning platform for the students. There were varying degrees of commitment from the companies to coach and provide constructive feedback to the students. There was also a fine balance between meeting the needs of the company and maintaining academic standards for high quality learning. The tutor had to keep an active industry network and this required time and effort to continuously engage industry partners in order to build a strong pipeline of projects.

Conclusion

This study showed that authentic learning was an effective pedagogical approach to enable polytechnic students to acquire skills and develop professional competencies. The real-world project provided an effective vehicle for the students to apply their HR knowledge to address specific HR issues and had enabled them to take greater responsibility for their learning and development. They became more confident in integrating learning to specific situations and through the process, they became active learners, strengthened their collaboration and communication competencies to be in sync with workplace expectations on professionalism. Their engagement in complex tasks and higher-order thinking skills helped them to develop a broader understanding of the role of HR practitioners in an organisation.

The students valued the coaching and feedback given by the tutor and the client because it provided guidance and a means of determining their areas for improvement. Therefore, it is important to build in space for feedback in assessment. Like collaboration and communication, feedback is integral in the real world, which is critical to successful performance in modern work environments.

The findings in this study may be limited as the sample size was small. It also did not consider other pedagogical approaches as a comparison to develop professional competencies. The projects which the students were invloved in were scaled down to allow them to complete the tasks within the limited timeframe and hence, the complexity of the tasks may not accurately reflect the complex patterns and partnerships that HR practitioners are involved in the industry.

The analysis of the curriculum design showed that there were some areas for improvement and these included: (a) deeper engagement with industry partners in coaching the students, and in scoping the authentic tasks to align with the academic rigour; (b) the development of a criterion-reference assessment rubric to enhance assessment reliability and enable students to aspire to higher performance standards; (c) reveiwing the teaching load or tutor-student ratio so that there is optimal learning for the students and to give the tutor time to build a strong network with the industry partners.

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Effects of intermediate research presentation on the graduation study

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Abstract

For most students, the graduation-research presentation is one of the most difficult challenges of their college life. For their presentation to be successful, students must be well prepared to explain the significance of their project, give the rationale for their approach, and provide a clear interpretation of their results. In this sense, the graduation-research presentation itself functions as a powerful active learning tool. The problem is, however, that the opportunity to experience this presentation process is typically limited to only once a year, at the end of the second semester. Because of this restriction, students sometimes conduct their experiments without truly understanding the importance of their research project, ultimately resulting in a poor final presentation. In the worst case, students fail to manage their schedule and end up spending most of their time merely assembling their experimental data without a comprehensive understanding of the value of their research. To make student graduation research more effective, our department decided to hold an intermediate poster-presentation at the mid-point of each student's graduation research. Participating in the process were faculty members of the department, fourth-year students, and representatives from other departments. Time in the poster session was divided between two groups; fifth-year students in each group gave an approximately one-hour presentation. The faculty evaluated each presentation and engaged the students in discussion. The intermediate presentation had several notable effects: First, students performed more experiments in the first semester in order to produce results to discuss at the presentation. Second, students were encouraged to carefully consider the purpose of their study, their principal experimental methods, their analysis and interpretation of results, and their future direction. Third, students engaged more actively in their research during the second semester, as they were able to grasp the importance of their research. Fourth, students were better able to prepare for the final presentation, having sufficient time to prepare for a proper presentation and discussion, and thus significantly improve the quality of their presentation. As a result, a number of students won Society Awards. Fifth, in addition to the merits for fifth year students, the intermediate presentation helped fourth year students learn about the department's laboratories.

Keywords: *Intermediate presentation, research project, poster presentation, graduation research, presentation skills*

Introduction

For many students, the graduation-research presentation is one of the most difficult challenges of their student life. For their presentation to be effective, students are required to explain the significance of their project, give the rationale for the approach they have chosen, and provide a clear interpretation of their results. Because it is a project-driven learning process, the graduation-research presentation itself functions as an active learning device. However, the opportunity for students to go through this presentation process is normally limited to only once a year, at the end of the second semester. Because of this, many students continue their experiments without understanding the importance of their project, which ultimately results in a poor presentation. In the worst case, students fail to manage their schedule and end up spending most of their time simply assembling experimental data without having a comprehensive understanding of the value of the research. To make graduation research more effective and productive, our department introduced an intermediate poster-presentation requirement.

Materials and Methods or Pedagogy

Role of participants

The Chairman of the Department of Chemical and Biological Engineering proposed the intermediate research presentation. A teacher in charge of academic issues in the department organized the presentation plan. One teacher of fifth year students and another teacher of fourth year students worked with their students. Faculty in our department conducting research with fifth year students evaluated the presentations (Syllabus 2015). All fifth year students prepared a presentation and presented their work, while fourth year students set up the presentation location and attended the poster presentation.

Planning

Following the department Chairman's proposal, the department changed the syllabus so that the intermediate presentation would be a part of the final evaluation. The intermediate presentation was included in Experiments in Chemical Reaction Engineering and Experiments in Biochemical Reaction Engineering for fifth year students (syllabus 2014 and 2015). Our department evaluated student achievement based on their reports, posters, presentation and attitude in their graduation research (Table.1). To obtain more effective feedback for students, it was determined that discussion time should be long enough to discuss the details of the research. Accordingly, we deemed that a poster presentation was superior to a strictly oral presentation. A supervisor, along with two other faculty members from our department, evaluated the presentations.

Table. 1 Evaluation of Achievement

Evaluation of Achievement (%)				
(1)Attitude in graduation Research				20%
(2)Experimental Achievement and Preparation of Reports				50%
(3)Poster presentation and explanation of their research				30%
Evaluation Method	Attitude	Report	Poster	Total
Percentage	20	50	30	100
Understanding	○	○	○	
Application for Thinking and Creation	◎	◎	◎	
Technique	◎ Solving Problem	◎ Logical thinking	◎ Communication	
Independence	◎ Leader ship	◎ Self - Planning	◎ Self - Planning	

Preparation before presentation

A meeting room with a seating capacity of 100 attendees was used for the poster presentation. A faculty member in charge of the presentation (organizer) along with two other faculty members, one from the fourth year and the other from fifth year held several meetings to create the schedule for the presentation. The organizer managed the setup of the presentation room (Fig.1), checking the poster boards, the legs of the boards, and providing push pins and tape. The organizer and fourth year faculty member directed fourth year students to set up the room. The organizer assigned two faculty members to perform the evaluations. The fourth year faculty member assigned his students to each presentation and distributed documents with a questionnaire for the presenter, along with comment sheets. In advance of the presentation, the fifth year faculty member described the presentation process to her students (Fig.2).

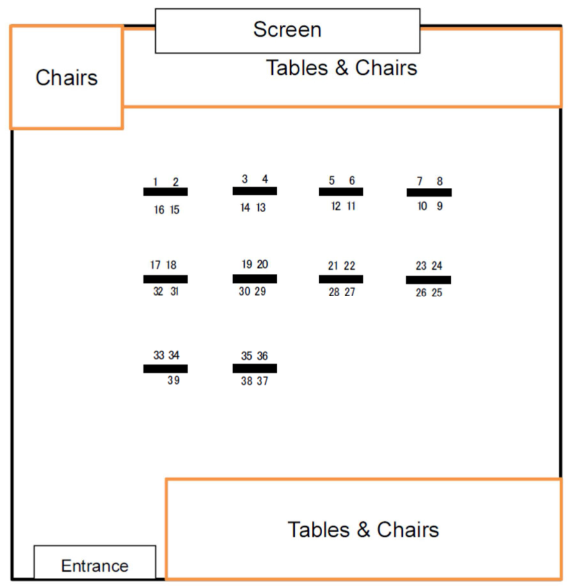

Fig. 1 Setting up presentation room

Intermediate Graduation Research Presentation of Chemical and Biological Engineering Department, 2015

15th July, 2015 (Wed) 13:00-15:00
Multi media room, Library Building 2nd Floor

Program

13:00~13:05 Opening Speech by Chairman of Department

13:05~13:45 Poster Presentation of Odd Number

13:55~14:35 Poster Presentation of Even Number

14:35~14:50 Judgement by Teacher

14:50~15:00 Comment by Chairman of Department

Fig. 2 Time table of Intermediate Research Presentation

Result and Discussion

Pre-study for fifth year students

A supervisor helped each student plan his/her experiment schedule, obtain experimental data, and organize results for the intermediate graduation study. Students were motivated to plan and implement their experiments in anticipation of their intermediate presentation. They had the opportunity to carefully consider their project and ask appropriate questions regarding such matters as the aim of the project, how best to design the experiments, the principles behind the methods used, and how to draw conclusions from the data. As a result, the students were able to learn more about their project, producing positive effects on their graduation research.

The poster presentation

At the presentation, fifth year students used posters to present their study. They discussed their achievements with faculty members and fourth year students (Fig.3). Faculty members evaluated six or seven student presentations as vice judges. In those cases in which students were unable to answer every question put to them, they had the opportunity to seek out the appropriate answers from their supervisors after their presentation. Through the poster presentation, participating students were able to rethink important aspects of their research such as the purpose of their project, the principles behind the methods used, their analysis and interpretation of results, and the future direction of their research.

Fig. 3 Scene of Poster Presentation

The effect of poster presentation

After their presentation, students showed increased motivation and became more actively engaged in their research during the second semester, as they were able to grasp the importance of their work. Because they learned how to organize their presentation, they understood what they would need to do and what was most important in their research. In general, they were better able to plan their experiment schedule according to appropriate experiment priorities.

The effect of the poster presentation on the graduation presentation

Because they had the experience of preparing their documents and slides for the intermediate graduation research presentation, students were much more prepared for their final presentation. They had sufficient time and direction to prepare for their graduation presentations and discussions so that the quality of their final presentation became significantly better. Before the introduction of the intermediate presentation, some fraction of the presenting students answered faculty questions poorly at the final graduation-research presentation. However, following the introduction of the intermediate presentation, many of them were able answer faculty questions much more competently. This was the result of a deeper understanding of their research and the extended time they had to ponder their work. Because of the improvement in their final presentations, some of the students earned Society Awards—including awards from the Free Radical School in 2015, the annual meeting of The Japan Association for the College of Technology in 2015, and the student presentation meeting of the Society of Chemical Engineers in Japan (2015).

The effect on the fourth year students with regard to their introduction to laboratories

In addition to the positive effects on fifth year students, the intermediate presentation helped fourth year students learn more about department laboratories. Fourth year students normally join laboratories during their second semester (College Bulletin 2015). We took advantage of the intermediate presentation to introduce laboratory alternatives to fourth year students who were to decide which laboratory they wanted to join. Before the intermediate presentation requirement became part of the curriculum, the department would hold a short introduction to its laboratories at the beginning of the second semester. Each laboratory had five minutes to introduce itself to the students, which seemed far too short a time to provide sufficient information. With the intermediate presentation, fourth year students are now much more able to choose a laboratory that fits their interest, resulting in a noticeable increase in student motivation.

Faculty burden

We did not find that the intermediate presentation increased the burden on faculty. In the short term, faculty members spent more time with their students to help them prepare for the intermediate research presentation. However, through the intermediate presentation students acquired a better understanding of their research and developed the ability to push their research forward independently, which saved a substantial amount of faculty time.

Future direction

Our department has decided to continue the intermediate presentation requirement. Our model has brought a new education style to the college, as another department—the department of business management—has, with our support, begun to require intermediate presentations (Syllabus of Department of Business Administration 2016). We plan to support the introduction of intermediate presentations in other departments as well. We also intend to report the positive effects of introducing intermediate presentations at professional meetings, as a reference for other institutions.

Conclusion

The introduction of an intermediate student presentation has brought several positive effects to the entire graduation research process. First, students have conducted more experiments in the first semester in order to produce results to discuss at their presentation. Second, students now have a chance to think more carefully about their research, including the purpose of their study, the principles underpinning their experimental methods, the analysis and interpretation of results, and their future direction. Third, students have more actively engaged in their research during the second semester, as they are better able to grasp the importance of their research. Fourth, students are more able to prepare for their final presentation, so that the quality of their presentation has become significantly better. A number of students have won Society Awards as a result. Fifth, in addition to the merits for fifth year students, intermediate presentations have helped fourth year students gain a greater understanding of the various department laboratories.

Acknowledgements

We are deeply grateful for the support of the faculty members in Department of Chemical and Biological Engineering to conduct the intermediate graduation-research presentation.

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21st Annual meeting of The Japan Association for College of Technology, National Institute of Technology, Tokuyama College, 29th Aug, 2015

Free Radical School in 2015, University of Tsukuba, Tateyama 8th-9th Aug, 2015

18th Students' presentation meeting, The Society of Chemical Engineers, in Japan 5th Mar, 2016

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AUTHENTIC ASSESSMENT IN ENGINEERING – A REVIEW OF CURRENT IMPLEMENTATIONS

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Abstract

Authentic assessment is increasingly being recognized for the benefits it brings to students' learning. Assessment as a motivator to learning, development of soft skills and reducing students' motivation to cheat are but some of the benefits that this alternative form of assessment can bring about. This paper reviewed implementations of authentic assessments in engineering courses in three universities from Australia and Portugal. All of them shared commonalities such as having report-writing, and presentations contributing to part of the course grade. The paper also identifies some common challenges to overcome when designing such assessments. If the intention is to experiment with alternative assessment modes in a program, it might appear that implementing such changes in the first-year curriculum and allocating sufficient resources to conduct the assessment can make the difference between success and failure in the implementation.

Keywords: *authentic assessment, authentic learning, formative assessment*

Introduction

Over the years, incorporating authenticity in assessments has gained importance for educators around the world. It is now generally agreed that asking students to write an essay on a topic such as the engineering design process might not be the best way to assess their understanding of the topic. Similarly, there is no guarantee that a student who is able to convert a differential equation from the time-domain into its s-domain equivalent using Laplace Transform will be able to use the knowledge to analyze electrical circuits such as the one in Figure 1.

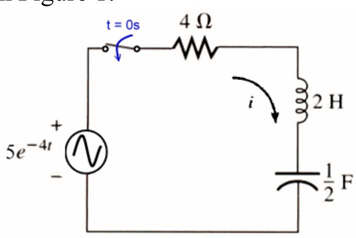

Figure 1 Circuit analysis using Laplace Transform

Traditional exams assess students' mastery of knowledge and skills by examining their response to unambiguous and yet decontextualized test questions. In comparison, the questions or challenges given in an authentic assessment are often ambiguous, ill-defined or open-ended. Authentic assessment comes into its own when the objective is to assess students' ability to apply their knowledge to real-world situations (Wellington, Thomas, Powell, & Clark, 2002).

Providing a context is the key to incorporating authenticity in assessments. The learning value in getting students to sit down for a 2-hour exam on circuit analysis is very different from getting them to explain a circuit that they have designed and built themselves, even though the same set of knowledge and skills may be required for both.

Therefore the techniques employed to conduct authentic assessments are very different from those in traditional assessments. Whereas traditional assessments typically make use of essays, short-answer questions and multiple-choice questions in the form of a pen-and-paper test to assess the outcomes of students' learning, authentic assessments may utilize methods such as presentations, peer evaluation and journal entries to achieve the assessment objectives.

Students are reportedly more motivated and engaged academically when such assessment methods are used. They are also less likely to plagiarize or cheat because the nature of the assessment is such that copying from existing pieces of work will not lead to a good grade (MacAndrew, S.B.G., & Edwards, K., 2002). The following section provides a brief review of how authentic assessments may look like in engineering courses.

Authentic assessment in engineering courses

Monash University, Australia Third-year undergraduate students from Industrial Engineering, Accounting, Marketing and Industrial Design courses are grouped into multidisciplinary teams of 8 to 10 to solve a problem that originates from participating companies. This initiative was brought about to solve the problem of engineering graduates lacking the necessary skills in teamwork, communication and solving problems that are ambiguous in nature.

The project module lasts for 15 weeks and culminates with a presentation to the management of the sponsoring company. Since one of the objectives of this project module was to hone students' teamwork and communication skills, the team of academics who had developed it did not rely on a final exam to assess students. Instead, the deliverables for the project consist of two interim reports, one final report, three peer assessments and one reflective journal. All deliverables form part of the assessment together with the team supervisor's observations (Wellington, Thomas, Powell, & Clark, 2002).

University of Minho, Portugal The term coined by this university to describe their project-based pedagogy is "project-led education" (PLE). First-year engineering students work in teams of 6 to 8 on multidisciplinary projects that encompass the learning objectives of 4 courses, namely Introduction to industrial engineering, Calculus, Computer programming and General chemistry. The motivation for this course to adopt this method of teaching is similar to that of Monash University, which is to enhance teamwork and develop competencies in communication and project management.

Deliverables that are assessed include project reports, presentations, peer assessments and a written test to assess students' understanding of the subject matter. The written test differs from a regular pen-and-paper test in that it is customized for each team based on its project solution (Fernandes, Flores, & Lima, 2012). A post-implementation study conducted by the university found that students had mixed responses to this mode of assessment. There exists a group of students who prefer the traditional method of assessment because they felt traditional assessments are easier to do well, where a student's performance does not depend on how the entire team performed, and there is no need to worry about applying or linking the concepts to real-life situations.

Deakin University, Australia: Several engineering programs ranging from Bachelor to Doctoral levels in the Deakin University School of Engineering and Technology adopt a flexible delivery mode and consequently utilize alternative methods to assess students (Palmer, 2004). In a subject known as "Strategic Issues in Engineering", authenticity, fairness and practicality are some of the criteria that are important to the administrator of this subject. Because the students who are taking this subject are in their final year of study, the emphasis of the assessment is to check the students for the necessary skills that they will require in the near future when they graduate and move on to professional practice. Table 1 presents the written assessment components of this subject:

Item	Marks
Reflective journal	10
Technological forecasting and assessment	10
Policy design in engineering organizations	10
Major report	20
Examination	50

Table 1 Written assessment components

In all of these items, apart from the examination, students are working in groups of three to study existing practices of real organizations and conduct interviews with professionals in the industry. Other than the written assessment components, there is also a 20-minute oral presentation as part of the assessment, during which the groups will present the findings documented in their major report.

Characteristics of authentic assessments

Based on the review of the various reports on authentic assessments implemented, there are certain traits that appear to be common across all implementations. First of all, assessment in all the case studies that we have presented did not occur as a one-off event. There are assessment activities conducted at various points throughout the semester in the form of report submissions, peer assessments and presentations. Due to the nature of the assessment activities, authentic assessments are mostly adopted by student-centric pedagogies which emphasize collaboration and learning through solving real-world problems.

The second characteristic of authentic assessments is that the assessments do not rely on the results of traditional tests, often conducted closed-book, to measure students' learning. Such pen-and-paper tests require the questions to be kept secret until the moment of assessment. If students get to know of the questions in advance, the test is no longer valid (Wiggins, 1990). In contrast, the challenges given in an authentic assessment are often made known to students in advance of the assessment for them to prepare and rehearse.

Authentic assessments require a different approach in determining their validity. The validity of traditional pen-and-paper tests is measured by comparing the test questions with the curriculum content. If the "correct answer" to the questions comes from the curriculum content, the test is deemed to be a valid one. Once again, the underlying assumption in traditional tests is that there is one correct answer to every test question. The validity of authentic assessments, on the other hand, has to be dependent on whether the assessment simulates real-world scenarios. Instead of asking "Are the students supposed to have learned this?", the test of validity for authentic assessments is "Will the students be doing this when they go out to work after graduation?"

Benefits of authentic assessment

One clear advantage that authentic assessment has over traditional exam is the reduction in the number of cheating cases. There is no point for a student to copy from another student when both are working on different projects. As students work on their projects under the guidance of their supervisors, they would come to know exactly what knowledge they are supposed to acquire and what they would be tested on during the final assessment. Hence there is no need for spotting of exam questions. Having the assessment activities spread over the entire semester also reduces the chances of a student scoring badly for a subject due to poor performance in a single, high-stake final exam. Thus the grade that a student obtains for a subject is more reflective of his level of mastery in that subject if authentic assessment were used.

Another benefit of requiring students to present before a panel of assessors is that students are more motivated to understand the subject matter because they know that they will be cross-examined on the concepts involved during their presentation. Compared to asking students to respond to a 5-mark question on “Explain the first law of thermodynamics” in a pen-and-paper test, listening to a student answering the exact same question verbally during a presentation session allows the assessor to have a better gauge of whether the student truly understands the first law of thermodynamics.

Incorporating team work, report writing and presentations into the assessment also drives students to work on these skills which are no less important than mastery of the subject matter.

Challenges

The amount of time and resources required for authentic assessment is the first challenge that institutions have to grapple with. The time and manpower that was previously allocated to marking exam papers are now required for grading reports and journal entries which make the task less straightforward. Reports and journals by their nature are open-ended with no single “correct answer” and hence there is no definite marking scheme for the assessors to fall back on in their marking.

Allocating sufficient time for project presentations is also a challenge. For example in the Aerodynamics course at Republic Polytechnic where presentations form part of the assessment, assessors found that in order to properly examine each student’s understanding of the subject matter, they often had to overrun the time limit given to each team.

The issue of reliability is always present in all tests, traditional or otherwise. However this issue is amplified in the case of authentic assessments where the assessors may comprise of different faculty members. In cases where peer evaluation is used, students play a part in the assessment as well. With only a set of grading rubrics to work with, assessors have to be properly trained on the use of the assessment rubrics in order for the assessment to have high inter-rater reliability.

It takes time to acclimatize not only the assessors, but also the ones being assessed to alternative methods of assessment. It can be a challenge to manage students’ negative responses to the change in the mode of assessment, which can be expected whenever there are any changes from what they have been accustomed to, as can be seen from the experience of the University of Minho. This is especially so if the change takes place in their final year of study before they graduate.

Conclusion

Some common benefits and challenges were shared among courses that had experienced using authentic assessment in place of traditional pen-and-paper tests. Students achieve deeper learning and find meaning in the assessment activities when the subject matter is learned in the process of solving a real-world problem. On the flip side, more resources have to be expended in the conduct of authentic assessment compared to traditional exams. This however should only be construed as a challenge, and not a disadvantage. If the benefits of authentic assessments are truly worthwhile to pursue, then sufficient time and manpower should be allocated to do it properly. We hope this review inspires more engineering schools to experiment with authentic assessments and give heart to those who are already doing so.

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Practical English Exercise and Curriculum Design

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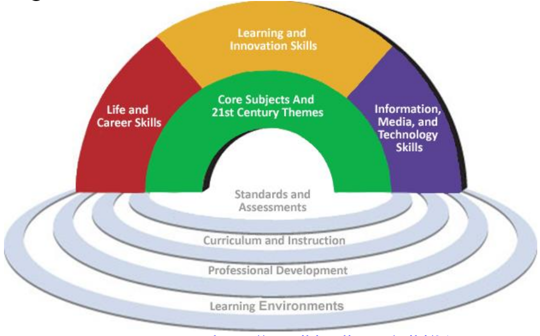
Abstract

Curriculum design is very important to achieve educational goals. The curriculum should contain the knowledge, skills as well as competencies that are required for the student's future success. The advanced engineering school of the National Institute of Technology, Kitakyushu College was reformed to aim at cultivating students to be creative engineers with multiple engineering viewpoints, problem-solving skills and global mind. In order to achieve these educational goals, the curriculum consists of thesis research, lab-work and exercise subjects, fundamental science subjects, liberal arts subjects, social science and foreign language as global/local study subjects. In this curriculum, there are 4 compulsory modules designed to connect directly each other and to deepen the students' understanding of engineering and English communication skills for the global Engineer. The students prepare and practice their English presentation on their project done in the previous modules. Thus, the students have to learn effective ways to explain and present their own idea: customized learning contents. This constructively aligned module structure with clear learning activities and outcomes is essential to achieve the educational goals, especially for school reform initiative. Moreover, short/long-term international exchange students are welcome to join these modules as international collaborative learning activities. It seems that the international educational collaboration in the curriculum provides ideal circumstances to foster the global mind/awareness.

Keywords: Global mind, English study, Group work, Presentation skills, PBL, CDIO

1. Introduction

There is no doubt that we are facing with the rapidly changing world of "Globalization." In order to improve the preparation of our students to meet high demands in rapidly globalizing world, we have to improve the curriculum as well as our educational approach. The 21st century skills shown in Figure 1, a set of essential abilities, are what our students need for their future; these skills should be recognized as one of the most important outcomes of teaching and learning through the curriculum.



https://en.wikipedia.org/wiki/21st_century_skills

Fig. 1 The 21st Century Skills

According to a blueprint for education reform in Japan, globally competitive talent of students has been a top priority on the agendas. Thus, collaborative problem-solving skills and intercultural communication skills for globalization, especially English language skills, are very important for our students. Although typical lecture plays an important role in English education, the intercultural communication skills can be also fostered effectively through a variety of international activities.

Based on these requests for educational institutes, the advanced engineering school of the National Institute of Technology, Kitakyushu College was reformed in 2015. Former three courses, Production Engineering Advanced Course, Control Engineering Advanced Course, and Material Science & Chemical Engineering Advanced Course have been consolidated into one course named "Creative Engineering" course. It aims at cultivating students to be creative engineers who are specialists of their engineering expertise and other related engineering fields with multiple engineering viewpoints, problem-solving skills and global mind; the curriculum was designed to achieve these educational goals effectively. Figure 2 shows the organization of reformed Kitakyushu College: 5-year college and 2-year advanced engineering course. The college part was also reformed and former 5 departments were consolidated in to "Creative Engineering" department. The Creative Engineering department provides 5-course.

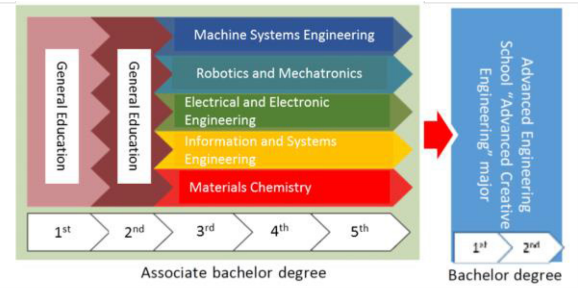


Fig.2 Organization of reformed Kitakyushu College.

In this paper, the curriculum design adopted in the advanced engineering school of Kitakyushu College is reported. The curriculum taking into account further international collaboration and exchange (e.g. short/long term student exchange programme) is discussed from the viewpoint of global education as well as practical English exercise.

2. Advanced School and Curriculum

The advanced school provides an additional 2-year multidisciplinary engineering education for graduates of colleges of technology (KOSEN) or junior colleges. Figure 3 shows the position of the advanced school in the school system of Japan.

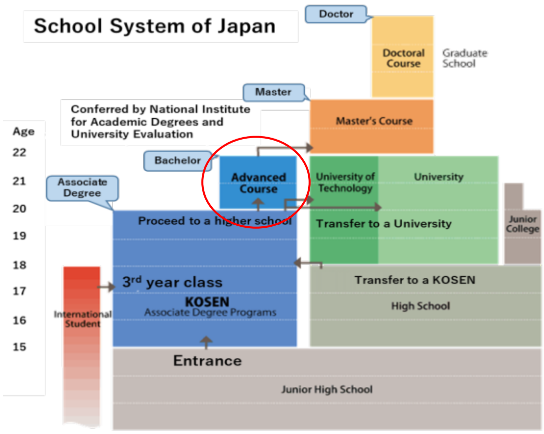


Fig. 3 The advanced school in the school system of Japan.

In the Advanced School of Creative Engineering, in order to foster the multiple engineers' viewpoints, the students study technologies from the stages of materials/ resources to final products with addition of recycling process for the sustainable/recycling-based society. The curriculum consists of thesis research, lab-work and exercise subjects, fundamental science subjects, liberal arts subjects, social science and foreign language as global/local study subjects, elective specialized subjects and subjects for three compulsory elective major fields based on demands for engineering and technology as well as regional needs of Kitakyushu district.

2.1. Curriculum Design for Practical English Exercise

In this curriculum, there are four compulsory modules designed to be linked each other and to deepen the students' understanding of engineering and English skills for the global Engineer: "Lecture for Creative Engineering Design and Production", "Production Design Engineering Practice", "Advanced Experiments for Creative Engineering", and "Practical English for engineers I." The students broaden and deepen their knowledge about manufacturing technologies in Lecture for Creative Engineering Design and Production, and these knowledge and ideas will be applied to their project as Problem Based Learning (PBL) in Production Design Engineering Practice. The students design, manufacture and evaluate devices in Experiments for Creative Engineering as summary of the learning outcomes as Project Based Learning. In Practical English for engineers I, the students prepare and practice their English presentation on their PBL works.

2.1.1 Lecture for Creative Engineering Design and Production

The main topic of this module is technologies in "Production." As the first Japanese government-managed steelworks/steel blast furnaces registered as World Heritage were constructed in Kitakyushu in 1901, "Steel manufacturing" is chosen to be the main topic (Fig. 4a). This module is an omnibus style lecture (90 min. ×15) consisting of 5 sub-topics: Mechanical engineering, Electrical engineering, Information technology, Control engineering, and Material Science & Chemical engineering corresponding to the former 5 departments. "Production" in the steel manufacturing is explained and discussed from different engineering points of view as total engineering. Figure 4(b) shows an example of application of Electrical engineering in steel manufacturing. The students learn their engineering expertise and other related engineering fields with multiple engineering viewpoints. This module also aims to foster local identity of Kitakyushu.

Fig. 4 (a) Yawata Steel Works in Kitakyushu and (b) inductive heating in steel manufacturing.

2.1.2. Production Design Engineering Practice

This module is designed as PBL and starts from the following trigger question.

You are a member of Research & Development team of Kitakyushu-Kosen Company located in Kitakyushu. You have to suggest a new product utilizing technologies of at least two different engineering fields. Please propose your product plan to the board of directors!

Fig. 5 A trigger problem for PBL.

The students are required to think and act as company researchers to propose new products as play roles. The students are divided into groups of 4 to 6 members with different major engineering fields as shown in Figure 6. After the instructions of PBL, they started to develop their products basing on their already learned knowledge and the investigation.

Fig. 6 A picture of students in Production Design Engineering Practice Class.

2.1.3. Advanced Experiments for Creative Engineering

The students try to design, manufacture and evaluate devices in Experiments for Creative Engineering as summary of the learning outcomes. The students are again divided into groups of 4 to 6 members with different major fields. This module provides 5 short experiments relating to 5 engineering fields mentioned above and one long-term project (3 hr. x 10). Therefore, this module is a mixture of conventional lab-work and Project-based learning. The topic of the project is chosen to be a chemical reactor system: a microreactor. A microreactor is a micro-channel reactor in which chemical reactions are designed to take place in a confinement with typical lateral dimensions less than 1 mm (Fig. 7). Microreactors possess many advantages over conventional large scale (bulk) chemical reactors, because of high energy efficiency, reliability, and a superior degree of process controllability. It should be noted that the fabrication, operation and evaluation of the microreactor requires knowledge and skills of all 5 engineering fields.

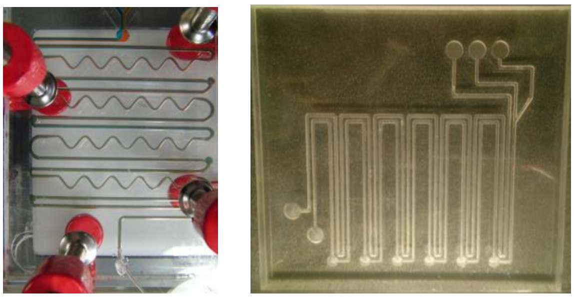


Fig. 7 An example of flow in a mcroriactor(left) and a microreactor designed by students (right).

2.1.4. Practical English for engineers I

In this module, the students work with the same group members from previous "Production Design Engineering Practice". The students prepare and practice their English presentation on their PBL project done in the semester 1. Again, it starts from a scenario continuing from the R & D team story. Thus, this module is supposed to be a sort of PBL for effective English presentation. It should be noted that their suggested products relate their major engineering field, but are quite different from their thesis research. Therefore, English terms and expressions used for the presentation are ones that they are not familiar with. The scenario for this module is that the member of R & D team received an invitation letter shown in figure 8. Figure 9 shows a picture of students' English presentation.

Dear Sir or Madam,

We are pleased to invite your company, considering its innovative experience and great idea of products, to take part in the WORLD INNOVATIVE EXPO 2015 and International New Products Conference that will be held on 19-21 December 2015 in USA.

We would like to invite you to present your product at an exhibition stand, and also to take an active part in the conferences accompanying the exhibition, including the possibility of giving presentations in details. We are very confident you will find this proposal worth considering and that any business talks held at the conference will be beneficial to your company in a number of ways.

We are looking forward to hearing from you at your earliest convenience

Yours sincerely,

Project Manager

Sent from iPhone7

Fig. 8 An invitation letter for students (e-mail).

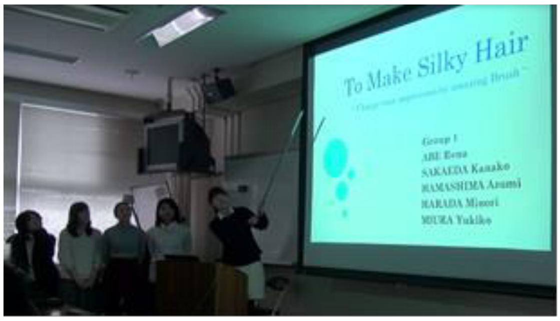


Fig. 9 A picture of students' English presentation.

2.2. International Educational Collaboration in Classroom

It should be noted that International Symposium on Advances of Technology Education (ISATE) is one of good examples of the institutional collaboration. Many faculties of educational institutes have exchanged and shared their pedagogy and future visons, as well as established international educator networks. Through ISATE, Kitakyushu College has been developed international/global education programs with several Polytechnics in Singapore and other Universities.

Figure 10 shows examples of short term exchange program at Kitakyushu College in 2014. The short or long term research projects, such as joint Final Year Project (FYP), are typical exchange programs. Durations of program are typically from one month up to about 3 months. Although these collaborative research projects are very effective way to foster the global mind of students, their activities tend to be limited within the research laboratory.

Fig. 10 Examples of short term exchange program at Kitakyushu College in 2014.

It is ideal that the short/long term exchange students join some modules with our students and learn collaboratively to achieve international learning environment, which also motivates other students who are not involved in the projects directly. It is important to establish the international collaborative learning environment for the globalization of education. However, as a small size of the advanced school (Annual admission: 35 students), there are not enough number of modules suitable for this purpose. The four modules mentioned in the previous section is designed to provide the short/long term exchange students opportunities to join and to learn collaboratively with our students. In 2015, two Singapore students joined "Advanced Experiments for Creative Engineering." As their final year project was also the development of microreactor, they presented the research results as well as conducted short experiments (Fig. 11).

The same two Singapore students partially attend Practical English for engineers I and another Indonesian student joined the final presentation. They gave the comments and asked questions after the presentation.

Fig. 11 Pictures of the students in Production Design Engineering Practice Class. Joining the short-term experiments (above) and Giving a presentation in the class (bottom).

3. Results and Discussion

It is shown that modules mentioned above are linked each other to develop competency for the global engineer: collaborative problem-solving skills and intercultural communication skills. Figure 12 shows the structure of these modules. The concept of this curriculum structure is basically the same as the integrated curriculum design of CDIO. In order to develop the students' competency, these modules make explicit connections among learning outcomes and supporting and complementing contents.

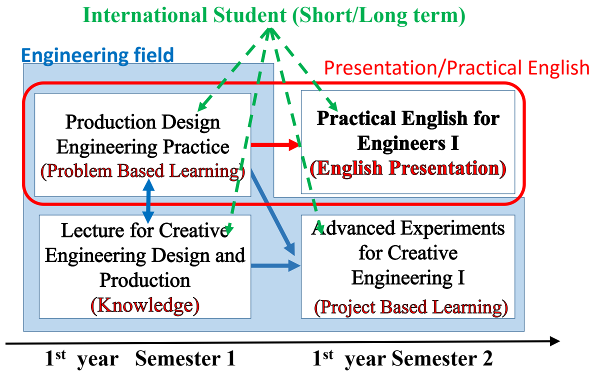


Fig. 12 Curriculum Design of the four modules.

3.1. As Modules Design

Three engineering modules are a core part of curriculum for learning "Production" from an engineering point of view. "Lecture for Creative Engineering Design and Production" provides basic knowledge of production technologies and multiple engineering viewpoints. At the same time, the students challenges to propose new products as Problem-Based Learning in "Production Design Engineering Practice". Then, the students are requested to draw on their previous experience in "Advanced Experiments for Creative Engineering" as Project-Based Learning.

Regarding practical English exercise, basing on previous engineering practice activities, "Production Design Engineering Practice" and Practical English for engineers I" are linked strongly together. Since the students try to figure out how to present and explain their original works in English, this activity is a simulation of real-world problem solving as English study. Different from teacher prepared hand-on topics, the customized learning contents (i.e. students' PBL works) let them be closely involved in thinking things as well as in making decisions.

3.2. International Educational Collaboration in the Classroom

In addition to the curriculum design, international educational collaboration in the classroom is also an important factor for the global engineering education. Participation of new international students to the classroom seems to simulate students' curiosity and interest. Especially in English class, the international students really endorse whether their English is understood or not. Moreover, they can teach us intercultural difference that is important, but is rarely taught. Here is a good example of intercultural difference which the students recognized during the presentation. When a group presented their IT controlled umbellar management system (holder) for home-use, the international students questioned a possibility of umbrella theft, and Japanese students could not understand the reason why they worry about theft. Japanese students believed that umbrella should be kept inside home (entrance hall), that is common in Japan, but the international students thought it should be outside. This is simply due to the life-style difference, and they found it through questioning and answering. It is noted that this type of experience show the students' English proficiency is not only important for communication as an engineer. Understanding cultural orientations and differences is important for successful communication.

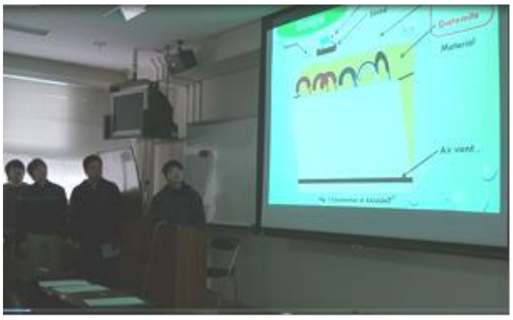
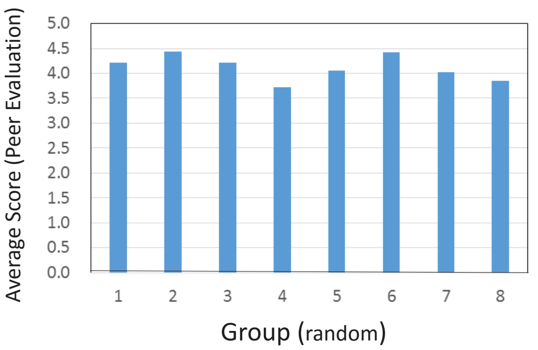


Fig. 13 A picture of group presentation of IT controlled umbellar management system.

Candid opinion from the international students are very important for the practical English exercise. Figure 14 shows the result of students' peer evaluation regarding understandability of their presentation. Even for the good score group, the international students point out the problems from the viewpoint different from ones of Japanese lecturers and students. Their comments are very persuasive and are quite meaningful to improve our students' English presentation including English skills itself and intercultural communication skills.



Average	4.22	4.44	4.22	3.72	4.06	4.42	4.03	3.86
SD	0.12	0.09	0.11	0.16	0.14	0.10	0.16	0.16

Fig. 14 Peer evaluation results regarding understandability of the presentation (5 point scale).

3.3. Follow-up Survey Results

As this module is for the students' practical English presentation exercise, we are not considering the direct influence on English examination score such as TOEIC and TOEFL at this moment. However, a follow up survey is conducted so as to consider the students' perspective after their class experience. Table 1 shows results of follow-up survey conducted after 5 months. The Questions #1 and #2 ask the students English skills that will likely be required in the future. The Question #3 is about the importance of cultural understanding in the communication. The Question #4 and #5 concerns participation of short-term international students in English class. The number of opportunities they give English presentations is also asked in the Question #6.

It should be noted that low negative response rates ≦10 % are obtained for all questions. It is shown that a high positive response rate of 83 % is achieved for both Q 1 and Q 2. These results indicate the students recognize the importance of practical English skills in their future career. A high positive response rate of 69 % is obtained for Q3 regarding cultural understanding in the communication. For Q4, the students give a positive response rate of 65 % for effectiveness of the participation of international students. Although the students give a positive response rate of 62 % for Q 5 about promotion of participation of international students in English class, the highest negative response rate of 10 % is also obtained. This result seems to relate to Q 6. It is found that 34 % of the students had no chance to give an English presentation except this module; only 10 % of the students are well experienced regarding English presentation. Due to the lack of experience, the students feel anxiety in their English performance in front of international students. In fact, some students mentioned that they concern about the gap between ideal and real performance when they talk with international students. These results shows that it is important to encourage the students not to hesitate to use English even if they might make mistakes and to provide the students opportunities to use English.

Table.1 Follow-up survey results

<table>
<tr><td colspan="2">Questions (N=30)</td><td colspan="5">Disagree ⇒ Neutral ⇒ Agree</td></tr>
<tr><td colspan="2">1. Do you think you will need higher English skills after graduation?</td><td>3</td><td>3</td><td>10</td><td>31</td><td>52</td></tr>
<tr><td colspan="2">2. The required English skills will be of practical use such as for presentation?</td><td>0</td><td>7</td><td>10</td><td>31</td><td>52</td></tr>
<tr><td colspan="2">3. Cultural understanding is particularly important in communication?</td><td>0</td><td>3</td><td>28</td><td>41</td><td>28</td></tr>
<tr><td colspan="2">4. Short-term international students' participation in English class is very meaningful to learn practical English.</td><td>0</td><td>3</td><td>31</td><td>31</td><td>34</td></tr>
<tr><td colspan="2">5. Do you hope to have more opportunities to communicate with international students in English class to learn practical English?</td><td>0</td><td>10</td><td>28</td><td>31</td><td>31</td></tr>
<tr><td rowspan="2">6. How many presentations have you done in English except this module?</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5≦</td></tr>
<tr><td>34</td><td>48</td><td>7</td><td>0</td><td>0</td><td>10</td></tr>
</table>

4. Conclusions

In this paper, the curriculum design of the advanced engineering school of Kitakyushu College is presented. Simulation of real-world engineering context were used for both engineering and language education. The constructively aligned and integrated module structure with clear learning activities and outcomes seems to be essential to foster the global engineering. In addition to the curriculum, participation of short/long term international exchange students to the classroom is very effective for the practical English exercise. It is shown that the international educational collaboration provides ideal circumstances to foster the global mind/awareness in the classroom.

Since the 1st ISATE held at 2007, many faculties of educational institutes have promoted the international collaboration. We hope that ISATE continues to be a platform to promote further international collaboration among institutes for the globalization of education.

Acknowledgements

We acknowledge schools and organizations that support the international program at Kitakyushu College.

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A METHOD OF DATA MINING TO CLUSTERING THE RELATIONSHIP OF ELECTIVE COURSES TO IMPROVE ACADEMIC PERFORMANCE

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Abstract

Academic analytic was proved to help students in studying. From the data of the academic department reveals that from 2007-2015, 34% of students are fully graduated, whilst resigned rate is 7% and academic disqualification student is 16%; it shows that graduation rate is not acceptable.

This paper uses data mining technique with association method to discover knowledge from TNI's registration system, by selecting only the data from 2007 to 2015 of the Faculty of Information Technology (IT). The aim of this study contributes to an improved quality of the third year and fourth year TNI's IT students by proposing a discovered knowledge from data mining system that assists students in selecting an appropriated elective course based on their profile and past's course outcome. The results of study found that some groups of elective courses associate with academic performance. The relationship can be classified into four groups: the first group of elective courses promotes academic performance when students study following the courses in this group, the second group of elective courses adversely affect academic performance when students study this group and the third and the fourth group of elective courses do not associated with academic performance.

This research enables teacher to track and analyse students' past performance and proposes a guideline to select a proper elective courses at the right time based on the development framework. In addition, the results from mining provide educators with the ability to give a good consult by giving students a choice for learning plan.

Keywords: *Data mining, Educational Research, Classification, Academic Performance*

Introduction

From information of Thai-Nichi Institute of Technology (TNI)'s registration system shows that the rate of graduated students in four-year program for faculty of Information Technology's graduated students is just 63% and over 4 years is around 10% as shown in figure 1.

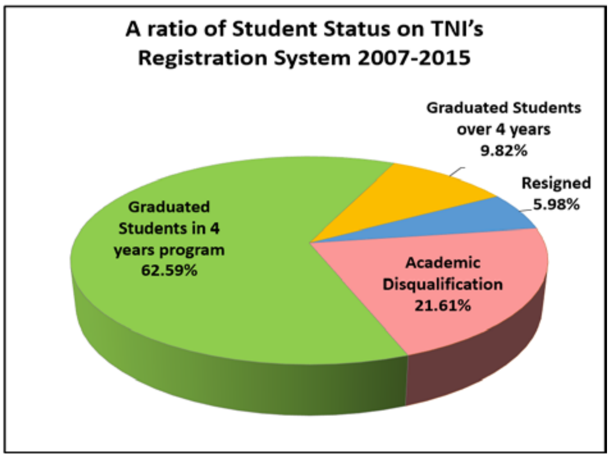

Figure 1: A ratio graph of student's status on TNI's registration system during 2007-2015

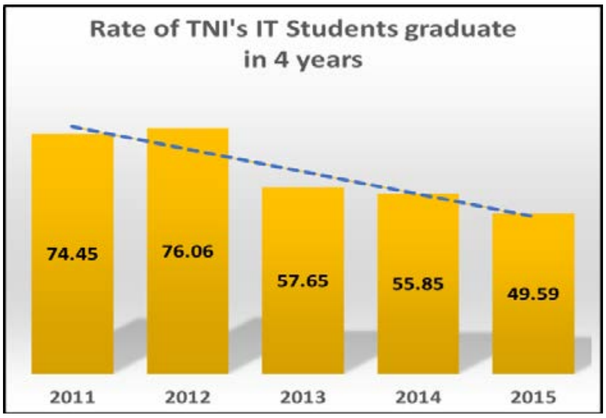

Figure 2: A graph of TNI's IT students graduate in 4 years rate.

From figure 2, it also reveals that percentage of graduated students in 4 years of study program compare with the new entrant students have been declined steadily from 75% (2011) to 50% (2015) in the latest year. The criteria for students graduate of four-year program is GPA greater than 2.00. However, from information as shown in figure 2 inspired us to find out what went wrong in our teaching system, our curriculum or the study planning of students.

In Thailand, industrial people recruit a new staff from academic performance. Especially, TNI is a private university, higher GPA is necessary for TNI students comparing to students from government university. For this reason, TNI's lecturers have to find out the solutions in order to help the TNI students to get a higher grade for attracting the employers.

Thus, this paper aims to create recommended plan of study for students. The study planning in this paper means the appropriate group of elective course for selecting in each semester according to their profile and in their course registering record

Materials and Methods or pedagogy

This paper is continued work from previous study which presented at International Conference on Business and Industrial Research, Thai-Nichi Institute of Technology, Bangkok, Thailand, 2016 as shown in figure 3.

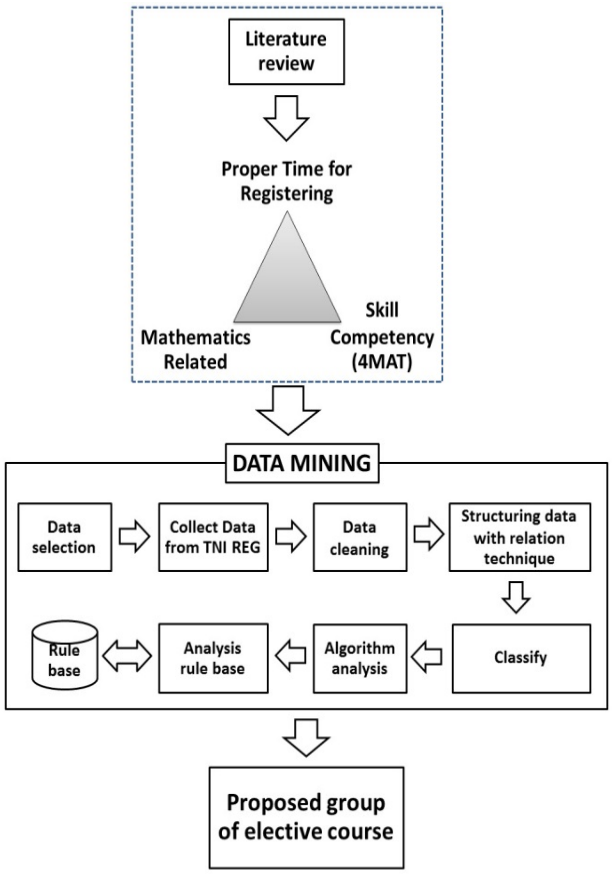

Figure 3: Framework to classify the relationship of elective courses and academic performance with data mining (Charoenpong, 2016)

This framework (Chen and Tsai, 2016) explains the key factors and variables for understanding the relation between course grades and elective course enrolment from TNI's registration data through the usage past record on students' academic performance. The key factors are proper time for registering, skill competency (4MAT) and mathematics related issues.

Based on the key factors, researchers use them for data selection process and identify the attribute for analysis as listed in table 1.

Table 1: The attributes for data mining (Charoenpong, 2016)

Attributed Name	Description
STUDENTCODE	Student's identification number
COURSEGROUP	The group set classify by 4MAT
COUSECODE	Subject code from TNI sysetem
ACADEMICYEAR	Academic year that student enrolled the course
SEMESTER	Semester that student enrolled the course
GRADE	Student's grade from the course
GRADELEVEL	Criteria to classify level of study

This paper applied data mining for extraction of implicit and interesting patterns from registration data to find out an information from mining to use as a tool to solve a business problem. In this study, we followed the mining steps as shown in figure 3, which are

1. Data selection and collecting from TNI REG. (December 2015 – February 2016)
2. Data cleaning (March – April 2016)
3. Data structuring (May – June 2016)
4. Data classification using an algorithm analysis (June – July 2016)

to proposed a group course for an elective course.

Data selection and collecting from TNI Registration system

This paper selected data from TNI's registration system, we scope this work for only IT students' data. For relevant attributes used for analysis, we chose "Student Code", "Student Status", "Academic Year", "Semester", "Course Code", "Grade" and "GPA" as shown in table 2.

Table 2: The Student Academic Record from TNI REG.

ADMITACADYEAR	STUDENTCODE	STUDENTSTATUS	FACULTYID	ACADYEAR	SEMESTER	GPAX	COURSECODE	GRADE
2550	50121033-0	40	2	2550	2	2.87	MSC-108	C+
2550	50121033-0	40	2	2550	2	2.87	JPN-102	A
2550	50121033-0	40	2	2550	2	2.87	INT-106	C+
2550	50121033-0	40	2	2550	2	2.87	INT-104	C
2550	50121033-0	40	2	2550	2	2.87	INT-103	C
2550	50121033-0	40	2	2550	2	2.87	HUM-104	B
2550	50121033-0	40	2	2550	2	2.87	ENL-102	B+
2550	50121048-8	40	2	2550	2	2.3	MSC-108	C
2550	50121048-8	40	2	2550	2	2.3	JPN-102	C
2550	50121048-8	40	2	2550	2	2.3	INT-106	C+
2550	50121048-8	40	2	2550	2	2.3	INT-104	C
2550	50121048-8	40	2	2550	2	2.3	ENL-102	B
2550	50121048-8	40	2	2550	2	2.3	INT-103	D
2550	50121048-8	40	2	2550	2	2.3	HUM-104	B+
2550	50121042-1	40	2	2550	2	2.67	MSC-108	C+
2550	50121042-1	40	2	2550	2	2.67	HUM-104	B
2550	50121042-1	40	2	2550	2	2.67	JPN-102	C+
2550	50121042-1	40	2	2550	2	2.67	INT-106	B

For this step, data were exported from system as an excel format in separated file. (16 files). After checking accuracy of data for the first times, we joined this file by using MS Access using student code as a primary key.

This step is an important step in the data mining process.

Data Cleaning

Data cleaning is an extremely important step in the data mining process to avoid GIGO (garbage in, garbage out). Generally, data are always coming with inconsistent value including missing data, null value. In our case, we also found missing data such as the grade that are not in suitable format (e.g., A, B+, B, C+, C, D+, D, F), GPAX of graduated students' is lower than 2.00. Thus, the cleaning data steps is essentially required for this work. Tasks are listed as following;

1) Merging 16 files using MS Access and some files are by MS excel.
2) Create the backup file and keeping original data in separated file.
3) Rearrange the data into tabular format. Each student has one record for their information and academic record.
4) Filtering inconsistent data and delete them.
5) Delete some grades that meaningless.
6) We changed the grades of each course to be "Yes" and changed blank value to be "No" for the meaning of "Enroll" and "Not Enroll".
7) Check the data by comparing them with the data in online TNI's registration system to ensure that they are accuracy.

After this step, we have 811 records of graduated students to be the training data for mining.

The verification of data quality was also done by checking for example missing data, data error and sample of inconsistent data are illustrated in table 3.

Table 3: Sample of Inconsistent data from REG

STUDENTCODE	STUDENTSTATUS	ACADYEAR	SEMESTER	GPAX
51121157-5	Graduated Students	0	0	2.5
52121902-2	Graduated Students	0	0	2.01
52122001-2	Graduated Students	0	0	2.47
53121109-2	Graduated Students	0	0	2.1
53121111-8	Graduated Students	0	0	0
53122086-1	Graduated Students	0	0	2.5
53122093-7	Graduated Students	0	0	0
53122102-6	Graduated Students	0	0	3.53
53122103-4	Graduated Students	0	0	3.27
53123070-4	Graduated Students	0	0	0
53123071-2	Graduated Students	0	0	0
53123072-0	Graduated Students	0	0	0
54121904-4	Graduated Students	0	0	2.4

Data Structuring

At this point, data structuring is a step for organizing data to suit to a studying purpose and also choosing an algorithm of data mining that suited our questions. Moreover, at this step, we also prepare data by categorizing courses based on core course, required course and elective course, social science course and language course. Then we merge this new data with cleaning data. After that, we chose only courses that we used them for mining by choosing only core course, required course and elective course.

Table 4: Data for mining by WEKA

STUDENTCODE	StudentStatus	ITE-301	ITE-304	ITE-305	ITE-308	ITE-401	ITE-402	ITE-414	ITE-417
50121002-5	Graduated Students	Yes	Yes	Yes	Yes	Yes	Yes	No	No
50121003-3	Graduated Students	Yes	Yes	Yes	Yes	Yes	Yes	No	No
50121004-1	Graduated Students	Yes	Yes	Yes	Yes	Yes	Yes	No	No
50121005-8	Graduated Students	Yes	Yes	Yes	Yes	No	Yes	Yes	No
50121006-6	Graduated Students	Yes	Yes	Yes	Yes	Yes	Yes	No	No
50121020-7	Graduated Students	Yes	Yes	Yes	Yes	Yes	Yes	No	No
50121022-3	Graduated Students	Yes	Yes	Yes	Yes	Yes	No	Yes	No
50121023-1	Graduated Students	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
50121025-6	Graduated Students	Yes	Yes	Yes	Yes	Yes	Yes	No	No
50121026-4	Graduated Students	Yes	Yes	Yes	Yes	Yes	Yes	No	No
50121029-8	Graduated Students	Yes	Yes	Yes	Yes	Yes	Yes	No	No
50121030-6	Graduated Students	Yes	Yes	Yes	Yes	Yes	Yes	No	No
50121031-4	Graduated Students	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
50121032-2	Graduated Students	Yes	Yes	Yes	Yes	Yes	Yes	No	No
50121033-0	Graduated Students	Yes	Yes	Yes	Yes	Yes	No	Yes	No
50121034-8	Graduated Students	Yes	Yes	Yes	Yes	Yes	Yes	No	No

At the end of this process, we got 811 records and 27 columns (attributes) for mining using classification algorithm as illustrated in table 4.

Data mining using an Association Rule Learning (Kotu and Deshpande, 2015)

This paper used association rule learning for discovering interesting relations between elective courses and required courses in REG. This technique use algorithm that finding the set of association of item set which is often similar At this step, we have to prepare the training set which developed based on observed data from year 3 and 4 only, where the prediction attribute is whether or not the students had a academic records problem. (Data mining concept, 2016) as shown in table 5.

Table 5: The example of student training data set.

STUDENTCODE	ITE-305	ITE-308	ITE-401	ITE-402	ITE-414	…
50121002-5	Yes	Yes	Yes	Yes	No	…
50121003-3	Yes	Yes	Yes	Yes	No	…
50121004-1	Yes	Yes	Yes	Yes	No	…
50121005-8	Yes	Yes	No	Yes	Yes	…
50121006-6	Yes	Yes	Yes	Yes	No	…
50121007-4	Yes	Yes	Yes	Yes	No	…
50121011-6	Yes	Yes	Yes	Yes	Yes	…
50121012-4	Yes	Yes	Yes	Yes	Yes	…
…	…	…	…	…	…	…

At this point, this paper derived a rule set from mining that we can use for solving our problems. In this section, we demonstrate the twenty kinds of rule sets as following figure;

```
1. INT-303=Yes 745 ==> ITE-302=Yes 745    <conf:(1)> lift:(1) lev:(0) [0] conv:(0.92)
2. INT-303=Yes ITE-301=Yes 743 ==> ITE-302=Yes 743    <conf:(1)> lift:(1) lev:(0) [0] conv:(0.92)
3. ITE-305=Yes 722 ==> INT-303=Yes 722    <conf:(1)> lift:(1.09) lev:(0.07) [58] conv:(58.76)
4. ITE-305=Yes 722 ==> ITE-302=Yes 722    <conf:(1)> lift:(1) lev:(0) [0] conv:(0.89)
5. ITE-302=Yes ITE-305=Yes 722 ==> INT-303=Yes 722    <conf:(1)> lift:(1.09) lev:(0.07) [58] conv:(58.76)
6. INT-303=Yes ITE-305=Yes 722 ==> ITE-302=Yes 722    <conf:(1)> lift:(1) lev:(0) [0] conv:(0.89)
7. ITE-305=Yes 722 ==> INT-303=Yes ITE-302=Yes 722    <conf:(1)> lift:(1.09) lev:(0.07) [58] conv:(58.76)
8. ITE-301=Yes ITE-305=Yes 720 ==> INT-303=Yes 720    <conf:(1)> lift:(1.09) lev:(0.07) [58] conv:(58.59)
9. ITE-301=Yes ITE-305=Yes 720 ==> ITE-302=Yes 720    <conf:(1)> lift:(1) lev:(0) [0] conv:(0.89)
10. ITE-301=Yes ITE-302=Yes ITE-305=Yes 720 ==> INT-303=Yes 720    <conf:(1)> lift:(1.09) lev:(0.07) [58] conv:(58.59)
11. INT-303=Yes ITE-301=Yes ITE-305=Yes 720 ==> ITE-302=Yes 720    <conf:(1)> lift:(1) lev:(0) [0] conv:(0.89)
12. ITE-301=Yes ITE-305=Yes 720 ==> INT-303=Yes ITE-302=Yes 720    <conf:(1)> lift:(1.09) lev:(0.07) [58] conv:(58.59)
13. ITE-301=Yes 809 ==> ITE-302=Yes 808    <conf:(1)> lift:(1) lev:(-0) [0] conv:(0.5)
14. ITE-302=Yes 810 ==> ITE-301=Yes 808    <conf:(1)> lift:(1) lev:(-0) [0] conv:(0.67)
15. INT-303=Yes 745 ==> ITE-301=Yes 743    <conf:(1)> lift:(1) lev:(-0) [0] conv:(0.61)
16. INT-303=Yes ITE-302=Yes 745 ==> ITE-301=Yes 743    <conf:(1)> lift:(1) lev:(-0) [0] conv:(0.61)
17. INT-303=Yes 745 ==> ITE-301=Yes ITE-302=Yes 743    <conf:(1)> lift:(1) lev:(0) [0] conv:(0.92)
18. ITE-305=Yes 722 ==> ITE-301=Yes 720    <conf:(1)> lift:(1) lev:(-0) [0] conv:(0.59)
19. INT-303=Yes ITE-305=Yes 722 ==> ITE-301=Yes 720    <conf:(1)> lift:(1) lev:(-0) [0] conv:(0.59)
20. ITE-305=Yes 722 ==> INT-303=Yes ITE-301=Yes 720    <conf:(1)> lift:(1.09) lev:(0.07) [58] conv:(20.18)
```

Figure 4: Rule base from association technique by WEKA

Results and Discussion

As a result of data mining process, all twenty rule sets were found to contain the same four courses: INT-303, ITE-301, ITE-302 and ITE-305. These four courses were also grouped into a set of three. In total, four sets {INT-303, ITE-301, ITE-302}, {ITE-302, ITE-305, INT-303}, {ITE-301, ITE-305, INT-303}, were found at rules 2, 10, 11 and 16, at rules 5 and 6, at rules 8, 12 and 19 and rule 9 respectively. Then the grades of courses in each set were averaged and plotted as shown in Figure 5.

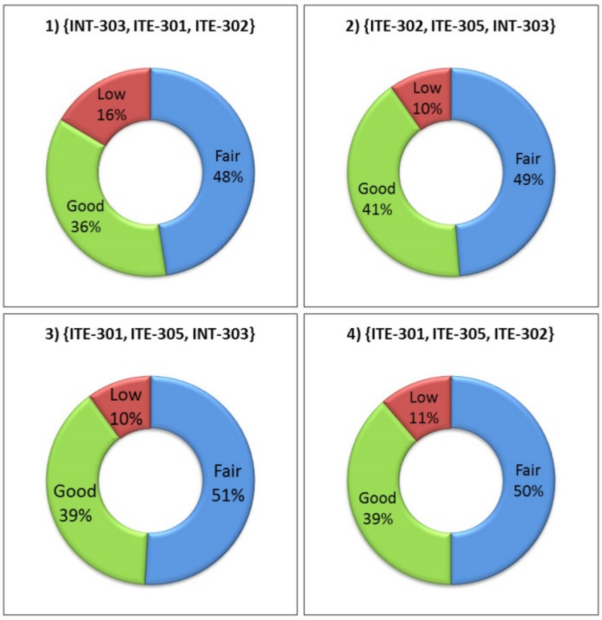

Figure 5: Comparison of average grade from each rule sets.

According to Figure 5, pattern 2 is recommended to the students because the number of students who received the average of grades greater than 3.0 from the three courses is as high as 41%. Students should avoid taking courses in pattern 1 since the number of students who received the average of grades lower than 2.0 is as low as 16%.

Conclusions

This study shows an opportunity from mining information from REG data using association rule. In this study, the proposed algorithm ‘‘The Apriori Algorithm” (Kotu and Deshpande, 2015) has been able to extract itemsets for understanding a group course that be used for counselling students in choosing a proper course for good academic performance. The novelty of this study is that we will use this techniques for further study in all faculty and then develop an application for students to help their registration.

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Sentence Diagramming as an Effective Tool for Teaching English to Engineers

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Abstract

Teaching English to future engineers has been an ongoing struggle in KOSEN, whose students tend to score quite low on TOEIC and other standardized English tests. In an effort to improve the English performance of these students, an original take on sentence diagramming based loosely on Chomsky's generative grammar has been developed. The example sentences utilize engineering themes to increase exposure to keywords in scientific and engineering fields. The diagramming itself is taught in English thus increasing student exposure and need for the target language. Sentence diagramming was found to be a valuable pedagogical technique to encourage greater interest and learning in English classes. Sentence diagramming as a teaching method was popular in the past for teaching native students grammar but has rarely been used for ESL (English as a second language) or EFL (English as a foreign language) despite many teachers learning about grammar through the technique. However, sentence diagramming has been reexamined and modified to creating a simplified system that is meant specifically to help EFL students learn about important features and rules of grammar. Sentence diagramming as a method to teach English to engineers was shown to be a way to get otherwise disinterested engineering students interested in English grammar and help them better learn relevant vocabulary and grammar. This technique is both a grammar consciousness raising technique and a vehicle for teaching IN English. Evidence of the technique's effectiveness is anecdotal at the moment, but future research will certainly clarify its efficacy. Data to test the hypothesis will be collected after the students' exposure has been sufficient (towards the end of the school year). Thus, this research is a work in progress and definite results cannot yet be given. Though a preliminary survey of student attitudes towards the technique indicates that students find the material engaging and helpful as compared to other English classes.

Keywords: *EFL, English, ESL, Grammar, Kosen, Pedagogy, Sentence Diagramming, TESOL*

Introduction

English education has been an ongoing challenge for teachers at KOSEN, where students frequently lack motivation and/or ability as reflected in their poor TOEIC scores, often scoring even lower scores when they finish their 5 year education with a KOSEN than when they began, Tokuda et. al. (2008). The 5th year students who participated in this study had a mean score of 326 on the TOEIC before beginning the class - their last English class before exiting the system. This puts them well behind the already minimal goal of 400 on the TOEIC - a score very few students successfully achieve. It is assumed that teachers have tried many different techniques over the 8 year course of their education. However, institutionally, so far nothing has gained much traction to replace the traditional grammar translation methods generally employed. Thus most classes are taught by non-native speakers using a grammar translation technique. This is apparently ineffective as indicated by the poor scores reported above.

As a result, the authors have decided to try a completely different approach that is rooted in both sound pedagogical theory and suitable for students with an engineering mindset and engineering ambitions. A method that should be comfortable for teachers and amenable to the larger system in which it has to be used. This technique is three-fold. Ostensibly, it is a sentence diagramming technique that is meant to raise student consciousness of English grammar. This is what is sold to the students and curriculum gatekeepers but there is a hidden idea at work, namely that the students will be learning about this diagramming IN English. This will make English both a tool for learning and the object of learning. Finally the sentences used for diagramming will heavily feature COCET vocabulary aimed at science and engineering students to improve engineering relevant vocabulary, Kameyama et.al (2011). This last point is often difficult to address as most scientific and technical English text books are aimed at students with much higher scores. It is hoped that this three-pronged teaching technique can improve the efficiency of English education in KOSEN. The technique will be more completely described below.

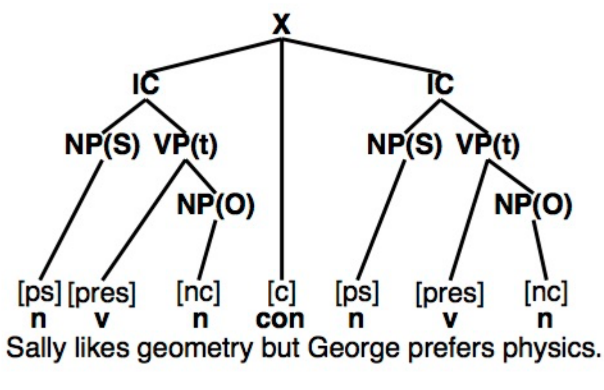
Pedagogy

The pedagogy employed by this technique is three fold: using sentence diagramming to raise grammatical consciousness, teaching this method IN English, and using technical and scientific vocabulary in the example sentences as recommended by COCET. It is hoped that this three pronged approach will both improve upon and scaffold on the grammar translation method that is already in use in most Japanese classrooms and reinforce the vocabulary Engineering students need for success in their fields. Since Japanese teachers of English already often use many of the concepts required in sentence diagramming due to their normal grammar translation pedagogy it was hoped that both teachers and students would be comfortable with the idea of teaching and learning sentence diagramming in English and they would already have the basic knowledge needed to succeed. Also as engineering students, they likely already use other kinds of diagrams in their major course work, so they may find a certain amount of comfort in using diagrams to help them with English grammar. Sentence diagramming is also a more interactive and visual technique than grammar translation, so it will engage them in ways they have not previously used in English class but have had success with in their major course work. Let us look at each of the 3 prongs of the approach separately so that we can have a better understanding of how each works.

The first prong of the approach and around which every other portion is built, is a modified version of tree style sentence diagramming based loosely on Chomsky's X Bar theory, Chomsky, N. (1980) and as presented in Burton Roberts, N. (2011). The material was presented to the students using a textbook created by the authors, Engineering English, Grumbine, Furuike (2016). As mentioned before it is hoped that this approach appeals to engineering students as sentence diagramming is more analytical and visual in its approach and scaffolds on the grammar translation systems to which they have already been exposed but with which they have generally had little success. The basic concepts and vocabulary presented should already be familiar to the students but the technique itself will be fresh to them. This combination, it is hoped, will allow the students to build on past knowledge and increase their motivation to learn. While the exact diagramming technique will be new, the idea of diagramming itself to make complex systems easier to understand should be a familiar exercise for them as well.

The exact system for diagramming the sentences was created by the authors with the aim of raising grammatical consciousness of the diagrammer. The first step in diagramming is to identify and label the basic grammatical building blocks of English - the parts of speech. From these blocks, the students will learn how they can be arranged into larger chunks or phrases which they will also label and see show how these phrases relate to each other to form clauses and coherent sentences by using a tree style diagram. Students must label the forms (clauses and phrases), functions (subjects, objects, complements, adverbials etc), and other details (tense, voice, count, plural, etc) and their relationships in the diagram thus forcing students to pay attention to many important aspects of grammar that they might not normally pay attention to or understand. This will serve to raise students' grammatical consciousness and help them better understand common patterns of English. The rules of grammar will take on a more analytic and visual form, hopefully making this information more accessible and memorable to them. The puzzle like aspect of diagramming also makes the activity a bit more interesting and can be done in small groups, encouraging team work and the sharing of knowledge. See the diagram in Fig. 1, below for an example of a basic sentence diagram.

Fig.1.



Sentence Diagram

In the diagram above, Fig.1, students have to first label the parts of speech in the sentence with lower case letters: noun, n; verb, v; conjunction, con. Then they have to identify details associated with the words previously labeled in brackets: proper noun, ps; present tense verb, pres; non-count noun, nc; and coordinating conjunction, c. Then they have to work top down to identify the clauses that make up the sentence and label them in capital letters, identifying the independent clauses, IC, that make up the compound sentence. Then they must identify the noun phrase, NP, and verb phrase, VP, that make up the subject, (S) and identify the predicate as transitive (t). Then they have to identify the noun phrase after the transitive verb and label it NP and identify it as the object of the verb, (O). Functions are indicated with capital letters in parentheses and predicates patterns are identified with lower case letters in parentheses. They also have to show the hierarchical structure of the sentences by connecting the parts appropriately using straight lines, showing which forms are, parents, daughters, or sisters etc.. Recognizing these relationships draws their attention to the forms, functions, and important details of a sentence that they might otherwise ignore.

The second prong of the technique is to teach the information IN the target language. The diagramming technique being new to the students is something that they will HAVE to learn in order to succeed in class. This learning is to be done IN English. This forces the students to USE the target language to acquire the skills they need to pass the tests given in class. Learning in the target language is believed to be one of the best ways to learn a foreign language, Krashen (1981). Thus the students will be both learning ABOUT English and learning IN English. This should make the learning MUCH more effective and satisfy both institutional and student expectations about English class. Since the basic concepts will be familiar to them, and the idea of diagramming is something they already have some experience with, this new information should not be too challenging for them to acquire IN English. Likewise, they will also be encouraged to ask questions in English and to produce their own original phrases and sentences in English, thus increasing their output in the target language.

The very limited and repetitive input of sentence diagramming has proven anecdotally to be a viable level of English to use in class. Few students shut down and most seem to follow what is being taught. And as the actual diagramming information is new they must maintain some focus to succeed.

The last prong of the approach is to use relevant vocabulary for engineering students as most textbooks are not geared towards this kind of student. The vocabulary employed will mostly be taken from the COCET 2600 word list, so students will be using words that should be helpful and apply directly to their more technical studies without being too difficult. This will make the lessons more relevant to their studies and match their interests and future needs.

This three prong technique is currently being used to teach all 5th year KOSEN students at the National Institute of Technology, Ariake College. The students are taught by a single teacher in groups of roughly 40 per class in 1.5 hours blocks once a week for 32 weeks with each class focusing on a particular grammar feature. The classes generally follows a regular procedure: A short review of the previous weeks work (usually in the form of interactive Q&A). Then several example sentences presented that feature the grammar point being explored that day with students encouraged to discover the patterns and relevant details and to build on what they already know by labeling the parts of the sentence. Then the remaining “new” forms or ideas are explored and taught including any new labels and diagramming techniques. After this has been presented thoroughly, the vocabulary is reviewed. And finally the students are broken into small groups (4-6 students) to work on diagramming more example sentences. When they are finished, groups are called to the board to present their diagrams which are then examined as a class for accuracy. A short review of the important points follows and finally a quick Q&A to check for understanding. Tests are given quarterly.

Results and Discussion

After 12 weeks the students were asked to take a short 7 point Likert like attitude survey to measure how they felt about this sentence diagramming technique. The survey was presented in both English and Japanese to make sure they fully understood what was being asked of them. (Twenty additional diagramming questions were also given just to get a feel of how well the material was absorbed. This portion of the results has not yet been evaluated at the time of printing.) The relevant survey questions are given below:

Diagramming Survey

Using a scale of 1 through 7 how much do you agree or disagree with the following sentences (1= completely agree and 7 = totally disagree):

下の文章にどのていど同感できるかを１から７の尺度で表して下さい。（１はとても同感できる、７は全く同感できない）

1. I found sentence diagramming to be more interesting than my usual English classes.
文の系図化（センテンス　ダイアグラミング）は、従来の英語の授業よりも興味深いと思った。

2. I felt that sentence diagramming was more helpful than my usual English classes.
文の系図化（センテンス　ダイアグラミング）は、従来の英語の授業よりも英語学習に役立つと感じた。

3. I found sentence diagramming to be more enjoyable than my usual English classes.
文の系図化（センテンス　ダイアグラミング）は、従来の英語の授業よりも楽しいと思った。

4. I feel that sentence diagramming will help me with my future English studies.
文の系図化（センテンス　ダイアグラミング）は、今後の英語の学習に役立つと思う。

5. I prefer sentence diagramming to other English classes.
文の系図化（センテンス　ダイアグラミング）は、他の英語の授業よりも好きだ。

The results of this survey were as follows:
Total number to which the survey was given: 163
Total number of responses: 162
Total number of disregarded responses: 5 (students who gave responses other than 1-7 i.e. 0,8 or 9 , etc., or who gave exactly the same answer to all questions including those not included here - it was assumed they did not give serious answers - i.e., just filled in #1 across the computer card).
Total number of used responses: 155
Mean scores: Question #1 = 2.41
Question #2 = 2.51
Question #3 = 2.00
Question #4 = 2.49
Question #5 = 2.66

These results show that the technique is thought by students to be more interesting, helpful, enjoyable, and preferred to their other English classes. Of course these are rather subjective elements of the class. Unfortunately these students are not required to take any standardized English test while they are 5th year students (they took the TOEIC test when they were 4th year students and had a mean score of 326 as reported previously). Their test scores on classroom exams has been good with a mean score of 77% with a 60% score being passing (and several students getting perfect scores) but this is not objective enough to be used as solid evidence and there is no control group so the evidence is only anecdotal at this point. Far more students are getting high passes than failing scores (high pass is 80% or better at a ratio of about 4 to 1 - in past classes it has been more like 1 to 1).

Conclusions

Sentence diagramming is mostly seen in a positive light by students, and they tend to feel that this method is more effective than those employed in their other English classes. Employing the method should not be too difficult for most teachers who already have a strong grasp of grammar and are familiar with the relevant vocabulary. The current largest stumbling block is the availability of ready made teaching materials and basic experience with the technique. To fill that void the authors are working on a textbook that is currently in beta form and was used in all the classes in this study. But the findings in this research are mostly anecdotal so further study will be required to appraise the true objective effectiveness of this 3 pronged technique. Such research and the required testing is planned for the near future.

Acknowledgements

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A STUDY ON THE ACTIVE LEARNING FRAMEWORK IN LAW AND ECONOMICS

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Abstract

This study evaluated and analyzed the active learning pedagogy applied during the course of 'Law and Economics', an elective offered by the National Institute of Technology, Tokyo College, where students learn about the theory of economic analysis of the rationale behind the legislative system. In the first half of the term, 11 students (10 male and 1 female) were taught on the theory of 'Law and Economics' and report writing. To encourage students to engage in proactive thinking and cross-examination, and to ascertain that students had prepared for their lessons, they were tested prior to classes before being asked to prepare reports for their presentations. In the second half of the term, students reviewed each other's reports through group work before presenting their reports individually. In addition to asking essential questions about the presentations that reflect critical thinking, students also had to collaborate with the presenter to come up with good answers. This group work is therefore a simulation of the actual presentation in which students could polish their presentation skills by analyzing the reactions and responding to the questions of the audience. The contents of the students' presentation reports were analyzed to evaluate their progress in various skills. Results indicated that students' overall presentation skills, self-expression and communication skills were significantly improved. In addition, students conducted peer-evaluation using a rubric assessment where one of the descriptors was "Characteristics of an excellent presentation". Presenters would receive high points for clear and effective self-expression. As the scoring system used is a point-addition scoring system (no points are deducted), students were therefore more motivated to perform better as they could see their efforts being appraised positively from the increased points. Students who were able to accurately explain and describe the characteristics as to why the presentation was excellent would also receive high points. This study described the combination of group work and presentation utilized in the framework of active learning in "Law and Economics" and analyzed various relevant outcomes in a small setting of 11 students.

Keywords: *active learning, rubric, group work, simulation, point-addition scoring system*

Introduction

The National Institute of Technology, Tokyo College, is a science and technology college and currently offers an elective titled 'Law and Economics' to all final year students where they study the 'Economic Analysis of Law': a research method whereby microeconomic theory is applied to the analysis of laws and regulations (such as withdrawal rights) to validate the generated benefits in an economical way. An example is the analysis of economic efficiency regarding the regulation of property rights by comparing between two hypothetical societies with and without property rights. The regulation of property rights is considered to be economically justified if the benefits generated by the society with property rights are larger than the one without. Students learn the foundation of economic analysis of law (Eidenmüller, 2011) in this elective course by studying European withdrawal rights in English, which is defined by Article 9 of Directive 2011/83/EU of the European Parliament and of the Council of 25 October 2011 on consumer rights, amending Council Directive 93/13/EEC and Directive 1999/44/EC of the European Parliament and of the Council and repealing Council Directive 85/577/EEC and Directive 97/7/EC of the European Parliament and of the Council [2011] L304/64, as "the consumer shall have a period of 14 days to withdraw from a distance or off-premises contract, without giving any reason, and without incurring any costs". Although consumers are to keep their promises in the usual event (*pacta sunt servanda*), they are allowed to withdraw from the contract within the specified withdrawal period if the consumer deemed the contract broken. In other words, consumers, entitled to their withdrawal rights from the agreement established in distance selling, may return the goods and get refunds from the seller. Students are introduced to Eidenmüller's (2011) economic distinction between experience goods, search goods and credence goods, which forms the basis of withdrawal rights. Eidenmüller advocated that withdrawal rights are necessary for experience goods and supported it with an example of purchasing clothes through distance selling (i.e., mail order), where the consumer has to purchase the good before knowing whether it is comfortable or not. On the other hand, withdrawal period is unnecessary for search goods (such as unpacked fruits as the quality can be immediately ascertained) and credence goods (such as medical services since the non-professional consumer will find it difficult to ascertain the quality at any rate). However, in the case of experience goods, 'information asymmetries' (an economics term describing insufficient product information) between the seller and the buyer lead to market failure due to 'adverse selection' (i.e., consumer selects a low-quality good due to information asymmetries instead of selecting a high-quality good in a functioning market). In such a situation, consumers only pay low prices for experience goods of which they cannot ascertain its quality, and high-quality goods remain unsold, thereby leading to a market collapse. An effective solution for this situation is 'signaling' (i.e., indicator providing information indirectly). For example, if the buyer is unable to obtain accurate information about the good directly, he/she will expect the 'signal' (information conveyed by the seller about the good's supposed high quality) to be accurate. Withdrawal rights thus function as 'signals' in such situations since the consumer can withdraw from the contract after making the purchase even without product information. This way, sellers are able to sell goods without much product information by sending signals, consumers will not withdraw from the contract as long as they are not unpleased, and high-quality goods sellers will not have to contend with high withdrawal rates or the associated expenses. Eidenmüller also explained why mandatory law is inappropriate for withdrawal rights in the distance selling context since consumers want the good's price to be lowered if they are not entitled to withdrawal rights. Unlike doorstep transactions where the consumer is compelled to buy under pressure from surprise visits, Eidenmüller posited that withdrawal rights should not be made mandatory, but voluntarily in distance selling to respect the consumer's wishes.

There are not many students in the Tokyo College who take this social science elective as it is outside of their natural science majors, and those who take this course naturally have low study motivation. The main purposes of this study are to apply the active learning pedagogy onto 'Law and Economics' in an attempt to enhance students' motivations and skills through a combination of group work and oral presentations, and to analyze the various relevant outcomes. Despite the fact that 'Law and Economics' is not an engineering course, students still stand to benefit from this course as studying an elective from a different field would not only enhance their overall education but also help them in applying what they learned in their fields and achieve better research achievements. For example, the logical thinking skills required for studying economic efficiency and the self-expression ability required of this elective would no doubt help students in their natural sciences research pursuits. The active learning pedagogy is thus believed to enhance students' skills and motivations, and this paper describes the teaching method used and its results.

Pedagogy

11 students (10 male and 1 female) took this course and were not given any homework during the first two classes. When tested at this juncture for their overall comprehension of subject matter, only 3 students understood the concept of experience goods while 5 students mentioned 'information asymmetries' with reference to why 'withdrawal rights are necessary in distance selling'. In addition, none of the students demonstrated perfect understanding of 'reasons behind the inappropriateness of mandating withdrawal rights'. Only 1 student could answer that 'prices would increase if withdrawal rights are mandatory' while the remaining students were still unclear. In an attempt to improve students' comprehension, they were tested in the subsequent three classes to expound important terms and phrases, and to ascertain whether they prepared for classes beforehand. In the first test, they were asked to complete this sentence: "Given the high quality of the product, the associated ( ) costs are comparatively ( ). Along those lines, withdrawal rights can also be explained as a ( )". The answers were 'guarantee', 'low' and 'signal'. Through this test, students get to review these terms and understand the importance of 'the cost of signals in the form of guarantee will be low'. Similar tests were conducted in the second and third rounds to respectively explain the concepts of 'there are consumers who wish to buy at low cost without withdrawal rights' and 'large retailers tend to offer withdrawal rights to consumers'.

In the second half of the term, students were teamed up and asked to submit, present and grade each other's presentation reports in English in the following format: 1) overview of Eidenmüller's paper, 2) justification for withdrawal rights and why mandating it is inappropriate, 3) providing specific examples, 4) personal opinions, 5) questions to partner, and 6) answers to questions. Students were allowed to use photographs and illustrations as long as it did not infringe on portrait rights or copyrights. They were also briefed on the assessment criteria of the rubric (Table 1) in order to help them to clearly establish goals and effective learning plans. Students were graded on their understanding, logical explanation and ease of comprehension of various concepts (economic analysis of goods, relationship between information asymmetries and market, relationship between information asymmetries and signaling, difference between distance selling and doorstep transactions, efficiency of signals), extent and volume of research performed, volume and pace of their voices during oral presentations, and finally, integrity of their answers. Since a point-addition scoring system (no points deducted) was employed, there were situations where both 'graders' and 'presenters' received more than the full score of 100 points. The submission guidelines and passing criteria of their reports are as follows:

1) Accurately explain Eidenmüller's (2011) article,
2a) Explain and justify why withdrawal rights are necessary in distance selling using the same article. Students must demonstrate understanding of the relationship between experience goods and market failure, and that signalling is able to decrease information asymmetries and prevent market failure,
2b) Explain why 'not mandating withdrawal rights is better' with respect to 'mandatory law is inappropriate'.

Students must demonstrate understanding that waiver of this withdrawal right will lead to lower goods prices, and consumers' decision-makings are not twisted in distance selling as compared to doorstep sales,
3) Explain in detail the rationale behind this justification using specific examples (such as specific legal system, products, settings, and clothes purchase). The use of illustrations and photographs will facilitate ease of comprehension,
4) Accurately explain and describe their opinions,
5) Prepare questions and corresponding answers for their partners,
6) Prepare answers based on questions submitted by their partners.

Table 1. Assessment criteria of rubric

Descriptors	Criteria (3 = excellent, 2 = satisfactory, 1 = slightly unsatisfactory, 0 = unsatisfactory)				Points
	3	2	1	0	
Comprehension and expression of the basis of justification of withdrawal rights					
Comprehension and expression of the reasons why mandatory withdrawal rights are inappropriate					
Relevance, ease of comprehension and expression of specific examples					
Relevance, ease of comprehension and expression of personal opinions					
Relevance, ease of comprehension and expression of questions					
Relevance, ease of comprehension and expression of answers					
Characteristics of an excellent presentation	(Students to fill in)				

Results and Discussion

To validate the results of the initial test, students were again tested on their comprehensive understanding of the topic before the commencement of group work. 2 students demonstrated perfect understanding of 'justification for withdrawal rights', 5 students could understand and describe 'information asymmetries' but 4 students were unclear about the difference between distance selling and doorstep sales. None of the students could explain that 'consumers' wishes are not twisted in the context of distance selling' with respect to 'why mandating withdrawal rights is inappropriate'. While 5 students indicated that 'prices would increase if withdrawal rights are mandatory', the remaining 6 students remained unclear.

Results from the rubric assessment of 11 students revealed that only 5 students demonstrated perfect understanding of the 'justification of withdrawal rights'; another 5 students could understand and describe information asymmetries but 1 student remained unclear. Overall, the skills of 6 students were improved from group work. With regards to the 'reasons behind the inappropriateness of mandating withdrawal rights', only 1 student demonstrated perfect understanding; the other 9 students managed to point out that 'prices will increase if withdrawal rights cannot be waived' while 1 student remained unclear. Again, the skills of 6 students were improved from group work. Analysis of students' descriptions of 'Characteristics of an excellent presentation' from the rubric assessment revealed that the main characteristics included 'specific explanations with illustrations' and 'presentations were accurate, simple yet easy to understand'. Even when more than half of the students did not perfectly understand the topic, they achieved more than 100 points for self-expression during their oral presentations. On the other hand, there were many students who were unable to grade poor presenters on the 'Characteristics of an excellent presentation'. Overall, student's presentation skills, self-expression and communication skills were significantly improved and they were also motivated to perform better since their efforts were positively appraised with the point-addition scoring system.

Conclusions

Active learning pedagogy employed for this 'Law and Economics' elective in a small setting of 11 students has clearly demonstrated that the combination of group work and oral presentation reports helped students to improve their presentations skills by analyzing real-time reactions and responses of the audience. Students' comprehension, self-expression skills were similarly boosted through this simulation of presentation while the implementation of group work and evaluation tests at each and every level also enabled students to recognize their own improvements. Students came to realize the need for simulation (practice) before their actual presentations and that this experience would be the most beneficial of all. One noteworthy mention was a student who enthusiastically commented, "presenter's analysis was very clear", suggesting that students find this helpful and interesting and should be incorporated as one way to engage them in learning.

Overall, active learning, combined with the point-addition scoring system unique to the Japanese education system, has produced excellent results from the students than originally expected. This scoring system (with no upper limit) is thought to be effective since students are encouraged and motivated to study harder. Although it is difficult and impractical to implement such an evaluation system with no upper limit in schools (the maximum allowable score is 100 points), this should be considered for further investigation.

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A Student-teacher Type of Class and an Experimental Device Designed/made by Students for a Deep Understanding of Autoignition

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Abstract

In this paper, I propose a new and effective method of class for lower grade students by using a little new experimental device made by their seniors. In the department of maritime technology, we teach and train students who will become navigation officers or engineers. To play an active part as engineers of the ship, they must study a wide range of academic knowledge. Especially, they are required to have a practical knowledge of mechanical engineering to treat various machines mounted on the ship. To show the autoignition phenomena to the lower grade students in the class, some students in my seminar and I tried giving the preliminary experiment using a simple device which was already on the market. In conclusion, some problems were revealed. A device was only able to visualize autoignition, and did not have other functions. Moreover, it has structural defects from the viewpoint of stability and safety of experiment. In the seminar, students made an experimental device, which is able to visualize autoignition and measure the temperature of the internal space. This device was made from an acrylic pipe, a stainless steel rod, two aluminium blocks and a thermocouple. The temperature was recorded by the data logger. First, students researched the autoignition points of the tested samples (paper, cotton, etc.) and calculated the temperature of the air after compression. Then, they decided the compression ratio and structure of the device based on the calculation and problems as mentioned above. Next, students designed and manufactured an experimental device by their own hands. After the assembly, they ran the experiment, and observed autoignition and got the temperature data. Then, I set up an opportunity for them to give a lecture on autoignition in my class. This class was held for 3rd grade students, and seminar students lectured for them. In result, the autoignition experiment succeeded, and the 3rd grade students deeply understood autoignition phenomena and temperature increase by compression. On the other hand, seminar students acquired skills of planning, designing, manufacturing and lecturing through this activity. Moreover, they achieved a sense of accomplishment, contributing to the lower grade students' deep understanding of the phenomena.

Keywords: *Design and production, Higher grade and lower grade students, Experimental device, Mechanical engineering, Autoignition*

Introduction

In the department of maritime technology, we teach and train students who will become navigation officers or engineers on the ship, for example container ships, petroleum tankers, LNG ships, ferries and so on. The department of maritime technology consists of the nautical science course and the marine engineering course. The students of the engineering course study the handling of various machines mounted on the ship, mechanical engineering, electrical engineering, material science, drawing and so on. Especially, to treat the main engine, engineers have to have a deep understanding of thermal dynamics and combustion phenomena occurring in the diesel engine.

I give lectures mainly about the diesel engine to all grade students of the marine engineering course, and feel the difficulty of teaching the mechanism of the diesel engine to the junior students. They can't imagine the phenomena occurring in the engine, because they were junior high school students until quite recently, and they don't have enough scientific knowledge and boarding experience. So I show animation and movie and the actual pars of the diesel engine to help their understanding, and take a long time to explain politely. As a result, most of the lower grade students understand the mechanism of the engine. On the other hand, it is true that some students' understanding of diesel combustion (injection-autoignition-combustion) is inadequate. There are more than a few lower grade student who has doubts about the mechanism of the diesel engine like the following. In the past, the same could be said with 5th grade students (senior students) in my seminar.

- Why does the temperature rise by air compression?
- How is the compression ratio related to the auto ignition and the in-cylinder temperature?
- Why does the fuel ignite by air compression?
- What is the difference between the adiabatic and the polytropic change?

Then senior students and I decided to make a device which can help the understanding about diesel combustion completely. As a trial implementation of the teaching method like a “learning assistant”, which has spread among universities in recent years, senior students tried to plan, design and manufacture the device. Finally, they gave a lecture to the 3rd grade students (junior students). This activity was conducted as part of the graduate research of senior students.

Experimental device
1. Design concept

The senior students conducted preliminary experiments using the autoignition experiment device on the market. And then, some problems were revealed. Problems were as follows.
a) Low success rate of autoignition
b) Wobble of the device at the compression stroke
c) Difficulty of cleaning the inside of the cylinder
d) Little functionality

With these matters in mind, the students set concepts as follows and designed the device.
a’) Higher temperature after the compression stroke
b’) Setting of firm foundation
c’) To make both ends of the cylinder possible to be opened
d’) Measuring the air temperature inside the cylinder and piston displacement

To meet the concepts mentioned above, the students planned to provide sill (under the piston), thermocouple (inside of the cylinder) and high speed camera (to shoot motion of the piston). By measuring the temperature, we can research the autoignition point of the tested samples approximately, and observe the increase of the temperature in the combustion process. Moreover, by measuring the piston displacement, we can do the exercise of polytropic change based on the obtained values by the experiment.

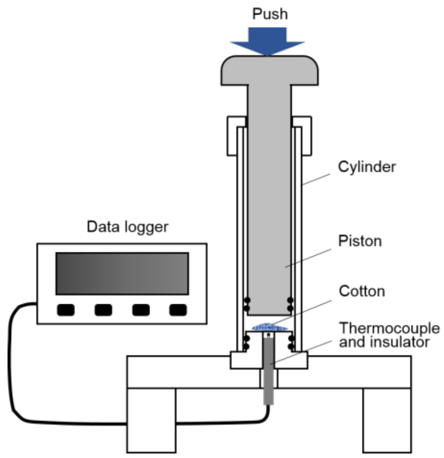

Fig.1 Schematic diagram of experimental device.

Table 1 Principal specification of device.

Wide, Depth,	100×100 mm
Height (TDC~BDC)	300~430 mm
Cylinder diameter (outer)	φ 20 mm
Cylinder length	150 mm
Cylinder thickness	5 mm

Fig. 2 Manufacturing of equipment parts.

2. Manufacturing

Fig. 1 shows the schematic diagram of the experimental device which was made in the present activity. The cylinder was made of an acrylic pipe. The piston was made of a stainless steel rod. To prevent leakage of air in the cylinder, two O-rings were mounted on the tip of the piston. On both ends of the cylinder, alminum caps were mounted. R thermocouple covered with the insulator penetrated through the bottom cap. Temperature data was recorded by the data logger. The principal specifications of the experimental device are shown in table 1.

The students used a lathe (Fig. 2), a drilling machine, and a milling machine. It took 10 hours in total to manufacture the autoignition experiment device.

Experiment
1. Experimental method and conditions

In this activity, cotton was employed as tested sample. An appropriate amount of cotton was putted in the cylinder, and we closed the caps mounted on both ends of the cylinder. Then we pushed the piston quickly, in-cylinder temperature increased. If it went well, auto ignition of cotton occurred.

Initial in-cylinder temperature was room temperature (about 300 K), and pressure was atmospheric pressure. Piston stroke is about 130 mm at maximum, and the compression ratio was about 15 at maximum in present activity.

2. Experimental result

Before the lecture by senior students, they tried auto ignition experiment by using the device which they made. Fig. 3 is continuous photos of the autoignition. At the start of the experiment, the piston was placed on the top of the cylinder, and it was pushed downwards quickly. After that, if the in-cylinder temperature rose over the auto ignition point, the tested sample (cotton) was ignited.

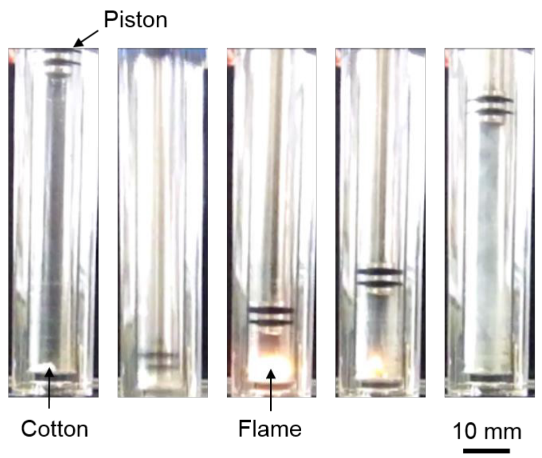

Fig. 3 Continuous photos of auto ignition.

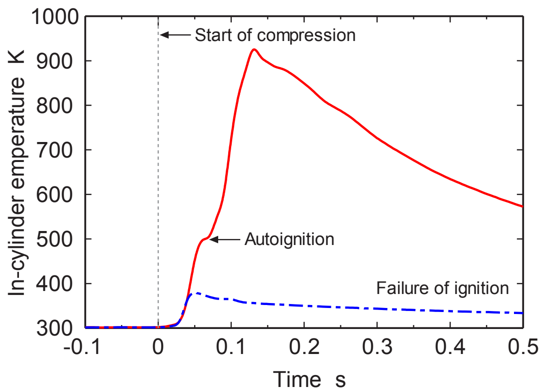

Fig. 4 Time histories of in-cylinder temperature.

Fig. 4 is part of the temperature data obtained by the thermocouple and the data logger. The vertical axis is the in-cylinder temperature, and the abscissa is the elapsed time based on the time of starting compression. The solid line (in red) is the result in case of success of ignition, and the dashed line (in blue) is the case of failure. When the auto ignition succeeded, the in-cylinder temperature rose from 300 K to 500 K by compression (Fig. 4: Time=0.06 s). Immediately after that, the auto ignition occurred, and the in-cylinder temperature rose to about 900 K (Time=0.13 s). Then the piston returned to initial point, and the temperature decreased gradually. On the other hand, when the increase of temperature was not enough, the auto ignition did not occur.

Class

1. Autoignition experiment and discussion

First, the senior students explained the purpose and aim of this class to the junior students. The aims of this class were that the junior students would become able to explain the details of the auto ignition and the increase of the in-cylinder temperature, and to estimate the in-cylinder state. After that, senior students explained the structure and the functions of the device, and how to use it (Fig. 5a).

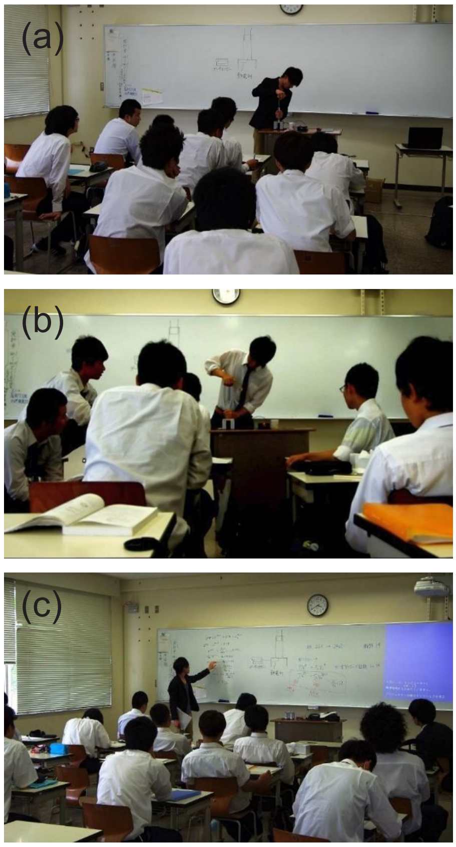

Fig. 5 (a) Demonstration of the experiment.
(b) Competition.
(c) Lecture and discussion.

In this class, the junior students (19 people) were separated into four groups, and they competed each other to increase the compression temperature and the success rate of ignition. Before the experiment, they discussed and made strategies. Main contents of the discussion were as follows.

- Compression stroke, speed
- Inbricants (oil or grease or no use)
- Volume of cotton

They gave a short presentation about their strategies, and conducted the experiment (Fig. 5b). The students were allowed 5 attempts per group. After the experiment, the senior students showed the graphs of the in-cylinder temperature, and they gave each group the value of the compression temperature.

To summarize, each group had the data as follows, where V is volume of a cylinder.

- Initial temperature T_1 :About 300 K
- Compress. temperature T_2 :Obtained data
- Compression ratio ε ($=V_1/V_2$):Obtained data (Observation using digital camera)

Assuming the simple polytropic change, the relation between the temperature and the volume of the cylinder is expressed in the following equation (1), where n is polytropic index.

$$T_1 V_1^{\,n-1} = T_2 V_2^{\,n-1} \qquad (1)$$

Equation (1) is deformed as follows.

$$T_1 \varepsilon^{n-1} = T_2 \qquad (2)$$

By substituting the initial and obtained value (T_1, T_2, ε) into the equation (2), the junior students can calculate the polytropic index n. The index "n" differed depending on the groups. Moreover, all of these values are smaller than the specific heat ratio. The junior students discussed reasons for these differences. After the discussion, the senior students explained the reasons for these differences, and I added some auxiliary explanation. Then, this class was over.

2. Impressions

2.1. 5th grade students

Through this activity, senior students of my seminar commented as follows.

- I could tackle to this activity with a great sense of responsibility for juniors.
- I acquired skills of planning, designing, manufacturing and lecturing.

To accomplish the purpose of helping junior students understand the diesel combustion phenomenon, they made efforts to study various things actively and deeply. A sense of responsibility for juniors was one of the important factors which motivated them in this activity. Of course, this sense is effective at what kind of class that senior students give to junior students.

2.2. 3rd grade students

After the class, the questionnaire was conducted by secret ballot. Questions were as follows. Figure 5 shows aggregate results.

Q. 1 : Did you tackle this class actively?

Q. 2 : Did you understand auto ignition phenomena by the experiment?

Q. 3 : Did you understand differences between adiabatic and polytropic change?

Q. 4 : Did you understand the formula of polytropic change by calculation using obtained data?

Looking at the result of Q. 1, it is shown that there were a small number of students who were not active. Looking at a result of Q. 2, it is shown that all of the students understood auto ignition phenomena on one level or another. I think, it is because of the experience that the junior students ignited cotton by their own power without ignition source. Looking at results of Q. 3 and Q. 4, it is shown that most of the students understood differences between adiabatic and polytropic change, and calculation as to polytropic change.

Conclusion

1. Achievement

I think, this activity has an educational effect on both senior students and junior students. The senior students tackled this activity with a strong sense of responsibility, and they made an effort to enhance various skills.

On the other hand, most of junior students understood auto ignition phenomena, thermal dynamics deeply. These themes are very important to learn internal combustion engine engineering. By solidifying the foundation of knowledge, high degree of comprehension can be expected in the future class.

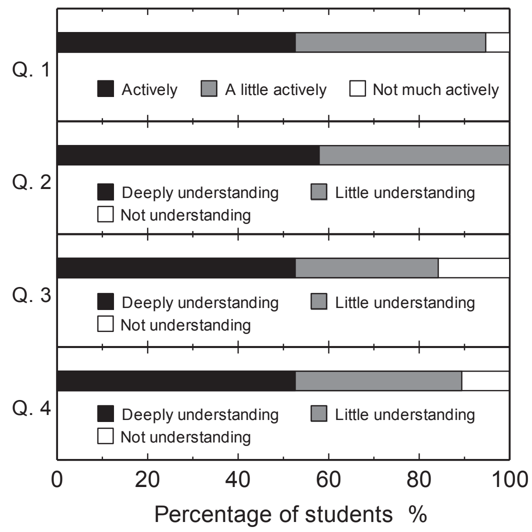

Fig. 6 Results of class evaluation questionnaires.

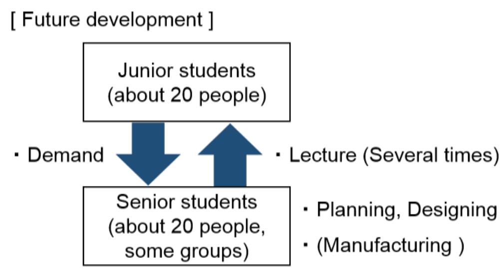

Fig. 7 Schematic models of future activity.

2. Future work

Fig.7 shows the schematic models of future activity. In present activity, two senior students and I determined the contents of the lecture one-sidedly, and two students gave a lecture to their juniors. I am going to try to change the system of this activity as follows.

- The number of senior student is about twenty (This is all of the 5th grade student of the engineering course). They make groups consisted of 3 or 4 people.
- Senior students conduct interviews with juniors, asking them what knowledge they want to acquire, or what kind of skills related to internal combustion engine engineering they want to get.
- Each group determines the activity theme, and plans how to advance the activities.
- Each group prepares for the lecture. If necessary, they manufacture teaching materials.
- Each group gives a lecture to juniors.
- After the lecture, Senior students make out a report about this activity.

It may be very difficult to make all of the students have an interest, be active, understand deeply. However, it will be possible with more ideas and efforts to get to the ideal class.

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INFUSING DESIGN THINKING AND SERVICE LEARNING INTO THE DIPLOMA IN CLEAN ENERGY MANAGEMENT (CEM)

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Abstract

Engineering courses traditionally focus on domain discipline knowledge that is often termed "technical" knowledge". However, over the years, the traditional model of engineering studies is increasingly seen as not addressing the needs and demands of today's fast-changing innovation economy and complex world. Employers are increasingly looking for graduates who are not only excellent in their technical knowledge, but are also able to offer human-centred engineering considerations in addressing complex problems. Critical and creative thinking, clear communication and an awareness of global perspectives are also key attributes expected of engineering diploma graduates. To prepare our students for the future engineering workplace, the Design Thinking and Service Learning philosophy was infused into the curriculum of the Diploma in Clean Energy Management (CEM) course, to cultivate in our students a purposeful learning experience and a passion for lifelong learning.

Design Thinking offers a process for students to infuse user-centred considerations into engineering projects before a product or service is conceived. Service Learning puts a human face on the otherwise cold and hard engineering products and technical solutions. These two pedagogies provide the vertical integration of modules students study from the first to the fourth semesters.

This paper outlines the framework CEM has piloted for the past two years to achieve a more holistic approach to learning design and delivery. In the process "Connecting the Dots" to bring about a better appreciation of how the learning in the various modules are interlinked. The key modules include Clean Energy and A Sustainable Environment (CESE), Electrical and Electronic Practice Skills (EEPS), Clean Energy Mini Project 1 (CEMP1) and Clean Energy Mini Project 2 (CEMP2). These modules are supported by Innovation Toolkits (INNOVA8), Power Electronics Applications and Practice (PEAP), Computer-Aided Design (CAD). The deliberate effort in actively engaging students' learning within a meaningful service learning context has produced positive outcomes and deeper learning.

Keywords: *Design Thinking, Service Learning, Engineering Education, Human-centred Engineering, Project-based Learning*

Introduction

The Diploma in Clean Energy Management (CEM) was introduced in 2009 as a result of government and industry consultations regarding the long term skilled manpower needs for the CleanTech sector [1] of the Singapore economy. The diploma is offered as one of the engineering diploma under the Ngee Ann Polytechnic, School of Engineering's twelve diploma courses in the Electrical Engineering Division (EE). The diploma focuses on clean energy technology and energy management. The diploma's curriculum was formulated in consultation with relevant industry partners and institutions of higher learning. Course reviews carried out every three years indicated that while the course content have adequately addressed the needs of the industry, students were lacking in the ability to relate contents of earlier semester's modules with later semester's modules. Students are learning content in silos and are not able to see the "big picture" or how their learning can impact the community. This results in students who are able to achieve good grades for their individual modules but unable to make use of module content learnt in an earlier semester to better understand a new module.

This "isolated" manner of learning is in contrast to the graduate outcomes that Ngee Ann Polytechnic wants to achieve. In 2015, Ngee Ann Polytechnic announces our Ngee Ann Graduate Outcomes - Passionate Learners, Big-hearted Persons and Global-smart Professionals. In line with this initiatives, NP seek to infuse into our course curriculum more learning opportunities for our students with the community at large. The Design Thinking and Service Learning pedagogies were identified to create such learning opportunities for our students. Design Thinking offers a process for students to infuse user-centred considerations into engineering projects before a product or service is conceived. Service Learning puts a human face on the otherwise cold and hard engineering products and technical solutions.

In view of the need to enable students to learn in a holistic manner and to see how their content knowledge has real world application, the CEM team decided to revise their curriculum to infuse Design Thinking and Service Learning into their diploma, with the intent to allow students to appreciate how their content knowledge is applicable to daily life and can support the needs of the community.

The CEM Course Curriculum

The Diploma in Clean Energy Management curriculum covers several core fundamental engineering modules. These are Electrical Technology (ELTECH), Engineering Mechanics (ENGMEC), Engineering Mathematics (EG1) and Computer Programming (COMPRO) in the first semester of studies. In addition, students also study the module Clean Energy and A Sustainable Environment (CESE) and the module Innovation Toolkit (8INNOVA). During the second semester, CEM students take Electrical and Electronic Practical Skills (EEPS) and 9INNOVA modules. In the third semester, CEM students take the Clean Energy Mini-Project 1 (CEMP1) and Power Electronics and Applications (PEAP) modules in addition to their core modules. And for the fourth semester, they take Clean Energy Mini-Project 2 (CEMP2) and Computer Aided Design (CAD) modules.

8INNOVA module focuses on exposing students to various skill sets in the innovation journey & gives students practical insights into design thinking. It aims to foster their creative confidence through an emphasis on observation, ideation techniques and market validation skills.

9INNOVA module enables students to apply skills earlier acquired in 8INNOVA for the School of Engineering (SOE) Creativity and Innovation Week. During the Creativity and Innovation Week, students will showcase and present the final outcome of their design thinking journey.

Table 1. The CEM Course Curriculum Map

Level 3	Level 3.2	6-month internship							
	Level 3.1	Building Energy Studies	Clean Energy System Integration and Protection	Design and Operation of Photovoltaic Systems	Energy Audit and Measurement		World Issues: A Singapore Perspective	IS	
Level 2	Level 2.2	Clean Energy Mini-Projects 2	Energy Management in Electrical & Mechanical Systems	Photovoltaic & Cells Fabrication Technology	Electrical Controls and Drives Practices	Engineering Mathematics IIIA	Computer Aided Drawing	IS	
	Level 2.1	Clean Energy Mini-Projects 1	Wind Hydro & Fuel Cell Technologies	Electric Circuit Analysis & Measurement	Electrical Installation Design	Power Electronics & Applications	Career & Professional Preparation 2	IS	
Level 1	Level 1.2	Analogue Electronics & Applications	AC Circuits	Electrical and Electronic Practical Skills	Digital Electronics and Practice	Engineering Mathematics II	Communication & Contemporary Issues	9INNOVA	
	Level 1.1	Clean Energy & A Sustainable Environment	Computer Programming	Electrical Technology	Engineering Mathematics I	Engineering Mechanics	Career & Professional Preparation 1	8INNOVA	S&W

Design Thinking

The Stanford Arts Institute [2], described Design Thinking as "The process that first defines the problem and then implements the solutions, always with the needs of the user demographic at the core of concept development. This process focuses on need finding, understanding, creating, thinking, and doing. At the core of this process is a bias towards action and creation: by creating and testing something, you can continue to learn and improve upon your initial ideas.

The design thinking process consists of these 5 steps:

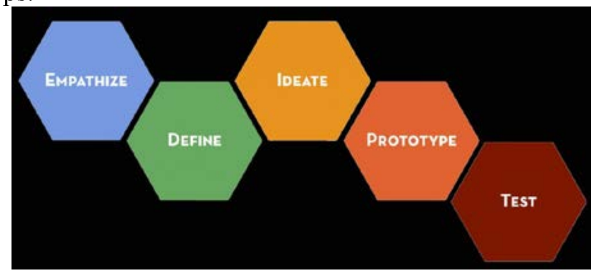


Figure 1. Design Thinking Stages

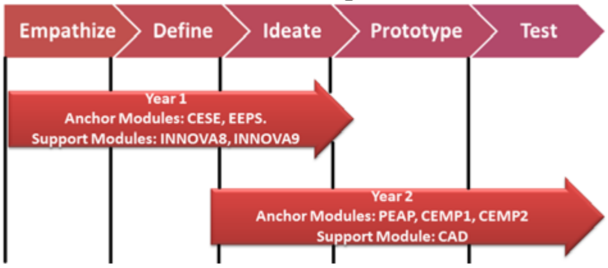
- **EMPATHIZE:** Students understand the experience of the user i.e. gardeners, receptionists, service crews, and the resort guests in Siloso Beach Resort (SBR) [3] through observations and interactions.
- **DEFINE:** Students process and synthesize their observations and findings from their empathy work in order to form a user point of view that they will address with their proposed solution.
- **IDEATE:** Students explore a wide variety of possible solutions, allowing them to step beyond the obvious and explore a range of ideas.
- **PROTOTYPE:** Students transform their ideas by building a prototype to realize their proposed solution.
- **TEST:** Students test their circuits (prototype) and use observations and feedback to refine their prototypes.

CEM Module Alignment for Design Thinking

Design Thinking was explored in April 2013 as a potential pedagogy to provide the linkage and build understanding between various modules in the curriculum. Design Thinking was chosen as the identified anchor and support modules have learning activities which can be aligned with the various stages of design thinking as outlined by the Stanford Arts Institute.

CEM anchor modules are designed with lectures, assignments, projects and workshop sessions with specific focus on key stages of the design thinking processes. Table 2 shows how various anchor (core) and support modules are mapped into the design thinking process.

Table 2: CEM Module Alignment for Design Thinking



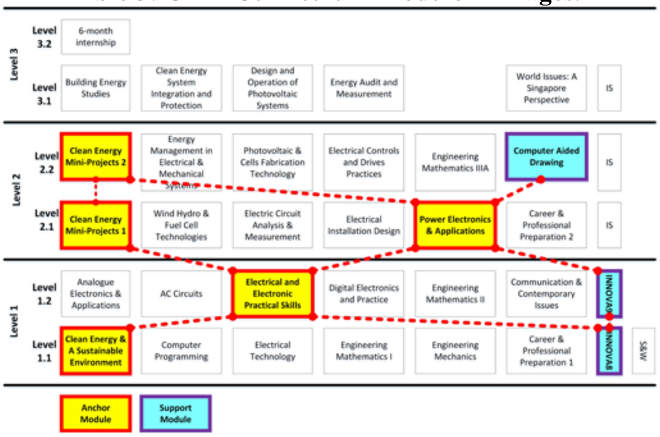
CEM Year 1 students learn key processes (Empathize, Define and Ideate) through the various learning activities in the CESE and EEPS anchor modules supported by 8INNOVA and 9INNOVA modules.

CEM Year 2 students learn key processes (Ideate, Prototype and Test) through the various learning activities in the PEAP, CEMP1 and CEMP2 anchor modules supported by CAD module.

Anchor Modules and Support Modules – Creating the connection between modules

A "Connect-the-Dots" table is shown in Table 3 to better illustrate the relationships between the various anchor modules and support modules over the four semesters. The relationship between the modules will require students to bring knowledge from one module to another. This means that students now have to make their own mental linkages between the different set of content and to learn to see them as a whole rather than just individual modules or topics as they are expected to draw on their previous content knowledge to progress in their project in the modules.

Table 3: CEM Curriculum Module Linkages.



In Semester 1, the anchor module Clean Energy and A Sustainable Environment (CESE) introduces students to the causes and impacts of global warming and climate change, and the urgency for clean energy alternatives to current sources of energy. It covers fundamental knowledge on energy, environmental sustainability and the interrelations among energy, environment and society. This module serves as the kick-off core module for the diploma as it builds up the core knowledge to support subsequent modules relating to clean energy and energy management. This module provides the ideal module for students to start their design thinking journey. Students also learned the various key skills in their corresponding Innovation Toolkit (INNOVA8) modules on Spotting Opportunities through Observations. It is also during this semester, where students are introduced to Siloso Beach Resort (SBR) which is a Resort on the Island of Sentosa in Singapore.

Introduction to Design Thinking: Contextualising

Students' design thinking learning journey starts with an off campus visit to the award winning Siloso Beach Resort (SBR) on Sentosa Island during the induction week of their first semester in Ngee Ann Polytechnic. This is to expose students to the concept of off campus learning implemented in this course. The Resort is an important industry partner in our learning roadmap for our students as it provides the real-world context for the students to see how the content they learnt in the classroom has practical application in the real world. This is especially so when much of the visit at the resort is an off campus Eco Tour to learn more about the Resort's various green initiatives which are directly relevant to the course.

The key highlight of this trip is the Eco-Tour which brings students throughout the Resort showcasing the various efforts to save water and energy. The Resort features a heat recovery system whereby heat from the air-conditioning system is recovered for hot water heating. It also features the use of spring water and water saving features in all the Resort's rooms. A wormery with almost a million worms provides organic fertilizers and pesticides for the extensive greenery area in the Resort. This Resort will form the backdrop to the design thinking journey which students will embark on in the second semester of this course.

In Semester 2, students who take EEPS module which prepares them for the required electrical and electronics skillsets, will start their design thinking journey by visiting SBR again. They visit on their own in teams of 3-4 students where they will begin their Design Thinking process by observing the Resort to identify possible projects and solutions that they can undertake as part of their "EMPATHIZE", DEFINE and IDEATE stages of their project. These students will continue their Design thinking journey through Semester 3 and 4, where students complete their IDEATE, PROTOTYPE and TEST stages of the design thinking process in the various other core modules.

Implementation, Learning Activities and Outcomes.

a) CEM Year 1 Semester 1: EMPATHIZE
CESE, INNOVA8 Modules.
Students are introduced to the Siloso Beach Resort during their first off campus visit. They get to learn

about the Resort's various eco-friendly initiatives and how they have actively incorporated corporate social responsibilities into their everyday activities. Sites visited in the Resort include a roof top garden, a no-chlorine used swimming pool, a wormery and a resort in a garden design concept.

b) CEM Year 1 Semester 2: DEFINE and IDEATE
EEPS, INNOVA9 Modules
Students learn to document their observations guided by the acronym POEMS#. They also learn to doodle and share their observations. All observations are documented in a learning journal. Students working in teams make several trips to SBR on their own to interact with staff of SBR and make on-site observations of activities in the Resort. They are allowed to take photographs to capture the situations they have observed. Students brainstorm proposed solutions to address identified 'pain-points' as documented in their learning journal. They present and share their proposed solutions with their classmates.

An acronym introduced in the INNOVA module for students to be guided during their "Opportunity Spotting through Observations" exercise. POEMS stands for:

P - Process Explanation
O - Objects used by the users
E - Emotion
M- Multiple Perspectives
S - Services Rendered

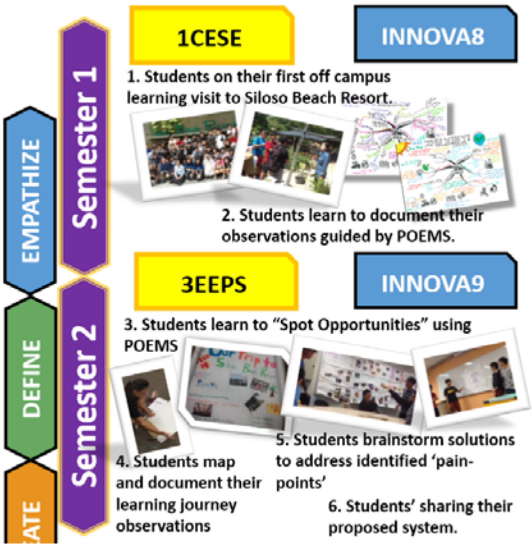


Figure 2. Summary of Year 1 Design Thinking student learning activities.

c) Year 2 Semester 3: IDEATE and PROTOTYPE
CEMP1, PEAP Modules.
Students learn to translate their proposed solutions into electrical and electronic circuit diagrams using the knowledge they learned from two anchor modules. Students will need to make connections between the 2 modules and propose a workable design that meets the users' needs. The Clean Energy Mini Projects 1 (CEMP1) Module guides students to build an electrical or electronic application using clean energy at the end of the module. Students are guided in each workshop practice to learn about various practical electronics and electrical circuits, batteries charging and discharging circuits, microcontroller and microcontroller interfacing with sensors, relays, switches, serial and network devices. The Power Electronics and Applications (6PEAP) Module introduces to students the principles of operation and analysis of power conversion circuits such as AC to DC converters, DC to DC converters, DC to AC converters and AC power controllers. Students learn to apply their knowledge in power semiconductor applications to the control and conversion of electric power. Students will learn build and test their circuits as part of their solution.

d) Year 2 Semester: PROTOTYPE and TEST
CEMP2, CAD Modules
Students integrate sub circuits into a complete project solution in the Clean Energy Mini Project 2 Module. This module aims to allow students to deepen their knowledge and skills in developing a clean energy application or an energy management system. Students work on mini-projects using skill-sets learnt in Clean Energy Mini Projects 1 to gain hands-on experience and understand how different clean energy technologies are deployed and managed to convert clean energy sources to electrical power. Here, the students assemble and test circuit with a live PV system installed at our Solar Technology Centre in the Polytechnic. Students are also required to use their AutoCAD knowledge to document their circuits and systems by creating digital drawings to be included in their final project reports.

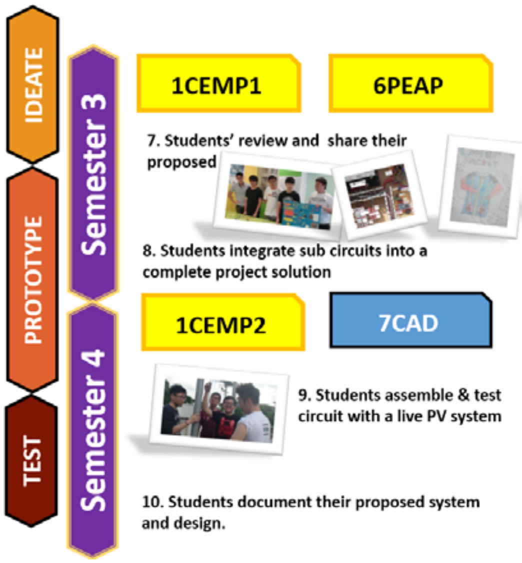


Figure 3. Summary of Year 2 Design Thinking student learning activities.

Service Learning: Using their learning for the Community

The adoption of Service Learning in the curriculum is also part of the process to develop our students into "Big Hearted Persons" that cares for the community, and the willingness to use what they have learnt to serve others.

Service learning was piloted during the April 2014 and April 2015 Induction Week for Year 2 students. Service Learning elements has been added to the course curriculum guided by the following service learning principles. [5] Service Learning activities will involve students in community service activities and applies the experience to personal development. Service-learning occurs when there is "a balance between learning goals and service outcomes". Service Learning differs from internship experience or volunteer work in its "intention to equally benefit the provider and the recipient of the service as well as to ensure equal focus on both the service being provided and the learning that is occurring". Service Learning course objectives are linked to real community needs that are designed in cooperation with community partners and service recipients. In Service Learning, course materials inform student service and service informs academic dialogue and comprehension.

Service Learning engages students in a three-part process: classroom preparation through explanation and analysis of theories and ideas; service activity that emerges from and informs classroom context; and structured reflection tying service experience back to specific learning goals.

On their first trip to the Senior Activity Centre, students engage the seniors in several activities such as serving them afternoon snacks, perform song and dance items to entertain them, help them in the making of small projects and spend time chatting with them to better understand their life and challenges faced. This stage is important as the observations from the visits would allow students to reflect on the areas in which they can make a difference in the daily lives of the Seniors.

During follow up visits, students will start to use their learning from the course to design and develop small projects that can help the Seniors cope with their daily life.

Figure 4. Summary of Service Learning student learning activities.

Discussions

With the infusion of Design Thinking and Service Learning pedagogies into the course, module experience survey results (refer Table 4 below) have shown improvements across the board. This survey examines students perception of their learning experience and the improvement was seen in terms of Feedback and Materials which are the areas that are usually low in the scores as inidcated in the table below.

This result also shows that a change in the T&L has allowed for more interactions between the students and also encouraged students to be thinkers and learners rather than just passive recipients of knowledge. More significantly, the use of Design Thinking and Service Learning have not dilute the content that is being taught as students have indicated that their understanding of the content has not reduced instead the quality of feedback and materials have improved. This indicates that students are taking more ownership of their learning and are using the opportunity provided by the Design Thinking and Service Learning processes to be more engaged in their learning through discussions and consultations ingwith lecturers rather than just be passive listeners in the lecturer theatre.

Another benefit of infusing Service Learning into our course curriculum is the opportunity for our students to interact with a segment of the Singapore population which is projected to increase over the next few years, i.e. those aged 65 years old and above, and living alone. According to The Straits Times [7], Singapore's national English newspaper publication, this segment grew from 19.2% in 2000 to 31.3% in 2014 and is projected to grow over the next few years.

Table 4: NP Module Experience Survey: CEM

Year Of Survey	Q1 S&K	Q2 Thinking	Q3 T&L	Q4 Feedback	Q5 Materials	Q6 Activities	Q7 Overall
10/11 FT	4.57	4.52	4.43	4.33	4.22	4.46	4.52
11/12 FT	4.51	4.52	4.52	4.28	4.31	4.48	4.61
12/13 FT	4.55	4.50	4.50	4.32	4.27	4.48	4.54
13/14 FT	4.55	4.61	4.51	4.34	4.31	4.53	4.58
14/15 FT	4.62	4.64	4.55	4.43	4.40	4.53	4.57
Improvements %	2.44%	3.11%	2.71%	3.50%	4.27%	1.57%	1.11%

The seven survey questions are shown in the Appendix (A). In addition, students' feedback has mainly been positive. They found that design thinking gives them a sense of purpose when they develop their projects. Some students' non quantitative feedback is listed in the Appendix (B).

Conclusions

The need for a flexible learning design in curriculum delivery has been well documented.[6] Student feedback from these new blended learning models has been mainly positive. However an appropprite level of blending of the traditional classroom-workshop based learning model and newer pedagogies is essential for effective learning to take place in the 21st century. Finding a good balance will always be a challenge as technology changes have brought about a huge change in the availability of content for learning any time any place. Infusing Design Thinking and Service Learning philosophy into the curriculum are just small steps taken in response to the changing education landscape and thinking, the course curriculum must remain flexible and relevant to the changing expectations of the learners and the industry. The new curriculum design encourages students to take ownership of their learning and enables students to make connections between different modules. Students are also more aware of how their content knowledge is applicable in the real world and the impact it can have on the community.

Although it is early days, we are certain the infusion of the Design Thinking and Service Learning pedagogies into the curriculum will benefit our students and will bring about the desired learning outcomes in our graduates so that they are better equipped for their next learning journey and future career beyond the Polytechnic.

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[1] CleanTech sector includes Clean Energy, Environment and Water, https://www.edb.gov.sg/content/edb/en/resources/downloads/videos/sg-a-cleantech-hub.html

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[3] Siloso Beach Resort (SBR) is a Resort on the Island of Sentosa in Singapore. It has won many eco-friendly and sustainability awards for its efforts and activities. http://silosobeachresort.com/index.aspx

[4] Lion Befrienders Singapore, Senior Activity Centre (SAC) http://www.lionsbefrienders.org.sg/services/community-outreach/senior-activity-centre-sac/

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[6] Ben J. McGarrya, Karen Theobaldb, Peter A. Lewisb, Fiona Coyerb, 2015, Flexible learning design in curriculum delivery promotes student engagement and develops metacognitive learners: An integrated review, Nurse Education Today Volume 35, Issue 9, September 2015, Pages 966–973 http://www.sciencedirect.com/science/article/pii/S0260691715002610

[7] The Straits Times article published on August 17, 2015, headlined 'Old and home alone' http://www.straitstimes.com/singapore/old-and-home-alone-in-singapore

Appendix

A: NP Module Experience Survey Questions

Q	Category	Details
Q1	S&K	The module helped me to develop useful skills and knowledge
Q2	Thinking	This module stretches my thinking
Q3	T&L	The teaching and learning approaches are appropriate for this module/project
Q4	Feedback	I received useful feedback in a group/individually on my progress in this module/project/internship
Q5	Materials	The module materials (including materials on MeL and other online platforms) helped me understand
Q6	Activities	The module activities enhanced my overall learning
Q7	Overall	Overall, this module provided a good learning experience

B: Samples of our students' survey feedback.

I liked that we had a CEMP1 and CEMP 2 projects in our year 2 semester and it was a challenging experiences having to juggle with other modules and the project. I learned a lot during the project as we had to make our own system of our choice and connecting it with a stand-alone solar panel system. Improvements.

Practical work (site visits, learning more about electrical systems and renewable energy system in a practical way not just on theory.

Its well-rounded skills and knowledge acquired from different modules throughout the 3 years can be used in other modules.

So far the course has been an enjoyable experience and enjoyed it thoroughly.

We had interesting excursions to Siloso Beach Resort and other places.

The course is relevant to the current working world and the modules are good.

I like how our modules are mostly hand on which makes learning a lot more fun!

I get to be able to work on my very own project and have to come out with my own circuit.

Helps us to relate what we learn in class to practical use.

I was able to construct a project for a Resort.

This module helps me to understand how everything we study links together.

Being able to design our own circuit diagram.

This module exposes us to hands on experiments and we get to know better on what our course is about.

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MENTORING & COACHING ON COLLEGE LAB STUDENTS

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Abstract

Mentoring is a management technique to enhance both team performance and the each member's performance in a company. When I was in a company, I was applied by my boss as 20s and I also used the technique for young engineers beyond I took the training class.

Since 2011, I have joined in present university and have conducted students in a lab as a lecturer. Then, I tried to apply the mentoring technique on them through a probe chip manufacturing project. The probe chip is the typical product in the lab.

The first step was to let them know the purpose of the project. The purpose is to succeed the traditional process technique. However each student had individual research subject. The manufacturing project was a side work for them. In that case, I suggested them a sense of achievement that they did for one project as one team. They understood the purpose slowly along the team building.

The second step was to let them have a responsibility. The manufacturing process was divided and was assigned each to 2-student group. I trusted each group. The senior student executed mainly the processing and showed the attitude to young student. He (or she) felt a duty that completes the process, and the young student learned the process skill. In next year, the young one must feel same responsibility as previous senior one when he (or she) becomes senior.

The third step was to let them have a confidence to what they achieved. Some processes had often unexpected result. In such the case, I gave a hint and let them propose the mitigation plan. We discussed and I basically agreed their plan. When they fixed the problem by their plan, the success experience became their confidence. Also the confidence grows them up to a reliable engineer both for individual and for the team.

I recommend you to apply the mentoring technique on any teams and the members who are expected to step up, not only in the lab student case.

Keywords: *mentoring, team building, achievement, responsibility, confidence, step up*

1. Introduction

In first 10 years I joined a company as a fresh man, I experienced product introduction in a fab, failure analysis for yield enhancement and new product development in R&D in Austin, TX. Those were focused on my individual performance improvement.

After I came back in Japan, I had to work as a leader for a young engineering team. However, it was difficult for me to make a good output from the team, not only myself.

Thereat, I took "Mentoring and Coaching" class as a manager's training subject in the company. Mentoring is a management technique to lead young engineers step up and to enhance the team performance as the result. In the class, I remembered that my former bosses put on me the mentoring technique when I was young. So, I understood at last that they guided me to use my ability fully for their team in each case in past.

Later, when new products were transferred from US, I led the product engineering team as the sub-project leader and applied the mentoring technique on them. I thought we became good team at that time.

In 2011 when East Japan Earthquake occurred, I left the company and have joined present university from the October.

In this paper, the mentoring technique and my experiences are introduced in the university. The mentoring effects on a student and a team are verified. And social style and continuous team growth cycle are also discussed because those are important factors for mentoring.

2. Mentoring and the skills

Mentoring is a technique and a process which makes team members' relationship to coordinate each member and the team, and achieves the team target as the result. The manager who leads the team members is called "mentor", and the members are called "mentee".

Mentoring includes 5 skills[1)], Coaching, Counselling, Teaching, Role Modelling and Championing.

(a) Coaching

The mentor discusses with the mentee to set the team target. At this point, the mentor must let them up motivation to the target. Coaching is to enhance the motivation in each mentee until the achievement.

(b) Counselling

Counselling is a feedback method to the mentee. The mentor hears mentee's opinions then gives suitable advises both good and even bad points openly and honestly. It shows the mentor's attitude that he always keep them in touch and makes liability each other.

(c) Teaching

Teaching is to give knowledge and skills to the mentee basically. In mentoring, teaching is also to share the value for the target achievement. And it also expects that the mentee will be able to teach them the other members later.

(d) Role Modelling

The mentor shows a model performance for a job and the mentee learns the role seeing it. Role modelling expects that the mentee will be able to play the role instead the mentor.

(e) Championing

The mentor assigns a mentee as a champion for a job. At the first moment, the mentee may not be the specialist for the job. He must learn the job with some advises from the team members. Championing shows trust relationship between the mentor and the mentee, and expects that the mentee will become real specialist for the job.

3. Students in the college lab

From my view point which experienced over 25 years as an adult worker, college lab students who just joined there look too young to take a responsibility. Back in memory, I was also incompetent at that time.

They have learned many subjects in the classes. In some cases, they know the latest knowledge which I didn't study at same age. And they are using Internet and the application tools naturally. In our generation, we also use the tools recently. However, young students master new tools much faster than us.

However they haven't gotten an attitude yet to apply the knowledge on actual fields. Even if they know the theory in their head, they cannot make an image how the experiment to be executed. So it must be learned through a lot of experiences.

Thus, I applied mentoring technique on them in order that they take the attitude until they graduate. The experiment environment was explained as below.

4. Experiment condition

My mentoring experiment was tried in 2014 and in 2015, 2 times.

4-1. Object students (as mentees)

In 2014, they were master-course 1st –grade (called M1) and 2nd –grade (called M2) students belonged to a lab which makes neuronal probe chip (named Toyohashi Probe see Fig. 1) using VLS growth+ technique. In 2015, former M1 became M2 and new M1 students joined.

+ VLS growth is a selective crystal growth method that source material is applied as a Vapour, solves in catalytic material as a Liquid and precipitates from the saturated liquid as a Solid.

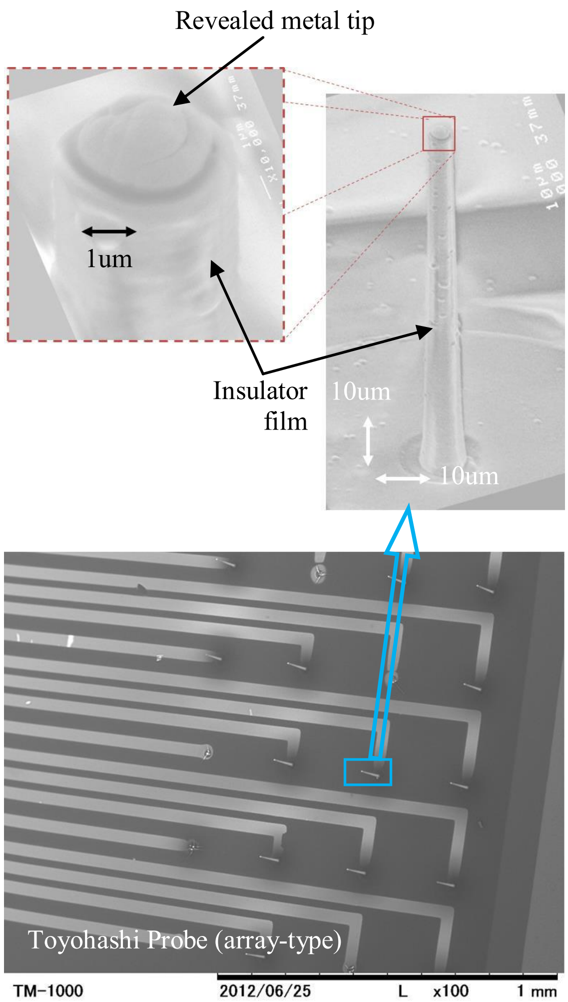


Fig. 1 Toyohashi Probe

4-2.Shttle project

The probe chip manufacturing is basically Integrated Circuit (IC) wafer processes those are film growth or deposition (Depo) - photo lithography (Photo) - wet or dry etching (Etch) repetition (see Fig 2). Our university has the tools and facilities those achieve the processes.

We named the manufacturing Shuttle project. The process flow was divided to 9 steps in 2014 and 12 steps in 2015, and they were assigned to a M2-M1 student group each as shown in Fig. 3.

Only VLS growth at step 6 was executed by me and doctor-course student Kb. Because the growth process is the most important that determines the probe shape like very narrow needle. Further, the growth tool operation is so very complicated that limited students can succeed the technique every other several years.

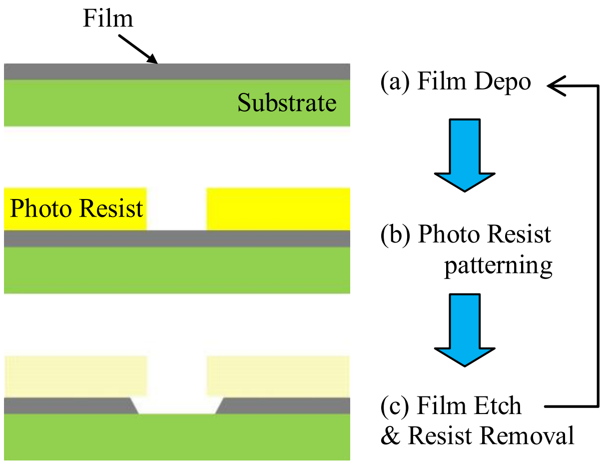


Fig. 2 Basic IC process cycle

4-3. Experiment expectations

Through the projects with mentoring techniques, I expected that the students felt following subjects;

(i) Team building,
(ii) The project purpose,
(iii) Responsibility and
(iv) Confidence.

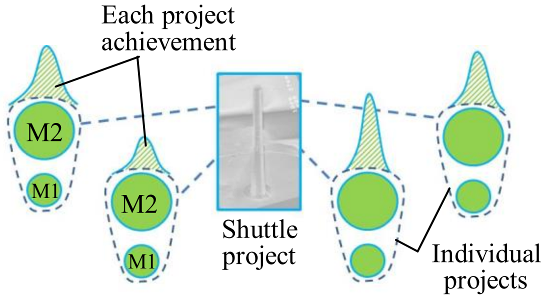
5. Results

This experiment results could be seen only on the students (as mentees) the behaviour and the attitude change through the project.

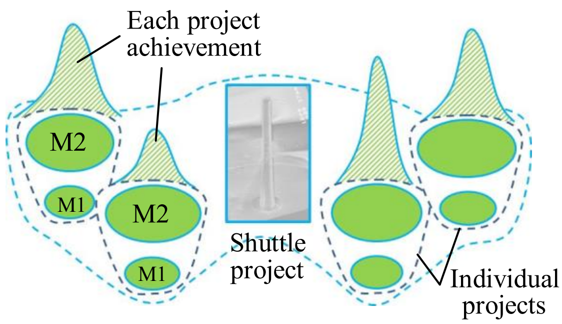
5-1. Team building with the project purpose

The first step was to let them know the purpose of the project. The purpose is to succeed the traditional process technique and share in the lab. As told in the above, our university has the process tools and can realize an IC chip along our design. Only, the tool operation must be trained by the actual users' handling.

On the other hand, each student had individual research project. They have to spend their time on their project at 1st priority. Therefore, the shuttle project was marked down as a side work for them. If no action applied, they grow isolated in the lab even with each skill up (see Fig. 4(a)).



4(a) Shuttle project as side work for each project

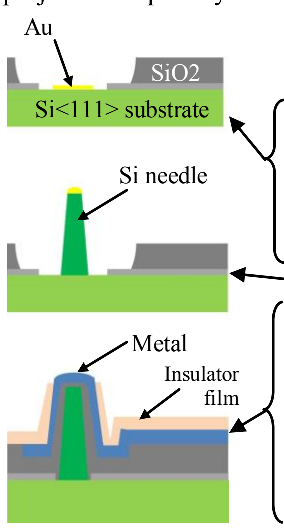


4(b) Shuttle project as shared work in the lab team

Fig.4 Team building effect with common project purpose

In this case, I suggested them with (a) coaching technique, a sense of achievement that they did for one project as one team. The coaching process was as follows. Their process skill up is good progress for each. If they could share the traditional process technique in the lab members, the lab's baseline skill would also be improved by all the members. It would make them up one team that they share the common purpose project. Further, each individual project should've also achieved better result on the wider baseline than before (see Fig. 4(b)).

They suspected my suggestion at first because they worried their own research time reduction. However,



		2014			2015		
step#	Process	T or D	M2	M1	T or D	M2	M1
1	Align.Target etching		Tk	Sk		Sk	Ns
2	Sub-Con opening					Mt	Ag
3	WSi runner patterning					Mk	Mr
4	Au patterning		Yg	Ur		Ur	Yh
5	CVD patterning		Tk	Ur		Do	Yc
6	VLS growth	Oi	Kb		Oi & Kb		
7	Poly Si/Au Removal		Kb	Mt	Kb		Ag
8	CVD Dense/Anneal		Oi	Mt		Do	Mr
9	Contact opening					Mk	Ns
10	Metal patterning	Ym		Mt		Sk	Yh
11	Parylene/Tip opening	Sw	Yg			Mt	Mr
12	Parylene/PAD opening			Mk, Do		Ur	Yc

Fig. 3 Shuttle Process Flow and Assignment

they had been feeling the effect in weekly lab meeting when every process step succeeded. Finally, they understood the purpose, to succeed the traditional process technique, along the lab team building.

5-2. Responsibility

The second step was to let them have a responsibility. The manufacturing process was divided and was assigned each to M2&M1 2-student group.

M2 students had already some experiences of the IC processes in his their M1 period on their project. However, in the beginning of the M2 period, they were not so matured yet to teach the process to the M1 partner. And they had not felt the responsibility in each process step yet.

In that case, I told each group with (e) championing technique, I trusted they can do it. This was also my expectation that senior M2 student so mastered the process that they teach it others and young M1 student learned the process for succeeding next year. Further, I encouraged them with (a) coaching that it would be an important contribution for the project and the lab team.

From the encouragement, the M2 student was doing the process mainly with the partner M1 student. Even if the M2 student did the process clumsily at this time, he (or she) tried to execute the process until completion. So, he (or she) felt a duty on the process step, their group must do it by themselves.

In the same time, the partner M1 student saw the M2 student's attitude to the process and learned the process skill. In fact, the M2 student played (d) roll modelling as a mentor, instead of me. However, the M1 student might not feel same responsibility as the M2 student's one at this moment.

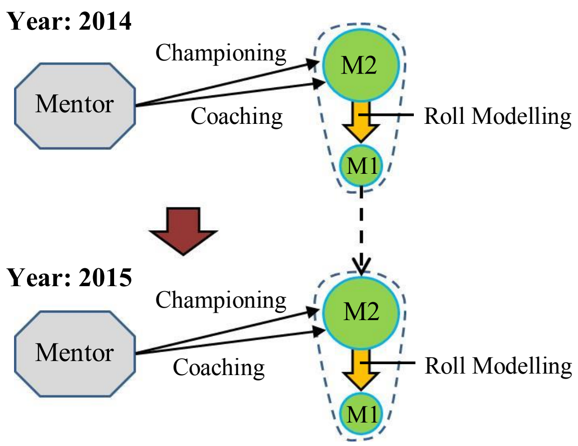


Fig. 5 Responsibility grown by championing

The learning effect at M1 period came out in next year, M2 period. He (or she) became senior M2 and in same position as former M2 students in previous year. When new shuttle project started in the year, I encourage the M2 student and the partner M1 student. At the time, the M2 student must've felt same responsibility as previous senior M2 student (see Fig. 5).

5-3. Confidence

The third step was to let them have a confidence toward what they achieved. Just doing the process becomes cumulative experience for the students. As stepping up, the confidence which they can do the process, is gotten through the difficult situation.

In shuttle project, some processes had often unexpected result. Even if same condition as last year was applied, different result may come out on our tool. Because the tool condition itself might be fractured by any other experiment records in past time.

In such the case, we discussed about the progress in the process with (b) counselling technique. At first, I heard their explanation without any objection. Next, we extracted good points and bad points on the story, and sorted the truths along the time line. The sorting is very useful for us the root cause finding of the trouble.

From the sorting result, I gave a possible hint with (c) teaching technique to the students, and let them think some proposals to solve the problem. We discussed their proposal and I basically agreed their plan even if it was not the best way I thought. I believed them and just observed their proposal trial.

When they fixed the problem by their plan, the success experience became their confidence. Also the confidence grew them up to a reliable engineer both for individual and for the team. Unfortunately, when the trial failed, we were back to the discussion and repeated trial persistently until the problem fixed.

6. Discussion

From some examples, the validity of the mentoring effect on the students and the team was verified.

6-1. Total effect on a student

For instance, Metal photo process in 2014 is introduced as follows.

1. Ym(M2) and Mt(M1) tried Metal photo process but found particle on the pattern (see Fig. 6).
2. They reported the particle problem.
3. I suggested photo resist (PR) removal and rework.
4. They proposed PR renewal with the bottle washing before the rework.
5. Their proposal fixed the problem and made clear metal pattern (see Fig. 7).

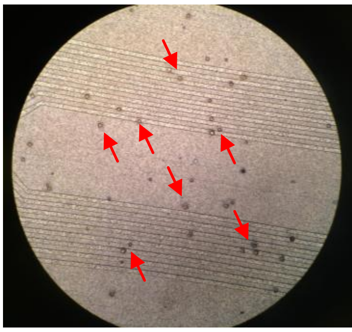


Fig. 6 Particle on the sample after Metal photo

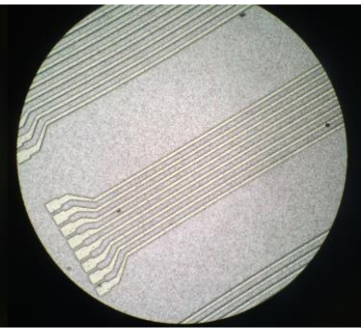


Fig. 7 Clear pattern after the problem fix

Mt learned the process skill and had confidence from the problem fix success at the M1 period in 2014. Next year 2015, he became M2 and could teach some process steps to M1 students with the responsibility (see Fig. 3). Therefore, he achieved the shuttle project purpose, to succeed traditional process technique in the lab team.

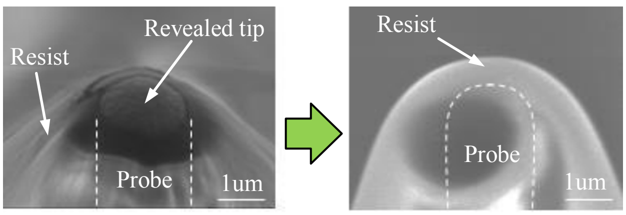
And he also showed some evidences of mentoring effect. He got the leader's sense, confidence and responsibility in the lab team. Further, he so grew up that he could teach the other students instead of me.

These were the expected result for me as their mentor. Thus, I guess that the mentoring was effective on him through the shuttle project.

6-2. Total effect on the team

For another example, Spray Resist Coating in 2015 is introduced as follows.

1. Ym and Kb who supported for Sk and Yh, tried spray resist coating to protect the probe needle from etching damage at step 10. But the resist coverage failed on the probe tip.
2. They reported the coverage failure on the tip.
3. We discussed the possible root causes around stickiness condition as I suggested.
4. The other student found that the resist production lot was renewed from previous one. And the viscosity looked much lower than previous one.
5. Ym and Kb proposed resist dilution ratio reduction to increase the viscosity.
6. Mt and the other team members also tried the resist dilution experiment for the process step.
7. Finally they succeeded to cover the probe tip with new resist dilution ratio.



(a) Dilution Ratio = 1:4 (b) Dilution Ratio = 1:3

Fig.8 Resist coverage on the probe tip

In this case, the problem was fixed by all team members' cooperation. M2 students recognized that the resist coverage problem was the common issue also for their individual project. M1 students also worked together excited by M2 student attitude.

And, since that, the new resist dilution condition has been shared by all team members and the other lab students also. It was good result as the team.

The lab members showed these evidences of mentoring effect. It meant that they were built up as a team and so stepped up that they could make better result than each member alone.

Thus, I believe that the mentoring was effective also for all members and the team through the common purpose shuttle project.

6-3. Social style factor

Mentoring effect depends on the mentee's social style strongly because mentoring is interaction between the mentor and the mentees each other.

Social style is a personal tendency plotted on 4 quadrants with assertiveness x-axis and responsiveness y-axis defined by Merrill and Reid[2)]. Strong assertive and high responsive is Promoting (P) style. Weak assertive and high responsive is Facilitating (F) style. Strong assertive but low responsive is Controlling (C) style. And weak assertive and low responsive is Analytical (A) style.

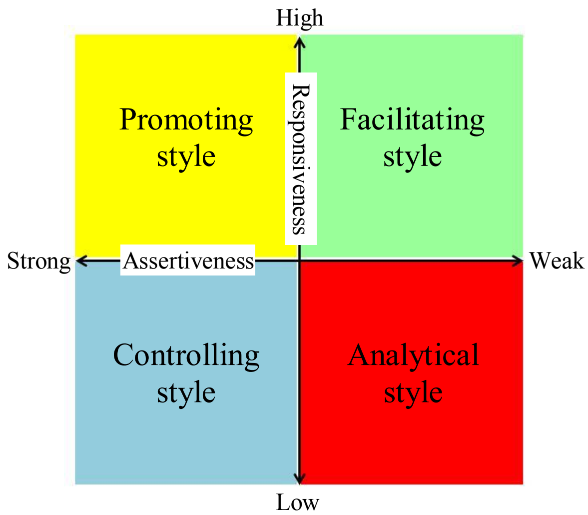


Fig.9 Social Style Matrix

Motivation is enhanced by different needs for each social style. P style wants praise from the team members, thus P style person tries all-new trial easily. F style wants acceptance, thus F style person collaborates with the other members. C style wants achievement on time, thus C style person uses any resources as much as possible. A style wants assurance based on past result, thus the A style person takes all data in the work.

It is not important which style is the best. Any team with some members must be consisted of the 4 styles combination. The team leader or manager as a mentor also has individual social style. Each person may have the strongest style and the 2^{nd} strong style. Thus the team behaves influencing the members with individual social styles each other.

Therefore, understanding the social style importance, mentor should keep in touch with the mentee along his (or her) social style to enhance the motivation. And mentor should also sometimes rearrange the other team members to extract the best team performance as much as possible.

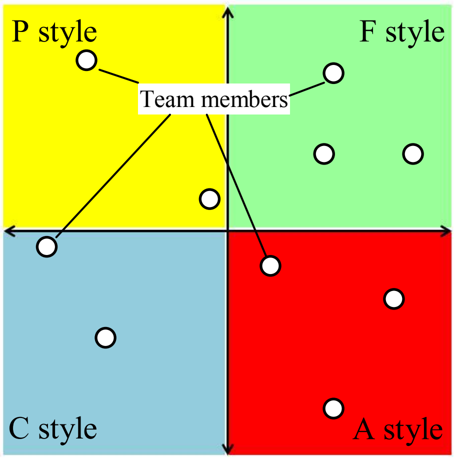


Fig. 10 Any team consists of 4 style members

6-4. Empower for innovation

In order to keep the team growing up, the team leader or manager has to transfer the competence to young champion person in the team every other several years. The champion is expected to make new innovation in the team. It is similar way to a long-lived company on the growth curve[3] (see Fig. 11), for instance, the president turns over.

The team starts up with the team leader's idea in the team policy forming phase (Phase1). In the phase, the team members might be confused or react to the new method, thus, the team performance does not rise up as the leader's intention.

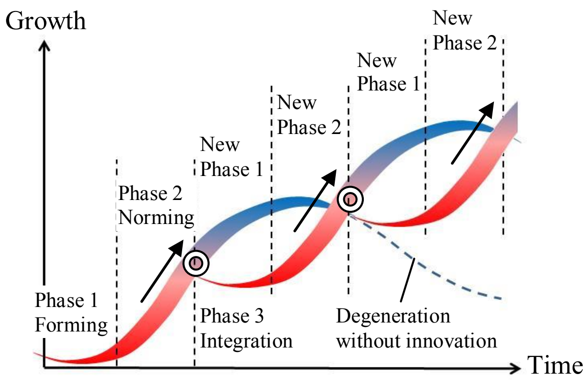


Fig.11 Continuous growth curve cycle

Thereat, the team leader applies mentoring technique on the team members. The team members are getting familiar the new policy by degrees and making better performance like it has already owned at last. It is the policy norming phase (Phase 2) when the growth up rate is also increasing.

The important point is to restart up with new idea within the high growing up phase. In parallel, previous matured method is succeeded as the team tradition and integrated into the team members. It is called integration phase (Phase 3) and overlaps in new phase 1.

The new phase 1 may be started up by new team leader who was assigned the champion in previous phase and empowered by previous team leader. The team would trace same declined phase 1 as previous cycle. However, the new team leader tries to grow up the team again in new phase 2 with the new idea and mentoring technique which learned from previous leader.

These are continuous growth curve cycle with periodic empowering shown in Fig. 11. Even if the team did not restart new phase 1, the team could grow up for a moment during the matured method is still effective. But the old method has no longer made new result and has been just a load for the team. Finally the team descends down and would be eliminated. It looks like a big company's up and down that the 1st president made it and the 2nd president grew it but the 3rd president close the company by just eating up.

In the shuttle project, I assigned doctor-course student Kb as the champion for the key process, VLS growth, and let him try to lead the lab team in the 2 years. At last year end, I empowered him as the next project leader. Now he is playing the new role with his original idea in the lab team.

Therefore, the empowerment timing to new leader is very important for the continuous team growth. Only, until the transfer, the current team leader has to grow next leader managing the team and the other members in parallel with the mentoring technique.

7. Conclusion

From the examples and evidences, the mentoring technique is effective for each student and the lab team through the common project and the purpose. And they and the team can grow up and step up more than on each isolated project.

I recommend you to apply the mentoring technique on any teams and the members who are expected to step up, not only in the lab student case.

8. Acknowledgement

I appreciate associate professor Kawano and his lab students those they agreed the experimental shuttle project as my intention.

And I also thank professor Ishida and professor Sawada who called me to join to present university after the East Japan Earthquake in 2011.

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PREPARING STUDENTS FOR THE WORKFORCE THROUGH WORKING ON REAL WORLD PROJECT

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Abstract

Graduates joining the workforce in the present context are expected to have industry-relevant and soft skills that allow them to be effective in their workplace. This is especially important in the new national Singapore initiative of skillsfuture. To better prepare students to develop such skills and be more 'work ready', it is ideal to provide them with opportunities to work on potential or real world projects.

Machine Development Centre at Singapore Polytechnic (MDC@SP), a Centre at the School of Mechanical and Aeronautical Engineering (MAE), works closely with the industry by providing turnkey automation and robotics solutions to improve their quality and productivity. Final year project students attached to MDC are given opportunity to work alongside staff, industry partners and suppliers on real world projects.

This paper shares the experience on how an industry project's enquiry with an initial doubt on its workability was taken up by the students as their final year project. The project was carried out by two groups of project students over two semesters. It was closely supervised by MDC staff and the students were guided through the different phases of the project using design thinking and Conceive-Design-Implement-Operate (CDIO) framework.

To ensure students learning, the process of carrying out the project is benchmarked to the final outcome of the proof-of-concept on the critical areas highlighted by the end user. 3D CAD software, with suppliers' catalogues downloaded into the program, is used in the design of the prototype. Students were required to incorporate the range of skills learned across the course to validate the design concepts before selecting the appropriate components for their design. The actual prototype building process was monitored closely with regular feedback given to the students to ensure the correct assembly and troubleshooting techniques were applied.

The students were able to successfully prove the workability of the prototype within schedule and present their working model to the end user. They were promptly rewarded when the end user was impressed with the successful proof-of-concept and gave MDC the go-ahead to develop the complete automated machine for their organization.

Keywords: *Design Thinking, CDIO, final year project, automation and robotics, real world projects*

Introduction

Employability of graduates is one of the key concerns of institutions as shown from the findings carried out by numerous research firms. Table 1 shows key concerns of 400 companies by a survey conducted in 2015 by The Institute of Engineering and Technology (IET) (UK) on 'Skills & Demand in Industry'.

Table 1: Key Concerns of Engineering Employers in the United Kingdom (UK)

No.	Concerns	%
1	Are concerned that the education system will struggle to keep up with the skills required for technological change	66%
2	Say a shortage of engineers in the UK is a threat to their business	64%
3	Are most concerned about graduate skills (of all types of engineering recruit)	61%
4	Claim technical degrees don't develop practical skills	57%
5	Feel that engineering and technology degrees do not meet industry needs	28%

In another research by The British Chambers of Commerce's Workforce Suvery 2014, it shows that 76% of employers believed that the graduates lack of working experience made them unprepared for the workforce.

The current curriculum for training of engineering students is adequate in the areas of theoretical and laboratory works. Students are required to work on projects as part of their requirements by institution to enable them to put into practice the theoretical knowledge they have acquired in the classroom sessions Skills such as teamwork and communication are also required in carrying out these projects. This approach enables the engineering students to have a better integrated understanding of the concepts learnt, relevance in application contexts and opportunities to practice other generic competences such as communication skills. However, unless the institution has vast industry contacts that provide industry related projects, most of the projects carried out by the students are typically in-house proposed projects. These projects may lack the stringent requirements and urgency as compare to industry projects that has implications if the project is delayed or not successfully implemented.

In a report by Dr Robert N. Charette for The Source (2016), he mentioned that there is no shortage of Science, Technology, Engineering and Math (STEM) graduates but institutions are not producing STEM graduates that are workforce ready. The report also mentioned that multiple surveys of employers reveal that it is not necessarily STEM graduates with technical prowess that they prize most, but graduates who demonstrate leadership ability, have the capability to work in teams, possess written and oral communication skills, have proven problem-solving and critical-thinking skills, as well as exemplify a strong-work ethic.

To prepare the graduates to be workforce ready, many institutions have started to collaborate with corporations within the industry to work on industry-related or sponsored projects with the intention of bridging the gap that institutions lack in their in-house projects. The institution-industry collaboration benefit the students as they are exposed to the industry and understand the expectation of companies through working on the projects. Internship at companies are also being promoted as it provides the students with a vital working experience in a company during their course of study. The companies also have the opportunity to evaluate suitable students that may be offered employment upon their graduation.

Methodology

Machine Development Centre (MDC), a Centre at the School of Mechanical and Aeronautical Engineering (MAE), was setup to train and equip students with relevant skillsets required by the industry. MDC staff have the relevant industry experience and assist companies with improving the productivity and quality of service through the automation and robotics projects. Most of the projects secured were turnkey in nature and involve mechanical, electrical and software programming skills, Fig 1. MDC students are assigned to the different groups to work on the project. Staff in the respective area of expertise will be guiding and mentoring the students to build and deepen their skillsets in the assigned area. The mechanical group will focus on mechanical design using 3D CAD software, assembly of standard and fabricated parts, module intergration and troubleshooting of the system. Electrical group focuses on electrical and control design, module and system wiring, and troubleshooting. The alogrithm for the logical functioning of the whole machine is developed by the programming group. The testing and troubleshooting of the complete machine is carried out by all groups to ensure the system is functioning according to specification. For some projects, students were also involved together with MDC staff for reviews with end users on their specification and updates. Some students may even have the opportunity to involve in the installation and commissioning at end user's site.

This approach of training is to enable the students to be competent in various areas and be ready for the workforce.

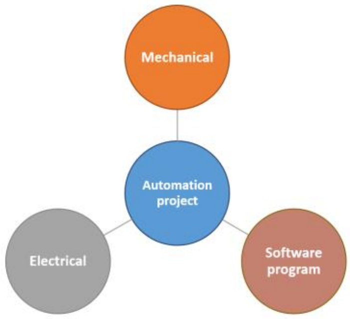

Fig 1: Turnkey Automation project involve Mechanical, Electrical and Software program

Singapore Polytechnic incorporates the CDIO (Conceive-Design-Implement-Operate) Engineering Education Framework and Design Thinking as a significant part of its overall holistic education model. CDIO is an international initiative, originally conceived at the Massachusetts Institute of Technology (MIT) in Cambridge, Massachusetts in the late 1990's. In 2000, in collaboration with the Swedish universities of the Wallenberg Foundation, Chalmers University of Technology, Linkoping University and the Royal Institute of Technology, the CDIO initiative was formed.

The initiative represented a response by engineers in industry, government and academia to a concern about the present state of engineering education. Essentially, engineering education was seen as over prioritizing the teaching of theory, especially mathematics and science, while not paying enough attention to the real world of engineering practice and the need for skills such as design, teamwork and communications. As Crawley et al (2007) summarized:

> ...we identified an underlying critical need – to educate students who are able to Conceive-Design-Implement-Operate complex, value added engineering products, processes and systems in a modern, team-based environment. It is from this emphasis on the product, process, or system lifecycle that the initiative derives its name-CDIO. (p.1)

The importance of Conceive-Design-Implement-Operate, as an organizing frame for engineering education is further explained by Crawley et al (2007:

> Modern engineers lead or are involved in all phases of a product, process, or system lifecycle. That is, they Conceive, Design, Implement, and Operate. (p.8)

Central to the curriculum approach is the specified CDIO learning outcomes, derived from extensive stakeholder collaboration and tested by peer review, which form the basis for program design and assessment. Crawley et al (2007) summarizes as follows:

> A CDIO programme creates a curriculum organized around mutually supporting technical disciplines with personal and interpersonal skills, and product, process and system building skills highly interwoven. These programs are rich with student design-implement experiences conducted in modern workspaces. They feature active and experiential learning and are continuously improved through a robust, quality assessment process. (p.3)

The approach in executing the automation project is according to the CDIO framework as shown in Fig 2.
The stages are as follow:

1. **Conceive**
   During the conceive stage, the problem statement is defined, and the specifications discussed and agreed with end users. Brainstorming sessions are carried out to determine the best approach in solving the problem and concepts are presented to end user for approval. The brainstorming sessions are repeated until the final concept is accepted by end users.
2. **Design**
   Once the concept is approved, detailed mechanical and electrical design are carried to identify the standard components to purchase and drawings for fabrication are send to the machining shop to fabricate.
3. **Implement**
   Upon receiving the standard purchased components and fabrication parts, the mechanical and electrical assembly are tasked to carry out the assembly of the whole machine. The machine is then troubleshoot and tested to ensure it works according to specifications.

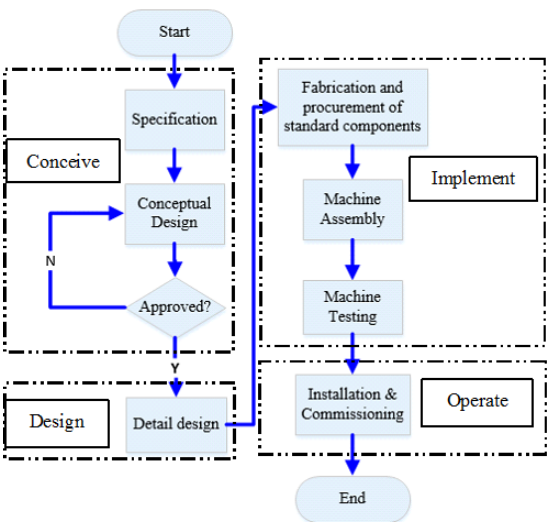

Fig 2: Typical approach of an automation project and its relation to CDIO framework

4. **Operate**
   Once the machine is fully tested, the end user will conduct the user's acceptance test. Upon end user's acceptance, the machine will be installed at end user's site for commissioning. It will be operational once the machine is commissioned.

Project Opportunity

With the changing economic environment worldwide, it is important for a country like Singapore to stay competitive through raising productivity and creating value-added jobs. Mr Tharman Shanmugaratnam, Deputy Prime Minister and Minister for Finance (2014) emphasized that:

> It is a very important challenge: for us to be able to raise productivity while providing jobs and opportunities for all our citizens. It is a much bigger challenge than raising productivity by shedding jobs. That is what has happened in many countries.

With the intent to improve productivity and not make their staff redundant, one of the organisation approached MDC to look into the possibility of automating one of their mundane process carried out by three of their office staff. The staff has been working for the organisation for many years and the current nature of the work is to scan with either single or double-sided barcoded cards. The scanned information is transferred to a server at the end of the day for data consolidation and verification. The process is repetitive with minimum skill needed and there is no advancement prospects for the workers. If the project is successfully implemented, the staff will be redeployed to a higher value-added job with better prospects and training opportunities to upgrade their skills.

As the organisation has limited exposure to factory automation, there were numerous discussions between the organisation and MDC on the followings;

i. to have a better understanding of the existing manual process of card scanning
ii. the best strategy to automate the process
iii. understand potential issues that may pose problem to automating the process

There were three key area of concerns raised by the organisation and they were apprehensive on automating the process. The concern areas are

i. ability to scan barcodes on both sides of the card
ii. handling of cards for scanning by scanner
iii. sorting of good and bad cards automatically

Proof-of-Concept Project

The apprehensiveness by the organisation has provided an opportunity for MDC as the technical area of concerns can be taken up as a final year students project and also as a 'proof-of-concept' (POC) to ascertain the workability of the project.

The area of concerns fitted nicely into the domain knowledge required by the students as part of their training in solving real world problems. Table 2 shows the relevant skillsets required to solve the issues and the corresponding approaches are described in the following section.

a. Scan barcodes on both sides of card

Knowing the standard commercially available industry product is an important skillset as all theoretical calculation required for an application will not match exactly to the commercial product. Rather, the theoretical calculation serves as a minimum required that the product has to meet.

Table 2: Skillsets training for students

Problem	Approach	Domain knowledge
a. Scan barcodes on both sides of the card	Evaluate commercially available product	Understand commercially available product for the project. Product evaluation. Dealing with suppliers
b. Conveying of cards across scanners	Mechanism design	Analytical thinking and problem solving
c. Sort good and bad cards into respective bins	Translation of theory into application	Application of proven theory.

To be able to scan the barcodes on the card, the size of the card has to be determined. The commercial available product is sourced and discussions with various vendors are carried out to determine the most suitable product to use. Once the appropriate product is confirmed, the selection is based on vendor's catalogue to facilitate mechanical and electrical design. It is also important to assess the feasibility of the scanning by conducting an evaluation.

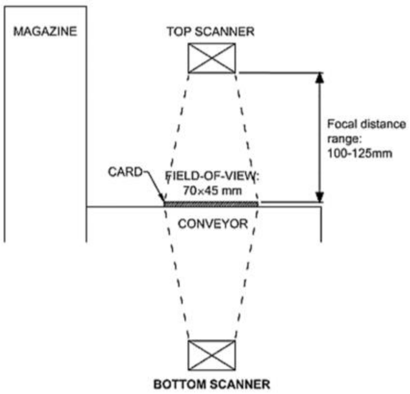

Fig 3: Setup of Top & Bottom Scanners to scan both sides of card

With the card's dimension of 86mm (Length) by 54mm (Wide), it was found that the Keyence's barcode scanner, model SR-710, is suitable as it can read the barcode information from a distance of 100mm to 125mm as shown in Fig 4.

To ensure the card can be scanned on both sides, it is necessary to place two scanners, one on each side of the card as shown in Fig 3. With this setup, the operator is able to load the cards without worrying on the correct orientation and will also improve the productivity. The team did an evaluation with the vendor to provide the scanners for the testing. A mock-up similar to Fig 3 was set up to evaluate the workability of the scanners at the sensing range. The result was positive and the detail design was proceeded to emulate the setup.

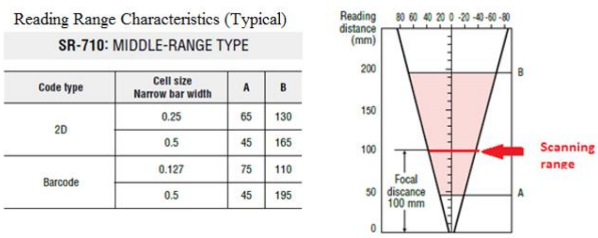

Fig 4: Scanner's Reading Range

b. Conveying of cards for scanning

To ensure the number of cards to be scanned can meet the required quantity, the cards has to move continuously without stopping. After numerous brainstorming sessions by staff and students, the proposed method is to have the cards moving in a continuously motion on a mini-conveyor belt (Fig 5) and pass through the scanners so that the barcode information can be captured.

Detailed design considerations were taken to ensure the card can be conveyed smoothly through the guide rails by the belt. 3D CAD design with application of Geometric Dimensioning and Tolerancing (GD&T) learned in classroom were applied.

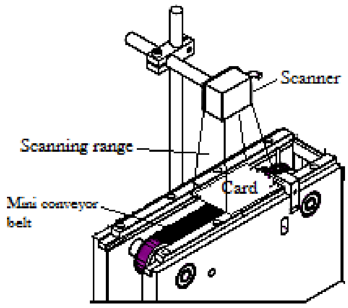

Fig 5: Card moving continuously on mini-conveyor belt

c. Application of proven theory

An initial analysis of the mechanism to sort good and bad cards shows that the oscillatory motion is similar to the Quick Return Mechanism (Fig 6), Vinodh Reddy Chennu (2016).

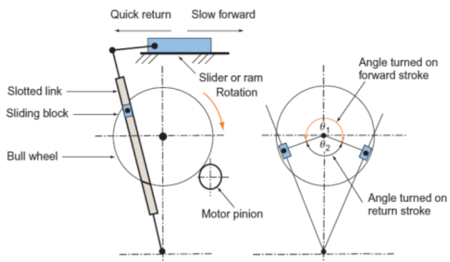

Fig 6: Quick Return Mechanism

The Quick Return Mechanism converts rotary motion into reciprocating motion, but unlike the crank and slider, the forward reciprocating motion is at a different rate than the backward stroke. At the bottom of the drive arm, the peg only has to move through a few degrees to sweep the arm from left to right, but it takes the remainder of the revolution to bring the arm back.

Detailed study of the quick return mechanism was done and the corresponding components needed for flipper unit were identify and included. The conceptual flipper unit design is shown in Fig 7.

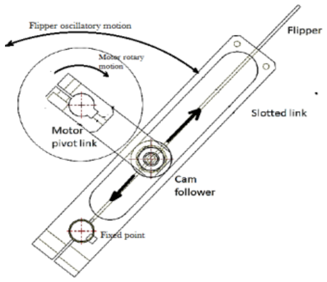

Fig 7: Flipping Unit Design

The finalised design for the proof-of-concept prototype was shown in Fig 8. The prototype includes all the necessary mechanism for automating the process of card scanning.

The operation of the card scanning is as follows;

i. The cards to be scanned are loaded into the magazine unit.
ii. The mini-conveyor belt will convey the card and passed through the top and bottom scanners. (This allows the cards to be placed without the need for proper orientation.)
iii. The card information will be captured by the scanners and transmitted to the computer to compile.
iv. The scanned card will be sorted accordingly as it dropped into the flipper unit.

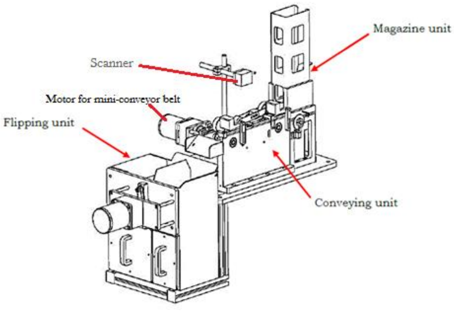

Fig 8: Conceptual design of card scanning unit prototype

Results and Discussion

Through close supervision and mentorship by the staff, the students were able to acquire and apply their theoretical and practical knowledge successfully to complete the project in time for the 2016 SP's Engineering Show, Fig 9. It attracted numerous industry and schools visitors who were impressed with the project.

The students also had the opportunity to present to the end users the completed POC project. The customer was impressed by the high standard of work done by the students. MDC and the students were elated when the customer gave the team the go-ahead to build the fully automated card scanning machine.

The project successfully incorporated the key stages of CDIO, providing these students with a real world engineering experience. Apart from applying technical competencies, they were able to have experiential learning of such skills as teamwork, communication and problem-solving, and the necessary attitudinal components to get things done under real work conditions.

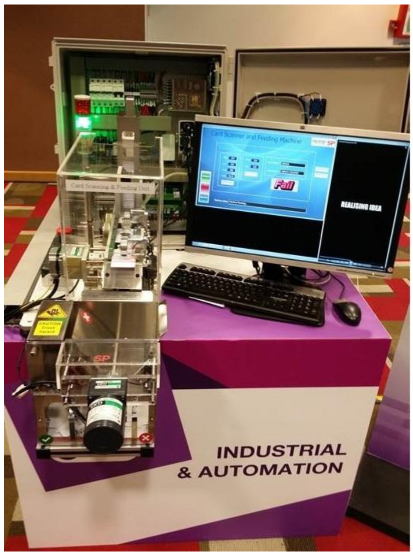

Fig 9: Completed POC project displayed at 2016 SP's Engineering Show

Evaluation

Over the past three years, 37 students have had the opportunity to participate in three turnkey automation and robotics projects secured by MDC.

As to yet a detailed evaluation framework has not been employed to ascertain, in either quantitative or qualitative terms, a detailed profile of all aspects of the outcomes of these projects. Rather, the successful completion of the projects and positive feedback from employers and the students involved has provided a high level of face validity for the approach taken. Similarly, compliance to the CDIO Engineering Education Framework, especially key standards relating to the importance of skills beyond technical competencies (e.g., problems solving, teamwork and communication), integration of content knowledge and skills, and a focus on active and experiential learning, are key validating frames.

There were many industry visitors during the 2016 SP Engineering Show and the frequent comments that were heard from the visitors were of the kind

> "We are impressed by the students work and it is comparable to industry standard".

The end users who were present at engineering show were also impressed by the students' work and commented that

> "We are glad that the prototype has proven that the concept is workable and we are confident and looking forward to MDC to build the fully automated machine".

From observation and conversations with student faculty noticed that students working on these real world projects were generally more engaged and motivated, and would spend time beyond the curriculum hours designated.

The real world projects have also provided students with opportunities to work collaboratively with academic staff, industry partners and suppliers, and participate in discussion with end users. These authentic learning experiences led one of the students to comment that:

> "Working on the real world project has helped her gain confidence to lead, delegate and liaise with companies.

She added

> "These are the skills that I will not be able to learn from lectures and tutorial lessons. I am really grateful for the opportunity given to me and the experiences gained from working on the project will better prepare me for the workforce."

From a faculty standpoint it was satisfying to see how the students were energized and working hard to solve a 'simple' machine problem arising from a real world project. The staff mentoring the students were also able to gain satisfaction in seeing students apply the theoretical knowledge into project as shown in Table 2 presented earlier. The staff were particularly encouraged when two of the students who had completed their studies in March 2016 continued still coming back to SP to observe and learn from the staff working on the fully automated machine.

Future research will employ a more extensive and focused evaluation approach to identify more precisely which features of the project experience have been most beneficial in terms of enhancing learning and motivation. In this way, we may be able to extend such project opportunities to more students than presently.

Conclusion

With Singapore's emphasis on skillsfuture, which emphasizes providing more real work related experience and competence, the type of project experience outlined in this paper is clearly a more educationally useful direction for our students than in-house projects or industry sponsored projects that have no real world implications in terms of outcome.

In this particular case, MDC students were presented with an opportunity to work on a potential industry project through proof-of-concept to show the customer the feasibility of building a fully automated machine. They managed to overcome the end user's areas of concerns and successfully completed the prototype.

The ability of the students to successfully carry out the POC projects shows that they are able meet the industry requirements, displaying confidence in dealing with the various problems that arose from the dynamics nature of real industry projects

This project has also illustrated the importance of educational institutions working hard to collaborate with industry, explore opportunities for real world projects and better preparing students for the workforce.

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iii. FYP students who willingly took up the challenge to work on the demanding industry project.

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Prior Education for Performing Social Implementation in the Field of Electrical and Electronic Engineering

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Abstract

We have already proposed Social Implementation Education (SIE) that aims to develop advanced inter-personal communication and creative thinking skills, as well as to promote proactivity in addressing complicated problems. SIE involves Conceive, Design, Implement and Operation (CDIO) concepts, and emphasizes the application of such concepts to real-world problems. SIE is composed of four steps: first, discovering problems in the real world and proposing new services and devices to improve or solve them; second, designing and implementing these services and/or devices; third, operating them in the real world; and finally, obtaining feedback from real users and going back to the former steps to improve the services and devices. The second, third and fourth steps are repeated multiple times. However, these steps are too difficult for students without prior education, because many students are not accustomed to finding problems independently and actively trying to solve them.

We considered that the students need to experience the entire CDIO process before they face real-world problems. This paper demonstrates that doing special hands-on exercises using a small-sized microcomputer system is an effective tool to be used in experiencing the CDIO process. The hands-on exercises allow students to create anything of their choosing under certain limited conditions. Students must plan decide what to create independently. Some students plan to create something that solves an inconvenience in their daily life, while others create objects used for entertainment. Every student sets a different goal for his or her hands-on exercises. They are required to complete their projects by a specified deadline. Students work on designing and implementing something based on their interests and ideas.

According to a questionnaire given to the students, the results shows that doing the hands-on exercises cultivates students' confidence and teaches them that they can accomplish the task if they put in the requisite amount of effort. Students' confidence is based on their experience of finding problems or inconvenience in their daily life, and improving or solving them through the hands-on exercises. As a result, they become prepared for working on real-world problems.

Keywords: *social implementation education, creative thinking, confidence, hands-on exercises, real world problems, real users, CDIO*

Introduction

In the twenty-first century engineering education, advanced inter-personal communication skills, doing creative thinking and the promotion of proactivity in addressing complicated problems must be strongly developed. However, such abilities do not get developed sufficiently through the study of scientific and technological contexts in a school setting. Thus it is necessary to go face real-world problems and try to solve them. Engineering education that introduces this process is called social implementation education (SIE) (e.g. Asano (2014)).

SIE is composed of four steps: first, discovering problems in the real world and proposing new services and devices to improve or solve them; second, designing and implementing these services and/or devices; third, operating them in the real world; and finally, obtaining feedback from real users and reflecting upon users' opinions and revising the services and/or devices. The second, third and fourth steps are repeated many times (NIT, Tokyo College (2015)).

In colleges of technology (KOSEN), fifth-year or final-year regular course students do one year of graduation research under the guidance of a supervisor in their engineering department. This graduation research can be seen as a good opportunity to perform SIE. However, there seems to be a big hurdle for students who are used to simply solving the problems given to them by their supervisor. In SIE, students are required to work proactively. We propose that prior education for performing SIE is necessary. It provides fourth-year students with the opportunity to become accustomed to finding problems independently and to learning actively and willingly, which in turn develops their confidence.

This paper demonstrates that doing special hands-on exercises using a small microcomputer system is an effective component of students' prior education in the field of Electrical and Electronic engineering. Students experience the entire CDIO process in engineering workspaces prepared in our school before facing real-world problems.

Special Hands-on Exercises using a small-sized microcomputer system

In these hands-on exercises, a Peripheral Interface Controller (PIC) microcomputer is used as a teaching material. The hands-on exercise using the PIC microcomputer is comprised of three stages: the first stage (Stage 1) consists of a four-hour long class once a week for four months; the second and third stage (Stage 2 and Stage 3) consists of two-hour long class once a week for two months, respectively.

Stage 1-Special Hands-on Exercises:

In Stage 1, students learn basic information about a PIC microcomputer, how to build programs and how to handle electrical components such as LED, a seven segment LED, an eight times eight LED matrix, a tact switch and a piezoelectric loudspeaker, etc. They also acquire necessary skills to create anything of their choosing. Each class consists of a 45-minute lecture at the beginning of the class and a 135-minute experiment and accompanied by exercises. Basic knowledge and theory is presented in the lecture. After the lecture, students make a circuit on their breadboard as shown in Figure 1, and are immediately thereafter assessed on what they have learned in the lecture. Some examples of programs and exercises are provided to students. Students gradually deepen their understanding of the knowledge and theory by performing exercises. They become accustomed to making programs by partly modifying the programs that are given to students. Furthermore, they acquire the knowledge related to the microcomputer through exercised-based learning.

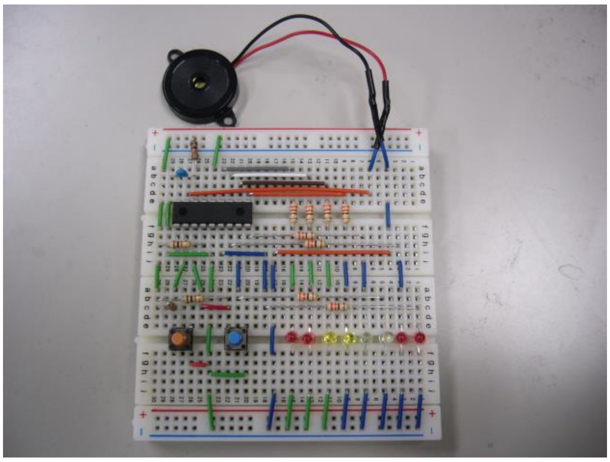

Figure 1: An example of a circuit wired on a breadboard.

At the end of Stage 1, students work on an implementation exercise. A diagram of a specified microcomputer circuit is given to students. Then, students think and decide on the arrangement of the electronic components on a universal board, and solder wiring of the components on the rear of the board as shown in Figure 2 and Figure 3. Finally, students affix a speaker and an acrylic board to the universal board with screws to complete this exercise as shown in Figure 4.

Figure 2: A student works on soldering.

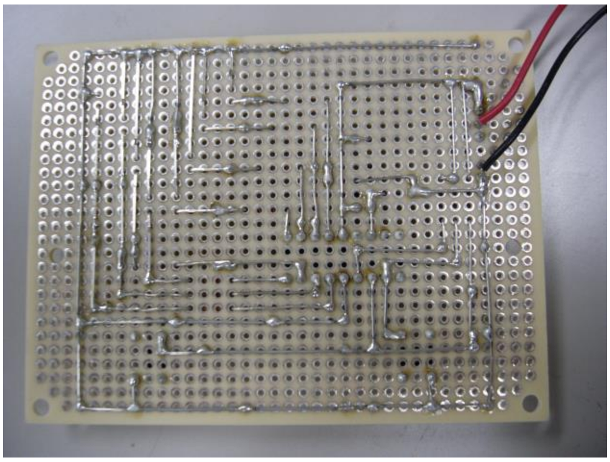

Figure 3: Soldered wiring of the components on the rear of the universal board. This circuit is the same as the one wired on breadboard as shown in Figure 1.

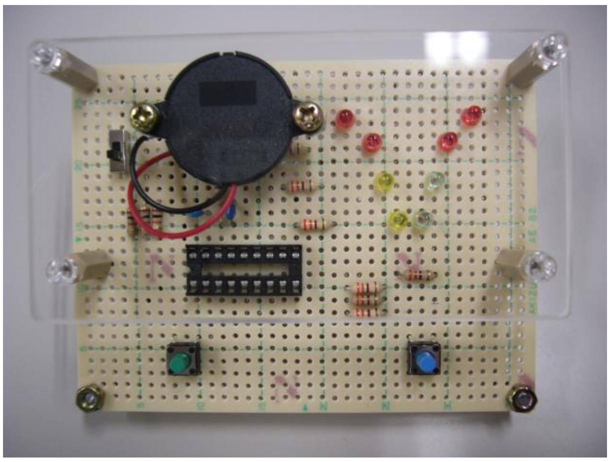

Figure 4: Surface of the universal board for the completed work.

Stage 2-Special Hands-on Exercises:

In Stage 2, an exercise that urges students to think freely and creatively is conducted. At the beginning of Stage 2, the following instructions are given to students: "conceive an original game that entertains people, and then design and implement it using what you have learned in Stage 1."

The task urges students to think creatively about what kind of game they wish to make. At this point, students have already learned in Stage 1 how to make use of electronic components such as LEDs, a tact switch and a piezoelectric loudspeaker with a microcomputer. In addition, they have also acquired skills such as soldering and assembling components to carry out their ideas. They are ready to design and implement their original games based on their ideas.

Figure 5: An example of their original game, "obstacle race."

Figure 6: Another example of their original game, "playing tag."

The examples of their original completed games are shown in Figure 5 and Figure 6, respectively. The name of a game shown in Figure 5 is "obstacle race." An obstacle is identified by shining a red LED on its location. Obstacles move down vertically from top to bottom, one after another, on each red line at a random time interval. A player's position is shown by a shining LED on three white LEDs at the bottom. A player must avoid those obstacles by moving left or right by flipping two white switches.

Another example shown in Figure 6 is referred to as "playing tag". There are fifteen LEDs that form a horizontal line. Shining an LED on the line shows a player's position. This game machine can detect a slope of itself. If the player tilts this game machine leftward, the shining LED moves leftward, and vice versa. The LED on the left side is connected to the one on the right side. Then, an ogre symbolized by a flashing LED appears and follows the player. The player escapes from the ogre by manipulating the game machine leftward or rightward.

At the end of Stage 2, all games that students designed and implemented are put on public display, as our school holds a school festival at the time of the year. Many people in the local community near our school enjoy playing these games and vote on which game they deemed to be the most fun (Figure. 7). The result of the vote is later reported to back to the students. Obtaining feedback from people in the local community is part of the operation process that corresponds with the CDIO concepts.

Figure 7: All games are displayed at the time of school festival. Many people enjoy playing them and vote on which game they deemed to be the most fun.

Stage 3 - Special Hands-on Exercises:

In Stage 3, students perform the second special hands-on exercises to strengthen their understanding of professional knowledge and theory. At the beginning of Stage 3, students receive simple instructions to "conceive of something that entertains people or solves or improves upon a daily inconvenience, and then design and implement it using what you have learned so far." The object of the hands-on exercises in Stage 3 is not limited to a range of games. Every students sets a different goal for his or her hands-on exercises.

Our department provides workspace to facilitate these special hands-on exercises as shown in Figure 8. The workspace is open to students after school.

Figure 8: Workspace for the hands-on exercises.

Figure 9 shows an example of a completed electronic device called an "Electronic music generator." It has an eight times eight LED matrix, in which each horizontal line corresponds to sol-fa syllables: do, re, mi, fa, sol, la, ti, do from top to bottom. After repeating the selection of the musical scale sixteen times using a blue switch to select a musical scale and a red switch to move on to the next musical scale, this device makes sounds automatically according to the selected musical scale information.

Figure 10 shows another example of a student-created device called a "Shinning sandglass." The student who conceived of this device often eats instant noodles for his lunch. He thought that counting time after pouring hot water is very important to make good noodles. Therefore, he wanted to make a stylish electronic sandglass by himself. This device has a switch to select one-minute timer or three-minute timer. It starts counting time when upon being turned upside-down. It controls the LED display as if sand falls during the counted time.

At the end of Stage 3, all students demonstrate and explain their designed and implemented devices to third-year students, who are supposed to conduct these hands-on exercises in the next year, as is shown in Figure 11. Fourth-year students share useful advice with third-year students, such as their challenges and what they deem to be important points in proceeding from these hands-on exercises. Thus, third-year students can prepare for the next year's education. This opportunity corresponds to an operation process related to the CDIO concepts.

Results and Discussion

Figure 12 shows the result of questionnaires conducted in both 2014 and 2013 at the end of the hands-on exercises. In response to the question, "Have you been interested in these special hands-on exercises?" About half of the students answered that they were "very interested," and more than two-thirds of students reported that they were interested in these hands-on exercises. They worked on them willingly and proactively. Figure 13 also shows the result of another question: "Do you think your ability to design and implement something improved?" In response to this question, more than two-thirds of students answered "Yes."

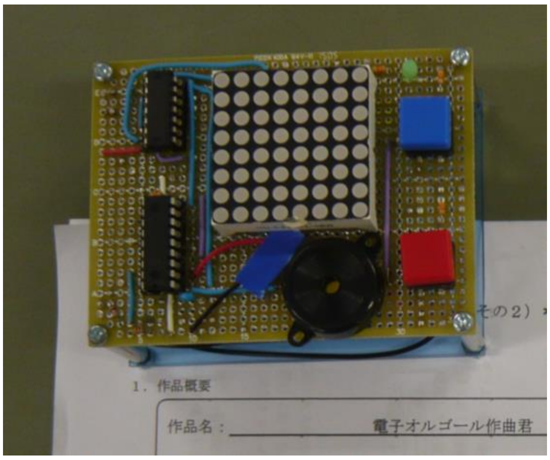

Figure 9: An example of an electronic device of the hands-on exercises named "Electronic music generator"

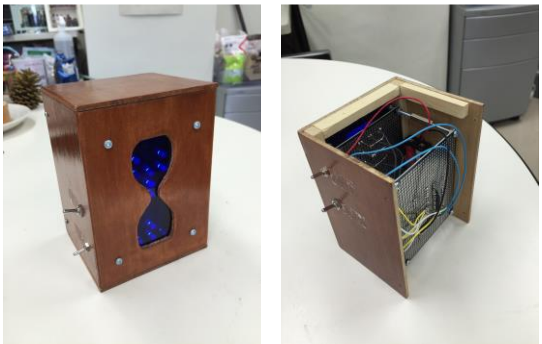

Figure 10: Another example of an electronic device that was created during the hands-on exercises, named "shining sandglass"

Figure 11: All students demonstrate and explain their designed and implemented devices to third-year students.

We can see from these results that doing special hands-on exercises enables students to cultivate their confidence in their abilities to accomplish task if they put forth an appropriate degree of effort. The experiences they received in finding problems or inconvenience in their daily lives, and solving or improving them is effective. In addition, almost all students prepare for their own tool box willingly as is shown in Figure 14, though the instruction to prepare for the tool box is not given to students. There are various kinds of electronic components and tools in the tool box. Students always carry them when they move during the period of these hands-on exercises. Thus, they are prepared to work on real-world problems.

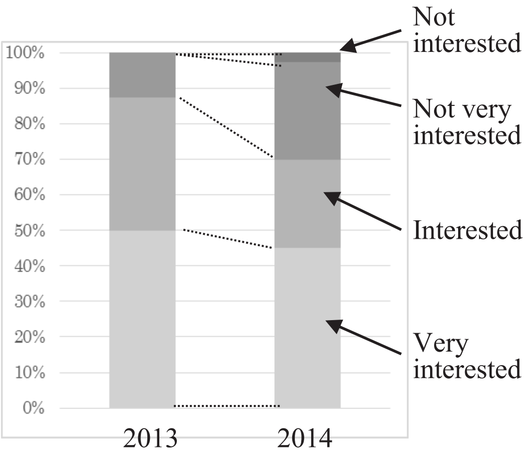

Figure 12: The result of a question, “Have you been interested in these special hands-on exercises?”

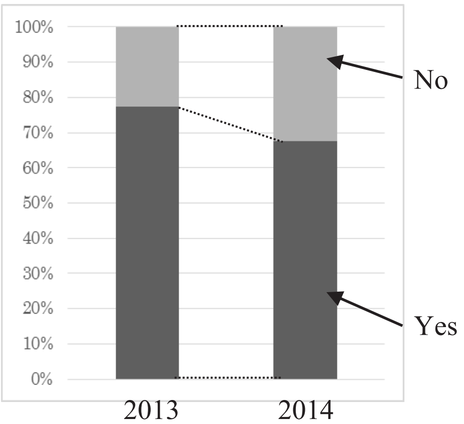

Figure 13: The result of a question, “Do you think your ability to design and implement something improved?”

Figure 14: A tool box in which there are various kinds of electronic components and tools. Almost all students willingly prepare for their own tool box during the period of performing hands-on exercises.

According to a pedagogical theory (Matsuda (2013)), cultivating students’ confidence is required in order to motivate them to work on new challenge, such as social implementation projects. Therefore, it follows that these special hands-on exercises are an effective component of their prior education that is needed before they conduct social implementation.

Summary

In this paper, we introduced special hands-on exercises using a PIC microcomputer system. The hands-on exercises consist of three stages. In the second, and third stages, students repeat the CDIO process twice. Through these hands-on exercises, students become accustomed to independently finding problems and to learning actively and willingly. Performing the hands-on exercises enables students to cultivate their confidence in their abilities to accomplish self-directed tasks. This prepares them for working on real-world problems. It follows that hands-on exercises are an effective form of prior education for performing social implementation.

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AIMING FOR IMPROVED DIGITAL SKILLS

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Abstract

The Finnish government has strong belief in digitalization. It is one of their current key action lines. They are emphasizing especially the digitalization of education and digital awareness and capabilities of teachers. The strategy of Turku University of Applied Sciences emphasizes digitalization as part of the technical innovation university of the future too. Excellence Center in Digitalization in one example how we have reacted to the strategy. Another established activity in Turku University of Applied Sciences is Innopeda Tech Lab which focuses on supporting faculty development in ICT skills. This training answers to the requirements of CDIO standards in faculty development too. Innopeda Tech Lab is a co-effort of our university and Microsoft. The aim of the Innopeda Tech Lab is to promote our pedagogical approach together with up-to-date digital skills. Innovation pedagogy contributes to the development of new generations of professionals, whose ways of producing, adopting and utilizing knowledge make innovative thinking and creating added value possible. The development of new generation of professionals requires that university staff is operating in same digital level as the young generation. Innopeda Tech Lab is an effort to narrow that cap between our lecturers, coaches and students. Turku University of Applied Sciences has introduced Office 365 environment for both staff and students, but it seems that working with clouds and other new tools is more natural to our students than to our staff. Innopeda Tech Lab focuses on daily operations with office tools, clouds, group activities and communication tools. Innopeda Tech Lab training have been running since autumn 2015 and a good number of staff have participated these trainings. Still, our university is not satisfied with the level of digital skills among our staff and we want to further boost this. Our university is starting a strategic activity called "Digitalization leap" on improving digital skills among staff. In this paper, the Innopeda Tech Lab concept is introduced and the Digitalization leap initiative is described and discussed.

Keywords: *Digitalization, Teacher's training, Faculty development, Innovation pedagogy, CDIO*

Introduction

Digitalization is changing the world rapidly. European Commission estimates that the digital economy is growing at seven times the rate of the rest of the economy. (European Commission, 2014). Education is not isolated from this change either. Actually, education cannot be outside of this development of digitalization, rather it has to be inside the transform preferable even guiding the change (Hietikko, Ilves, & Salo, 2016). Digitalization is changing the labor markets and affecting the demands on universities, but at the same time the educational system is also going through a digital transformation of its own (Top of Digital Europe, 2015). A recent study in Finland says that digitalization changes higher education significantly (Elinkeinoelämän keskusliitto, 2015): a) working life expectations are changing, because professions as changing, b) working life expects digital skills and awareness for knowledge creation and interpretation, c) the concepts of information and skills are changing due to all the time available information and d) the expectations of students are changing when sharing information is no longer a bottleneck. Although we see the changes that digitalization is bringing to education, the real contributions ICT can make to teaching and learning are not yet fully realised and exploited (OECD, 2015). Very often the digitalization in higher education is connected with increasing online education and MOOC (Massive Online Open Courses). Digitalization certainly has an effect on these areas of higher education, but before a higher education institute can reach these a crucial factor is the digital skills and awareness of those producing and using these possibilities.

Nowadays almost an unlimited number of different digital technologies are available for teaching and learning. There are social media tools, online games, different applications, multimedia tools, cloud computing and all mobile tools. Digital tools enable different types of learning and teaching. For example, technology can enhance experiential learning, foster project-based and inquiry-based pedagogies, facilitate hands-on activities and cooperative learning (OECD, 2015). Digital tools affect the pedagogies used in teaching and learning and can result in blended learning, virtual learning, collaboration locally and globally just to name a few. Technology can be seen as supporting element to new pedagogies that focus on learners as active participants (OECD, 2015). In digital world students become more like part of the learning process and less like teaching targets (Jungner, 2015).

Digitalization is very high on every policy maker and governments' agenda too. OECD (2015) is urging countries to create a convincing strategy for building teachers' capacity in digitalization. In Finland digitalization is one of the key action lines of Finnish government and it has connections to education as well (Prime Minister's office, 2015). European Commission (2013) highlights the importance of digital skills in their report too: *Digital skills are fundamental to an effective use of ICT*. A recent report about the influence on ICT in the productivity and economic growth in Finland says that Finland has good preparedness to increase productivity and economic growth with digitalization (Pohjola, 2014). Still, there is a strong need for teachers' skills in ICT, virtual teaching and learning (Eskola-Kronqvist, Mäki-Hakola, Mäntylä, & Nikander, 2015; Prime Minister's office, 2015). This is another skills gap that is mentioned in (European Schoolnet & DigitalEurope, 2015) – there is a need to raise the basic level of digital skills and everyone must be equipped with the skills required for using digital technologies. This is identified in the Turku University of Applied Sciences too. Digitalization is one part of our strategy within the future technical innovation university (Kontio, 2015). We have seen that there is a need for strengthening personnel skills in modern ICT-tools that can support teaching and learning. One solution to answer this need is the Innopeda Tech Lab. In this paper, we first focus on faculty digital skills. After that, we describe the theoretical backgrounds of Innopeda Tech Lab and introduce the concept. Finally, we discuss and conclude TUAS experiences.

Faculty digital skills

European Commission's Digital Agenda for Europe (2014) states that more than 90 % of professional occupations nowadays require some ICT competence and ICT practitioners are a key pillar of the modern workforce across all sectors of the European economy, with demand growing annually by 3 %. Having a future that looks like that places pressure on education too. Digitalization might make you think about the technology and the tools, but like OECD report confirms faculty pedagogical skills are still the key success factor in good teaching and learning. The report summarises that technology can complement teaching, but not even a good technology can replace bad teaching (OECD, 2015). A challenge is that education is not entering into the digital era before our teachers move there (Hietikko et al., 2016). Another challenge we have is that our teachers are mostly digital immigrants. Prensky (2001) defined digital immigrants as those of us who were not born into the digital world but have during their lives adopted many new technologies. There is a need to give teachers the tools and skills to include ICT in their teaching (Top of Digital Europe, 2015). A Finnish study (Hietikko et al., 2016) shows that majority of teachers see their digital skills moderate or even weak. The digital skills they possess mostly focuses on using the basic technology and office software. Use of digital tools and skills to improve learning and pedagogy is much weaker. The same result was reported on (Morris, 2010): *Teachers' knowledge of technologies is often at a basic level.*

Innovation Pedagogy with CDIO

Our pedagogical approach in the Turku University of Applied Sciences is innovation pedagogy (Kettunen, 2011; Kontio, 2015). The objective of innovation pedagogy, developed at the Turku University of Applied Sciences (TUAS), is to provide the students with innovation competences in order to enable them to participate in innovation processes in their future working places and develop them (T. Penttilä & Kontio, 2016). In the Faculty of Business, ICT and Chemical Engineering of Turku University of Applied Sciences innovation pedagogy is implemented with the CDIO approach (CDIO, 2014a). Both innovation pedagogy and CDIO are not new to our university rather we have been working with them many years. Our university joined the CDIO initiative in 2007. Still, the latest strategy is our first that truly combines the strengths of both. Actually innovation pedagogy and CDIO complement each other well (Kontio, 2012; T. Penttilä & Kontio, 2014; Taru Penttilä, Kontio, Kairisto-Mertanen, & Mertanen, 2014). Innovation pedagogy integrates entrepreneurship, applied research and development, and internalization with education and working life (Kettunen, 2011). CDIO on the other hand emphasizes educating students with deeper working knowledge of the technical fundamentals and educating engineers that a capable of leading the creation and operation of new products and systems.

The three key elements of the CDIO approach are understanding the context of engineering education, understanding the abilities needed by contemporary engineers and reforming education to ensure that students learn these abilities. (E. Crawley, Malmqvist, Östlund, Brodeur, & Edström, 2014) The abilities are described as a reference model in the CDIO Syllabus (E. F. Crawley, Malmqvist, Lucas, & Brodeur, 2011) and the education program reform guidelines are expressed as CDIO standards (CDIO, 2014b). The CDIO syllabus does not have direct references to digitalization, but it does have several references to topics that can be understood to contain issues relating digitalization too. There are sections such as 2.5.4. Staying Current on the World of Engineering, 4.2.3. Technical Entrepreneurship and 4.2.6. New Technology Development and Assessment. CDIO standards 9 and 10 focus on faculty development. Faculty digital skills development fits well into the ideas of CDIO Standard 10. Standard 10 emphasizes actions that that enhance faculty competence in providing integrated learning experiences, in using active experiential learning methods, and in assessing student learning.

Innopeda Tech Lab

First step towards Innopeda Tech Lab was taken in the autumn of 2014 together with Microsoft. They had a learning environment – The Microsoft Customer Immersion Experience – for their updated tools where interested companies could come and learn upcoming new features and tools in a hands-on introduction workshop running in a simulated company environment. After this workshop, we started planning a similar kind of learning environment, but targeted to public organizations and especially to education sector. We had special interest to this since our university was moving to Office365 solutions and we understood the need to organize trainings to our personnel. This learning environment was named Innopeda Tech Lab - Laboratory for Innovation Pedagogy and Pedagogical Technologies. The aim of the Innopeda Tech Lab is to promote our pedagogical approach together with up-to-date digital skills. The goals we defined at the beginning were following:

1. Development new models of learning – make technology support learning and teaching
2. Pilot new technologies in teaching
3. Train teachers to new technologies and digital skills.

At the beginning Microsoft participated actively in the planning and creation of the Innopeda Tech Lab. They offered valuable insights and help in the startup phase. Nowadays when we have activities running Microsoft has stepped backwards, but is still helping for example in our trainers' education.

We can describe Innopeda Tech Lab as a training and learning environment which focuses on supporting faculty development in ICT skills. It is our effort to narrow that cap between our lecturers, coaches and students. Innopeda Tech Lab is a physical and virtual environment. We have physical room equipped with up-to-date tools such as personal computers, tablets and mobile phones, but at the same time we have a cloud based virtual environment to simulate the new possibilities of digital technologies and tools. The technical environment is separate from the "production environment" of our university and it is a little more versatile Office365 environment with some additional tools available that we have not taken into active use yet. This simulation environment has independent user accounts and profiles which encourage the participants to test and try different features and tools without being afraid of mixing up their active user accounts. Innopeda Tech Lab focuses on daily operations with office tools, clouds, group activities and communication tools. Innopeda Tech Lab trainings have been running since autumn 2015 and during the first year several activities have been carried out to answer the goals we defined at the beginning.

Innopeda Tech Lab has arranged a good number of training sessions and thus we have improved the digital skills of our personnel. A typical training session last three to four hours and it can take around 15 participants. The trainings have so far focused mainly on the new O365 environment and the tools it provides. Special attention has been placed on communication tools such as Skype for Business, Yammer and Outlook, but also applications such as OneNote. In addition, the concept of clouds and possibilities of them has been explained, taught and experienced. Depending on the group participating the training there have been different emphasis areas. Due to the limited time available the trainings mostly only touched the surface of the tools and possibilities, but still the participants have got some practical and useful hints to start working with right away. In addition to these organized trainings group of teachers started a self-study group to learn the features and possibilities of OneNote.

Through Innopeda Tech Lab piloting new technologies in teaching have been tested and new models to utilize technology in learning and teaching have been introduced. Our students started with Office365 earlier than our personnel and this possibility has been utilized with several pilot groups, courses and modules. All students have been encouraged to use online Office applications, Skype for Business messaging and OneDrive cloud. One group of Business students has tested especially OneDrive as a common working area for sharing documents with fellow students and their teachers too. One course in Healthcare program was taken strongly towards raising the digital awareness and gaining experience on Office365 tools while learning the actual topic. A collaborative learning task has been introduced and piloted in OneNote Online and feedback on the experiences and needed guidance has been collected. Skype for Business has been introduced as a possible thesis guidance tool both in Business and Healthcare programs. Skype for Business and shared folders have also been used as a tutoring tool both for individual and group tutoring.

Discussion

Turku University of Applied Sciences has recognized the need to improve digital skills among the faculties. Innopeda Tech Lab was our first very concrete reaction to the identified gap of our digital immigrants, our personnel. Innopeda Tech Lab has trained a good number of our personnel, but we have seen that this training is not enough. One identified challenge has been that the skill level of our personnel has quite high variance. Innopeda Tech Lab started partly to introduce the new technologies to our university personnel, but as important or even more important factor is the changing role of working life and requirements there. For example, we should be able to work from anywhere, we should be able to work together and share ideas easily, information should always be available in one place and we can join meetings online.

Introduction of Onedrive has decreased the number of papers moving between students and teachers too. Sharing documents online has proved the power and possibilities it has although we had some technical problems with configurations at the beginning. In addition, we see that some short communication has moved from email to Skype fro Business. Furthermore online meetings are nowadays a reality and increased number of online meetings are held. Personnel have learned to ask for an online possibility which has influenced positively to our travel costs and it has also saved some time for them. Online meetings have had some challenges too. Typical challenges have related to the poor network connection and voice coverage, but we are all the time learning in here as well. Another problem at the beginning was that we couldn't invite people outside our university to join Skype for Business meetings.

The simulation environment we have used so far has independent user account and profiles needed in place, but what should still be improved are the use cases that can really help the participants to realize the possibilities of these digital tools. The tools that we are offering in our university Office365 package are shown in Figure 1.

Figure 1. Office365 tools in use in TUAS.

Although the awareness of technology possibilities and practical skills in using the tools has clearly improved, it has become clear that we need more goal-oriented and better planned training to answer the challenges presented earlier in this paper. Therefore a new training program, "Digitalization leap", has been proposed in the Spring of 2016. The aim of this new training program is to raise the awareness of opportunities with selected technologies and improve the digital skills of personnel. This training program will hopefully shift TUAS personnel into the next level in digital skills. This program has three modules starting from different level of skills and competences of the participants. The program is going to start in the autumn of 2016 and will continue along with our other personnel development training. The training program is targeted for our personnel, but at the same time we are creating modules in digitalization for our students too.

Together with the training program we are introducing general principles of enhancing digitalization in daily activities of our university. Several principles have been discussed, but these are not confirmed at the moment. Some of the principles discussed are:

- aiming for a paperless office
- all TUAS personnel use of Outlook calendars
- active and versatile use of smartphones
- always provide a possibility to join a meeting online
- sharing and working with documents online.

In addition, we are working with our information architecture consisting of technologies, networks and information systems.

Conclusions

Digital skills are essential in nowadays working life and higher education is transforming as the reports cited earlier in this paper have shown. The steps we have taken in Turku University of Applied Sciences have moved us in the right direction, but we still have quite a long way to go. Innopeda Tech Lab is a wonderful concept, but we should have put much more effort and time to reach wider change in the digital skills of our personnel. Digitalization is part of our strategy, but we did not fully connect Innopeda Tech Lab there. We had it there, but it has been mostly dependent on the personnel's own interest to join the trainings. Innopeda Tech Lab should have been made a mandatory part of personnel training and development. With the latest initiative, "Digitalization Leap", we are hopefully getting the right emphasis and attention to the digital skills of TUAS personnel. Maybe with our activities and support our personnel become so fluent in digital skills that we can forget speaking about digital immigrants rather we can just ne proud of their digital skills.

This paper has described one case study which shows how an university has started to improve the digital skills of their personnel. This case has shown that it is not a simple task rather it requires time and effort. Based on our experience we strongly encourage other higher education institutes to take steps to bridge the digital skills gap if no activities have yet been taken.

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Working to active learning by Creative Engineering in NIT SUZUKA college.

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Abstract

Since 2000, the education program "*Creative Engineering*" has been set in National Institute of Technology, SUZUKA college (NIT SUZUKA college). The purpose for the course was to switch on students to be creative as well as productive-oriented, so that they would play important roles as creative engineer in the 21st century. We aimed to cultivate them, so that each of them could create brand-new values in the future. Before this program started there were some classes for creative education in our college, such as Problem Based Learning, Project Based Learning, Team Based Learning. However, they were just fundamental and small scale trials by some individual teachers and most of them were carried out as elective class or subject. On the other hand, our country and industries were standing at a crossroad where we were trying to change our scientific and engineering attitude and mindset from catchup-type to value-creative one. Those needs of times combined with the new trials, and the brand-new programs for the whole of our college was established 2003. Our Creative Engineering Classes have two unprecedented characteristics mainly. #1: They are compulsory courses for all 4th graders and cross-departmental at the same time. #2: The classes are open for them at the same time frame. Students are divided to each small group to design, evaluate, set and solve problems by themselves. Teachers play the role of adviser, coach and supporter. In recent years, retired engineers who experienced Core Manufacturing Technology (MONODUKURI) have been invited as adjunct teachers. The theme and content differ from department to department, such as creating devices and machines, programming, improving elemental technologies etc. However, students can acquire same abilities, such as application, self-solving, presentation, report creating. Their abilities and results are evaluated by interim and final reports and presentations. Furthermore, the final outcomes are disclosed to public at school festival (*KOSEN-SAI*). Creative Engineering has been the important preliminary step for 5th graders' graduation research activities, so that they would be more effective higher qualitative. This program meets the standard of the Japanese Accreditation Board for Engineering Education program (JABEE) and it is evaluated from this organization formally.

Keywords: *Creative Engineering, cross-departmental, preliminary step of graduation research, Japanese Accreditation Board for Engineering Education program (JABEE)*

Introduction

National Institute of Technology, *KOSEN*, was founded in 1962, in response to the strong demand from the industrial world for engineers to support Japan through its period of high economic growth starting in the mid 1950's, and to make contribution to further development of science and technology[1]. Since then, the requirement for many professional jobs has been changing. Concretely speaking, highly advanced knowledge skills and interpersonal services emphasizing personality indicating highly professional human resources were needed in industrial world as Core Manufacturing Technology "*MONOZUKURI*". From this background, *KOSEN's* education had to be reformed, inevitably. In 1991, students who completed of associate degree program could be awarded as associate degree, and advanced course was installed. Since then, *KOSEN* students entering advanced courses have been able to get bachelor degrees, when they pass an examination given by the National Institution for Academic Degrees and University Evaluation after their completion of advanced course students[2]. The reason for these educational reforms, should be attributed to that the industrial society requires *KOSEN* graduates problem solving skills and design ones in addition of conventional technical ones. From the viewpoint, traditional classes, such as catch-up type lectures and experiments, were difficult to develop the human resources who were required from industrial world. Of course in NIT SUZUKA college, there were some classes for creative education[3,4]. However, there were just fundamental and small scale trials by some individual teachers. Therefore, a completely different curriculum system was needed to realize more higher and full scale creative engineering education. Although graduation research belongs to the category, it had been provided the final associate graders only in one year. Therefore, new class which was able to foster the creative engineer were set at 4th grade as "*Creative Engineering*". In this report, we introduce to content and the result of "*Creative Engineering*".

Materials and Methods or pedagogy

"Creative Engineering" has two properties, #1: They are compulsory courses for all 4th graders and cross-departmental at the same time. #2: The classes are open for them at the same time frame. The reason of #1 could be attributed to that the 4th grade students have basically abilities, since they already have experiences many professional lectures and experiments. In addition, *"Creative Engineering"* could serve as preliminary step of graduation research. Therefore, some important educational tools, Problem Based Learning, Project Based Learning, Team Based Learning, can be used at more advanced level. The reason of #2 could be attributed to that all department students can take part in interdisciplinary area project such as Robot competition (ROBOCON), Design competition, Eco-Car project. These educational projects will be reported at another opportunity.

The purpose of *"Creative Engineering"* is described in syllabus as "Students should solve problems and projects which are established by teachers or themselves, and find solutions by experiments. Students should cultivate and improve engineer's pride (motivation, passion, challenging spirit, etc.), and they should acquire abilities, such as planning, application, self-solving, presentation, report creating"[5]. Table 1 shows knowledges and abilities that can be learned by this class. These abilities and knowledges meet the standard of Japanese Accreditation Board for Engineering Education (JABEE) program[6]. *"Creative Engineering"* has 180 minutes each time and it continues for 15 weeks. The 1st week is the guidance, and teachers explain about the contents of *"Creative Engineering"*. Then students select theme and they are divided to small groups. Next, students discuss and hypothesize solution of theme's problem (Figure 1 (a)), and they start to solve and improve the problem of theme (Figure 2 (b). Teachers play the role of adviser, coach and supporter. For example, they teach how to use the instrument and make clear everything about the problems (Figure 1 (C)). In recent years, retired engineers who have already experienced Core Manufacturing Technology (MONODUKURI) have been invited as adjunct teachers. The theme and content differ from teacher to teacher and department to department, as for creating devices and machines, programming, improving elemental technologies etc. The contents of each department are introduced.

・Department of Mechanical Engineering

Mechanical Engineering students create electromechanical game machines and demonstrate them at School festival. In our class, students learn to take priority of customer satisfaction (CS) of visitors and acquire skills in fabricating machines which should work two days without breaking down. In designing machines, we attach importance to proper difficulty, easily understandable rule and safety, taking into consideration the fact that a wide age range of visitors stay shortly to see the performance. Students learn in

Table 1 Knowledges and Abilities can be learned.

- **Students can recognize the matters which they should prepare, and they can learn continuously.**
- **Students can grasp the problems to be solved, and they can learn to the solution autonomously.**
- **Students can proceed strategically challenges aware of the goals of the theme.**
- **Students can be innovation and ingenuity in the process of advancing the theme by yourself.**
- **Students can make the announcement, which was devised and easy to understand, and they can discuss accurately in interim and final reports and presentations.**
- **Students can report logically.**

Figure 1 Scenes of *Creative Engineering*.

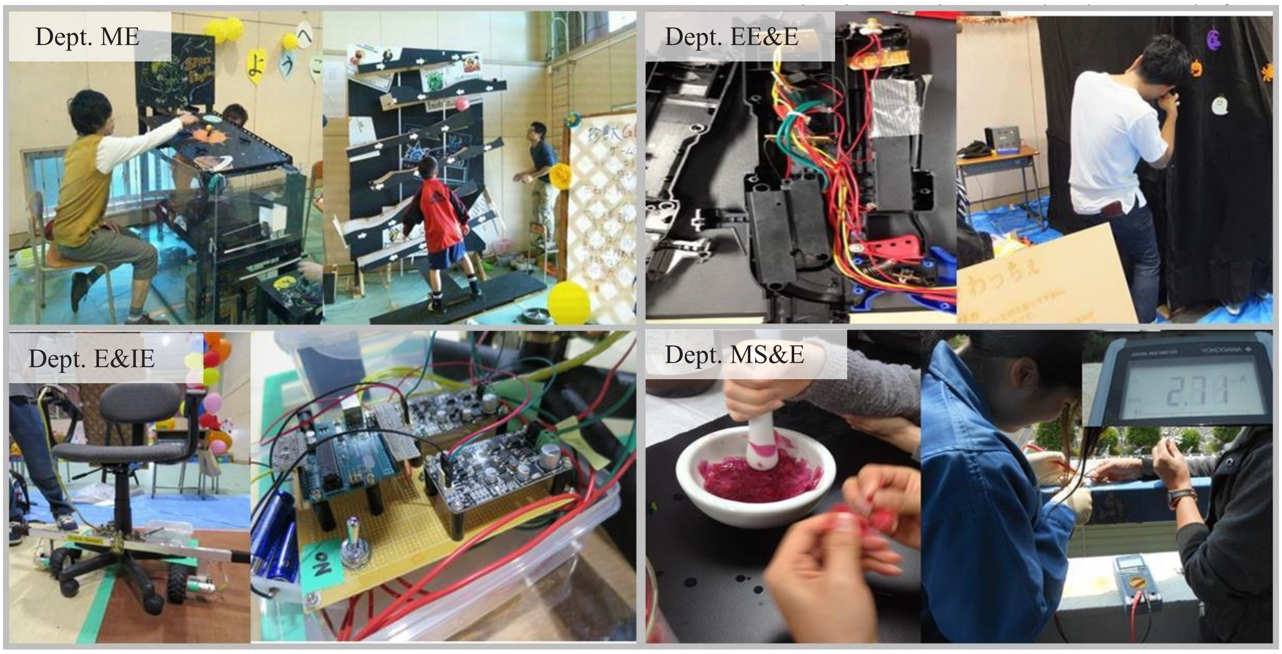


Figure 2 Scenes of each department.

groups of two to five the whole process: they discuss ideas, build design specifications, design roughly and then in detail, purchase materials, machine parts, assemble parts, make parts adjusted, operate the machine and dispose of the waste. They use 3D-CAD: SolidWorks for designing. School festival is an ideal opportunity for students to listen to users' opinions directly through the operation of machines that they developed by themselves. They learn one of the pleasures of designing machines when they see people enjoy their performance as well as difficulties. They learn also how to handle the problems that they could experience in the actual work place.

(b)Department of Electrical and Electronic Engineering

Department of Electrical and Electronic (Dept. EE&E) students manufacture machines system and game programs, in order to raise recognition and familiarity for Electronics. The Electronics from power electronic to control and signal circuit is very widely fields, such as programing, electronic circuit, semiconductor devices and communication system. At school festival, they demonstrated the shooting game which is body-sensitive game by vibration and sound. The concept was "Providing game abundant in ambiance by feeding back the result of game proceeding or the result of actions by a player to the player in a more real manner." The machine was designed by 3D-CAD system, and processed by a laser processing technique.

(c)Department of Electronic and Information Engineering

The students in department of Electronic and Information Engineering (Dept. E&IE) develop a device using information engineering, electronic control, and the integration of those technologies, such as electric control by microcontroller (e.g. Arduino, AVR), 3D and (e.g. Unity, Android studio, Swift), Wireless communication system and the instrumentation and control system by credit-card sized computer (Raspberry Pi) etc. Students create using the brainstorming ideas of their device. Figure 2 shows that electric wheelchair by microcontroller module. It is unique that was used trackball as an operation method. The students were studying their own the electronic circuit fabrication, the microcontroller motor control and its control program.

・Department of Chemistry and Biochemistry

In the Department of Chemistry and Biochemistry (Dept. C&B), the students are working on the themes originated with themselves or their supervisors. The subjects listed in 2013 are as follows; new proposal for the preparation and application methods of photo-catalysts, fabrication of liquid crystal coaster, environmental analysis on the mudflat, dynamic nano-structural model for understanding the functions and the structures of microbes, production of ecological paper, web-site creation for the studies of organic reaction mechanisms, fabrication of airship, swimming power measurement using simplified apparatus. Here, the subject of "environmental analysis on the mudflat" (Yamaguchi *et. al.*, 2014) has been briefly introduced[7)]. There are three educational purposes intended by the staffs. First, the subject is suitable for the encouragement of autonomous learning of the students because they are interested in the chemical and biological analyses, environmental issues, and so on. Second, they will understand that the knowledges and techniques learned in the classes, such as titration, absorption photometer, and so on, can be also used practically. Third, the practice program will cover chemistry, biology, and environmental science, which are the educational and research topics of the department. The main topic of this subject is the environmental analysis on the mudflat near the mouth of Tanaka River in Mie, that is, identification and quantification of inhabited animals (2012~), examinations of water (2012~), sediment microbial fuel cell (sediment MFC) using the mud on this mudflat (2013~) and discussion of the relationship between them. It has been found that different kinds of crabs in this mudflat should have different environmental preference, the amount of phosphate in the mud and the distribution of inhabited animals show a certain degree of correlation, negative electrode potential of sediment MFC should be strongly affected by both the amount of microbes and sulfite ions in the mud, and so on. The questionnaires for the students in 2012 reveal that three educational purposes intended by the staffs shown above should be accomplished in general.

・Department of Materials Science and Engineering

The students in department of Material Science and Engineering (Dept. MS&E) created processing, devises and manufacture, utilizing material characteristics, such as colourful mirror by metallic process, synthesis of jewel, Fuel Cell, Solar Cell etc. Students measured performances of devises and evaluated material properties by some analytical instruments. Figure 2 shows that students extracted dye from vegetables and plants. They evaluated cell performance from dye absorption and tried to fabricate Dye Sensitized Solar Cell (DSSC) having high performance and design. DSSC could be fabricated very easily. On the other hand, it was suitable for the teaching materials, since it could incorporate some academic elements, such as Electrochemistry, photochemistry, physical chemistry etc. In this case, they found an efficient extraction method of the dye, and investigated the relationship between the colour change and solar cell characteristics due to pH. They manufactured the Future Eco-House model and demonstrated these results at our school festival, and they exerted a powerful appeal to the importance of energy for visitors.

Results and Discussion

Abilities and results obtained through "*Creative Engineering*" are evaluated by interim and final reports and presentations. Figure 3 (a) shows the scene of presentation. They generally share the presentation in group, and make announcements at 2 to 3 minutes for each presentation. Students should talk their original ideas and call attention with their results to the audience in a certain presentation time. As a result of such trial and error, it leads to improvement of their presentation capabilities. Other students diligently listen to the presentation by other students. And not only teachers but also students join discussions in question and answers time positively. In addition to these evaluations, the final outcomes are disclosed to public at school festival. Figure 3(b) shows the scene of school festival exhibition. In school festival exhibition, students should explain their result for general visitors

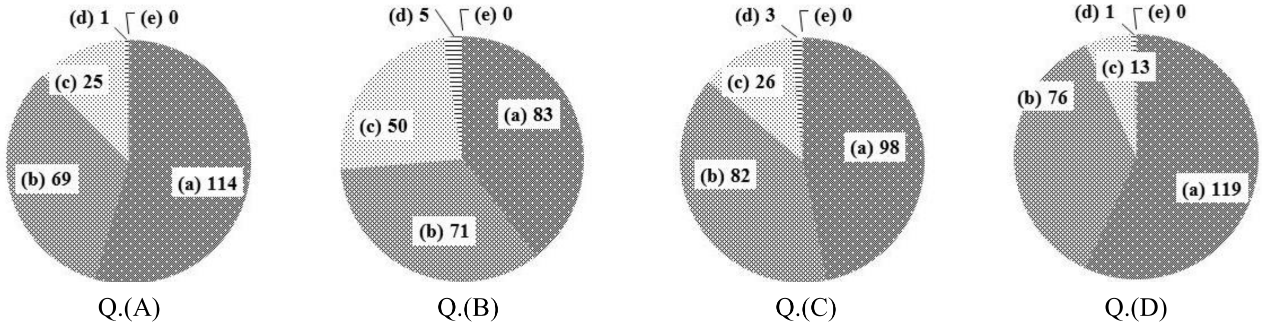
Figure 3 Scenes of presentation and demonstration.

who do not have expert knowledges. Therefore, higher level of the presentation skills is needed for students, since it is very difficult for them to talk in front of students and teachers who have expert knowledges. This experience should lead to graduation research and job interview at 5th grade. Especially at job interview, the experience should work well when they would write their resume etc.

Furthermore, from the results of the questionnaire, it is found that the students can recognize by their own that their abilities could be improved. Figure 4 shows that result of questionnaire last year. Most of students could answer that their abilities have been improved such as techniques, knowledges, improved problem-solving skills, presentation skills, cooperativeness and motivation. We think about that purpose of Active Learning, such as Problem Based Learning, Project Based Learning, Team Based Learning, enhance self-learning motivation, improvement of performances and recognize these factors by student themselves. From these result, we can conclude that our original aim and goal should be achieved sufficiently by *Creative Engineering.*

Conclusions

About 15 years have passed, since the education program "*Creative Engineering"* has been set in NIT SUZUKA college. The purpose for the course was to switch on students to be creative as well as



(A) Did you get the skills, knowledges and voluntarily learn attitude?
(B) Did you improved problem-solving skills and presentation skills?
(C) Did you learn the importance attached to the roles yourself and cooperation of the members in the group?
(D) Did you try to actively understand the contents of your theme?
Answer is (a):Excellent, (b):Great, (c):Good, (d):Not so good, (e): Bad, and number is the number of respondents.

Figure 4 The result of questionnaire to students who have been taken *"Creative Engineering"* in last year.

productive-oriented, so that they could play important roles as creative engineer in the 21st century. More than 2,500 students completed the this program alraedy, and they are already active as enginieer in domestically and overseas of universities and companies where are needed to "*MONODUKURI*". We wish the graduates and the future graduates be continued success and prosperity, and we will challenge to active learning education that students are satisfied and improved.

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WORK-BASED LEARNING VS MONOZUKURI EDUCATION: A COMPARATIVE STUDY

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Abstract

The curriculum of engineering education in Thailand is regulated by the Office of the Higher Education Committee, the Engineering Council, and the Dean of the Faculty of Engineering Meeting. The 4-year curriculum consists of about 140-145 credits with general education, basic of engineering, engineering core courses, free electives, and about 3-6 credits of engineering practices. Recent report from the education reform committee stated that, 3 to 4 students out of 10 high school graduated entering the university education. Finally, only one out of these 3 or 4 graduated could get a job after graduation. General survey from private sector indicated that almost all of these graduated needed to be trained for at least 6 months to 1 year before they would be ready to work as full time staff. Panyapiwat Institute of Management or PIM, one of a few corporate universities in Thailand, employs a new model called DJT with Work-Based Learning or WBL methodology for all our students including the engineering ones. Out of 48-week courses, students attend 30 weeks of lecture and laboratory practices with 18 weeks of practices in the private sectors. There are 3 classes of engineering graduated since the year 2012 with 100% job placement. On the other hand, Thai-Nichi Institute of Technology or TNI, employs the Monozukuri Education concept modeled after Japanese practical way of education. The DJT model and Monozukuri Education application to university study and the appropriateness for the present and future engineering education will be discussed in detail comparative study.

Keywords: *work-based learning, monozukuri education*

Introduction

There are 84 National or government supported university, institutes and/or colleges in Thailand. The private university, colleges, or institutes are about 34. Out of these nearly 130 units, 34 have a Faculty of Engineering for both undergraduate and graduate program. Panyapiwat Institute of Management or PIM, a corporate university under CP All PLC., is one of the private higher education institutions with 9 Faculty and one international college. PIM was first established in order to provide higher continuing education for the Diploma students form Panya Technology College (PTC) also owned by CP All PLC. So, there were initially only Faculty of Business Administration and Faculty of Management Science with about 500 students and 50 staff. The concept of work-based study has been experimented successfully in PTC and has since refined and continuously improved with the application of the DJT Model and quality management system in PIM.

Historical Background

Panyapiwat Institute of Management or PIM is founded with the funding from Sueksapiwat Company Limited, a subsidiary of CP All PLC. CP All PLC is a distribution arm of Charoen Pokaphand (CP) Group, a global conglomerate based in Thailand with operation and investment in agribusiness, distribution, and telecommunication. On March 9, 2007, PIM was granted the permission and license for the establishment of Private University (License N0.4/2550) by the Ministry of Education through the Office of Higher Education Commission and has since been operating as a higher education institution, offering fully accredited bachelor’s and master’s degree programs since June 1, 2007 and a doctoral degree program since October 1, 2012. [1] The university is located at Nonthaburi, a province north of Bangkok with the area of about 1.8 hectare. PIM has been expanded year by year from two Faculties in 2007 to 9 Faculty and one International College, from 500 to over 10,000 students and from 50 to 500 staff in 2016. There are twelve administrative units of which the six major units to provide supports and services to students. These are the Office of Educational Promotion, the Office of Student Affair, the Office of Information Technology, the Office of Arts and Cultural Promotion, the Office of Student Development, and the Office of Organizational Communication. There are an administrative building, a multi-purpose building, and a 15-floor CP All Academy building for lecture rooms, laboratories, faculty staff offices, meeting rooms, library, and canteen. The P in PIM came from Panyapiwat which means prosperity of intellect, characterized by academic and moral excellence. The philosophy of PIM is "Education is the Matrix of Intellect" focusing on Practicality. Innovation and Morality. The motto of PIM is "Create Professionals by Professional.

The vision of PIM is that it is aspired "To be Thailand's leading institution of higher education in retail, management, and technology that focus on learning through experience and creating innovation. To realize this vision, there are 5 items in the mission, namely,

1. To provide quality work-based learning programs and produce graduates with requisite knowledge, skills, and competency sought by employers.
2. To produce high quality research in various fields of study and develop new bodies of knowledge and creative innovations for the betterment of the Institute, Society, and the Country.
3. To provide academic services to businesses, communities, society, and the country.
4. To protect, preserve, and promote the arts and culture of Thailand and foster cross-cultural understanding and exchange.
5. To enhance organizational capacity to increase efficiency and effectiveness and strengthen competitiveness to ensure sustainable growth and workplace happiness.

"Work-Based Learning" or WBL at PIM is a system that supports and inspires students' growth in all aspects through a combination of classroom and workplace training together with opportunities to cultivate a wide range of skills including social competencies, life skills, and higher-order thinking skills. These combinations of grown-up skills exhibited the strong identity of PIM's graduates.

Thai-Nichi Institute of Technology or TNI is founded with the funding from Technological Promotion Association (Thailand-Japan) or TPA. [2] The permission and license were granted on September 29, 2006 and the education program was started from the educational year 2007, the same period as PIM. The institute is located at Pattanakarn Road in the eastern of Bangkok Metropolitan. There are three main buildings housing administrative and faculty offices, library, and fully equipped learning and research laboratories. As the offspring of TPA, whose philosophy is "Dissemination of academic knowledge to create the bases of economy, the philosophy of TNI is "Development of academic knowledge and supporting the industry to contribute for economic and social well-being". The vision of TNI is that it is aspired "To be the leading private university in technology and management science focusing on communication skill with strong domestic and overseas networks, to achieve academic excellent and application, and to be a center of knowledge dissemination to the society". To realize this vision, there are 5 items in the mission, namely,

1. To provide higher professional education program corresponding to the demand of business and industrial sectors with focusing on academic excellent, practicality, and actual application.
2. To foster students with knowledge and integrity, requisite knowledge, responsibility, and social awareness.
3. To produce research, creativity, technology development, and new knowledge that supports the education and the development of business and industry.
4. To disseminate advanced knowledge and technology contributing to the creation of competitiveness in business and industry.
5. To protect, preserve, and promote the arts and culture of Thailand and foster cross-cultural understanding and exchange.

The Bachelor Degree program consist of three faculties, namely , Engineering; Information Technology; and Management. The Master Degree program consists of 5 programs, namely, Engineering Technology; Information Technology; Industrial Management; Executive Enterprise Management; and Japanese Business Administration. The Faculty of Engineering offers 5 fields of undergraduate study, i.e., Automotive Engineering (AE), Production Engineering (PE), Computer Engineering (CE), Industrial Engineering (IE), and Electrical Engineering (EE) with one Master Program in Engineering Technology (MET). As of 2016, there are about 500 faculty staffs and 4000 students. The strong relationship between TPA, the mother organization, with the Japanese public and private sectors, resulted in the strong support from overseas and domestic Japanese organizations. For example, the Japan Chamber of Commerce provides a number of scholarships for students. The networking with several Japanese university paving the way for sending students for internship in Japan too.

DJT Model with Work-Based Learning

Work-Based Learning at PIM based on the DJT model of education uniquely created and refined over the year through quality management system of PDCA or Plan-Do-Check-Action. Each letter in the DJT came from the name of a country that exhibit uniqueness of working and living style. It came from Deutsche Japan Thailand Business Model. Though PIM based its education system mainly on German or Deutsche's Work-Based Learning, the system has been modified by combining the strength of Japan and Thailand together. PIM believes that this combination could create appropriated body of knowledge and thus, qualified and well-trained graduates for the country.

D for Deutsche or German is a country that excels in fostering human resources through Work-Based Learning, continuously pursuing innovation, best practitioner of productivity improvement and

perfectionism.
J for Japan is one of most industrious nations, excels in marketability, cultivation and application of information, and continuous development of technology.
T for Thailand is a country with creativity, flexibility, and relaxation culture. [3]

Monozukuri Education

TNI employs the Japanese Monozukuri ways of education in the curriculum. The principle values of TNI consists of 6 items, namely,

1. Monozukuri …..*ability to think and make.*
2. Kaizen…….. *continuous improvement*
3. Hansei……*self-reflection*
4. Honest …*loyalty and integrity*
5. Respect….*oneself and others*
6. Public-Interest Conscious…*awareness of common interests.*

The Monozukuri ways of education emphasizes the important of Professional Competency, Language Competency, Basic Management Skills, and Basic Skills for Society Members.

Quality Assurance System

No matter what kinds of model applied in the work processes, quality assurance system is a crucial factor to continuously deliver the best outputs and outcomes. Establishing and implementing an effective system for quality assurance has been a priority for PIM in order to:-

1. Assure the public confidence in the academic standards and quality of academic program offered by the Institute;
2. Ensure that the Institute's academic standards and quality of graduates are recognized by society;
3. Assure standards and quality in every aspect of the core missions of the Institute including research, provision of academic services to society and promotion of the arts and cultural heritage.

To enhance the Institute's educational service quality, PIM Internal Quality Assurance Regulation B.E. 2556 has been developed based on the quality assurance framework established by the National Education Act of B.E. 2542 (1999) and Amendments (Second National Education Act B.E. 2545 (2002) and the Ministerial Regulation on System, Criteria and Methods for Internal Quality Assurance in Higher Education B.E. 2546 (2003) and promulgated and adopted by all Institute's academic and administrative units.
The Internal Quality Assurance System and Mechanisms specified that:-

1. The Internal Quality Assurance Board shall be appointed by the Institute to oversee institutional quality assurance.
2. The Institute's internal quality system shall be established in a structured and continuous manner in line with the spirit and educational standards of Thailand.
3. Components and indicators for internal quality assurance shall be developed based on the Manual for Internal Quality Assurance in Higher Education.
4. The Institute shall set up its own quality assurance agency to be responsible for internal quality assurance.
5. Each academic and administrative unit shall appoint a responsible person for internal quality assurance tasked with coordination and preparation of annual reports to be submitted for review by the Institute to measure the progress achieved against the internal quality assurance components and indicators established. The results of internal quality assurance assessment are to be communicated to the Institute's executives in each academic and administrative unit to carry out further and continuous improvement.

The Faculty of Engineering and Technology or ET is the third faculty established at PIM. In 2009, the faculty offered only one degree program in information technology (IT) and was known as the Faculty of Science and Technology. With the launch of two new degree programs in computer engineering (CPE) and industrial engineering (IE) in 2011, the faculty's name was changed to its current name. In 2014, the faculty launched two new degree programs in automotive manufacturing engineering (AME) and master degree program in information technology (MSIT). As of present, there are 4 bachelor degree and 1 master degree programs. There are 30 teaching staffs and 14 administrative staffs with about 400 undergraduate degree students and 4 master degree students. Similar to all other faculty, the curriculum of the ET consists of both coursework and internship or professional development program over the 4-year period. The ratio between coursework and internship is 60% to 40% or 30 months of coursework and 18 months of internship. Total credits for every engineering undergraduate program are about 140 with roughly 20 to 25 credits for internship. In contrast, the engineering curriculum for other university in Thailand consists mainly of coursework with only 1 month for internship in ordinary program or 3 to 6 months of internship for cooperative program. Study and/or internship periods in PIM are organized as 2 block courses per one semester. So, PIM student will have a very short vacation period, about a week between each block. This is a major reason why PIM could provide longer time for internship for the student. Table 1 shows study and internship plan for the ET student.

Table 1 Study and Internship Plan for ET student

Y1	S:12 W	S:12W	B	S:12W	P:13W	B
Y2	S:12W	S:12W	B	P:12W	S:12W	B
Y3	S:12W	S:12W	B	S:12W	P:1W3	

Y4	P:12W	P:26W				

Y= Year, S=Study, P=Practices W=Week, B=Break

Internship plan for ET student of PIM and engineering student of TNI

As can be seen from Table 1, there is internship or professional development period in every academic year for ET student of PIM . The detail plan is:-
Year 1 – 3-month of training at a 7-Eleven store to develop service mind, creative thinking skill, and to learn the store technology system.
Year 2- 3-month internship in student's chosen area of study.
Year 3- 3-month internship to strengthen work competencies and problem solving skills.
Year 4- 9-month of professional placement. [4]

CP All PLC owned an exclusive license to operate 7-Eleven convenience stores in Thailand so that PIM could organize the stores as initial training sites for all of its students. For the second to fourth year students, network of alliances company has been built over the past 8 years for professional training sites. So, from the second year, the IT and CPE students could practice as programmer, system engineer, or documentation specialist in a software house. The IE students could be trained in logistic, environment, or production management in manufacturing plants. The AME students could be trained in assembly lines, parts production, or service centers.

To create professional awareness and real life working situation, Project-Based Learning is applied over the whole internship period. Students would work individually or with group of partners to submit proposals of work place or process improvement in the first year. For the second year, the project will be more focus on corresponded area of their study and report on implementation is required. The third and fourth year projects will be more comprehensive as a senior graduation project.

The internship or professional development program for the engineering student of TNI can be divided into two categories. About 30% of the students enter into the 2-month summer apprentices program with the private sector. Another 70% enter into the so-called 4-month co-operative internship program, also with the private sector, during the fourth year semesters. Project-Based Learning in the same manner as PIM student is also applied over the whole apprentices or internship program. [5]

Evaluation of Professional Development

Generally speaking for both PIM and TNI, the apprentices and/or internship program for student begins with the discussions among two internal parties, namely, the student's academic advisor, representative from the Office of the Student Development, and one external party, namely, representative of an alliance company. The agenda consists of apprentices and/or internship period, detail of project work, expected outcomes, scoring scheme and responsible evaluators from each party, student's per diem (if any), accommodation and transportation (if applicable). The score is distributed among the project accomplishment, written report, and oral presentation. The outcomes of the final presentation at the end of the fourth year are one of the most important factors for graduation.

Results and Discussion

The graduate number from ET of PIM between academic year 2012 to 2015 are 18 (IT), 28 (IT), 61 (16 CPE, 26 IE, 19 IT), and 76 (27 CPE, 21 IE, 28 IT) respectively, totally 183 persons. Immediately after graduation, 112 persons has been employed by companies outside CP group or established their own business, 69 persons by CP and Subsidiaries Company and 2 persons decided to continue studying for Master Degree. Under the global economic recession situation, these nearly 100% employment of the graduated reflected the strong demand for the "ready-to-work" graduates with minimum training required in the workplace.

The graduate data from TNI between academic year 2012 to 2015 compared to 2nd year student are 63% for AE, 64% for PE, 61% for CPE, and 48% for IE and 30% for MET. With the exception of IE graduated in which the data is under collection, 100% of the graduated from TNI were employed immediately after graduation.

In addition to the internal quality assurance of the institution, the Office of Higher Education annually performs third party surveillance audit as internal quality assessment. Then every 4-year period, the Office of Academic Standard would perform third party surveillance audit as external quality assessment. The internal quality assessment has been done since 2010. ET of PIM achieved the score of 4.42 in 2010, 4.65 in 2011 and 4.81 in 2012 out of the full score of 5. The score over 4.5 signified the very good level. As for the round 3 external quality assessment done in the year 2014, ET achieved the highest score of 4.67 out of 5 among all Faculty of PIM. The average score for overall institution was 4.52. So, ET achieved very good level for both internal and external quality assessment by third party. [6]

In case of TNI, users of graduated assigned the evaluation score (out of 5) as 4.13 for AE, 3.97 for PE, and 4.03 for CE.

Since the industrial revolution, the speed of change in the private sector, the user side of human resources, is getting higher and higher year by year. Meanwhile, the change in educational institution is still very slow. For example, it would generally takes about 3 to 4 years to change the curriculum in the higher educational institution. Needless to say that, the curriculum including the teaching and learning practices rarely reflected the up-to-date situation in the private sector. So, for the countries like Germany and Japan, internship program and closely collaboration between university and private sector are the keys to success in fostering qualified and well-trained human resources to satisfy the immediate needs of the user side. As a corporate university under one of a global conglomerate, PIM realized the significant roles of Work-Based learning to provide best quality graduate corresponded to the needs of the private sector.

The DJT Model with Work-Based Learning has been created, modified, and continuously refined over the past 8 years through internal and external quality assurance system and PDCA cycle. The main ingredient of the model is the internship program or professional development plan. Detail planning between internal units and alliance companies, couple with annual internship period resulted in “ready-to-work” graduates with 100% employment right after graduation.

The initial 12-week training at 7-Eleven convenient stores provides significant character development and basic understanding of working culture to the student. Lack of communication skill in almost all technical students could be alleviated by conversation practices with roughly 400 customers during each working shift. Instill of discipline during internship is done through the system of three-shift work. Student has to be on time for their shift. Dedication to the duty is also instilled as the student has to stay in the store after the shift ended to transfer the duty to the person who works in the next shift. Student is also trained to be honest as they must be responsible for all the money received from the customers. Last but not least, working in the store with hourly wages would help student to fully realize the hardship of earning their own money. After this 12-week internship, the thinking and manner of the students are remarkably changed from just a learner to a real practitioner and from childhood to adulthood. Consecutive training for another 15 months over the next three years will further hone their skill to be “ready-to-work” engineer when they are graduated.

The monozukuri education employs by TNI exhibited the excellent outcomes of graduated who could get a good employment almost immediately after graduation. The evaluation score by users of graduated of TNI at the level of 3.97/5 to 4.13/5 reflected that TNI education system could foster high quality human resources whose skill could satisfy the requirement of the employee quite well.

Conclusions

PIM, one of a few Thai corporate universities, employs the work-based learning system or WBL which required engineering students to spend at least 40% of the time in the internship program. The internship period has been designed to spread out over the 4-year program. The targets of the training period range from work-life awareness to actual career training. On the other hand, TNI employs the monozukuri education system which also emphasizes the important of practices through apprentices and/or co-operative program. The practical training period for TNI engineering student is about 1/9 to 2/9 of the PIM ones. The training period of TNI student is either in the summer semester of the third year for apprentice or in the first or second semester of the fourth year for co-operative program. Almost 100% of graduated from TNI and PIM were employed immediately. Compared with the report from the education reform committee, only one out of 3 or 4 graduated from other university could get a job soon after graduation. Also, the general survey from private sector indicated that the graduates from other university would require the training period of at least 6 months to 1 year before they would be ready to perform their duty. So, both WBL and Monozukuri could foster better graduated than the traditional education system employ in other domestic university.

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A new approach in physics class activities to foster the scientific mind-set for first-year students in academic quarter system

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Abstract

A scientific mind-set and logical thinking is very important for modern engineering education. In order to foster these competencies, we encourage students to learn on their own and think by themselves. However, we find almost first-year students have no experience of any research based on self-direction in secondary education through our questioner's survey. Moreover, in our Kosen, academic quarter system have been adopted and carried out a curriculum overhaul in 2015 academic year. As the result, the number of physics and applied physics classes is decreased by about 20%, thus we cannot carry out class plan as before. Therefore, in order to foster students' scientific mind-set and logical thinking, and to encourage students to learn on their own and think for themselves, we try new physics class "Introduction to Essential Physics (hereafter, IEP).

Each IEP class progress fully group activity, thus we are not "teacher" but also "coordinator". In IEP, we set two learning goals to students; 1) learn the relationship between body feelings and the meanings of physical quantities, 2) debate with the friends (team member) to get answers. In order to attain of these goals, we prepare a task that has many potential answers and enough time to debate each other. For example, "Measure the volume of your classroom without tape measure", "Guess how many people in restrooms at this very moment in Japan in a scientific way." Students summarize the process of how they find their solutions, the conclusions they reach, and how they evaluate their conclusions to A3-sized blank paper calls "labo-note" (short word of "laboratory notebook") each group. "Labo-note" have no format except the space to write the team members name. Thus students can obtain opportunity to acquire how to write a scientific paper, i.e., how to describe purpose, methodology, results, conclusions, and recommendations through the process of making "labo-note".

We have so far get positive response from students. The present approach is deeply related to self-direction inquiry introduced into our Kosen since the 2015 academic year.

Keywords: *active learning, physics class, scientific mind-set, academic quarter, and self-direction inquiry*

Introduction

In order to foster scientific mind-set and logical thinking, we encourage students to learn on their own and think by themselves. Therefore, introducing active learning method in physics class is very important. However, students' learning style is not prepared for accepting active learning.

In almost Kosen in Japan, a uniform examination in physics for third graders is carried out in every January[1)]. Table 1 indicates that score ratio of our Kosen to national average in this uniform examination. From table 1, we find that the score of uniform examination is decreased by about 30% in 2015 year in our Kosen.

Table 1. The score ratio of our Kosen to national average in uniform examination for third graders.

Academic year	2013	2014	2015
Score Ratio (National average =1.0)	1.27	1.26	0.93

In our Kosen, we carried out simulation test for this uniform examination in a physics class until 2014 year (Niwa et al. 2016), but we terminated it from 2015 year. Thus, we consider that this result correlate strongly with stop of simulation test. In addition, this result also indicates that many students completely depend on rote memorization to study physics. Moreover, we find about 70% first graders have no experience of any research based on self-direction in secondary education through our questionnaire survey. On the other hand, in our Kosen, academic quarter system has been adopted in 2015 year. At the same time, curriculum overhaul also carried out. As the result, the total number of physics class and applied physics class is about 27.3% less than before introducing academic quarter (Table 2). In paticular, applied physics class decreased by 50%.

Table 2. Decrease ratio of physics class and applied physics class

Physics (for younger than 3rd graders)	Applied Physics (for elder than 4th graders)	Total
0%	50%	27.3%

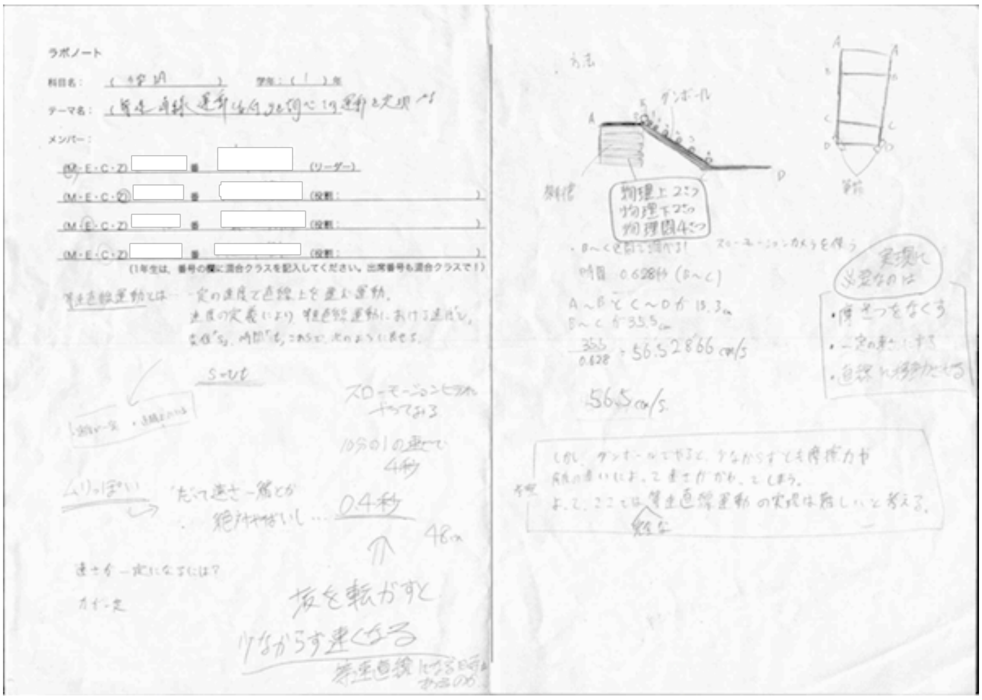

Fig 1. A typical example of “labo-note” (in order to privacy protection, we edit name field). Students can edit freely. This is a result of task of “Rrealization of uniform velocity motion experimentally”. In the right side, students describe the definition of uniform velocity motion and method of realization. In the left side, we find illustration of experiment device. Moreover, students also describe about difficulty of realization caused by friction in the box.

From these facts, present situation surrounding our Kosen is serious to foster scientific mind-set and logical thinking. This indicates that we have to change our physics class to active learning approach from lecture-based learning. In addition, we find that if we carry out active-learning type class, we need to introduce it in lower grade as soon as possible from a result of curriculum overhaul. Therefore, we try new physics class “Introduction to Essential Physics (hereafter, IEP)” for 1st-year students. In this paper, we will introduce about IEP class activities.

Overview of IEP class

The IEP have offered in first-quarter since 2015 year, comprising a total of 7 lessons. There is two learning goals; (1) learn the relationship between body feelings and the meanings of physical quantities, (2) debate with the friends to get answers. IEP is fully progressing group activity. Each group contains three or four students, and does not change till the end of IEP class.

Each group members address task during the class. Students may collaborate other group to complete tasks and to share experimental data. If students finish a task, they summarize as a report that called “labo-note” and some groups make a presentation about results.

In order to evaluate performance of students, we evaluate perfection level of “labo-note” instead of result of paper-based examination.

Tasks in IEP class

In order to attain of two learning goals, we prepare a task that has many potential answers and enough time to debate each other. Table 3 is list of task for IEP.

Table 3. Prepared tasks for IEP class in 2015 -2016 year

Related goal	Task
(1)	• Measure the volume of your classroom without tape measure • Determine “10 meter” and “5 kilogram” using your body feeling. • Find value of “π” without mathematical formulae related in π. • Estimate probability that the head of the coin comes out • Measure the speed of propagation of human’s reflex nerve
(2)	• Guess how many people in restroom at this very moment in Japan in a scientific way • Measure the gravitational acceleration • Realization of uniform velocity motion experimentally • Realization of uniform acceleration motion experimentally

Summarizing “labo-note”

If students finish a task, they summarize results to an A3-sized blank paper calls ”labo-note“ (short word of “laboratory notebook”) each group. Students can edit freely only except name field. However, we demand students summarize three topics to labo-note; (1) the process of how they find their solutions, (2) the conclusions they reach, and (3) how they evaluate their conclusions. These are correspond to “introduction and method to solve problem”, “results and discussion”, and “conclusion” in scientific paper. Thus, students can learn and train how to write scientific paper naturally.

Figure 1 shows a typical example of labo-note. This is a results of task of “Realization of uniform accelerated motion experimentally”. The definition of uniform accelerated motion and method of realization is described in the right side. On the other hand, in left side, they describe a part of results and discussion, and they also draw illustration of experiment device produced by them. From this fact, this labo-note satisfies our demand at least. In IEP class, labo-note is most important evidence for their activity; thus, perfection level of labo-note is verification to determine students’ academic results.

Role of academic in IEP

In each IEP classes, we are not teacher but also “coordinator” or “facilitator”. We never teach answers about each task directly. Our main role in IEP class is mediation of discussions among groups.

We have responsible for passing along a fact about physics. However, discussing each other to find answer is more important than teaching answers directly. Therefore, we give students some facilitating questions during the presentation to lead the answer.

Education effect in IEP

Figures 2 thru 4 are pictures of a part of IEP class. Figure 1 shows students trying the task of “Measure the speed of propagation of human’s reflex nerve”. Many students collaborate with each other to measure speed of propagation. At first, students were trying this task in an each group; however, students realize a limitation to conduct answer of this task. As this result, many groups collaborate with each other spontaneously. After this experiment, students share obtained data, and began to discuss about speed of propagation including errors and accuracy of experiment.

This scene indicates that we attain the two learning goals at a time. First, students find that physical experience through their body feelings (human’s reflex nerve) can convert fundamental physics quantity (speed of propagation). In addition, figure 2 and 3 show scene of presentation. We can find students participate in an active discussion and consider many students realize the ”joy of discussing each other” from the look of discussion. Moreover, we have so far get positive response from students through description of impression in their reports.

Results and Discussion

In order to evaluate learning effect of IEP quaititatively, we investigate the score of paper-based test of phycics class for 1st graders (Dynamics I) which open directly after academic period of IEP in 2015 year. As this result, examination pass rate of Dynamics I is 57% in average. In other words, almost half of students failed in a test of Dynamics I.

This indicates that mathematical exercises are insufficient in IEP (and Dynamics I) class. In other words, students may be not able to understand about relationships physics and mathematics completely. This

Fig 2. Many groups collaborate with each other to solve a task of “Measure the speed of propagation of human’s reflex nerve”.

Fig 3. Scene of presentation (1). Students participate in an active discussion.

Fig 4. Scene of presentation (2). Students are preparing their presentation about the task of “Find value of “π” without mathematical formulae related in π”.

the relationship between mathematics and physics. This is main problem to improve IEP class.

Conclusions

In this paper, we introduce a new approach in physics class activities to foster the scientific mind-set for first graders in academic quarter system. We consider our attempts are largely successful. However, we remain some problems especially insufficiency of mathematical exercises. In addition, quantification of learning effects are not yet. These are discussed continuously as a future issue.

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The Implementation of Monozukuri Concept to Education Systems

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Abstract

This paper will present the implementation of Monozukuri concept for students and for teachers. The best practices will be demonstrated to show the good performance of the implementation. PBL (Problem Based Learning) system will be discussed as one of the key issue.

Keywords: *Monozukuri, Hitozukuri, Human Resource Development, PBL*

Introduction

Monozukuri is a unique Japanese word which has the original concept meaning for manufacturing style as creating things with spirit of innovation and craftsmanship. The word can be generally translated as "the Japanese way of production", reflecting Japan's status as the first country in the world that successfully developed the manufacturing industries with high quality products. The Toyota Way is one of the most successful Monozukuri's examples. It is a set of principles and behaviours that underline the Toyota Motor Corporation's managerial approach and production systems. Its philosophy of manufacturing is to continuous improvement and respect for people.

Nowadays, Monozukuri concept is widely used in various aspects, therefore the question arose as to what Monozukuri really is. In year 2008, the Science Council of Japan announced the definition of Monozukuri as "Monozukuri is the manufacturing of products (including software products) by humans to make life easier. It covers concept, design, production, usage, disposal, recovering, recycling and work systems in an organization. The products made with Monozukuri must have social and economic value and minimal impact on humans and ecological systems."

Accordingly, the human resource development (or Hitozukuri in Japanese word) regarding to Monozukuri is very important. That is recently implemented of Monozukuri into education systems. Thai-Nichi Institute of Technology is one of the education institutes that implement the concept of Monozukuri with the principle of "nurturing intellectual and emotional intelligent students who will have both theoretical and practical skills". The students can think and create their work and innovation with responsibility and doing in team work.

This paper will present the way of implementation of Monozukuri for students and for teachers in Thai-Nichi Institute of Technology (hear after referred as TNI) as the example model. The best practices will be demonstrated to show the good performance of the implementation. The PBL (Problem Based Learning) system will be discussed as a function of Monozukuri concept.

Basic Concept of Monozukuri in Manufacturing

The main objective of Monozukuri in manufacturing is to produce good quality products that matched with the need of customers. It is also to reduce the production loss and lower the cost. In order to obtain this objective, the following production process is said necessary.

Task1: Continuously improve the production system in order to reduce the defect and error.
Task2: Produce high quality products that match the need of customers.
Task3: Implement eco technology and sustain creative production process.

On the other hand, Hitozukuri is to produce good quality human resource for societies. Figure1 shows the equivalence of Monozukuri and Hitozukuri.

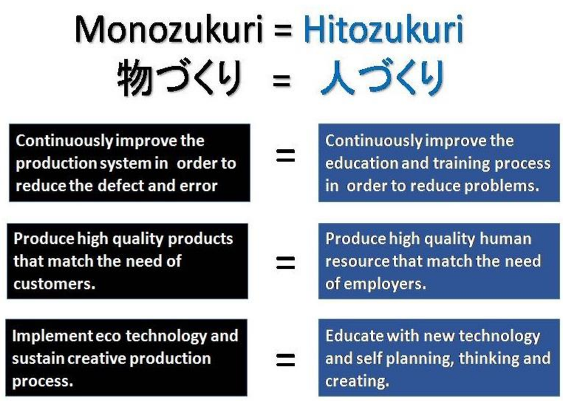

Figure1: Equivalence of Monozukuri and Hitozukuri

It is clearly to say that the "*human*" mentioned in Hitozukuri based on education is "*student*". This is the initiative motivation of implementing the concept of Monozukuri or Hitozukuri in TNI's education system in order to produce good quality students that match with the requirement of employers. Figure2 shows the relation of Monizukuri in manufacturing and in education. That is to produce products in good quality, the manufacture need good skill workers. To achieve good workers is the aim of Hitozukuri. This requirement will feed back to education sectors to pay attention and emphasis on the strategy of producing good quality graduated students. TNI strongly consider prioritize this matter regarding to the design of study curriculum.

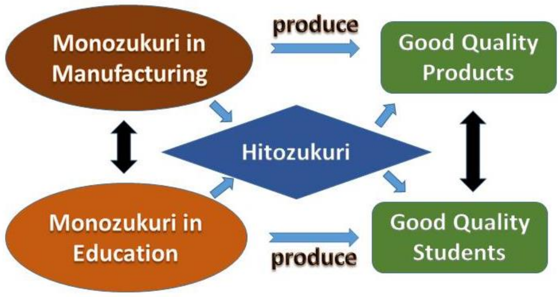

Figure2: Relation of Monuzukuri in Manufacturing and in Education.

Design of Study Curriculum based on Monozukuri

The aim of the bachelor program of TNI is to educate and produce good quality graduated students who have both technical and soft skills. The technical skill means theoretical knowledge and real practical experience. The soft skill means creative thinking, teamwork, honest and punctuality. Therefore, almost of the learning subjects will be designed with two or three hours lecture together with 3 hours workshop or practice. The workshop and practice can be done inside and outside the class room. Some subject will assign the students to work in group and solve the problem together which called as PBL (Problem Based Learning). The Figure3 shows the outline of course designing. The other ways to achieve the technical skill for students is cooperative program with industry.

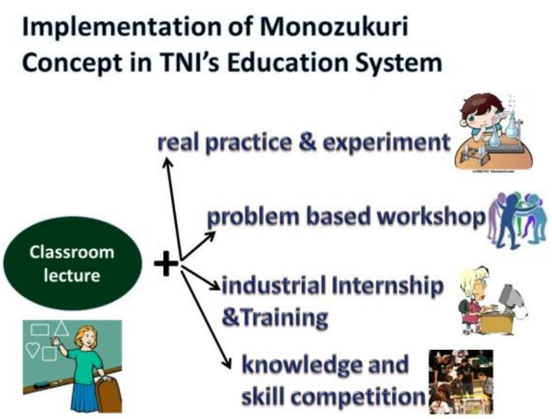

Figure3: Structure of TNI's curriculum designing.

The cooperative program with industry or company is designed in three categories as follows.

(1) By lecture:
- Invite expert from industry to give a lecture and workshop.
- Invite expert from industry to give special talk.

(2) By training:
- 4 months internship program at industry.
- 2 months summer training program at industry.

(3) By observation:
- Study visit real sectors related to subject.

Moreover, the teachers are always encourage the students to participate technical competition whenever they have chance. The university will support some necessary financial to students for preparing, tutoring, and attending the technical competition.

The TNI's education system also included 5-GEN, one of the keys function of Monozukuri. 5-GEN means Genba (現場): actual place, Genbutsu (現物): actual thing, Genjitsu (現実): actual condition, Genri (原理): principles or theory and Gensoku (原則): fundamental rules. The internship, summer training and factory visit are designed in according to 5-GEN. The students will have opportunity to study in actual company, actual material and equipment under real condition and principles, and learn working rules for safety.

The designing of Internship Program

The industries internship program at TNI is 4 months compulsory course that all students have to perform during the first semester of 4th year. The program is divided into three phases, i.e. before, during and after internship.

<Before internship>
- Matching appropriate company or industry to a student in according to his/her major.
- Orientation on the principle of internship program
- Lecture on necessary manner, discipline, ethics, practice and safety during internship.

<During internship>
- The responsible teacher will visit the site of internship at least once a month to investigate, observe and discuss with company or industry advisers.
- The responsible teacher is always ready for consulting whenever the problems are occurred.

<After internship>
- The students submit internship report and present in front of 3 referees.
- The evaluation is S:successful or U:unsuccessful.
- For student who achieves S will obtain 6 credits.
- For student who achieve U will be assigned doing internship again.

Role of Teachers based on Monozukuri Concept

It is obviously to say that teacher and his teaching method are the most important factors to produce good quality graduated students. The model of teaching at TNI is shown in Figure4.

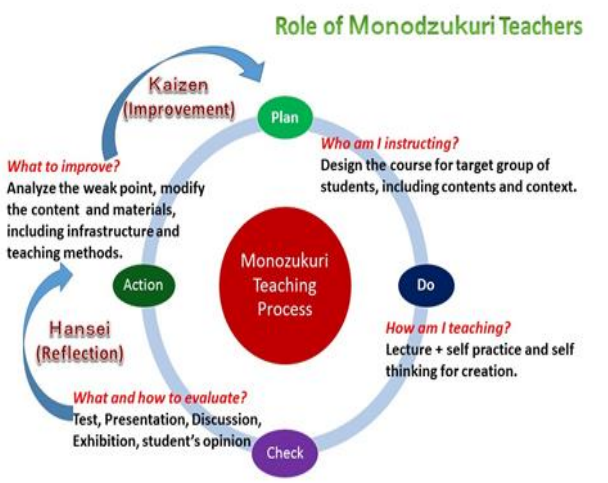

Figure4: Monozukuri teaching process at TNI.

The teacher at TNI will be assigned to use PDCA (Plan, Do, Check and Action) for designing his/her teaching content, context, methodology, etc., as follow.

<Plan process>: The teacher has to design the content and context of subject based on the level of the target students.

<Do process>: The teacher has to consider and prepare the appropriate teaching methodology that allows the student to understand the content easily. The lecture should include practice or workshop. The PBL will be implied in the course in order to nurture students to have the skill of self-thinking, self-creation and responsibility of working in group.

<Check process>: The teacher has to design how to evaluate the study performance of each student. It can be done together with examination test, report presentation, group discussion, exhibition etc.

<Hansei process>: *Hansei* (反省) is a Japanese word means *reflection*. In this state, the teacher has to consider the performance of each student. If there is any matter decreases student's performance due to teaching strategy, then it should be improved for better.

<Action process>: Reflection will be forwarded to improvement. In this state, teacher has to analyse the problems to see what to be improved, such as teaching content, teaching methodology, infrastructure and materials. This state is called *Kaizen* (改善) in Japanese word which means *improvement*.

Results and Discussion

The internship program shows a very good outcome. The evaluation demonstrates that students had gained very useful experience and skill. They had chance to apply the knowledge learnt from the lecture to the actual works. Some students had shown their good manner and hard work so that the company willing to employ them after graduation. Figure5 shows the example of internship in actual company and environment.

Figure5: Example of TNI internship program.

According to the reflection and improvement of the teaching content and teaching methodology by using PDCA algorithm, the teachers have more confidence in teaching. The study behaviour of students is improved and their technical skill performance is also increased significantly. Finally, we assure that the aim of producing good quality graduated students can be achieved in term of target students, who can think, design and create by themselves (Figure6).

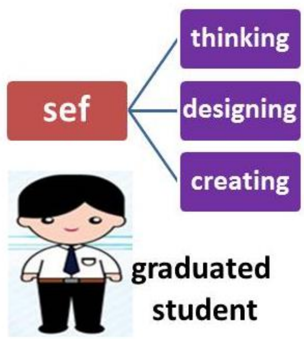

Figure6: Target graduated students of TNI.

<Performance Evaluation>

We annually made the survey on the satisfaction of employing TNI's graduated students. The questionnaire included the following items;

(1) Identities of TNI's students
(2) Moral and Ethics
(3) Professional Knowledge and Skill

(4) Intellectual Skill
(5) Interpersonal and Responsibility
(6) Skill of Numerical Analysis and ICT (Information and Communication Technology)

Here, let us discuss about the results of performance evaluation survey that has been performed for ***2015 academic year***. The questionnaire has been sent to various organizations where TNI's graduated students were employed. There were 309 organizations replied with effective answers. The types of 309 organizations are shown in Table1 individually.

Table1: Type of organization that replied questionnaire.

Type of Organizations	**Number**	**%**
Automotive Manufacturing	93	30.1
Information and Communication Companies	45	14.56
Fabric and Clothes Manufacturing	43	13.92
Service Enterprises	25	8.09
Steel and Machine Industries	23	7.44
Import/Export Companies	19	6.15
Electronics and Electrical Industries	14	4.53
Education Institutes	7	2.27
Logistic Corporations	2	0.65
Associations	1	0.32
Financial and Stock Institutions	1	0.32
Others	36	11.65
Total	**309**	**100.00**

As shown in the Table1, most of TNI's graduated students (98.4 %) were employed by private business sectors. The evaluation results for each item are shown in Table2 – Table7, respectively. The scores for showing the satisfaction levels of employers are designed as follows.

The maximum average score is 5.00.
average score 4.50 – 5.00 = Excellent
average score 3.50 – 4.49 = Good
average score 2.50 – 3.49 = Moderate
average score 1.50 – 2.49 = Fair
average score 1.00 – 1.49 = Poor

Table2: Identities of TNI's students

Items	Average score	Satisfaction levels
Discipline	4.23	Good
Professional knowledge and skill	4.05	Good
Contribution of best quality work	4.35	Good
Skill of work in team	4.29	Good
Japanese language skill	3.48	Moderate
Total	**4.08**	**Good**

Table3: Moral and Ethics

Items	Average score	Satisfaction levels
Responsibility	4.30	Good
Punctuality	4.31	Good
Adherence to ethics	4.37	Good
Diligence and commitment	4.37	Good
Patience to work	4.33	Good
Honesty	4.55	Excellent
Mannered, humble and tactful	4.41	Good
Total	**4.38**	**Good**

Table4: Professional Knowledge and Skill

Items	Average score	Satisfaction levels
Ready to work immediately	4.09	Good
Skill in operation	4.01	Good
Skill of development and apply	4.05	Good
Total	**4.05**	**Good**

Table5: Intellectual Skill

Items	Average score	Satisfaction levels
Planning ability and time management	3.87	Good
Ability to analyze and improve performance	3.86	Good
Creativity at work	3.95	Good
Total	**3.89**	**Good**

Table6: Interpersonal and Responsibility

Items	Average score	Satisfaction levels
Adaptability at work	4.23	Good
Leadership	3.80	Good
Personal development	4.02	Good
Total	**4.02**	**Good**

Table7: Skill of Numerical Analysis and ICT

Items	Average score	Satisfaction levels
Numerical analysis and the implementation of ICT	3.96	Good
Communication and presentation skill	3.87	Good
Saving resource / energy-efficient utilization	4.01	Good
English language skill	3.66	Good
Total	**3.88**	**Good**

From Table2, it shows that most of the employers satisfied TNI's graduated students to have good discipline, good professional skill and knowledge, hard work for good quality, know how to work in team. Even though their Japanese language skill is moderate, but overall satisfaction regarding to this category is 4.08 or 81.6%. When mention only on professional knowledge and skill which the score is 4.05 (see Table4), that means TNI's graduated students are acceptable to work immediately with their job assignment. This is one of the successful achievements of Monozukuri education.

The Japanese language of TNI's graduated students was evaluated as "Moderate". This is because all of TNI's students have to learn Japanese language as the compulsory subjects for 15 credits.

As seen from Table3, Most of TNI's graduate students have good moral and ethics so that employers evaluated their honesty as a level of excellence.

Moreover, due to the Monozukuri education, they were evaluated to have good intellectual skill, interpersonal and responsibility (see Table5, Table6). And according to the PBL workshop in and outside classroom together with internship program, students can achieve good skill of numerical analysis and the implementation of ICT (see Table7).

Let us summarize the overall performance from Table2 to Table7 as shown in Table8. It is obviously that the employers evaluated TNI's graduated students with satisfaction level "Good" and gave average of satisfaction point "4.05" or 81%.

Table8: Overall Performance

Main Items	Average Point	%	Satisfaction levels
(a) Identities of TNI's students	4.08	81.6	Good
(b) Moral and Ethics	4.38	87.6	Good
(c) Professional Knowledge and Skill	4.05	81.0	Good
(d) Intellectual Skill	3.89	77.8	Good
(e) Interpersonal and Responsibility	4.02	80.4	Good
(f) Skill of Numerical Analysis and ICT	3.88	77.6	Good
Overall average	**4.05**	**81.0**	**Good**

Overall performance in Table8 is converted into histogram in Figure7. Each main item is represented by bar (a), (b), (c), (d), (e) and (f), respectively. Accordingly, it can be confirmed that the highest score is moral and ethics (b) with 87.6% of satisfaction. Even though, the evaluation averages of intellectual skill (d) and skill of numerical analysis (f) are closed to the middle level of "Good", but in overall, it can say that employers satisfied to employ TNI's graduated students.

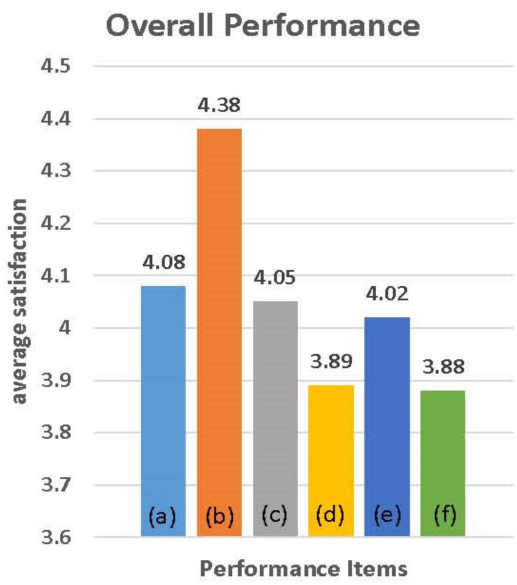

Figure7: Overall evaluated performance in histogram of academic year 2015.

Conclusions

The implementation of Monozukuri concept into education system is introduced. TNI's education system is discussed as an example. The evaluation of the implementation of Monozukuri is performed in term of satisfaction on TNI's graduated students. The annual evaluation is always done by sending questionnaire to organizations where TNI's students are employed. The evaluated result for academic year 2015 (for graduated students in March 2016) is presented and discussed. The results show that most of employers satisfied TNI's graduated students in all aspects with average "Good".

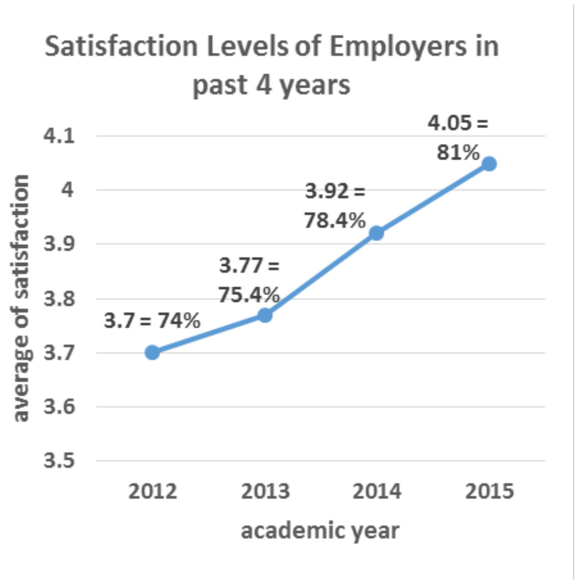

Figure8: Comparison of satisfaction levels.

Figure8 shows the overall evaluation results in the past 4 years, from academic year 2012 to 2015. The overall satisfaction levels are 3.7, 3.77, 3.92 and 4.05, respectively. According to annual PDCA on teaching process and methodology, the satisfaction level of employers increases significantly. This demonstrates the important benefit of implementing Monozukuri concept into education systems. The core competency and moral of TNI's graduated students are recognized by almost employers.

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Manufacturing Project on Science Festival for Children

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Abstract

In Japan, there is a problem that children turn away from science, so that developing interesting science education for children is an important issue. In Kumamoto city, a science festival for children has been held every year, where children can try various scientific experiments to be interested in science. Our school has also cooperated in this event, especially from 2014, a plan began to carry out manufacturing projects by our students and engineers of local company, and it has contributed as one of the highlights plan of the festival. The theme of this project is "making things to delight the children in the venue," and our students discuss what they make, then manufacture it by two months. In 2014, two items, "a voice conversion device of bow tie" and "an electric skateboard," are manufactured. These are very famous items in Japanese animation. Especially, the electrical skateboard was featured by Fukushima TV, so that it was modified to improve power and make larger size for adults, then the special TV program was broadcasted for various areas. In 2015, our students manufactured "Daruma-san fell robot" which is the robot to realize a famous child's play with the robot, and "personal hovercraft" as the future of the vehicle. On the day of the event, these things are presented on a stage, and there was always long que around our exhibition booth. Since that shows popularity of these things, the children looked like so happy actually. It seemed that this approach improved leadership and teamwork of our students, because they were able to experience the process of a product development through the manufacturing project from order to delivery. Although this project has a risk to depend on the ideas of students, they can do important experience and improve important skills through only two months.

Keywords: *Manufacturing project*, *Cooperation with engineers*, *Leadership*, *Teamwork*, *Science event*, *Practical education*.

Introduction

Though Japan is a technology-oriented nation, the percentage of the child who doesn't have an interest in science is increased in recent years, and Japanese high technical strength will be difficult to keep up from now on. "Science festival for children" is held at every region of the country as one of the matches children ask to have an interest in science. Many elementary school children participate in the events because it's possible to experience a scientific phenomenon through an experimental stage and construction there. As the effect of such scientific events, the children have been interested in science subject, even though 60 % of 6th grade elementary school children like Japanese and mathematics, 80 % of them like science by the whole country scholastic aptitude survey result of learning situations that was held by the Ministry of Education, Culture, Sports, Science and Technology. On the other hand all the subjects become equal with 60% about the result when the children were a 3rd grader of junior high school, and to lose interest to science shows conspicuously. Therefore even if short-term interest and pleasure in the place are felt by a scientific event, there is a problem that it isn't developing into interest to long-term science taking that as a start.

So a main school is also taking out the booth every year in this event, and it's expected that it may connect to long-term interest to science by holding admiration when the student with the close age is to explain the study contents and a making thing to children, and children would like to come to be a student of a technical college. Local engineers of an enterprise and student are to wrestle about the new plan produced jointly and hold admiration to the person of an enterprise who works as a grown-up engineer as well as admiration to a student in particular about recent 2 years, and it's expected to come near and get interest to long-term science. It's possible to be to produce items jointly with engineers and experience practicing development process for a student.

I thrust at the manufacturing plan and the making thing performed jointly with an engineer of an enterprise with writing, describe details and describe consideration about the educational effect of the student.

Science Festival for Children

Japan has grown as a scientific technology-oriented nation. It's the most important problem that the creativity which put on scientific thought brings abundant human resources up also to contribute to the world with science and technology from now on. On the other hand it's apart from child's science, it's a social problem that the machine which experiences naturalness and a scientific wonder decreases, and can be named as 1 of its cause. So "scientific festival for young people" is held as the event which can experience colorful experiment and construction at 1 meeting place from 1992. The "stage" etc. which spends enough time by the "booth" where an experiment and construction can be experienced by a short time over the counter and the limited number of people and does "workshop" and the experimental show which can experience those is prepared there. For example there is a theme of slime making using wash starch and HOU sand and the one which makes an object floating by static electricity. Staff are the engineers who work by the teacher, the student and the enterprise by which local elementary schools are junior high schools and high schools, etc., and there is a person who wrote a book about an experiment during it, too. The number of visitors is different depending on areas, but it's the scale of tens of thousands of people from thousands and there are a lot of family, grandparents and grandchild mainly.

Manufacturing Project with Working Engineers

A common manufacturing project with technical college draft beer has started with a scientific festival Kumamoto meeting newly with an enterprise engineer from 2014. Children were to include a student in a staff by a scientific festival up to now, and expected your elder brother with the close age and elder sister to hold admiration and get in touch to a long-term motivation to science only in the place, not interest. It's to add an enterprise engineer newly by this project and is the image children do using science and technology to have a long-term interest to science, and is expected. To produce items, the student who makes the subject this time made the wide knowledge which connects with both of hardware and software the 3rd grader of control information system engineering department he has. The match contents in detail are as follows.

(1) The engineer lectures on a process of product development especially and tells the flow which is "from receipt of order delivery" to a student.

(2) A student receives the order for the request to which the event host side says "He wants the children who come to make a scientific festival something to rejoice.".

(3) Students share an idea and decide about a theme.

(4) I'm conscious of a process of learned product development, work on manufacturing and deliver goods by a stage announcement of the event day.

The student who participates in a project can think the high educational effect is obtained as PBL because it's possible to experience a discussion with an engineer and a practicing product development process.

Work on Manufacturing Project in 2014

After idea stock was performed, I'm going to reproduce the item which appears on the animation children like very much. The 1st is the bow tie type strange voice airplane, and it's possible to be to speak through this and issue different person's voice by an animation. However, I decided to limit to the height of the voice and manufacture a strange voice machine because it was difficult to copy person's voice. Figure? A picture of the NI produced strange voice machine is indicated. The size is big because a substrate is being installed in the back of the bow tie but it's possible to wind on a neck like an ordinary bow tie. Is a system configuration a figure? The speech signal input from a microphone is to pass the pace change IC so that NI may be indicated, and the height of the voice is adjusted. Speech signal is sent by an FM transmitter by a radio and is to receive by a mini stereo with the FM radio function, and the sound to which the height of the voice was adjusted from a loudspeaker is output.

Another was a skateboard with a turbo engine, but actual condition decided to reappear as an electric skateboard. For a child to take it, we assumed that safety was taken top priority and the max speed was made 5 km/h. The student who participates in development was investigating various documents by themselves, was questioning a physical teacher and was coming into action very actively because it was lacking in knowledge about a mechanical design. The electric motor which can be bought personally was limited, and I had a hard time with buying a selected motor, but I decided to find out that something used for an electric driver is suitable and make using this. A picture of the produced electric skateboard, figure? NI is indicated. The appearance is quite close to something to leave in an animation, but it's necessary to grasp and operate the one which connected by a cable by hand because a trigger of an electric driver is being diverted about an operating method. Is a system configuration also a figure? It's very simple as it indicates NI.

Figure 1 Bow tie voice changer

Figure 2 Electric skateboard

Work on Manufacturing Project in 2015

I'm going to put this project into effect next because a result of the 1st year was very popular. After idea stock was performed, I'm going to challenge to achieve the backlash of the child by a robot. There is something to which I say "Mr. daruma doll fell down." by Japanese traditional play. Only while it faces to the rear, if it's possible to move and a player touches a demon, a demon calls a basic rule a win. I decided to manufacture the robot which serves as this idle demon. The technical factor purchased by a demon is 3 mentioned below.

(1) "Mr. daruma doll fell down." finish reading by random speed.

(2) Look back and move.

(3) When looking back, detect a moving player.

I decided to record 10 patterns of voice onto a local star and play at random by a program by cooperation of a television station about (1). The bottom of cooperation in the robot computer part, a motor and the sill which makes a doll revolve using a microcomputer were manufactured about (2). I took a picture of a player using a camera about (3) and made the program in which a movement is detected by image processing.

Another is the oneseater hovercraft indicated on figure o. A small pool for domestic use was installed as a skirt and 400W blower for cleaning was installed as output for leap. On the other hand the driving force nose fry to move ahead and a person have to push it.

Figure 3 Robot for children's game

Figure 4 Personal hovercraft

Results

A stage announcement was performed about the respective making things on the event day. The presentation and the short play which used a slide for the purpose which are the children who arrived by a stage announcement, mechanism of a crop made of the conduct was explained clearly. Children experienced a making thing at the booth.

The students who participated in making, "It was fun to advance a policy while checking it by oneself as well as the thing learned at the session.", and, "A girl had come much, too, so, I'll have an interest in science taking the event as a start and want you to play an active part in the future as a science faculty girl.", impressions of etc. were described.

Figure 5 Presentation on stage

Discussion

When the contents in the 1st and the 2nd are compared, image processing as well as mechanical mechanism are included in a system in the 2nd, and the technical level seems to have improved. That concerning with an engineer has been strengthened can be named as this factor. The chance to confirm the way passage was just held twice in the 1st, but the chance to present at the stage designed after idea excuse was held newly in the 2nd. It's the beginning by this, it moves, begin very early, the picture in detail of a making thing could be bound with the early stage compared with last year. On the other hand to do idea stock based on a wide theme as "the one which can please the children who arrive", the point that it's difficult to predict a making thing beforehand is a problem.

A student can learn empirically very thick because it's possible to experience a process of product development briefly from idea excuse to a decision of a way, a design, supply, making and an announcement. Future will be a problem to utilize concerning with an engineer more effectively.

Conclusions

Common manufacturing with the engineer of an enterprise who went as a plan of a scientific event was described at a main school. After he wrestled for 2 years, a student wrestles in the 2nd and also improves the technological level of the contents, and can experience a series of flow of product development from receipt of order to delivery, too, and it seems possible to learn a practicing skill. There are also a case that a student can't expect a proposed idea and a temporal problem, but it's valuable to learn through communication with an engineer, and I'd like also to continue the activity from now on while improving about a way with concerning more effectively.

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DEBELOPMENT OF EDITABLE ELECTRONIC TEXTBOOK SYSTEM AND LESSON PRACTICE

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Abstract

We have been developing a next-generation editable electronic textbook education system called Gakuzai. In the Gakuzai system, an electronic textbook (e-textbook) is provided to teachers and students. In the Gakuzai system, user can electrically hidden the unimportant part of the long description of the electronic textbook although leaving only the important part. Teachers will be able to make in a short time the teaching material for the class; students can easily create their own notebook.

During class time, important words or equations can be marked up electronically in the e-textbook by the students. These functions can be useful when students review or do homework. Using the e-textbook, notes can be taken more easily than with pater notebook methods. In addition, the e-textbook facilitates more effective memorization and solving of problem exercises. As a result, education can be improved. Note that the Gakuzai system can also use electronic blackboards and can support traditional educational styles.

Two web applications have been developed for the Gakuzai system. One application is used to edit the e-textbook, and the other is used for self-learning based on edited e-textbook data. The Gakuzai system provides an environment that supports all study processes, including teacher led classwork and homework. The e-textbook con-tent is written in HTML, and the Gakuzai system has been developed using PHP, JavaScript, and a MySQL database. Therefore, the proposed system can be used with any ICT platform.

Trial lesson were conducted using the Gakuzai system. One half of the students used paper textbooks and paper notebooks, while the other students used the Gakuzai system. At the end of the lesson, all students answered a quiz and a questionnaire. The average scores for each group were compared by Welch's t-test. No significant difference was observed. This means that the Gakuzai system is not inferior to the conventional learning method. The results of the questionnaire indicate that student academic motivation improved by using the Gakuzai system.

Keywords: *ICT-based learning, editable e-textbook, reduction edit, learning style, home work, reflection*

Introduction

In education style using a blackboard, teachers describe textbook content and write important words, while students copy the blackboard content to their notebooks. This is one-way knowledge transfer from the teacher to the student. The disadvantage of this style is the significant effort required by the students. In some countries, national projects are attempting to improve education using information and communication technology (ICT) and related electronic equipment in the classroom, and researchers have evaluated the effects on education of the ICT-based learning and the e-textbook based learning. Only use the ICT-based learning or the e-textbook, will us improve the quality of education?

Bonham, Deardorff and Beichner (2003) set students either paper or web-based homework to compare their study performances. They found "no significant differences between the groups," concluding that "the change in the medium itself has limited effect on student learning."

Sun, Flores and Tanguma (2012) examined the relevant experiences of college students in terms of how the use of e-textbooks may enhance their learning. They found that e-textbooks are perceived to enhance a student's learning experiences in two complementary ways: (1) an e-textbook's helpfulness enhances students' learning outcomes directly and (2) student involvement plays an important mediating role between e-textbook helpfulness and learning outcomes when students use e-textbooks in class.

Rockinson-Szapkiw, Courduff et al. (2013) examined the relationship between textbook format, i.e., printed textbook or e-textbook, and 538 university students' grades and perceived learning scores. They found that "there was no difference in cognitive learning and grades between the two groups, suggesting that the e-textbook is as effective for learning as the traditional textbook. The mean scores indicated that students who chose e-textbooks for their education courses had significantly higher perceived affective learning and psychomotor learning than students who chose to use traditional print textbooks."

These results indicate that there is little to no difference in the learning outcomes with e-textbooks or e-homework compared with traditional homework or printed books. It is difficult to improve education dramatically by simply computerizing the learning environment. We propose that to significantly improve education, new educational styles that incorporate electronic technology are necessary. In addition, active learning has been attracting attention as a technique that can improve education. However, any changes to education must take into account the older generation of teachers who may not be aware of modern educational techniques, such as active learning.

Gakuzai system

E-textbook reduction processing method: We propose the reduction processing method (ERP method) and the Gakuzai system, which provides a new educational style based on ICT (Shiba, Ueta et al. 2013). By the ERP method, an editable e-textbook is provided to teachers and students. When the student develops understanding of a teacher's explanation, they can hide the corresponding content in the e-textbook (leaving only the important terms). As a result, the e-textbook is rewritten to note that only important terms remained for students. Because this work time is shorter than to copy blackboard content, the student is expected to quickly acquire knowledge. The e-textbook is then rewritten using an electronic operation, and the understood content can be obscured.

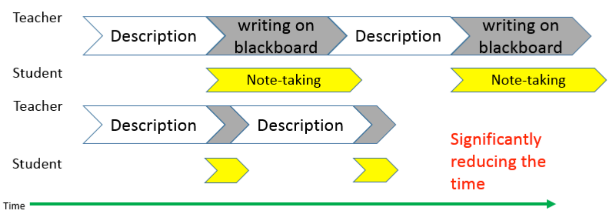

Figure 1 An improvement image of note take time shortening with the ERP method. Upper side show a timeline of traditional lesson; lower side show a time line of lesson with the ERP method.

Self-learning support: During class time, important words or equations can be marked up electronically in the e-textbook. These functions can be useful when students review or do homework. Using the e-textbook, notes can be taken more easily than with traditional methods (i.e., paper notebooks). In addition, the e-textbook facilitates more effective memorization and solving of problem exercises. As a result, education can be improved.

The Gakuzai system a ICT-based learning system that realise ERP method and self-learning support. Note that the Gakuzai system can also use electronic blackboards, so that can support traditional educational styles.

Gakuzai system overview: Two web applications have been developed for the Gakuzai system. One application is used to edit the e-textbook, and the other is used for self-learning based on edited e-textbook data. The Gakuzai system provides an environment that supports all study processes, including teacher led classwork and homework. The e-textbook content is written in HTML, and the Gakuzai system has been developed using JavaScript, PHP, and a MySQL database. Therefore, the proposed system can be used with any ICT platform.

The Gakuzai system has the following functions. (1) The e- textbook can be quickly edited during lessons. (2) The content can be reproduced. (3) The content is learnable at home. (4) The system must facilitate collaborative learning.

With these functions, the students can hide the corresponding content in the e-textbook. The e-textbook is rewritten to note that only important terms remained for students. Since these operations can be quickly, the note-taking time is shorter than the conventional note take. As a result, students can focus on description of class. The image is shown in Figure1. In the creation of time, more detailed explanation, simple experiment, can be performed with high quality learning such as the time to solve the exercises.

It will lead to the improvement of the learning efficiency. Note that individual and group study can be supported using these functions. The Gakuzai system has adopted HTML, because it is operating system and device independent, and can be easily customized. The Gakuzai system includes a server that distributes the e-textbooks and maintains edited e-textbook data. The Gakuzai system server was developed using PHP and JavaScript.

Quickly editing function: Screen shots of the Gakuzai system are shown in Figure 2. In Figure 2, the left and right images show e-textbook content from before and after a lesson, respectively. In the right (after) image, a long description, which was in the upper part of the left (before) image, has been replaced by a short sentence. Unnecessary parts can be hidden or replaced using a short phrase or single word or one blank character. It can also be undone by clicking. Important words can be marked (e.g., text color, underline, and highlights). This feature can be used in place of a coloring by the conventional marking pen.

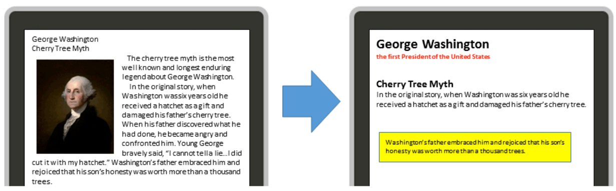

Figure 2 Screen shots of the Gakuzai system: e-textbook content before editing (left) and after editing (right) a lesson [e-textbook content taken from MOUNT VERNON: Cherry Tree Myth]

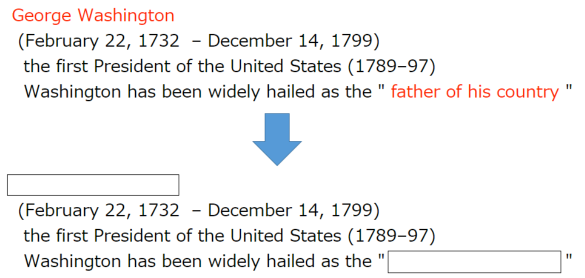

Figure 3 Marking e-textbook content: text color red (upper); marked words are hidden for rote learning (lower).

For memorization-based learning function at home learning: The Gakuzai system has an individual study function. Using this function, a student can mark (text color, underline, bold type, and highlight) the e-textbook content. Marked words are automatically collected using a PHP scripts and can be used to make formulas collection or important terms collection. In addition, marked words can be used for individual study; these words can be hidden in the e-textbook to facilitate rote (memorization-based) learning (Figure 3).

Trial lesson and Discussion

A trial lesson was given to students of (at February 2016, 40 students; approximately 17 years old). The trial lesson was conducted using the Gakuzai system with iPad mini. One half of the students used paper textbooks and notebooks, while the other half used the Gakuzai system. Fifty min were allotted for the trial lesson. The first 10 min were used to describe the functionality and purpose of the Gakuzai system. The following 30 min were used to deliver a lesson that described the discharge phenomenon. The final 10 min were used to conduct a quiz on the discharge phenomenon (full marks 10) and complete a questionnaire about the proposed system.

Figure 4 A photograph of a classroom with Gakuzai system. Students can use Wi-Fi and iPad or PC in the classroom.

Comparison of the Quiz results: The average scores of the quiz for each group were compared using Welch's t-test. No significant difference was observed; paper notebook: 4.90; Gakuzai system: 4.61. Takedani, Ueta et al. (2015) tried same trial lesson using the Gakuzai system. Their students were 42 person and other lesson condition was same to our trial lesson. Their result was average score of paper notebook: 4.81; Gakuzai system: 4.29. The comparison of two results show in table 1.

Table 1 Comparison of the Quiz average score.
*From Takedani, Ueta et al. 2015.

Paper notebook	Gakuzai system	Sig. difference
4.90	4.61	No
4.81*	4.29*	No*

Our trial lesson result and Takedani, Ueta et al. 's result is the same; paper notebook user group average score > Gakuzai system user group average score: no significant difference. We had expected that the Gakuzai system user is the high score, but did not. This reason is the Gakuzai system user had focused on using the iPad mini than to use the Gakuzai system. It is also conceivable that was not familiar with the operation for using the first time a new system. There was no significant difference in the average value of the two groups. This means that the Gakuzai system is not inferior to the conventional learning method.

Questionnaire survey result: A five-scale questionnaire was administered to evaluate the functionality and usability of the proposed system, where (5 is the highest and 1 is the lowest rank). The questionnaire included the following questions.

Q.1: Would you like to use the Gakuzai system?
Q.2: Do you want to try a e-textbook reduction processing method?
Q.3: Do you think the Gakuzai system could improve learning efficiency?

Only students who used the Gakuzai system replied to the following.
Q.4: Was the Gakuzai system easy to use?
Q.5: Do you think the Gakuzai system is convenient?
Q.6: Should we improve the Gakuzai system?
Q.7: Please write a free impression.

Table 2 Survey Results (values in parentheses are answers from students who did not use the Gakuzai system)

Quantity	5	4	3	2	1	Average
Q.1	9	18	9	6	3	3.48
	(7)	(6)	(5)	(1)	(1)	(3.85)
Q.2	10	14	11	3	2	3.68
	(7)	(7)	(5)	(0)	(1)	(3.95)
Q.3	7	9	12	8	4	3.18
	(5)	(5)	(8)	(1)	(1)	(3.60)
Q.4	0	0	7	8	5	2.10
Q.5	1	9	4	4	2	3.15
Q.6	9	11	0	0	0	4.45

The questionnaire result show in Table 2. Note that the values in parentheses are answers from students who did not use the Gakuzai system. The average value for the answers to Q.3 is 3.18, Q.4 is 2.10 and Q.5 is 3.15. Many students considered that the system had poor usability and that it should be improved. However, the average values for Q.1, Q.2 and Q.6 are very high; they are expected that this system improve their academic achievement. There were 21 free impression comments, of which 18 focused on usability improvements. The cause of the low average quiz score for the system users' group was therefore likely the difficulty of operating the Gakuzai system. To examine the effect of the Gakuzai system, a longer observation period is required. The results of the questionnaire indicate that we must improve the system usability; the results also showed, however, that student academic motivation improved when using the Gakuzai system.

Conclusions

We have been developing an editable e-textbook education system, called the Gakuzai system. By trial lesson and quiz, there was no significant difference between average scores of the Gakuzai system users and paper notebook users. This means that the Gakuzai system is not inferior to the conventional learning method. The results of the questionnaire indicate that we must improve the usability and student academic motivation improved by using the Gakuzai system.

Acknowledgements

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Simulated Practice Teaching Model for Computer Architecture and Operating System

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Abstract

This action research paper presents a simulated practice based case study for teaching the Computer Architecture (CA) and Operating Systems (OS) or CAOS module. The CAOS module is offered to first year students in the Diploma in Infocomm Security. We had used a blended learning teaching model composed of a set of learning objects with smaller, self-contained, interactive, re-usable units of learning for a cloud computing module. However, we have found that the complex dynamic processes presented in CAOS are difficult for students to grasp from static diagrams and text description alone. In addition, as the complex dynamic processes operate at speeds greater than one billion operations per second, students are not able to experience how they operate step-by-step in the human scale of time. We have found that by combining our blended learning teaching model with simulated practice we have increased student learning, enabled deeper understanding and enhanced student motivation. In comparison, the module content had been presented through lectures in the past with little or no hands-on for students to practise. The mode of assessment used in the past was primarily written tests and assessments. With the new blended learning with simulated practice teaching model, we have greatly enhanced the module delivery. Simulations are used for every topic in the syllabus for the module. Background theoretical concepts are briefed to the students, followed by hands-on practise with simulations, thereafter students are debriefed on the main learning points from the simulation. We use a variety of simulators that recreate and mimic the actions of a modern computer and OS but at much slower human scale speeds. In this paper, we present representative CA and OS simulators used in this case study. We use different simulators that focus on different aspects of a modern computer system without overloading students with information. The initial results have been positive and we will discuss the benefits in terms of student motivation, deeper understanding and assessment. We have used simulated practice in the module over two semesters. The median grade 80 students had increased by one grade.

Keywords: *simulated practice, pedagogic framework, computer architecture, operating system, curriculum*

Introduction

The study of computer architecture is challenging because of the high complexity and dynamic interactions between different components involved in any computer system. In addition, these complex interactions occur at speeds of a billion interactions per second. Students who are studying the Computer Architecture and Operating Systems (CAOS) module face a daunting task as they have no familiar prior frames of reference. To ease this complexity, different tools have been developed allowing different computer architectures to be simulated, examined and modified. This simulated practice approach is beneficial to students approaching computer architecture for the first time as it enables them to see the execution of low-level programs in the architecture at a controlled speed. When students are learning Operating System (OS) concepts, OS simulations are used to aid students in understanding the complex interactions within the OS. The hierarchy of simulation tools used are embedded within the core of a pool of learning objects (LO). Students make use of the simulation based LO to understand concepts otherwise difficult to comprehend.

Researchers have found that learning objects (Kay, R. H., & Knaack, 2009) offer considerable potential as effective learning tools. However, a sound pedagogic design and selection process is required in creating learning objects. Some characteristics of good LO include: (a) requiring students to construct and manipulate, (b) providing rich feedback, (c) providing concrete representations of abstract ideas and (d) supporting students in learning weaknesses such as limited working memory. In addition, the key to successful use of LO are instructional strategies that pedagogically support the use of specific learning objects, which requires a well thought out combination of instruction, exploration, practice and reflections (Kay, R. H., & Knaack, 2009).

This paper documents a case study for the teaching of a computer architecture and operating systems (CAOS) module, which has systematically employed a varied and differentiated collection of learning objects as key pedagogic tools in supporting the learning process (Beck, 2010). The learning objectives are largely achieved through interactions with learning objects at different levels of complexity. The main pedagogy employed in this module is simulated practice. Each learning object used is built around the core of a simulator suited to the learning objectives.

Table 1: Simulated Practice Learning Objects

Topics	Types of LO used in the case study	Core Simulators	Software or Service
Components of Computer Systems	Content LO Practice LO Communication LO	LMC	SaaS
Instruction Set Architecture (ISA)	Content LO Practice LO Assessment LO Communication LO	CPU Sim ARMSim NASM	Software Software Software
Micro architecture	Content LO Practice LO Communication LO	EDUMips64 ProcSim	Software Software
Memory Systems	Content LO Practice LO Communication LO	LMC JPACS	SaaS Software
Interfacing (I/O) and Bus	Content LO Practice LO Assessment LO Communication LO	Yasp	SaaS
OS Processes	Content LO Practice LO Assessment LO Communication LO	SoSIM	Software
OS Virtual Memory System	Content LO Practice LO Communication LO	OSSIM	Software
OS I/O System and File System	Content LO Practice LO Assessment LO Communication LO	OSSIM	Software

Table 1 shows the different LO and simulators used in the different topics. A hierarchy of simulators are used ranging from simple to more complex. This is intentional as a single complex simulator that is able to aid every topic would quickly overwhelm the student with its complexity in the more fundamental topics. Conversely, simple simulators like the Little Man Computer (LMC) (Yurcik and Osborne, 2001) would not adequately aid understanding for the more complex topics. Some of the simulators must be installed as software packages. Other simulators are available online as Software as a Service (SaaS). Wrapped around each core simulator are content, practice, assessment, and communication LO.

Model for Simulated Practice

Computer Architecture is traditionally considered to have a high difficulty threshold for learning. This is in part due to the difficulty in teaching the subject in an incremental and hands-on fashion. One reason for this is due to inappropriate tools being used for hands-on practice. A common approach is to use the in-built assembly language of a real processor to provide hands-on practice. These assembly languages were not designed as didactic tools. They were designed to be programming tools for experienced users who already have a firm grasp of computer architecture. This makes such languages hard for students to understand. In addition, student may not be able to distinguish between manufacturer specific features and more generally useful features from perspective of computer architecture. The technical documentation for these processors are also written in a very technical language which is difficult for students to understand. An analogy for this is trying to learn the Japanese language by using a Japanese dictionary. Such as dictionary has its place, and would be very useful in the hands of an expert. However, it is too hard a starting point for novices.

Any good learning model aims to teach students by introducing them to new concepts in an incremental fashion. The subject matter must be analysed and a learning path developed with the aim of keeping the learning difficulty threshold as low as possible at each stage. Learning of concepts is strongly reinforced by direct hands-on experience. This is perhaps the strongest argument for the use of simulated practice, as students gain a deeper level of understanding of the material. It also has implications for assessment, as students can demonstrate their knowledge of new concepts through direct manipulation instead of traditional written tests. Such reinforcement with hands-on practice should be introduced as early as possible. Any course in which weeks of background material must be introduced before students can undertake realistic exercises is likely to be considered “too theoretical”, or perceived as being “difficult”.

In our model, we have carefully selected a series of simulators with incremental levels of difficulty. We have wrapped the LO for each topic around these core simulators. Content LO are the videos tutorials, slides and notes that accompany a particular simulator. Content LO also inform students on what are the key concepts which they are learning through the use of the simulator. Practice LO are hands-on tasks on the simulator to reinforce the concepts introduced in the Content LO. Communication LO are additional tools such as Facebook groups, Google hangouts, and discussion boards which aid in faculty-student interaction and student-student interaction. Finally, Assessment LO are particular Practice LO that have a graded component which requires individual attempts by students.

Figure 1. Simulated Practice with Learning Objects shows a learning model where students are continually interacting with the learning objects and being supported through facilitation by the teaching faculty. The key is the optimized pedagogical design of the learning objects to enable the students’ to maintain an active and collaborative learning approach, supported by teaching faculty when needed, in mastering the desired learning outcomes. LO can be customized to suit individual capability, competence and prior knowledge. However, this individualized customization has been left to future work. Instead, each Practice LO has been configured with varying levels of difficulty: easy, normal and challenging tasks catering to different student ability.

In the dynamic process of learning, reflection and sharing of learning experiences, additional LO, from the pool of resources, are introduced when needed and facilitated according to student need. The importance of appropriate feedback is fundamental to supporting students' learning (Hattie, 2009) and is a key part of the ongoing instructional approach. The learning outcomes are evaluated by teaching faculty to continuously identify the learners' needs, and optimize the learning experience by reconfiguring the pool of LO. The model provides a continuous learning process, which allows the teaching faculty to add new learning objects, or reconfigure the sequence of the learning objects to meet the students learning needs.

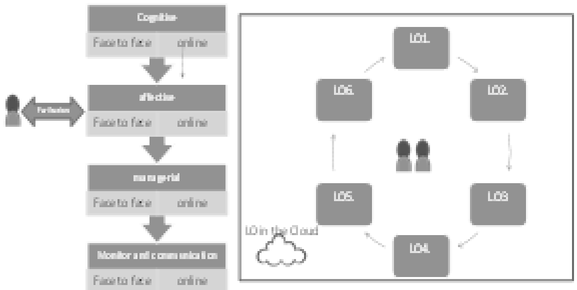

Figure 1 Simulated Practice with Learning Objects

The interactions between each component in the simulated practice learning model (see Figure 1) is enumerated and examined further.

- Teaching faculty—LO interaction: Identify the students' learning difficulties in achieving the learning outcome. Is it a problem with the simulator itself or some conceptual misunderstanding by the student? The teaching faculty must carefully configure the set of learning objects to address different learners' competency. Some students need may need to perform all easy and normal tasks in the LO, while others can go on the challenging tasks level.
- Teaching faculty—student interaction: Faculty need to provide timely feedback to the students. Such feedback is the key to facilitate students in using the simulated practice LO. A shared repository of simulator input files facilitates this interaction.
- Students—LO interaction: Self-paced learning is an interactive mode of learning that each learner does on his or her own, at his or her pace and in his or her time. The student can do this with either software installed on their laptops or accessing the SaaS through the internet. During class time, the teaching faculty can model the correct procedure to students. Students then use the LO on their own to complete the rest of the practice LO.
- Student—student interaction: Peer to peer interaction allows the students to share the learning experience, such as problems encountered, possible attempts and solutions. In the simulated practice learning model, communication LO are used to provide supportive feedback comments. Students can share files via the shared repository.

Case Study: Using Simulated Practice for teaching Computer Architecture and Operating Systems

Computer Architecture and Operating Systems (CAOS) is one of the key modules which characterizes the curricula of the Diploma in Infocomm Security. One of the most critical aspects on teaching this discipline is how to support the theoretical concepts of the subjects with appropriate practical experience, usually organized as laboratory assignments.

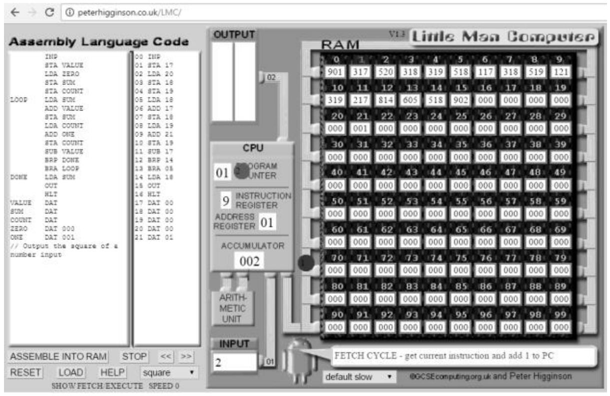

Figure 2 Little Man Computer Simulator

The teaching faculty determines the learning objectives, and provides a set of learning objects for student activity through the 15 weeks using the campus wide learning management system (LMS). The learning objects are built around a core simulator. Figure 2 show the Little Man Computer (LMC) simulator which provides a highly simplified computer system that had been devised for teaching. The LMC is used in the first few topics in computer architecture.

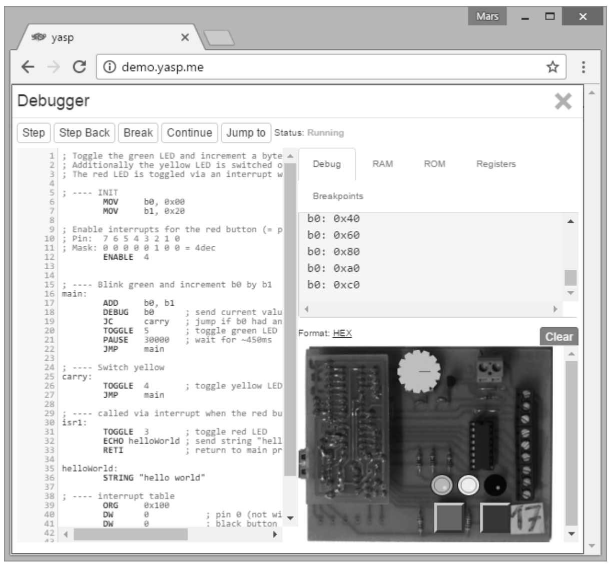

Figure 3 YASP Simulator

Figure 3 shows the Yasp simulator which is used to understand interfacing between the external world and the computer system.

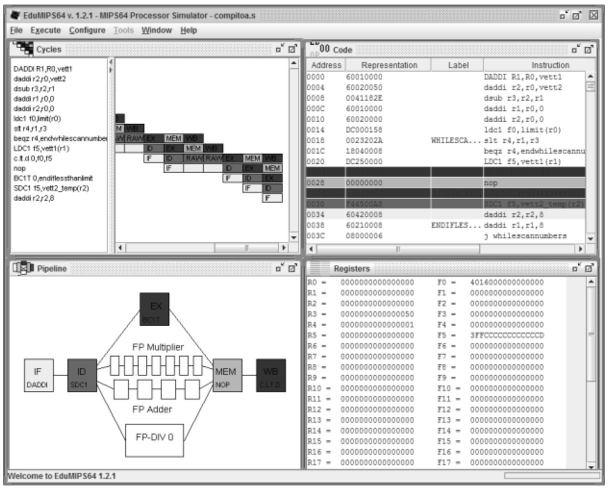

Figure 4 EduMIPS64 Simulator

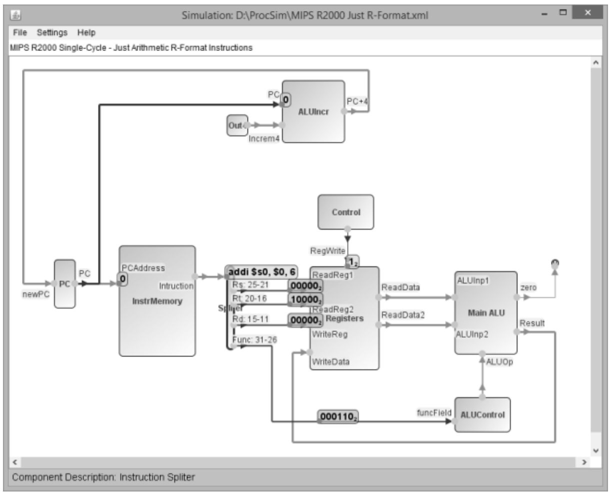

Figure 5 ProcSim Visual MIP 2000

Figure 4 EduMips64 and Figure 5 ProcSim are used for teaching the students about the microarchitecture or internal organization of a processor chip. Figure 6 OSSIM is one of the simulators used for the operating system topics. The teaching faculty identifies the learning difficulties and insufficiencies of the applied methods by examining the activities and establishes links between prior concepts with the new concepts to be taught.

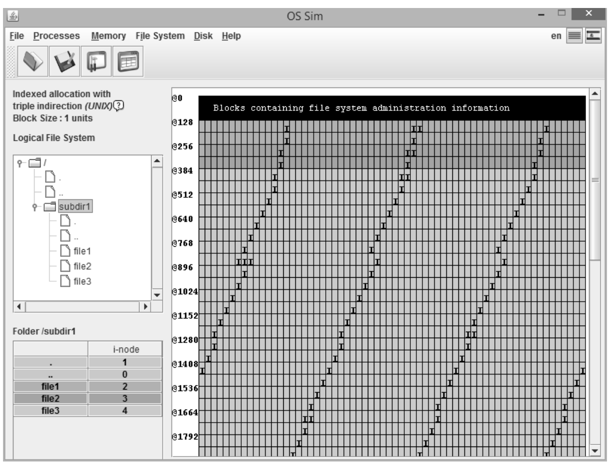

Figure 6 OS Simulator for File System

In the classroom sessions, the lesson begins with a briefing session by the teaching faculty. The faculty would explain the main objectives to be achieved in using the simulated practice LO in the lesson. The associated Content LO are used to introduce the students to the new concepts. After the briefing, students work individually or form small groups to work collaboratively. The task of the teaching faculty is to facilitate the learning process, identify the individual learning difficulties, and direct the students to think more deeply and creatively.

One of the aims of our model is to teach incrementally in order to lower the learning threshold. New learning objects with higher difficulty levels are gradually introduced when appropriate and to ensure an incremental learning process. As students provide solutions and present their ideas, the teaching faculty provides the necessary feedback. Finally, the teaching faculty evaluate their instructional approach and the learning objects involved in order improve their practice, renew learning objects, and modify the way they facilitate the learning process.

Following the briefing session, students would work on the hands-on practice to reinforce the concepts that they have just been briefed on. The students may start their learning by following the provided notes on google document, which allows students to write comments. When students face difficulties, lecturers may guide students individually. Students can then extend their learning by watching related online videos selected for their relevance to the content and outcomes of the practice session. Students then attempt the online quiz for self-assessment. In cases where the students are in doubt, they can refer to an online tutorial.

At the conclusion of the class lesson, students have a debrief session by the faculty. The teaching faculty would recapitulate the main objectives to be learnt from using the simulated practice LO. The teaching faculty would also address any question by students and provide feedback on their solutions presented.

Some of the key learning points are as follows:

- Incremental learning using the pedagogical model outlined earlier: This is important for establishing a sense of learning continuity with the students. In addition, it lowers the learning threshold when new concepts are introduced.
- Detailed Documentation for the LO: Detailed documentation for the learning objects, and simulators are important for student in the self-directed learning mode (such as during online learning). The teaching faculty's time would also be freed up to provide better feedback to the students.
- Linking simulated practice with previous class room activity seamlessly: When learning online, students may work on the learning objects, which is based on the previous class room activity. Similarly, the e-learning experience can be used as a resource for class room learning. This is facilitated through shared repositories.

- Use of shared repositories: To link class activity with online learning, students need to be able to share their work output with the teaching faculty as well as with other students. A combination of google drive and github accounts could be used to create shared repositories for simulation input files. All the simulators used support saving the input model as files. Most of the files used are text files containing assembly code. Some of the files are xml files that contain code and configuration information. By sharing these input files via the shared repositories, the teaching faculty could examine them and provide feedback. Other students could also look at them and provide comments too.
- SaaS is preferred over software installation: Software may not be available on all platforms that the students use. Student laptops may be running OS X or Windows 10. SaaS overcomes the need to different software versions. However, many educational simulators are provided as installed software instead of SaaS.
- Simulator fatigue: Some students provided feedback that there were too many simulator software to install. This is another reason SaaS is preferred to software installation. It is also important for the teaching faculty to link the use of different simulators so that students don't see each simulator as a standalone exercise.

Evaluation of Simulated Practice Model

The evaluation for the case study for teaching computer architecture and operating systems using the simulated practice learning model supports the importance of sound pedagogical design in order to facilitate the students' active and interactive learning. The lecturer's role both as a designer of the learning experience and as a facilitator in the learning experience are key factors for success.

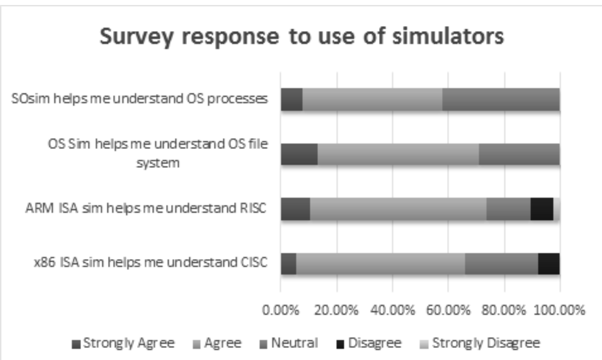

Figure 7 Survey on use of simulators

The evaluation data to date strongly suggests that the simulated practice model used in the teaching of this module has successfully engaged the students in the learning experience. The design and building of appropriate learning objects, which can fully address the learning needs and difficulties of students, is a critical success factor for this approach. The survey of the students indicate that the majority of the students are in favour of the simulated practice or find it helpful in their learning. Student motivation also improved.

The initial results have been positive. We have used simulated practice in the module over two semesters. The median grade 80 students had increased by one grade. This is an indicator that students have a deeper level of understanding. Students are also using the Assessment LO to demonstrate their knowledge by direct manipulation instead of traditional written tests. Through the Asseessment LO we are better able to assess student ability to apply their knowledge to problem solviing.

Related Work

Yehezkel describes the use of the Little Man Computer, RTLSim, and EZCPU (Yehezkel et. al. 2001) used in the teaching of computer architecture. A hierarchy of simulators with different complexities was used to fit different learning situations. Nikolic performed a survey to find suitable simulators for the teaching of computer architecture (Nikolic et. al., 2009). Yurcik described the use of the Little Man Computer in teaching Computer Architecture (Yurcik and Osborne, 2001). Maia presented the use of SoSIM for teaching operating systems (Maia et. al., 2003). Macia provides a simulator for other OS features such as disk scheduling and file systems (Macia, A, 2016).

Conclusions

The use of simulated practice help to reinforce the teaching of computer architecture and operating systems with timely hands-on practice pitched at the right level. Wrapping learning objects around the simulators help to reinforce their use for teaching. A key success factor is to identify and address the students' needs both in classroom and e-learning mode, through continuous improvement of the pool of learning objects, which provides a differentiated learning path for each student.

The choice of the simulator tools is important in order to lower the threshold for learning. Simulator tools designed to be didactic tools are more effective in learning new computer architecture concepts than using real processors. Incremental teaching using increasingly levels of complexity in the simulator also help students to learn the basic before advancing to more difficult concepts.

Most fundamental to success is good pedagogic design, which we have drawn from the work of Hattie, 2009, who synthesized over 800 meta-analyses of the influences on learning, identifying those methods that typically worked best in terms of enhancing student attainment. For example, the importance of activating students' prior knowledge, setting challenging goals and providing ongoing two-way feedback, have been extensively incorporated.

Further work includes exploring ways to run all the simulations required as an integrated SaaS platform instead of having the students install different simulation software on their laptops. One issue faced in using multiple simulators is the many different user interfaces that students need to learn. Another pitfall is the time consumed to install and test out the simulators on each student's laptop. We would explore having a single integrated SaaS platform to launch all the simulations as well as explore new ways to encourage students to share ideas, give and receive feedback in the learning experience (Daniel L. 2011). The integrated SaaS platform would also allow us to gather student data for learning analytics as well as to integrate the information into an intelligent question and answer tutoring system which uses machine learning algorithms.

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4403

CONTINUED EFFORTS IN THE CREATION OF AN ACTIVE EDUCATION ENVIRONMENT IN NIT, GIFU COLLEGE

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Abstract

Since 2001, with the help of the operating support fund from the Ministry of Education, Culture, Sports, Science and Technology (MEXT), our college has placed personal computers in the fourth-year classrooms, so that every student has exclusive use of a personal computer. However, in our fourth replacement of the entire system made last year, the fourth-year classrooms were reborn as classrooms where active education can be practiced. At the same time, the number of the seminar rooms of the Information Processing Center was increased from 3 to 5. Last year's activities related to the “Acceleration Program for Rebuilding of University Education (AP)” were to install equipment such as electronic blackboards primarily in the second and third-year classrooms, while promoting active education simultaneously in the second and third-year classes as well as in the first-year classes; equipment such as electronic blackboards was installed in the first-year classrooms two years ago. This year’s activities are to install equipment such as electronic blackboards in the fourth and fifth-year classrooms, while promoting active education simultaneously in the classes of all years in all five departments.

In academic year 2015, we promoted active education mainly by making specific, elementary-level teaching materials, based on the items suggested by some senior graduates of our college working in Japanese industries. The teaching materials made from senior graduates' recommendations had a different focus from those of our teachers. Also, in our college, we are aiming that students will acquire the ability to describe matters related to engineering in English, while promoting the interactions between the teaching of technical English and that of the specialized subjects through active education. The activities of our college in visualizing our educational content are promoted by clearly showing the learning content of each student conducted outside the campus and developing a database system which enables students to visually evaluate their degree of attainment. In academic year 2015, we developed a database system to visualize the learning content conducted outside the campus and started operations.

Keywords: *ICT-driven Education, Active Learning, Learning Environment, Creation of an Educational Environment, Educational Content, Learning Tools*

Introduction

National Institute of Technology (NIT), Gifu College has been promoting an approach to practice ICT-driven education in all of the fourth-year classes by placing personal computers in the fourth-year classrooms of all five departments, so that every student can use one exclusively. Also, forming a consortium with more than 20 colleges and universities within Gifu prefecture, we have been practicing distance education using e-Learning under the credit transfer agreement. Moreover, we have been providing another consortium, which is run under the credit transfer agreement, with some e-Learning lectures. The consortium, which our college participated in when established, covers colleges, universities, graduate universities, the Open University of Japan in addition to NIT, Colleges.

As just described, for more than fifteen years, our college has created an educational and learning environment capable of utilizing ICT and supported students’ voluntary learning. We applied for and successfully acquired the “Support Program for Contemporary Educational Needs (GP)” of MEXT in 2004, and its three-year major financial support helped build the foundation of the latter consortium as the “credit transfer project” using e-Learning. The project has successfully continued until today, and the number of NIT, Colleges which have participated in it has reached almost half of the total.

In 2014, MEXT inaugurated the AP with the aim of rapidly developing the projects of higher education institutions which have been successfully continued after the acquisition of “GP”, etc. We applied for and successfully acquired the AP in 2014, when it was inaugurated. Financially supported through the AP by MEXT, we are promoting a higher level of collegewide active education at an accelerating rate.

Renewal of the Fourth-year Classrooms and the Seminar Rooms of the Information Processing Center

In our college, ICT-driven equipment of the fourth year classrooms of all five departments, which we mentioned in the Introduction, has been replaced every five years since it was first introduced. In the fourth replacement done last year, we changed each of the fourth-year classrooms of all five departments into a flexible classroom environment where active learning can be practiced by using tablet/notebook computers, connecting to classroom wireless LAN. Prior to that, the system of the fourth-year classrooms was the same as that of three seminar rooms of the Information Processing Center. See Lage, Platt, and Tandreglia (2000), Begmann & Sams (2012), Khan Academy (2006), and Bonwell & Eison (1991) for various AL methods.

We expected, however, that the change of the fourth-year classrooms into a flexible classroom environment for practicing active learning by using tablet/notebook computers would make it almost impossible to practice programming/CAD. Before that, the students were learning them by using high-specification desktop computers with high memory capacity, high-speed arithmetic processing capacity and advanced drawing performance which were installed in the fourth-year classrooms. In order to deal with this situation, in this replacement we increased the number of the seminar rooms of the Information Processing Center from 3 to 5. (Figure 1)

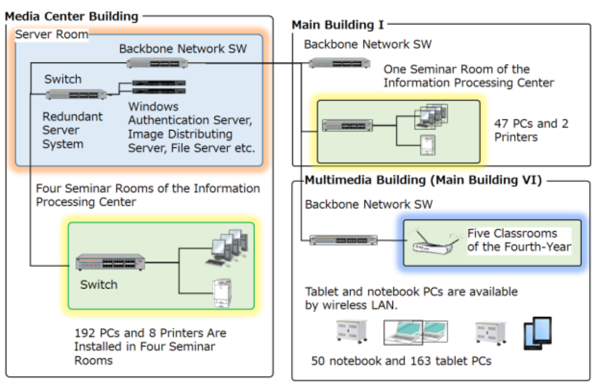

Figure 1 The whole image of the seminar rooms of the Information Processing Center and related facilities after the replacement

Through the replacement of the Information Processing Center the following were introduced and distributed into 5 seminar rooms: 242 Client PCs (DELL: OptiPlex 3020 SFF), 4 Servers (DELL: PowerEdge R430), 1 NAS (Dell Storage NX3230), 10 Printers (Canon Laser Beam Printer Satera LBP8710), 5 Document Cameras (EPSON: ELPDC12).

Establishment of an Educational Environment through the AP Project

The AP, now having five different themes, is an open-type project which MEXT inaugurated with the purpose of promoting the educational reform of Japanese higher education institutions at an accelerating rate. Theme I of the AP is “the practice of active learning”, Theme II is “the visualization of the learning outcomes”, and our successfully adopted project covers both Theme I and II. Now, entering the third year since our AP project started, our college is planning to install electronic blackboards in all classrooms from the first to the fifth year which will realize interactive function between teachers and students through a wireless LAN.

The above-mentioned system was introduced into the 5 classrooms of the first year two years ago, into 10 classrooms of the second and third years last year, and will be introduced into 10 classrooms of the fourth and fifth years this year.

The introduction of ICT-driven equipment into all classrooms of all the five departments will create a practical educational environment where students’ voluntary, active learning will be promoted.

Our college is utilizing two different kinds of LMS: Moodle, which we independently introduced as LMS, and Blackboard, which the head office of NIT, Japan is providing for nationwide NIT, Colleges. Each of them is suitable for the above-described educational environment and is useful for promoting active learning.

Teaching Materials Made from Senior Graduates’ Viewpoint

We refer to old-time graduates of our college as NIT senior graduates (NITsg). They have long contributed to the development of Japanese manufacturing industries, and have an understanding of what is expected of human resources NIT, Colleges have provided to the industrial world. Therefore, they are invaluable to our college, having an idea of the needs and seeds of technological education in Japan. The cooperation between old-time graduates and the field of education is the task imposed on NIT, Colleges today.

We are making teaching materials in cooperation with NITsg, while incorporating their suggestions about what students should learn. The suggested 45 subjects were categorized into the introductory, intermediate and advanced levels. (Table 1)

Table 1 The list of teaching materials made based on subjects highly recommended by corporate engineers (progress of making teaching materials as of July 7, 2016)

No	Subject	AL Content	Introductory	Intermediate	Advanced	The Presence of Cooperation with Graduates
	Liberal Arts					
1	Pollution Issues and Contemporary History	○	○	○	○	○
2	History, Politics and Economics, Law	○	○		○	×
3	The Constitution of Japan	○	○			○
4	Modern History of Neighboring Countries	○	○			○
5	Chinese Classics	○	○	○	○	×
6	How to Write Numbers in Japanese	○	○	○	○	○
7	Social Ethics	○	○	○		○
8	Engineering English	○	○	○		○
9	Writing Skills in Japanese	○	○	○	○	○
	Natural Science					
1	Moment of Inertia	○	○	○		×
2	Standard Deviation	○	○	○		×
3	Scatter Diagram and Regression Analysis	○	○	○		×
4	3D Printer	○	○			
5	IT Engineer Examinations	○	○	○	○	×
6	Arithmetic Mean and Geometric Mean	○	○			
7	Examples of How to Utilize Numerical Integral	○	○			
8	Linear Planning	○	○			○
9	yard, pound	○	○			○
10	Physical Meaning of Correlation Coefficient	○	○	○		
11	Orthogonality between Longitudinal Wave/ Transverse Wave and Function	○	○			
12	Human Error	○	○			
13	Multiple Classification Analysis	○	○			○
14	Design of Experiments	○	○			○
15	5S	○	○			
16	FMEA/FTA	○	○			
17	PLC/programmable controller	○	○	○	○	
	Practical Mechanics					
1	JIS Material Mark	○	○			○
2	How to Write Formula of Thermodynamics	○	○			
3	Law of Thermodynamics	○	○			
4	Energy in Thermodynamics	○	○			
5	Heat Calculation	○	○			○
6	Diagrammatic Drawing Used in Thermodynamics	○	○			
	Electronics					
1	Feedback Control	○	○	○		○
2	Operational Amplifier	○	○	○		○
3	Vector Control of Three-Phase Induction Motor	○	○	○		×
4	The Basis of the Finite Element Method	○	○	○		×
5	Time Constant	○	○	○	○	○
6	On-the-Spot Design Chart with a Nomograph	○	○	○	○	○
7	Phase Delay (Velocity) and Group Delay (Velocity)	○	○	○		○
8	Characteristic Impedance	○	○			×
	Environment					
1	Processing Test of the Activated Sludge Method and Measurement of Water Quality Management Items	○	○	○		○
2	How to Proceed with Soil Contamination Countermeasures	○	○	○	○	○
3	The Membrane Isolation Activated Sludge Method	○	○	○	○	○
4	Harmful Chemical Substances Contained in Materials	○	○			×
5	Industrial Activity/Daily Life and Environmental Issues (Various Environmental Cleanup Technologies)		○			

The 45 subjects shown in Table 1, which were highly recommended by corporate engineers, are used for developing the learning support content in consideration of a link with the Model Core Curriculum provided by NIT, Japan. However, some parts of the content do not completely conform to some class subjects of our college curriculum. On the basis that they will be used as study-support content when students learn the challenges corporate engineers tackle, we intend to promote development of the teaching materials.

We plan to use the teaching materials we make in specific classes and also in various related classes. In addition to these, we are going to provide them as autonomous learning materials for students who prepare for life after graduation. Moreover, we are promoting the making of the materials with a view to using them at "School for Fostering Core Human Resources", a recurrent education for mid-level engineers in the community

Visualization of Learning outside the Formal Curriculum

Aiming at establishing a system of visualizing students' learning activities performed outside the formal curriculum based on a points system, we discussed what kind of student activities are to be evaluated in all the departments of our college. Then, we selected the items to which the "practical engineering points" are to be given and determined the details. As a result, when students perform learning activities outside the formal curriculum, the activities started to be evaluated just like learning activities in the formal curriculum according to the rules of the respective department. So, we made up a system with a database with the purpose of visualizing these activities.

When implementing a database, we made it possible to work under a versatile environment and separate the database and the website. The program was written with PHP and JavaScript, the operating software for the server was Cent OS, Linux-based OS, web management software was Apache, and the database management system was MySQL. When implementing them, we separated data and appearance by using the different programs for connecting to the database and in the display area. By doing this, it will be easier to transfer the database into a different management system in future.

Users access the database through a web browser. The website of the system was designed to authenticate the students and the faculty with the campus authentication server in order to protect against unauthorized access. The acquisition of username after authentication made it possible to create a page specifically for the faculty.

We performed operation verification of the system in a test server for campus use only and compared the students' acquisition conditions of points collected so far in the Department of Electrical and Computer Engineering, with those of the same department collected in a server on a trial basis, in terms of acquired, average points per person. As a result, it turned out that the acquired points, among others, of the third year students had increased. (Figure 2) Every year, the number of points registered in the third year is very high in the department, for the number of accumulated points at the time of the third year decides on the course students take in the fourth and fifth years. Even so, the increase in the academic year 2015 when the system was introduced was especially conspicuous.

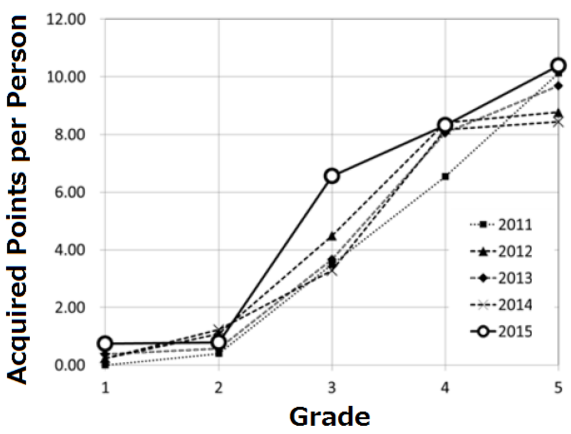

Figure 2 The changes in acquired points per person for each academic year, see NIT, Gifu College (2016)

Conclusions

In the modern era of expanding globalization, not only natural resources but also knowledge, technologies and human resources have already become borderless. While providing education to produce human resources with social competencies for survival who are capable of responding to the wave of globalization in future, NIT, Colleges are expected to provide education to contribute to local communities. In this project, we have established education systems to evaluate learning activities outside the formal curriculum, cultivate students' autonomy and initiative through development of teaching materials supported by NITsg with work experience, and develop students' innovative spirit through practice of active learning.

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4405

INTRODUCTIVE LECTURE OF MODERN PHYSICS USING ONLINE GROUP WARE FOR INFORMATION ENGINEERING STUDENTS

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Abstract

Lecture of modern physics is deeply related to novel technologies, such as a superconductor, laser and nuclear application and important subject for engineering student in the advanced level.

However, there are a lot of difficulties for information systems and software engineering student to imagine or understand theoretical law of modern physics such as quantum mechanics and nuclear structure.

The major fact is that most students who decide the information department to study IT, some students think that physics has no relation to their engineering life. Another fact is that in the case of the conventional teaching method, the laws of physics had been shown in the blackboard in the lecture format. Information systems student imagines being not tied to application products based on modern physics which has the possibility for them to be involved in the future. Therefore, conventional way is not enough contents for students to understand the important meaning to learn modern physics.

In this study, Active Learning (AL) in the introduction of the modern physics class with information systems students through joint work the groupware, Microsoft Office365, to be used in their computer will be reported.

To understand application devices, collection of the information about a given subject, such as LED, nuclear plant, superconducting application and so on, for each group was conducted in real time by using Excel Online. In addition, Posters presentation was carried out based on summarized information thanks to group ware PowerPoint Online. In this paper, result enhancement of the interest of the attendees of novel physics and IT communication tool will be reported.

Keywords: *Groupware, Applied physics, Poster session, research, Group work*

Introduction

Lecture program of novel physics is a field of study that uses many different notations to explain concepts and problem to overcome by using technology.

Since 2015, National Institute of Technology (NIT) provides online group working space and web based application through Microsoft Office 365.

Microsoft Office 365 is a web-browser version of Microsoft's Office suite of enterprise-grade productivity applications.

However, the use of these applications is not maximized because many students who do not know how to utilize Office365. And they have never been taught how to work together through cloud material.

Therefore, the purpose of this study is to apply the features of Office365 to novel physics class students in Toyota College. For this study we have started with information engineering student because they have already used to handle computers and office application.

Overview of Institute and class

National Institute of Technology, Toyota College (NIT, Toyota) has approximately 1000 students in 5 engineering departments. 50 graduated students in three advanced courses. Toyota College has been more than 50 years since founded in 1963.

NIT, Toyota has set the following three educational goals: striving to search for the truth, contribute to industry with a frontier spirit, and dedicate ourselves to the welfare of human beings

The academic calendar of NIT, Toba follows the Japanese fiscal year, class starts in April and ends in March. It is consisted two of 15-week semesters.

In FY2015, class of novel physics was a lecture courses throughout the year. In FY2016, the class was shortened to the half-year subject which was offered from April to end of July with 1 week in September. Insufficient learning amount must be compensated at home learning.

The point of this active leaning is that using online group ware helps student to understand key technology and application following the phenomena and equations.

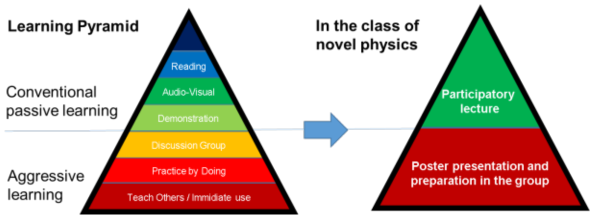

Figure 1 Poster session requires group discussion and teach to others

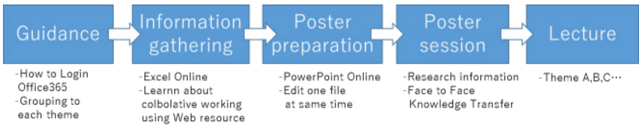

Figure 2 Model of active learning class.

Table 1 List of Theme offered in the class

Theme	Name pf Application
A	Nuclear power - Nuclear physics and power generation system
B	Thermal power generation -Phase transition and the Rankine cycle-
C	Light-emitting diode (LED) - Types and their structure -
D	Superconductivity - Principles and application equipment
E	Laser beam - Light amplification by stimulated emission -
F	Solid-state imaging device - CCD, CMOS image sensors
G	Radiation therapy -Radiation of the type and treatment methods -
H	Fusion energy - Nuclear structure and its application-
I	Accelerator - Structure and principles and their applications -
J	Air conditioning - Air conditioning of the principles and the phase-
K	Solid physical - Band theory and conductive material-
L	Radiation dating - Principle and type-radioactive elements

Microsoft Office 365:
Office 365 is delivered to users through the provided storage space on Microsoft's cloud storage service OneDrive. Web-based versions of the traditional Microsoft Office suite of applications, Outlook for email, SharePoint Online for collaboration and a suite of Office Web Apps can be used through 365 portal websites

Model of the AL class
Learning Pyramid charts were shown in the Figure 1 with the average retention rate for various methods of teaching. In this study, the part of aggressive larning was covered by poster presentation, preparation and discussion with a group member by using office 365. After presentation, detailed contents including mathematical calculation will be lectured in the class
Figure 2 shows the model of the active learning class. First 5 weeks follow guidance, information gathering, poster making and poster session. Those four topics are important in order to pass the basic image of the notation in the lecture. Detail of those topics are as follows.

Guidance: Introduction of the lecture was explained in the first class which includes how to login and use of office 365 will be announced in the guidance. The group will be organized by following 11 themes which are related themes with realistic physics. Each group was consisted with 3-4 students.

Information gathering: Figure 3 shows a window of computer that a student attempting the work to collect resources following theme. Basically web resource was referred for the information. Each group collected around 100 webpages. Therefore, students are required to shift through that information.

Poster fabrication: Figure 4 shows a preparation of a poster presentation using PowerPoint online.

Poster session: Figure 5 shows a poster session. One person has 4 times of presentations in 3 minute presentations and 1 minute question time.

Lecture: Lecture will be offered to students in the different week.

Figure 3 Information collection of specialty theme using Excel Online in Office 365

Figure 4 Collaborative editing of the poster using Powerpoint Online in Office 365

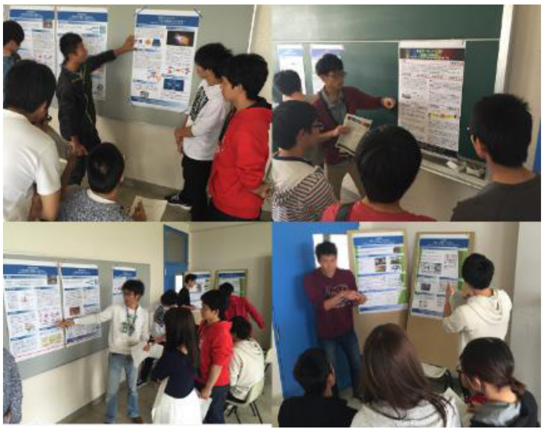

Figure 5 Poster session

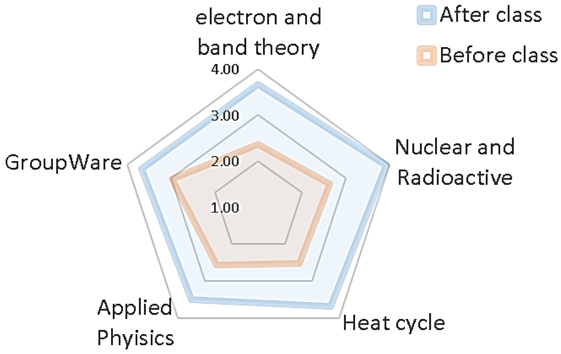

Figure 6 Interest before and after class

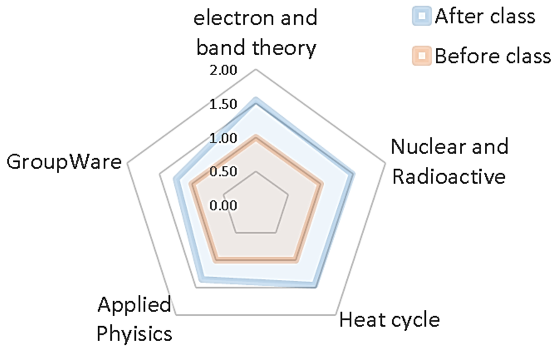

Figure 7 Interest before and after class (standardization before implementation)

Result and discussion

Change of interest before and after the poster session. Effect has been verified by taking the questionnaire 5 - stage evaluation questionnaires in each theme. Red circle shows the interest before the class and Blue circle shows after the poster session. Figure 6 and 7 shows the average score and standardized value of interest. As shown in Figure 7, all of the items were expanded by 1.5 times.

Because the students in the class were belonging to information engineering department, interest of the groupware was higher even before the class. Use of Office 365 gives students to experience in cooperative working style.

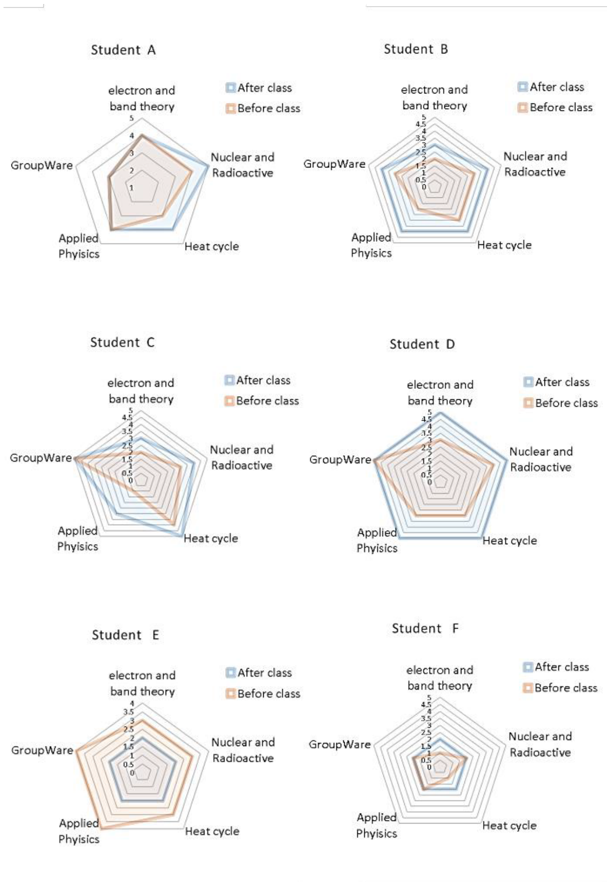

Figure 8 Individual students Interest before and after class

Figure 8 shows in the case of individual students. Most of student was satisfied through the work and scored higher point to each theme which makes the lader chart become bigger the before. For Student A, score of interest for technical part of the lecture become higher than before the class. For student B, all of the score become higher than before especially about the physics subject itself. Student C has high interest to the groupware ordinary. After the experience of the practical use through the information gathering and poster preparation, Student C still keeps the motivation of study using office365. Few students marked as shown in Student D, highest score in the all theme.

Few students were resulted in the other way from expected. 2 student marked as show in Student E. Students E was not fit to the way of the class with group work. The score of the paper test was good enough but the student did not agree with the way of the class.

In the case of Student F, the student originally not good at physics, and did not fit the style of the Active Learning. In the future, way to help this kind of student by lecture or group work need to be considered.

Conclusions

Introduction of the modern physics class with information engineering students through joint work with the groupware, Microsoft Office365, was conducted. To understand novel physics through applied devices such as LED, nuclear plant, superconducting application and so on, collection of the information was successfully carried out in real time by using Excel Online. In addition, posters presentation was carried out based on summarized information thanks to group ware PowerPoint Online. The combination of physics and group work through poster session supported by web based groupware can enhance the interests of the topics offered in the lecture.

From the result, active leaning using online groupware about key technology and application of novel physics help to understanding of the phenomenon and the equations.

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GAME-BASED LEARNING IN BUILDING SERVICES ENGINEERING VOCATIONAL AND PROFESSIONAL EDUCATION

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Abstract

The application of digital games and gamification mechanics to non-gaming contexts have emerged as one of the prime subject interest in different sectors, such as education, marketing, health, technology design, etc. in recent years. Game-Based Learning approach in higher education has drawn teaching academics increased attention. Many believe that the game play approach could offer many benefits including, socialization, engagement, and problem solving to the millennial students.

In engineering education at undergraduate level, new methodologies and tools are being developed using game dynamics to present scientific evidence in many different engineering disciplines, e.g. mechanical engineering, civil engineering, manufacturing etc.

In this paper, a literature review relevant to gamification and game-based learning approach in higher education for engineering is conducted. A discussion on some of the examples regarding engineering education is given. Game techniques, gamification practices applying to building services engineering training are critically evaluated.

Keywords: *building services engineering, game-based learning, gamification, vocational/professional education and training, BIM.*

Introduction

For those who were born between 1981 and 1999 are typically referred to as the Millennial Generation. This is a generation which is the first to grow up with the new digital technology, i.e. personal computers, videogames, digital music players, video cameras, cell phones, and all the other gadgets of the digital age. Their daily lives are totally integrated with computer games, cell phone, instant messaging, blogs, etc. As a result of constant exposure and intense interaction with this modern environment, the millennial generation thinks and processes information in a fundamental way very differently in comparison with their previous generations. This new generation can be referred to as “digital natives” in whom they are all “native speakers” of the digital language of computers, videogames and Internet (Prensky, 2001).

As the technology evolved, the teaching environment in a traditional classroom has also been changed significantly over the years, we have moved from chalk board to white board; transformed from transparencies pairing with incandescent overhead projector to computerised slide presentation with colour overhead projector. Education practitioners have been continuously trying to make use of latest technology for enhancing the teaching quality and learning experience in a traditional classroom setting for students. In the above mentioned changes, we focused onto improving the visual aids in traditional classrooms with an intention to make the delivery of information more attractive and interesting and therefore, helped to engage students. The enhancement was not solely on visual aids but various teaching methods were also being introduced over the years.

Price (2009) suggested that active learning methods, as opposed to a more traditional lecture-only format, would be more acceptable by Millennials. She pointed out that Millennials have grown up in an era in which they were constantly engaged (with the Internet). When they are not interested, their attention quickly shifts elsewhere (with the Internet).

There are many suggested forms of active learning. Bonwell (1991) "states that in active learning, students participate in the process and students participate when they are doing something besides passively listening”. In vocational education context of building services engineering education at Higher Diploma level, we have adopted various active learning sessions in the curriculum, e.g. laboratories, design projects, work place attachment and work place projects, etc. These are formed as an integral part of the holistic learning experience for our students. This curriculum design has been proved to be appropriate to match with the requirements of relevant professional institutions, e.g. the Hong Kong Institution of Engineers, the Chartered Institution of Building Services Engineers, UK, etc. However, when facing with the Millennial Generation, we considered it is the right time and the right moment to inject something new to suit our students.

As a form of active learning method, game-based learning approach is believed by many to be highly beneficial to millennial students. Gamifying in education is well known for its obvious benefit of increasing students' engagement and for some cases of improving students' short term learning retention. This is a very attractive active learning approach which has been explored by various education professionals at different levels.

However, as workplace practices and workplace environment have been simulated in vocational training context, we have to be very cautious when applying games-based learning approach to the curriculum or to individual modules that the industry working standard can be preserved. We definitely do not want to train students to play in the workplace. Game-based learning approach is intended to make the learning more interesting such that they have a better learning retention in a long run. In vocational education context, how far we could utilise game based approach to enhance teaching quality to students? How far would our employers tolerate their staff members playing games when performing assigned duties in a work place? Clearly, a balance between students and employers, we have a find a balance very carefully.

On the other hand, gamification, defined as the use of game mechanics, dynamics, and frameworks to promote desired behaviours, has found its way into domains like marketing, politics, health and fitness, and very recently to education. Game players voluntarily spend hours in developing their problem-solving skills within the context of games (Gee, 2008). They recognise the value of continual practice, and develop personal qualities such as persistence, creativity, and resilience through extended play (McGonigal, 2011). Gamification applying to education attempts to harness the motivational power of games and apply it to real-world problems.

With the determination to continuously improve and enhance the teaching quality and learning experience for our students, we are committed to investigate on the game based approach to our present Higher Diploma in Building Services Engineering curriculum. This paper looks at relevant works relating to gamification in engineering education and explores the ways on gamifying the Higher Diploma of Building Services Engineering programme in Hong Kong so that our millennial students could be benefited from this game-based learning approach.

Summary of Literature Review

There are numerous definitions regarding gamification and game-based learning (GBL). Gamification can be taken as when game design elements, e.g. points, leader boards, and badges, are used in non-game contexts to promote user engagement (Attali & Arieli-Attali, 2015).

In education, game design principles can be used to change non game-like classrooms into fun and engaging game-like environments, for the purpose of motivating and changing learner behaviours.

Jones (2013) suggested gamifying class can have the following benefits:

- Make classrooms more fun and engaging
- Motivate students to complete activities
- Help students focus and be more attentive to what they are learning
- Allow students engage in friendly competitions with peers

From the above definitions, gamification is focused on fun and engaging students rather than learner's knowledge retention. In this respect, gamifying classrooms could be regarded as using game-like elements to design activities that help to enhance the motivation of learner to complete certain activities.

While game-based learning (GBL), according to Wikipedia, is a type of play that has defined learning outcomes. Generally, GBL is designed to balance subject matter with gameplay and the ability of the player to retain and apply said subject matter to the real world.

It is the use of, predominately, video games for teaching a subject matter. The idea is to get students to play with games either ready-made or bespoke to fulfil a learning objective.

Deshpande and Huang (2011) provided a very comprehensive review on previous works relating to simulation games applied to engineering education. They concluded that simulation games would change the learner's role from passive to more active than in traditional learning. Simulation games also encouraged the learners to invest more time on the analysis of the topic learned. They surveyed 50 previous works between 1969 – 2006 on topic-based simulation games relating to civil engineering, electrical engineering, computer engineering, chemical engineering, mechanical engineering, industrial engineering and environmental engineering, 7 major engineering disciplines.

Of these 50 previous works, 16 related to industrial engineering. That makes industrial engineering is the most popular area of engineering in terms of applying simulation games in education. Civil engineering applied simulation games in education can be traced back to 1969 and 1976, according to Deshpande and Huang (2011).

Mechanical engineering and electrical engineering are both relating to a single subject or topic only. No simulation games for the whole systems can be found.

Building Services Engineering Vocational and Professional Education and Training (VPET)

Building services engineering is a very unique engineering discipline which integrating mechanical engineering and electrical engineering into the building relating environment. It is a well-developed engineering profession originated from the UK and then dispersed to some other former Commonwealth members.

Building services engineering covers all mechanical and electrical services in buildings and these can be typically categorised into four main systems which can be commonly found in buildings, i.e. heating, ventilating and air conditioning systems, fire services systems, plumbing and drainage systems and electrical installation systems. In North America, building services engineering sometimes refers to as mechanical, electrical package (MEP) or architectural engineering.

In Hong Kong, building services engineering education includes programmes designed for training craftsmen, technicians and engineers. From diploma to higher diploma to degree level of awards, students could study progressively to gain knowledge and experience in building services engineering through different awards. This discussion in this paper would be concentrated at the higher diploma level in which it is intended to train students to fit the rank of technicians or assistant engineers to help engineers to perform drafting, design calculations, documentations, etc.

A higher diploma (HD) programme which has at least 60% of the curriculum consists of specialised content in specific disciplines, professions or vocational skills. An associate degree (AD) programme, which is also pegged at the same Qualification Framework level in Hong Kong, has at least 60% of curriculum consists of generic contents (e.g. language, information technology, general education, etc.).

A higher diploma, by the above definition, should be a trade orientated programme in which the graduates of the programme should be able to work in the relevant industry without much difficulty on the required skills, attitudes and knowledge.

Computer-aided design (CAD) software is a vital tool for every building services engineering students in their normal working life. Currently, we use mostly 2D drafting to present the design of building services systems in buildings. However, the practice has changed very recently from 2D to 3D. This latest development is called Building Information Modelling (BIM).

In Hong Kong construction industry, Building Information Modelling (BIM) is a new tool which could probably revolutionise the current practice. With the lead from the Department of Housing, Hong Kong Government SAR, BIM is now a compulsory submission requirement for the design phase of all the Department's new projects. This new tool allows drawings produced from various design and construction teams to be shared in 3D, instead of 2D in the past. During the design phase, this standard 3D drawing presentation format can be an efficient way to allow various design parties to communicate in this common platform, such as, clashes can be checked and detail information about the building elements can be stored in the tool, etc.

To provide proper vocational training to our students, despite the use of BIM in Hong Kong is yet to be a mainstream, we have included an elective module to introduce BIM focusing on building services design in our HD curriculum. Further integration of BIM with other existing design related modules could be expected in the near future once the construction industry in Hong Kong has becoming more receptive with BIM as a common tool for design, construction and facilities management for buildings replacing the traditional 2D CAD drawings.

From all the information gathered above, BIM would be an appropriate tool to implement gaming to relevant design project modules in the existing HD in Building Services Engineering curriculum. It is obvious that the industry is in the path to utilise BIM as a tool to enhance communication effectiveness among different design, construction and facilities management parties. However, as this is a new tool, training for teaching staff is also very important for sustaining the development of this new tool and potentially for implementing gaming for some modules in the curriculum. Apart from training of teaching staff, applied research on the use of BIM for enhancing industry efficiency has to be encouraged, so that the new tool could be a training media for both students of pre-employment and practitioners of the industry.

Discussion

Alanne (2016) gives a very detailed study on applying game-based learning to building services engineering education. The following is a discussion based on Alanne (2016) work taking into account the situations of Hong Kong's vocational and professional education and training (VPET) in particular on building services engineering industry.

With the advance of mobile technology, we are constantly connected with the Internet by Wi-Fi or other connecting devices. It is therefore normal to deduce that the motivation of study could be increased when learning can be taken place everywhere according to one's will. The future of game-based learning environment could be so called ubiquitous learning (U-learning) or mobile learning (M-learning). That means a ubiquitous learning environment is that learning processes are present everywhere, and the learners are totally enclosed by the environment or even without being aware of learning.

To create an ubiqutious game-based learning environment, the use of augmented reality (AR) could provide a possible solution for building services engineering education. AR can blend the real world and digitial information, e.g. overlaying images, audio, video or haptic sensations over a real-time environment. Wang et al. (2012) propose a conceptual framework to integrate BIM with an AR application to make construction activities or tasks to be visualised in real time. Johansson et al. (2014) provide a tested prototype on immersive visualizations in the building design process integrating BIM with AR. Their model is aimed to help the design team members with different design culture and background, e.g. Architect, Structural Engineer, and Building Services Engineer, with an improved communication platform. This would reduce significantly the problems of insufficient collaboration and information sharing during the process. They argue that the ability to allow design team members to navigate freely through 3D scenes from a first-person perspective, it is possible to alleviate problems described above. BIM is therefore a good candidate for giving the handy 3D data from the architect's own design environment for this application.

The use of CAVE (CAVE Automatic Virtual Environment) and Powerwall are considered to be expensive and a large physical space is required for these systems to be installed and to be used as a fully immersive AR system. For CAVE, three walls and a floor are required for one person to operate the system. For a class of 30 students, the number of CAVE required to be built to reduce student's idling time during the class would become a hugh and risky investment. Powerwall is simply a high revolution large screen which required a big conference room to allow its functionality fully explored. A group of people can be gathered in the conference room to collaborate at the same time using the big screen. These two systems have to be installed in a fixed location which makes the collaboration of various design team members have to be met physically. The most problematic of these systems to be used in building design process is the limited BIM-support.

A portable system for immersive BIM visualization is then developed using three main components: (1) the Oculus Rift Head Mounted Display (HMD), (2) an efficient real-time rendering engine supporting large 3D datasets that is (3) implemented as a plug-in in a BIM authoring software. This is a low cost system as comparison with CAVE and Powerwall. No dedicated facility is need for this portable system. The specially developed rendering engine is capable of managing large and complex 3D datasets and be able to be implemented as a plug-in to a authoring BIM software.

However, from their test results, the time required to complete the rendering and to make iterations for every input, time delay is still very noticeable. This suggests future work is required for shortening the time delay for rendering and iterations between design inputs.

Nonetheless, Jonansson's proposed portable system is still an attractive system for implementing game-based learning for design project modules of the HD in Building Services Engineering curriculum. The system is low cost and is affortable to be setup in numbers for a class. The use of the Occulus Rift HMD makes it a game-like system in which the HMD is very often being used as a game-play essential equipment. The Occulus Rift is not being used by the gaming industry but it is also can be used in the actual building design process. That piece of equipment if being used by students would make them feel like in a game rather than in a classroom. Students could be benefited from collabrating with others in a design team for different mechanical and electrical services in a 3D building during the design project modules using the above proposed portable system in a traditional classroom.

Conclusions and Future Work

Traditional classroom education already has several game-like elements. Students get points for completing assignments correctly. These translate to "badges," more commonly known as grades. Students are rewarded for desired behaviours and punished for undesirable behaviours using this common currency as a reward system. If they perform well, students "level up" at the end of every academic year.

Given these features, it would seem that school should already be the ultimate gamified experience. However, something about this environment fails to engage students. In contrast, video games and virtual worlds excel at engagement (McGonigal, 2011).

Gamifying individual modules or the programme curriculum seems to have a brighter future for our new millennal students with increased engagement and problem solving skills.

BIM would become a new industry standard after CAD for building services engineering in the near future. Using BIM coupled with AR to enhance the learning experience of students and to impletment the game-based learning approach is an ideal platform. Training to be provided at VPET on BIM and AR with gamification would provide a seemless transformation from education to employment.

We have reviewed some previous works relating to game-based learning for building services engineering. Our next work would take a step to gamify some of our modules based on some of the ideas given here and to focus on students' performance and learning retention.

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PRACTICAL CASE REPORT: ACTIVE LEARNING STYLE EDUCATION WITH MATERIALS ON BLACKBOARD

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Abstract

The National Institute of Technology(NIT) has been promoting an active learning (AL) education such as interactive lectures and/or flipped classrooms (FC) in order for students to possess what the government refers to as "21st century skills". Faculty members of Hakodate college (Hakodate Kosen) have also been conducting various educational improvements/developments. In this report, we'd like to present a case of AL approach in an engineering subject, Electrical measurement engineering II (4th year, dept. of elec. elec. eng.) In this class, students had an exploratory activity and a presentation about their topics, that is a flipped classroom style, in the first half of semester. These topics have various levels, for example, easy topics whose answer can be investigated immediately on the Internet, average difficult topics which students are required to examine and consider. Since these problems/topics had been uploaded into Blackboard, which is a learning management systems (LMS), they were able to tackle them with their group members not only during but also before and after classes. After their presentation, they had to upload their materials as evidence of their effort into BB; then, the instructor checked them again, marked, graded their reports. They learned the other half semester in groups, that is, they tried to solve applied problems by themselves as a small project-based learning. In both cases, BB helped students' active learning. Since interactive lecture styles require more time while encouraging initiative to allow for students' deep discussion, such tools which help students to learn fundamental topics are useful for both lecturer and students; they can study when it is convenient for them. According to the result of the questionnaire, the number of the positive evaluations (e.g. "group works were good", "I focused well") was 36 answers. In contrast, the negative ones (e.g. "achievement of group works depended on the members", "I like the traditional lecture style") was only 10 answers. In conclusion, it is our firm belief that we have to improve/develop materials for student's effective learning.

Keywords: *Interactive teaching, Active learning, Flipped classroom, LMS, Blackboard*

Introduction

Education style has been drastically changing from "what do professors teach?" to "what did students learn?", that is, we must focus on outcomes (Barr and Tagg. (1995), Barkley (2005)). Students possess actual learning outcomes the fact that students can apply the various knowledge for practical problem solutions. Therefore, not only liberal arts and fundamental engineering knowledge but also various types of skills which is called "21st century skills" (e.g. information and communication skills, global awareness and cross-cultural skills, presentation skills, critical and inventive thinking, relationship management and problem solution skills) are required (this concept was proposed by Ministry of Education, Singapore, 2010). Many university and National institute of technology (NIT or KOSEN), of course including our college have applied a project/problem based learning (PBL) in order for students to possess 21st century skills (e.g. Moriya (2012)). The 21st century skills are also called generic skills with almost the same meaning. In this report, we use the word of "generic skills" instead of the "21st century skills".

The "Active learning (AL)" trend is one of the recent main stream in Japanese education (e.g. Kawai-Juku (2014)). In the AL style education, students can learn fundamental knowledge and how to apply it for problem solutions with training their generic skills. Additionally, various ICT tools well encourage a students' active learning; especially, learning management system (LMS) well encourages students learning before and after classes and reduces the teacher's time spent grading. NIT, Hakodate college (Hakodate Kosen) has been promoting an active learning (AL) education such as any interactive lectures (e.g. Kobayashi (2015), Shimogohri (2015)). Faculty members of Hakodate

Kosen have also been conducting various educational improvements/developments with AL and ICT.

In this report, we'd like to present a case of AL approach in an engineering subject.

Pedagogy and Materials

Class: Electrical Measurement Engineering II, 4th year, department of electrical and electronic engineering, 42 students, core subject 1 unit, 2 credits/week, 15 times in the first semester.

Subject design: First four weeks: flipped classroom style about the fundamental principle of an oscilloscope. Next six weeks (included a midterm exam): lectures and AL activities (a group discussion and a presentation) about fundamental properties of operational amplifier and their basic circuit. Last four weeks: lectures and AL activities about actual electrical noise problems.

Instructional design: Although students tends to want more solution/discussion time, a facilitator needs to manage time schedule according to an instructional design sheet. In the AL style, it is often considered that actual lecture time wasn't enough because deep discussion needs more time. Therefore, we need to manage each lecture, a basic element of instructional design. The instruction design is especially required for AL style.

Group discussion & Presentation: Each group included 5 or 6 students whose seats were near (Figure 1).

Figure 1. Group discussion. Each group had five or six students.

Group members were fixed during through the semester except for the flipped classroom. In each class, each group tackled practical/applied problem after they got a fundamental lecture. Although they can use any connected devices such as smart phones, tablets, laptops, to investigate the problem or to get useful information, they weren't allowed to communicate with the other groups in the first 20min. The lecturer should encourage student who are not good at communication with other members (Takeda, (2014)). Additionally, the lecturer needs to be just a facilitator during group discussion time, which means he/she is required not to speak; however, this is quite difficult for lecturers because we tend to want to explain more details. If you have an opportunity to participate in a facilitation training program, authors strongly recommend that you catch that chance. We should encourage an active learning, NOT active teaching. Figure 2 shows examples of their note.

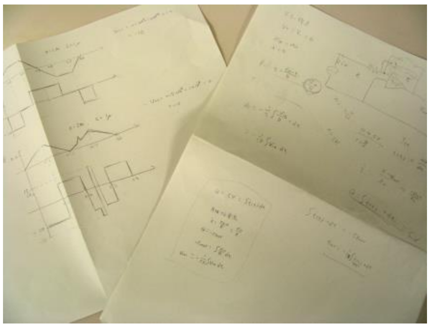

Figure 2. The examples of their discussion note. Each group make one report together with group members.

Then, some groups were chosen to solve and explain each problem on the blackboard in front of all students (Figure 3 upper and lower photos). Because each group was sometimes given the different problem, students needed to pay attention other group's presentation to understand all problems. Students can ask or discuss if they had questions and/or an opposite opinion. Presentation and discussion are also quite significant for both their comprehension and their generic skills.

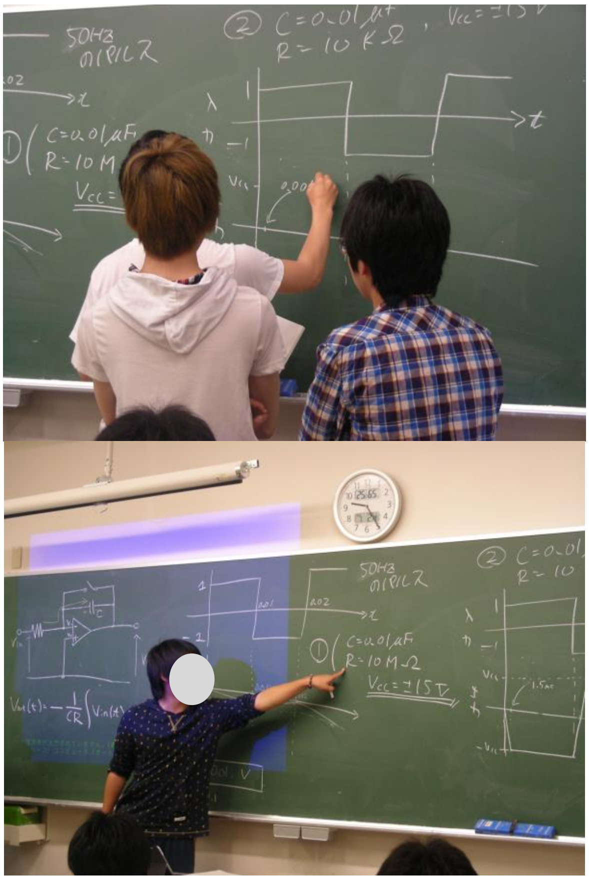

Figure 3. Upper photo: some groups were chosen to solve the problem on the blackboard after discussion. Lower panel: then, they explained their solution or their opinion. Each student in group was given their roles.

This class had 8 groups, however, only three or four presentations could be given in class. Thus, groups were chosen randomly by electronic dice which was made by students of Robot engineering club (Figure 4).

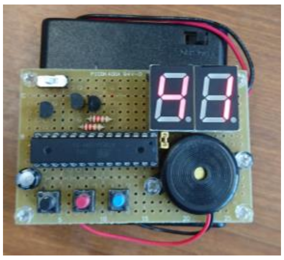

Figure 4. The electronic dice. After the number of class students is set, the dice randomly displays a number. Each number is used one time only.

Flipped classroom: In order to use the class time for their comprehension, studying before and after class is very effective, which is a flipped classroom (e.g. Berrett D. (2012)). However, choosing the level of each problem is very important and difficult; it needs to be interesting, not too easy, not too tricky, and the materials involved in it needs to be prepared. Since preparation and presentation is not an easy task for students, their efforts should be evaluated for subject grade. A balance in each group's ability is also important. Although each group should have a student who has active attitude, a leader type student must not decide all. Figure 5 shows the examples of student's presentation.

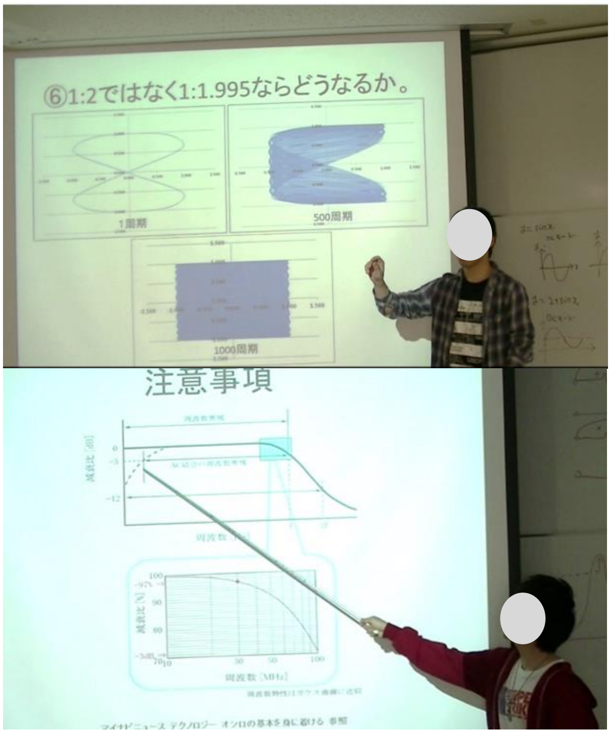

Figure 5. Examples of student's presentation. All students have to talk about their associated part.

Materials on LMS (Blackboard): Because students needed to study before and after class, we have to encourage their learning. Hakodate Kosen adopted Blackboard (BB) as a LMS (e.g. Kobayashi (2000)). All materials involved in the class can be downloaded and students can also use it with smartphone. Additionally, students can upload their reports and presentation files. The lecturer can also check their activities and conduct a quiz on the BB. Such ICT tools well assist AL style teaching especially flipped class. Of course, LMS is NOT absolutely necessary for AL style education, it's just one of convenient tools. Figure 6 is the example of BB contents.

Figure 6. The example of BB contents (this is the 2016 version). LMS is useful for both students and lecturer. BB is one of LMSs, any LMS must encourage students and lecturer.

Results and Discussion

Students' grade: Figure 7 shows their final grade distribution compared with a previous non-AL style class.

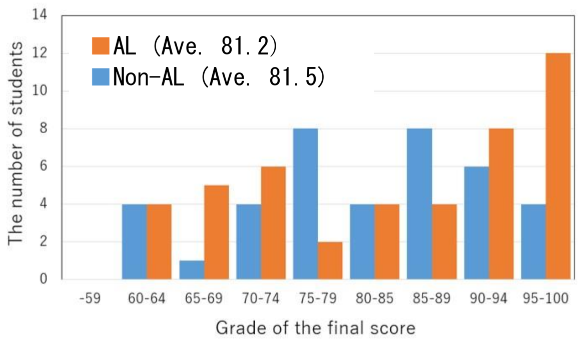

Figure 7. Final grade distributions of AL and Non-AL style. Subject and contents were same, but students (populations) were different.

Interestingly, although average scores were almost same value, the score distributed in the shape of a two-hump camel in AL style class. This result indicates that the students of intermediate grade group could understand because the students of intermediate grade group had studied interactively or taught each other in group works. Of course, although subject contents were almost same, the grades couldn't be directly compared because students belonged to different years. The comparison above shows a tendency, but has not been statistically proven yet; however, it seems to confirm our initial expectations.

Unfortunately, some students in each class didn't understand enough.

Students' opinions: A questionnaire about AL style was conducted. The number of the positive evaluations was 36 answers, in contrast, the negative ones were only 10 answers. Typical students' opinions both of positive and negative evaluations are shown below. They seemed to feel AL style was good practice for generic skills. However, because some students thought "achievement of group works depended on the members", group members should be remixed.

Positive opinions:

- Group works were good.
- I focused problems well.
- It was fun!
- Every student could understand due to group discussion.
- I could understand deeply.
- We got many types of skills!
- I didn't get sleepy.
- We tackled "so so" difficult problems, so that I didn't feel the examination was difficult.

Negative opinions:

- Achievement of group works depended on the members.
- I like the traditional lecture style.
- I'd like more discussion time.

Conclusions

The purposes of AL style education are 1) students understand more fundamental knowledge than a conventional teaching and can apply to practical problems, 2) students possess the generic skills (especially active and curious attitude for the problems solution) through discussion and active investigation. Authors have been attempting various interactive teaching methods in order to achieve these purpose. How much did this class achieve?

According to their grade and questionnaire results, they could understand fundamental content about Electrical Measurement Engineering. Although students of the middle grades might well understand thanks to AL style, class needed an improvement for the students of lower grades. Students seemed to participate and discuss actively with group work. We know students study hard in groups before their examination, which indicates that they also understand group work is effective method for deep learning; a keyword is students' "mutual teaching". Meanwhile, group work depends on group members. In other words, facilitation or instructional design is quite important. We'd like to research better facilitation skills from good case reports.

The LMS well assist students' active learning during, before, and after class. ICT tools are good and convenient materials for especially AL style.

It is sometimes said that some subjects are proper for AL style (e.g. English, math, social studies) but some subjects, for instance a specialized subject, are not. However, this class was specialized class in electrical engineering. The interactive, AL teaching has various methods as you know. Every subject could adopt proper AL methods. The group work and/or the discussion are NOT necessarily needed for whole of class. If we need to explain, we should explain through the class. The significant point is "which is better for students' comprehension?" We have to improve/ develop teaching methods and materials for student's effective learning.

Acknowledgements

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Additional statements

All student gave their permission to use the photos.

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Using data mining to reduce the drop out of the second year student: Suggestion for required course

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Abstract

With the accountability of university for student success, data analytics of academic must be done for helping fulfilling their academic missions. From Registration's data of Thai-Nichi Institute of Technology (TNI), it shows that dropped out student from TNI's starting of operation of Information Technology (IT) students is 403 of 1,775 which is 22.70%. Thus, student retention and graduation are the most important tasks for institution from this evident. The objective of this research is to reduce the number of student being dropped out from second year by applying a data mining technique using the framework of data classification. We also developed framework for mining the past data of TNI registration system from 2008 to 2016, by selecting the student data from the Faculty of Information Technology (IT) in second year students only such as grade point of average (GPA), grade point of require courses and grade point of standard courses. The conception framework was evaluated by 5 experts who were previously been publishing and experiencing in data mining technique and educational and training business. The result of evaluation is 3.80/5. Then we applied this framework and use selected data for discovering knowledge that provides the pattern of group of course (Require course) that student must enroll to avoid dropping out. The results from data mining give a suggestion for required course for enrollment as following; First group of good result of academic performance consists of Internet Technology course, Japanese course and Introduction to Computer Programming course. Second group consists of Internet Technology course and Japanese course.

Generally, students with high academic performance and with predicted probability of good planner were able to manage their studying, however, some students still do not understand how to choose appropriated course for studying in the same semester that may facilitate their success. Thus, from this research's outcome, it provides a guideline for student to choose or avoid an unexpected result of academic performance from group courses selection.

Keywords: *Data Mining, Education Technology, Education Research, Student Performance, Classification Technique, Decision Tree*

1. Introduction

Today, there are twenty-three information technology (IT) faculties in Thailand. Thai-Nichi Institute of Technology (TNI) is one of those university that provided this program. For admission score of TNI's IT student ranges from 10,000-12,000 points which closes to the five famous universities in Thailand as shown in table 1.

Table 1. The score of admission testing in 2015 of university in Thailand. (Association of University Presidents of Thailand, 2016)

University	Range of Admission Score in 2015
King Mongkut's University of Technology Thonburi (KMUTT)	16,755-14,612
Suranaree University of Technology (SUT)	15,275-11,418
Khon Kaen University (KKU)	15,575-13,276
Chiang Mai University (CMU)	16,963-14,322
Thai-Nichi Institute of Technology (TNI)	12,000-10,000

The number of applicants for TNI's IT is approximately 500 undergraduates every year and we can accept about 300 seats. Additionally, the number of IT's applicants have been growing up every year, but the number of dropped students is also linearly increased in the numbers as shown in table 2.

Table 2. Drop out of IT student from registration system

Year	Number of IT Student	Dropped out
2008	33	8
2009	122	23
2010	171	31
2011	223	63
2012	255	71
2013	216	84
2014	217	57

2015	286	83
2016	251	32

From table 2, it presents that dropped out student's rate is a bit high comparing to number of existing students. Especially, in 2013, a number of IT student is 216 and dropped out is 84 students, equal 38.8%. The data from registration system also shows us that there are totally 1,774 students for faculty of Information Technology since 2008-2016 and total dropped out students is 452, which is 25.47 %. The rate of dropped out could be reduced if there are some information to allow us to know the causes.

Thus, this study aims to develop the recommendation system from mining the past to reduce dropped out the second year student from a suggestion for registered required courses at a proper time.

2. Literature Review and Technology used

2.1 Data Mining

Data mining, namely knowledge discovery and data (KDD) is the process of extraction of implicit and explicit patterns from large data. It can find out different perspectives and summarize for business used**.** (Klösgen and Zytkow, 2002) Data mining is a tool in which several businesses apply a paradigms convergent for example decision tree construction, rule induction, artificial neural networks, instance-based learning, bayesian learning, logic programming and statistical algorithms to increase revenue, cuts costs, or both by transform its information from mining to visualized data**.** (Romero et al., 2008)

2.2 Data Mining Process Model

This research uses six processes of CRISP-DM to discover the relation between pattern of study plan and TNI student academic performance.

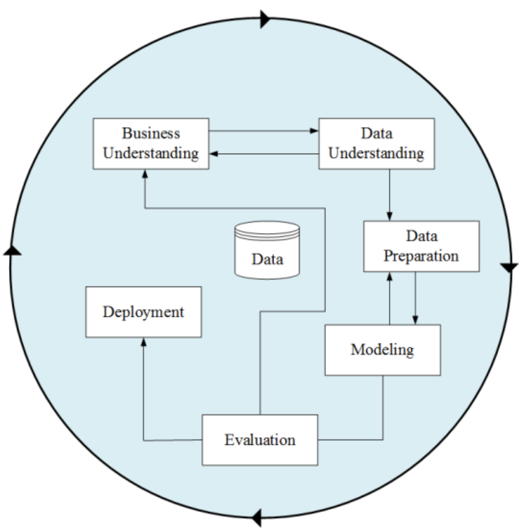

Figure. 1 CRISP-DM Reference Model (IBM SPSS Modeler CRISP-DM Guide, 2011)

From figure 1, CRISP-DM (Cross-Industry Standard Process for Data Mining) is a data mining standard process that we used in this study. The six phases are listed below:

1. Business understanding and
2. Data understanding,
3. Data preparation.
4. Data modelling.
5. Data evaluation.
6. Data deployment.

1. Business Understanding

This is the first process of data mining, which also includes determining business objectives, establishing data mining goals, and developing a project plan. For the problem definition of this study, we started from finding the big volume of dropped out students at the second year of study. Thus, the aim of this research is to analyze data form TNI's registration system to discover the associated pattern of the first and second years' course with academic performance.

2. Data Understanding

The second process is data understanding which consist of collecting initial data, data describing, data exploring, and data verifying. After understanding the problem area, researchers discussed with officer from academic service department for available data for mining. This steps involve exploring the structure of table, its attribute and also determining the data quality in order to verify to be sure that the data in registration system(REG) are enough to mining for our study.

Researchers received a registration data in MS excel format and they are 16 files separated. In this case, merging these file is the first important task for us to begin this paper.

3. Data Preparation

The third process is preparation data from REG that contains three sub processes

Data cleaning:

This step not only remove the inconsistent data or noise, but also collect necessary information from REG. The incompleted data are removed such as blank cells, unstructed data, etc. The verification of data quality was also done by checking for example missing data, data error and sample of inconsistence data are illustrated in table 3.

Table 3. Sample of Inconsistent data from REG

STUDENTCODE	COURSE CODE (Missing data)	COURSE CODE (Error data)
50121002-5	-	K
50121003-3	(Null)	NC

From table 3, sample of inconsistent data that we found from REG

- Missing Data - There are no data in that field such as course grade, some contain blank and some contain "Null" or contain "-".
- Error data are data in field that fielded in with appropriated symbol such as Course grade that must be "A or B or C or D or F" but it does have "K" or "NC". For this error data, we need to clean it up before mining.

Those inconsistence data may be from human error and system error, in this paper, we use MS excel in cleansing.

Data Selection:

Following from data cleansing, the process of data selection is to employ the data fields or attributes which are listed below;

- The student status data, i.e., normal or retired.
- The course enrolled list for the 1st and 2nd students
- The enrollment results of them.

Data transformation:

Data was converted into a suitable format for analysis. Students data are rearranged and sorted into new table as shown in table 4.

Table 4. The example of student data transformation

STUDENTCODE	ENL-101	ENL-102	ENL-201	GPAX
50121002-5	C	C+	C	Fair
50121003-3	A	B	C+	Good
…………..	…….	…….	…….	…….

4. Data Modelling

At this point, this paper spent a lot of time to determine which type of modelling that can answer our questions. Although we have some ideas for our techniques to be used in this research, we still have to consider the pattern of data training set (table 4) and proper type of mining model to meet the criteria for "goodness" of a model. The model is implemented in the Weka software as shown in figure 2 as the following steps;

1. Import new table from preparation process (.CSV format) into the Weka software. (Weka 3 - Data Mining with Open Source Machine Learning Software in Java, 2016)
2. Choose the feasibility attributes to construct the model.
3. Choose the data mining approach which is decision tree for this paper.
4. Simulate data to create the model.

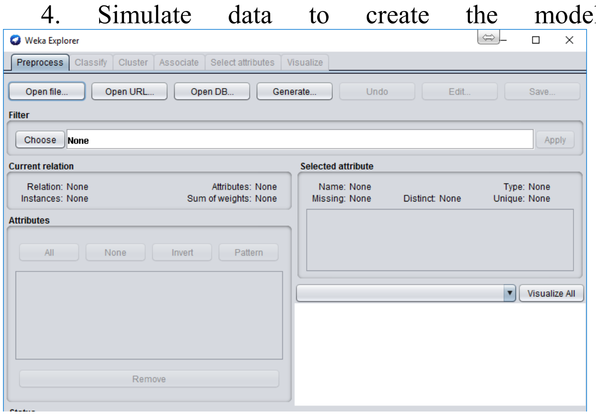

Figure 2: Weka application

This paper applied decision tree (Quinlan 1993; Hastie et al. 2001; Duda et al. 2001). to classify data. The process started from supervising the training data set. for being a model to predict the result of the data. Decision tree consists of two main parts which are nodes and branches Node is able to handle both numerical and categorical data, i.e., it can be labeled by many types of the attributes. Each node is capable of the multiple outputs depend on the training dataset. Next, brances bring the decision from the ancestor node to the predecessor node, i.e., step down to the next level of the tree. The node that do not have any branches will be called leaf node and it, on the other hand, is called root node. This paper uses a statistical classifier, C4.5, algorithm to generate the decision tree. At the final state, the rule bases are created by the decision trees as shown in Figure 3.

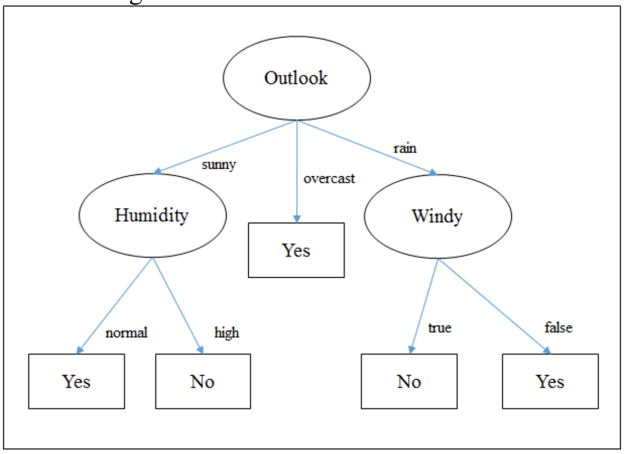

Figure 3: Decision Tree C4.5, algorithm (Quinlan, 1986)

5. Evaluation

At this point, this paper could only be useful if the information we derived from mining model becomes a knowledge that we can use for solving our problems. In this section, we demonstrate the kinds of rule sets extracted from the C4.5, algorithm as shown in figure 4 below.

Rule Base from C4.5 algorithm

INT-105 = B+
| JPN-101 = C+
| | ITE-302 = C+: Fair
| | ITE-302 = B: Good
| | ITE-302 = A: Good
| | ITE-302 = D+: Fair
| | ITE-302 = C: Fair
| | ITE-302 = B+: Good
| | ITE-302 = D: Fair
| | ITE-302 = F: Fair
| | ITE-302 = W: Fair
| JPN-101 = B+: Good
| JPN-101 = A: Good
| JPN-101 = C: Fair
| JPN-101 = B
| | ENL-101 = B+: Good
| | ENL-101 = A: Good

```
|  |  ENL-101 = B: Good
|  |  ENL-101 = C: Fair
|  |  ENL-101 = C+: Fair
|  |  ENL-101 = D+: Fair
|  |  ENL-101 = F: Retired
|  |  ENL-101 = W: Retired
|  |  ENL-101 = D: Fair
|  JPN-101 = D+: Fair
|  JPN-101 = F: Retired
|  JPN-101 = W: Retired
|  JPN-101 = D: Fair
INT-105 = B
|  INT-101 = C: Fair
|  INT-101 = A: Good
|  INT-101 = B: Fair
|  INT-101 = D+: Fair
|  INT-101 = B+
|  |  JPN-101 = C+: Good
|  |  JPN-101 = B+: Good
|  |  JPN-101 = A: Good
|  |  JPN-101 = C: Fair
|  |  JPN-101 = B: Fair
|  |  JPN-101 = D+: Fair
|  |  JPN-101 = F: Good
|  |  JPN-101 = W: Retired
|  |  JPN-101 = D: Fair
|  INT-101 = C+
|  |  ENL-101 = B+: Good
|  |  ENL-101 = A: Good
|  |  ENL-101 = B
|  |  |  INT-102 = D+: Fair
|  |  |  INT-102 = A
|  |  |  |  INT-202 = A: Fair
|  |  |  |  INT-202 = B+: Good
|  |  |  |  INT-202 = C+: Fair
|  |  |  |  INT-202 = B: Good
|  |  |  |  INT-202 = F: Good
|  |  |  |  INT-202 = C: Fair
|  |  |  |  INT-202 = D+: Good
|  |  |  |  INT-202 = W: Good
|  |  |  |  INT-202 = D: Good
|  |  |  INT-102 = C+: Fair
|  |  |  INT-102 = C: Fair
|  |  |  INT-102 = D: Fair
|  |  |  INT-102 = B+: Good
|  |  |  INT-102 = B: Fair
|  |  |  INT-102 = F: Fair
|  |  |  INT-102 = W: Fair
|  |  ENL-101 = C: Fair
|  |  ENL-101 = C+: Fair
|  |  ENL-101 = D+: Fair
|  |  ENL-101 = F: Retired
|  |  ENL-101 = W: Retired
|  |  ENL-101 = D: Fair
|  INT-101 = D: Fair
|  INT-101 = F: Fair
|  INT-101 = W: Fair
INT-105 = A: Good
INT-105 = C+: Fair
INT-105 = D+
|  JPN-101 = C+: Fair
|  JPN-101 = B+: Fair
|  JPN-101 = A: Fair
|  JPN-101 = C: Fair
|  JPN-101 = B: Fair
|  JPN-101 = D+: Fair
|  JPN-101 = F: Retired
|  JPN-101 = W: Retired
|  JPN-101 = D: Retired
INT-105 = C: Fair (326.61/68.8)
INT-105 = F: Retired
INT-105 = D: Retired
INT-105 = W: Retired
```

Figure 4: Rule Base from Decision Tree

6. Deployment

To use the knowledge acquired from mining, we need to develop the application of a model for prediction to new data. We plan to present a prediction by the way that students can use it for study planning in this section, it is a future work that we are going to ask our students what platform and technology they are familiar with and usually use it in order to make use of the acquired models from this paper.

Result and Discussion

Dropped out figures from REG encourages us to find out pressures on students of push and pull dropout factors. Normally, students plan to drop out from school when facing situations with low academic performance lead to consequences, resulting in dropping out. Doll et al., (2013) supported this evidence from their writing that students falling out of school, when a student cannot get a significant academic performance. The results from our study also imply to their study that dropped out students from TNI's IT are from their low academic performance. From mining, we found courses that result in dropping out students as following;

1st rule: If INT-105 is B+ and JPN-101 is F.
2nd rule: If INT-105 is D+ and JPN-101 is F.
3rd rule: If INT-105 is D+ and JPN-101 is W.
4th rule: If INT-105 is D+ and JPN-101 is D
5th rule: If INT-105 is F.
6th rule: If INT-105 is D.
7th rule: If INT-105 is W.

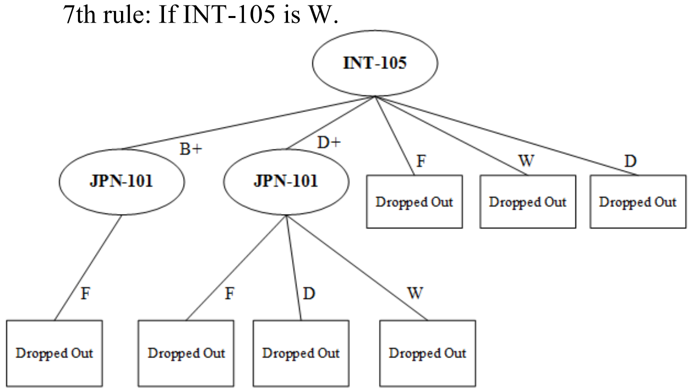

Figure 5: Dropped out rule base from Data mining

From mining rule using decision tree, we found that 2 courses that highly effect to push students dropping out are INT-105 Internet Technology and JPN-101 Business Japanese 1.

Conclusions

The results from this study implies that courses that have a strong relationship with dropped out students are INT-105 Internet Technology and JPN-101. For the future work, we will apply this finding knowledge from data mining to be a application system. This system will be a tool for helping and consoullling students. However, for completion of consoullling, other factors required to including in analysis such as semester of studying, family status, students attention in studying, students' responsibility, family expenditure with acedemic fee and university's admission schedule.

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Too young to do research?
- Let students do self-directed inquiry, let us coordinate them in a fun, easy way

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Abstract

A fun, easy way of coordinating large numbers of Kosen students' self-directed inquiries all at the same time is presented and implemented. In our Hachinohe Kosen an academic quarter system has replaced the conventional two-semester system since the 2015 academic year, which made our Kosen the first one to do so among all Kosens in Japan. The drastic system change is aimed to offer the students an ideal environment for letting them experience doing research called "self-directed inquiry (SDI)". One notable point is our Kosen has installed an inquiry-intensive quarter (Fall quarter), in which, unlike the other quarters, no daily routine teachings are given to the students. They instead are privileged to totally concentrate on their SDI. The most notable is that it is the students themselves, not teachers ourselves, who direct the whole process of the SDI, as the word "self-directed" suggests. The students' academic curiosity and self-direction are respected. We teachers are supposed to play a role of "coordinator", giving the students a "supportive push forward". The new system, to be sure, sounds epoch-making, but a major concern is revealed. It is found from the survey of the present study that most of the students are totally stranger to doing any research based on self-direction. How do they set about and accomplish their SDI with the support from a limited number of coordinators? In the 2015 academic year the author was appointed a coordinator for a first-year class of 42 students. As a potential practical, sustainable solution to the above concern, a combined method of holding a weekly progress report meeting open to public and utilizing Office 365 (a powerful communication tool introduced into all Kosens in Japan since the 2015 academic year) was tried. The students' SDI outcomes prove the method successfully works and is a sort of active learning. In conclusion, they can grow to be a researcher even in their Kosen first-year. They don't need to wait to grow up to be a researcher.

Keywords: *Self-directed inquiry, academic quarter, coordinator, active learning, Office 365*

Introduction

In our Hachinohe Kosen the conventional two-semester system has been replaced by the new academic quarter system since the 2015 academic year. The drastic change is aimed to offer the students an ideal environment for letting each of them experience doing their own research, "self-directed inquiry (SDI)". All students, including even the first year students, are obliged to do SDI. What SDI is all about is that it is the students themselves, not teachers, who direct the whole process of the SDI, as the word "self-directed" suggests. The students' academic curiosity and self-direction should be most respected. We teachers are supposed to play a role of "coordinator", giving the students a "supportive push forward". Fall quarter is an "inquiry-intensive quarter", in which, unlike the other quarters, no daily routine teachings are given to the students. They instead are supposed to devote themselves entirely to their SDI activity. The poster presentation is scheduled near the end of the fall quarter (Fig. 1).

Fig. 1 Poster presentation of SDI (Nov. 2015)

The academic quarter system with such an adventurous fall quarter sounds epoch-making if it works. The key is the fall quarter. What should the coordinators do to contribute to the inquiry-intensive quarter? In Hachinohe Kosen each class consists of about 40 students, with two SDI coordinators assigned to it. A simple calculation results in one coordinator per about 20 students! It is obvious that we have to come up with some smart way of coordinating SDI. In this study, a fun, easy way of coordinating SDI is presented.

"One-on-one" or "Full-disclosure"?

In the 2015 academic year the author was appointed one of the two coordinators for a first-year class (42 students). All first-year students (166 students) are not allowed to set up any team to do SDI. It should be noted that the survey of the present study shows that the great majority of the class (73.8 %) is totally stranger to doing any research based on self-direction. It is easy to imagine that under such a situation, being an SDI coordinator would be tough if the coordinator interact with a number of students on a "one-on-one" base. Moreover, we have to consider potential undesirable side effect from the one-on-one interaction between the coordinator and a student. That is, the possibility of a self-directed inquiry turning to a coordinator-directed inquiry. Another way, other than one-on-one, is desirable from these viewpoints.

Unlike the other classes, the author's class was not divided into two. He, in collaboration with the other coordinator, instead held a weekly progress report meeting attended by the whole class during the fall quarter (Fig. 2). The routine meeting is aimed to offer the students without background knowledge about how to do SDI opportunity to learn to see how the seeds of SDI are sown and grown (Nakamura, 2016). This "full-disclosure" meeting is interesting from the viewpoint of active learning (e.g., Meyers and Jones, 1993; Johnson and Johnson, 1998; Bean, 2011; Freeman et al., 2014) because they are offered an opportunity to learn from each other how to do SDI.

Fig. 2 Snapshots of SDI weekly progress report meeting.

Results and Discussion

The full-disclosure progress report meeting has been successfully operated with the use of Office 365, a powerful online communication tool introduced into all Kosens in Japan since the 2015 academic year. Figure 3 shows the results of the survey to probe the major difficulties the students encountered in doing SDI (a), and what helped them to overcome the difficulties (b). Obviously the weekly report meeting plays an important role. It should be noted that the listed items "Teachers", and "Friends" in Fig.3(b) are closely related to the item "Weekly report meeting", because the former two correspond to the help the students got from the teachers and the friends in the weekly report meeting. It was only the author's class that held this kind of full-disclosure routine meeting during the fall quarter.

After the poster presentation, prizes are awarded to the most excellent SDI. For reference, the author's class successfully won four prizes including the first prize out of the top eight prizes.

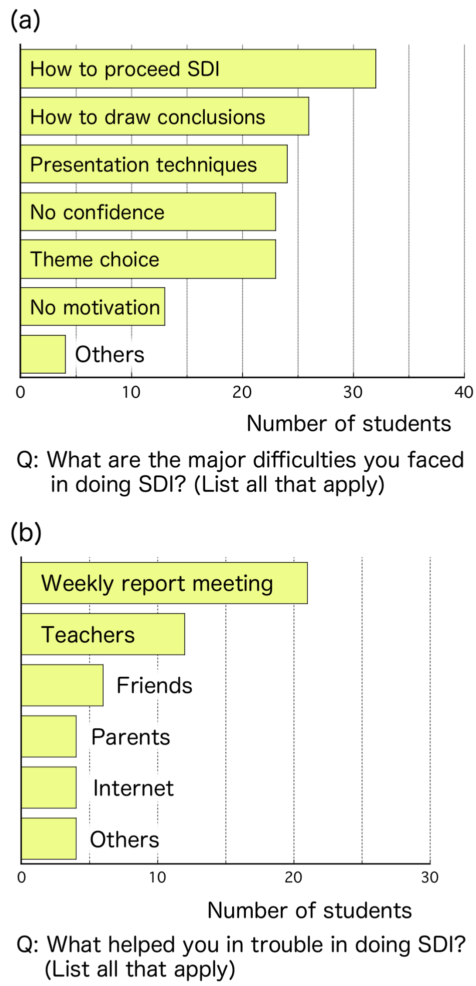

Fig. 3 Results from the survey conducted for a first-year class (42 students), Hachinohe Kosen.

Conclusions

In conclusion, a practical, sustainable solution to let the students learn how to set about and complete their SDI was found in the present study, i.e., holding a routine, full-disclosure progress report meeting. The students' SDI outcomes proved the method successfully works. The first-year students are not too young to start SDI.

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Active learning approach to encourage 1st and 2nd year students' activities at NIT, Sendai College

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Abstract

We report our classroom practices in math, physics and chemistry using active learning strategies for students of 15-17 years of age in the 1st and 2nd years of National Institute of Technology (NIT), Sendai College. The primary purpose of active learning in the lower grade years is to encourage them to proactively participate in the class, for Japanese younger students have very few experiences in expressing their opinions. Active learning activities of group work and cooperative learning are applied in the class of math and physics exercises. Students are allowed to use their own smartphones to search some information on the Internet to solve problems. In these classes, students discuss the problem with a partner or in a group and learn from each other. Investigative learning is also useful to make them active. At the beginning of the classes, giving simple quizzes related to the subject are a useful method to direct their interest to the subject. Active learning of the students is supported by distributing handouts containing problems and the summary of the lecture.

Active learning activities in the classes are promoted by use of Information and Communication Technology (ICT). The image projection such as animations, pictures, graphs and schemes help them understand the contents of lecture. The easiness of understanding leads to an increase of their motivation for learning. Sometimes tablet PCs are used in chemistry, physics and math classes. For example, some applications help them to learn the periodic table and atomic structure efficiently. Clickers are also a very useful tool to encourage the students to express their opinions, for whom it has not been considered important to express their own opinions in the primary education of Japan for a long time. In this improved clicker system, we can send not only the choices but the drawings related to the thinking by use of tablet PCs or smartphones. In the near future, the ICT environment for active learning will be improved because all students will have their own tablet PC. In such environments, the students can download and submit a task using a Blackboard system and express their opinions and idea during class. It will make their discussions more active during class.

Keywords: *Tablet PC, clicker, investigative learning, gamification, peer instruction*

Introduction

Most students learning in technical colleges become engineers after graduation. Engineers make society better by using technology and should make people happy. Active learning is very important to get the abilities to be required in society. The abilities that an engineer is required to have is not only technological knowledge but also communication skills and abilities to deal with complicated and field-crossing problems. We have introduced active learning that make students more active in our college. Table 1 shows the methods and tools to get necessary skills in society. Now that active learning shows enough effects in the upper years, it is important to introduce active learning into class from the beginning of the first year and for the students to be used to the methods and tools. In this paper, we talk about some active learning methods and tools we use in math, physics and chemistry classes.

Table 1 Generic skills required in 1st and 2nd years

	Skills to be expected to obtain	Methods and tools
Generic skills	Information gathering	Lecture, peer instruction
	Information analysis	Peer instruction, ICT
	Information organization	Peer instruction, group work
	Identifying challenges	Group work, PBL
	Affinity	Group work, PBL
	Self development	Group work, PBL
	Ability to plan	Group work, PBL
	Practical skill	Group work, PBL

Active learning activities in chemistry, physics and math classes

In the case of math classes, we have introduced active learning activities of group work and cooperative learning to younger students since 2014. An ordinary math class consists of a short introduction and lecture, a long exercise by group work, and a brief test at the end of class. The learning level of students is grasped by the test. It is expected that the activities are useful for the students to acquire knowledge and learning methods, and to digest the knowledge. In 2015, the math courses for the 1st year students started with a 90 minutes' ice breaker activity [1] to remind the students of the importance of a deep discussion and to provide a proper environment for group work. The score of their discussion in the ice breaker activity was evaluated by comparing an individual work score with a group work score of worksheet. Here we analyze the score in order to grasp a tendency of the students' communication skills and motivation quantitatively. Such an information would be useful to develop group work in the lower grade years of college.

Figure 1 is a histogram showing the score difference between the group and individual work score. The high score means that a student had a deep discussion in their group work. On the other hand, the low score means that a student could not claim an answer although the student had a good opinion and individual work. The histogram reveals that the 60-70% of the 1st year students were weak in discussion, especially when they have to work out an answer as a group. The tendency is similar to our teaching experience. We should organize a class and facilitate group work while paying attention to the inclination.

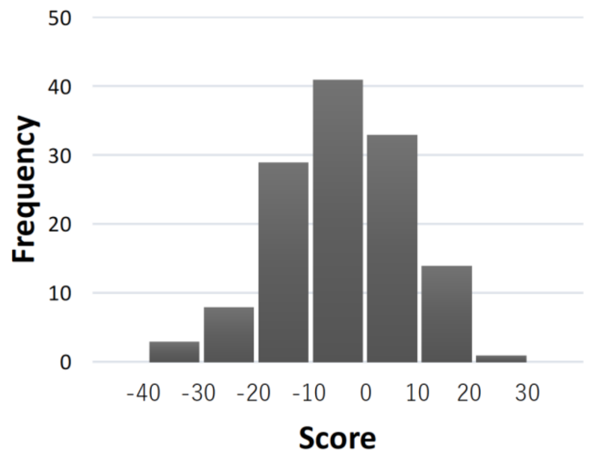

Figure 1 The score of the ice breaker activity in the first math class for the 1st year students. The high score means that a student had a deep discussion in their group work. When the score is 0, the individual work is equal to the group work.

In the case of physics, classes practiced using active learning techniques are reported. In these classes, Information and Communication Technology devices are used to show animations, pictures, graphs and schemes, in addition to conventional approaches such as individually distributed handouts of printed synopsis of lectures or printed practice problems (Fig. 2). The correct images of physical phenomenon help students to understand physics and to engage students in the learning activities. The students are also allowed to use smartphones or tablet computers in appropriate learning activities.

Peer instruction [2] method is useful to enhance students' motivation to study physics. The students work on quizzes to confirm concepts in physics. The questions for the quizzes have to be prepared properly. The students answer the questions using clicker [3] after some discussion with a partner or in a group. In these learning activities, the students corroborate their knowledge and engage in deeper learning. The results obtained exceeded our expectations and the students have become able to express their opinions more actively. So, the use of the clicker system is helpful to facilitate active learning.

Methods of group work and cooperative learning are used in investigative learning and exercises of physics. The students use their own smartphone or tablet computer, look up the meanings of words and physical laws, and search websites for some hints to solve problems, in addition to using conventional tools such as textbooks, study-aid books and the electronic dictionaries. These learning activities are practiced to prompt the students to acquire reliable knowledge, and digest and apply the knowledge they learned.

Through the series of learning activities shown in Fig. 3, students discuss with and learn from each other using a whiteboard, tablet and something they want to use, and the teacher goes round in classroom from one table to another to stimulate the activities and gives students some advice to learn deeper, shown in Fig. 4.

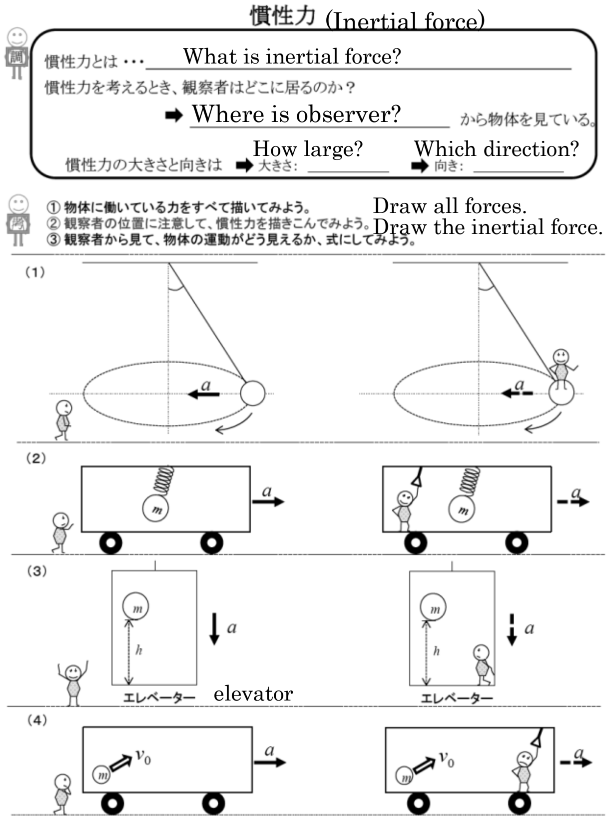

Figure 2 An example of handout of printed synopsis of lectures for the investigating leaning activities.

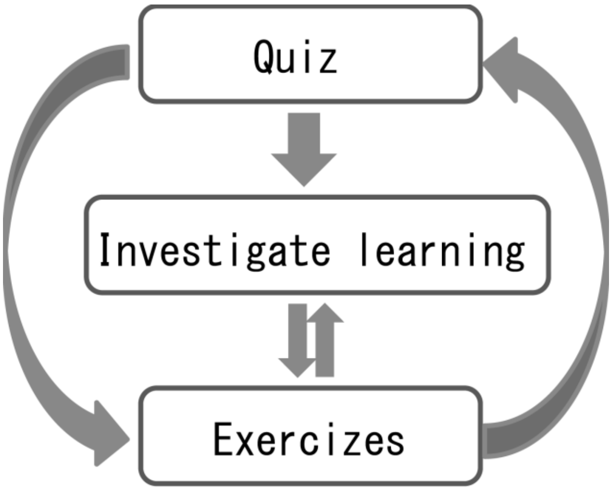

Figure 3 The series of learning activities.

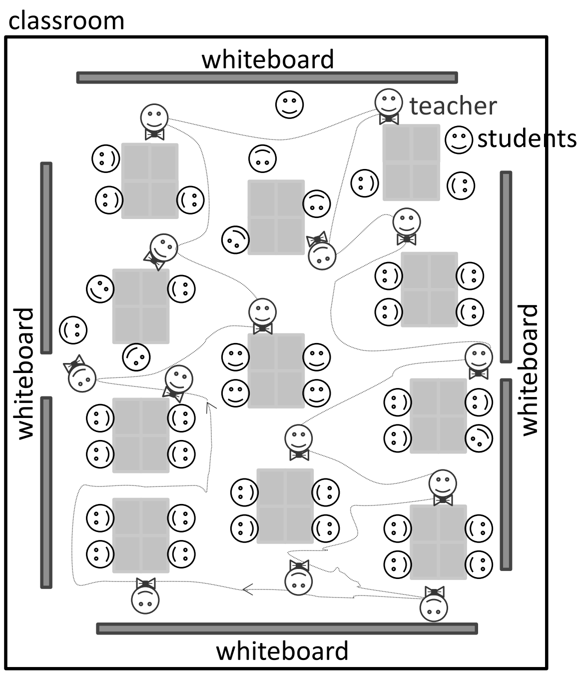

Figure 4 A schematic image of classes in learning activities. Student discuss with each other and teacher walks around the tables to facilitate the activity.

Cross-cutting learning activities, which are anticipated to expand students' skills available in co-creation, would be facilitated to practice by using active learning techniques, and is experimented in physics classes to integrate physics with math, chemistry and English, for instance.

In the case of chemistry, we show examples of use of the IT tools in the first year. In the first grade, the students will spare much time for acquisition of the basic knowledge of chemistry. We teach it in a lecture style. Because outermost electrons and valence electrons play an important role in the chemistry, the elemental periodic law, a periodic table, and understanding of the structure of the atom are very important. The elements are arranged in the order of their atomic number in the periodic table. It is important to memorize the elements including their family and period. Because it is a boring task, we introduce a periodic table puzzle [4] on iPad as a helping tool. The puzzle is a time trial event. The students can memorize a periodic table in a short time while competing with a friend for the time required. In addition, we use a software [5] which composes an atom on iPad to realize the structure of the atom. In this software, if the numerical balance of protons, electrons and neutrons are bad, the atom collapses. The students can understand that matching an electronic number with a proton and adding an appropriate numerical neutron stabilizes an atom. The ICT apparatus visualizes the invisible world artificially in this way and becomes able to facilitate understanding. Figure 5 shows the scene where the students are learning with ICT apparatus.

Figure 5 The students are learning with ICT apparatus.

Results and Discussion

In active learning class, students teach each other. But Figure 1 indicated that younger students were not used to participating in group work. Therefore, at first we built the environment in which students could express their own opinions without hesitation. For example, a clicker system was a very useful tool to express their opinions. In such an environment, the teacher promoted the students' understanding problems surely by optimizing the degree of difficulty of the problem step by step. It gave confidence to students to solve problems by themselves. The confidence improved motivation to learn. In addition, it is very important that we pick up the creativity and originality in the questions and answers of the students and praise them. One of the key issues to make active learning successful is teachers' ability to make appropriate problems and to pick up the originality of the students.

Conclusions

We report our classroom practices in math, physics and chemistry using active learning strategies for students of 15-17 years of age in the 1st and 2nd year of National Institute of Technology, Sendai College. In active learning, group work was very important, but Japanese younger students were weak in it. Therefore, we have our students practice group work while using clickers in the lower grades and comprise it for the full-scale active learning in the upper grades.

Acknowledgements

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DEVELOPING THE FOUNDATION FOR SELF-DIRECTED LEARNERS WITH THE USE OF TECHNOLOGY

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Abstract

In line with Temasek Polytechnic (TP)'s aims to develop graduates who are life-long learners, with mastery in key skills of practice and self-directed learning capacity, the Centre for Foundation Studies (CFS) embarked on the Self-Directed Learning (SDL) project in April 2015. A team of CFS teaching staff was formed to pilot SDL modules for core subjects that all Polytechnic Foundation Programme (PFP) students undertake. With reference to existing studies and Singapore's Ministry of Education's monograph on "Self-Directed Learning with ICT", it was decided to use technology and an online learning management system as a platform to pilot and support the self-directed learning initiative. The team's pedagogical approach was adapted from TP's Learning Academy framework on SDL, with the focus on the self-management skill. A content developer and an evaluator from the team were assigned to each subject. The primary role of the content developer was to research and identify suitable topics, online pedagogy and software to design and produce the SDL modules. Content developers applied strategies such as game-based learning and scenario-based learning in creating interactive, non-linear modules. In addition, content developers learnt how to use various softwares such as Articulate Storyline and Swivl to create the interactive online modules. The pilot SDL modules were implemented in April 2015 to February 2016. This paper will focus on the design, implementation and review of two pilot SDL modules for the subjects, Mathematics & Logical Thinking (M&L) and Language & Communication (L&C). Qualitative and quantitative data were gathered upon completion of each of the SDL module in the form of a survey. Analysis of the survey results served dual purposes of providing a form of reflection for the students and as feedback on the design of the SDL module. The findings indicated that the PFP students had gained skills in time management and self-assessment and had enjoyed the learning process. The finding is in line with the growing body of literature indicating that technology is a suitable mode of supporting self-directed learning. The future plan of the CFS team is to integrate the SDL modules into a flipped-learning curriculum.

Keywords: *technology, foundation, self-directed learning, self-management skill, softwares, online learning pedagogy*

Introduction

With the introduction of developing self-directed learners in the 21st century, the Ministry of Education (MOE) gave an outline of the skills and competencies that all students should strive for in the 21st century, one of them being "Students should cultivate a positive attitude to lifelong, independent learning".

In 2004, Mr Tharman Shanmugaratnam, then Acting Minister for Education, gave a speech when he launched the monograph on strategies for active and independent learning (MOE, 2008). He mentioned the objective of the monograph was to teach students to take responsibility for their own learning, which could be achieved by engaging students in active and reflective learning and guiding them in cultivating independent learning habits. In the process, the students need to be aware of what they know, the level of knowledge they have, and the activities they need to do in order to improve. This existence of awareness is the key to help students adopt and learn Self-Directed Learning (SDL). SDL is defined as "an approach where learners are motivated to assume personal responsibility and collaborative control of the cognitive (self-monitoring) and contextual (self-management) processes in constructing and confirming meaningful and worthwhile learning outcomes" (Garrison, 1997).

In TP, students in the PFP spend one year in foundation studies after completing their Singapore-Cambridge General Certificate of Education Normal (Academic) Level Examination, before they move on to Year 1 of their chosen diplomas. CFS aims to help these students to be more involved in their own learning by guiding them through the process of SDL and self-managing their studies.

Literature Review: Using Technology to Enhance the Self-Directed Learning Process

According to Huang (2002), interactivity in online environment promotes motivation and stimulation for the learners. Authentic learning is another important feature in online learning. The design of online activities should be meaningful and practical. Activities such as games and case-studies would provide meaning for students in an online environment. A study by Deepwell & Malik (2008) shows that students agreed that learning technology contributes positively to their attitudes toward independent learning. To create an engaging online learning experience for the students, the CFS SDL team focused on developing interactive online learning materials for the SDL modules. The content developers created interactive online modules using several software such as Adobe Presenter and Articulate Storyline.

Motivation to learn in an online learning context may be difficult due to the easy-to-procrastinate nature of online learning (Elvers, Polzella & Graetz, 2003). In order to motivate learners to stay on task and persist to complete the online modules, several online learning strategies were implemented, specifically scenario-based learning and game-based learning. Scenario-based learning and game-based learning are based on the principles of situated learning theory (Lave & Wenger, 1991), which maintains that learning ideally takes place in the context in which it is going to be used, and situated cognition, the idea that knowledge is best acquired and more fully understood when situated within its context (Kindley, 2002). According to Song & Hill (2007), integrating the learning context in the study of SDL is important as the context where learning takes place impacts the level of learner autonomy, how a learner utilises resources and strategies and becomes motivated to learn. Chizmar & Walbert (1999) believe that the context of online learning provides flexibility for learners to pace their own study. The anytime, anywhere feature of asynchronous online learning provides learners with the ability to plan their activities at the same time and the plans that are most convenient for them (Palloff & Pratt, 1999). Jonassen (2000) summarised that technologies are cognitive tools that help learners to engage in meaningful learning. Hence, the context of an online environment, using the platform of an online learning management system was explored for the pilot of the self-directed learning project by CFS.

MOE's Monograph: SDL with ICT

The team was guided by the design principles for SDL from MOE's Monograph: SDL with ICT (refer to Figure 1), which are based on three main assumptions:

1. Students capable of being self-directed learners.
2. SDL is both an outcome and a process.
3. Technology by itself does not promote SDL; rather it supports or enhances the learning process.

Three important SDL aspects were entailed in the monograph namely (a) ownership of learning; (b) self-management and self-monitoring; as well as (c) extension of learning. Hence, the team decided that the learning outcomes of the SDL would be decided by the teacher and "self-managed learning" as a suitable phase of SDL spectrum (Gibbons: 2002) for the PFP students. Following that, the team explored how to design and implement SDL into our curriculum and ways to use technology to enhance the learning process. Consistent with the goals of SDL, the team focused on assessment for learning in the SDL modules designed.

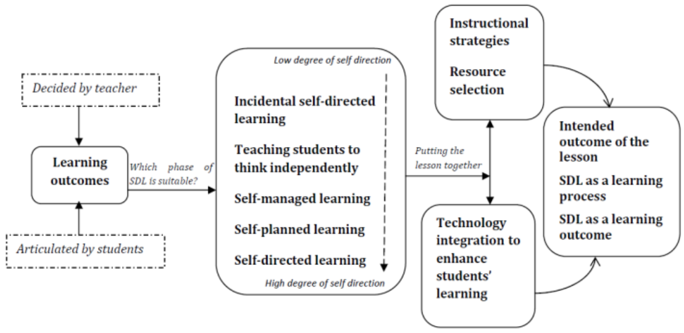

Figure 1: Design Principles for SDL

Pedagogical Approach

TP SDL framework

Song, Hill (2007) believed there are three key areas in a SDL process in an online context. They are planning, monitoring and evaluating. In addition, Zimmerman (2002) proposed three phases in self-regulated learning, namely forethought phase, performance and self-reflection phase. With the background of self-regulated learning, online learning and principles of motivation, CFS SDL team adapted its pedagogical approach from TP SDL framework as shown in Figure 2. This will be described in further details in the approach taken by CFS.

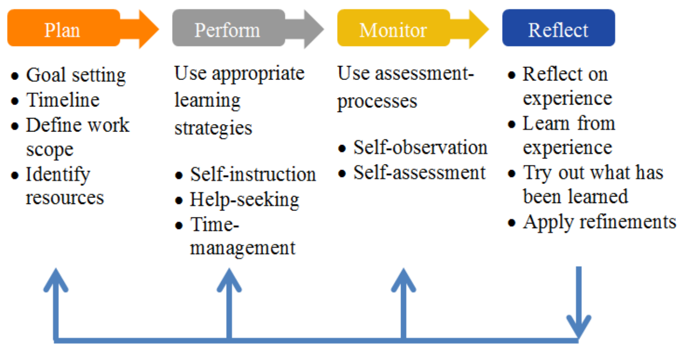

Figure 2 TP SDL framework

Focus on self-management

In Self-Directed Learning: Toward a Comprehensive Model, Garrison (1997) introduced the three dimensions of SDL: self-management (task control), self-monitoring (cognitive responsibility) and motivation (entering and task). Self-management is defined as the "external task control specific to the management of learning activities." An emphasis in the article reflects SDL does not mean the learners learn in isolation. Assistance in the form of guidance, support, and direction is provided throughout the learning process. This paper focuses on the students' self-management aspect. Garrison (1997) highlighted that self-management of learning brings with it an increase of awareness of the need to construct meaning to the learning. If learners were able to provide meaning of the learning on their own, they would be able to accept more responsibility in monitoring their own progress throughout the learning journey.

Approach by Centre for Foundation Studies

The CFS team targeted to develop and implement two SDL modules per subject in each semester of the programme. The pilot SDL modules were implemented in April 2015 to February 2016. To provide more exposure to the students, four of the seven subjects, namely Language & Communication (L&C), Research and Reasoning (R&R), Mathematics & Logical Thinking (M&L), and Personal Development & Effectiveness (PDE), are involved in this project. Each subject consists of a content developer and an evaluator. The primary role of the content developer was to research and identify suitable topics, online pedagogy and software to design and produce the SDL modules. Strategies such as game-based learning and scenario-based learning were used in creating interactive, non-linear online modules. Several software (refer to Tables 1 and 2) such as Articulate Storyline, Adobe Presenter, Powtoon and Swivl were explored and used to create these modules. This paper will focus on the design, implementation and review of two pilot SDL modules for the subjects, L&C and M&L.

Induct

Before PFP students embark on SDL modules, they are inducted on the purpose of acquiring self-directed learning skills. During the Manager's talk, the PFP cohort is briefed on the importance of SDL and a video is shown to help them understand the meaning behind the SDL process. Hence the students will be ready and willing to begin the journey with the right attitude and mindset.

Plan

Song, Hill (2007) wrote that the flexibility of an online lesson encourages learners to take control of the learning pace and activities, and plan their activities at a time and place that are most convenient for them. With the aim to equip PFP students with the foundation in SDL, the CFS team designs the SDL modules with the structure of informing students of the learning outcomes with a given time frame, and helping students identify strategies and learning resources to complete the tasks. These are given as a form of scaffolding and students learn to plan their time.

Perform

PFP students are encouraged to carry out the learning activities according to the time and use appropriate learning strategies such as time-management to complete the online activities. If students are unsure, they are able to revisit concepts and learn them at their own pace, or seek assistance from the tutor should they need to.

Monitor

One important aspect in self-regulated learning is "'self-oriented feedback' loop" (Zimmerman, 1990, p. 5). This is a recurring process whereby students continually monitor the learning outcomes and evaluate the effectiveness of their strategies. Wherever applicable, the students make changes to either or both their strategies and behaviour. This monitoring process works in both positive and negative observations of their learning outcomes. As students carve out the path to making their own knowledge, their motivation increases and are engaged in the process. Upon completing the task, they feel a sense of independence. Above all these, students can learn to self-assess their work and progress instead of relying on teachers to check and mark their assignments. The act of self-assessing helps guide the students to take their learning as one of their priorities. In an online environment, the responsibility of monitoring one's progress is left largely to the learner, as written by Song, Hill (2007). Students are given the autonomy to decide if they have understood the lesson completely, and to seek help from instructors or peers when the need arises. PFP students carry out the given tasks to achieve the stated learning outcomes within a stipulated duration. In the process, students monitor their own progress through formative assessments such as online quizzes and detailed feedback received for both correct and incorrect responses from the quizzes.

Reflect

Reflection is an important tool in the process of self-directed learning. Brescia (2008) pointed out that to incorporate self-directed learning in curriculum, the design on student reflection on their learning is essential. Zimmerman (2002) wrote that the entire self-regulation skill is cyclical and the reflection phase is highly correlated to the planning stage and performance stage, and will affect subsequent planning stage. The reflection phase includes finding the causes for failures and success encountered in the learning process. Garrison (1997) believed that self-direction is associated with critical thinking. Learners who are reflective in their learning are able to develop skills in monitoring themselves in various situations. Lowenthal & Dobrovolny (2011) discussed the two-way benefits of using structured reflection surveys in online courses, where students are guided to think about their learning experiences, and the data from the survey provided the faculty feedback for continuous improvement. To aid in the reflection on their learning behaviour, PFP students complete a qualitative and quantitative survey at the end of each SDL module (refer to Tables 3, 4, 6 and 7).

Two subjects in studies

L&C equips students with communication skills for an evolving technological world. The subject provides opportunities for students to build their confidence and develop skills to respond critically to texts in various formats, and to present arguments in spoken and written English. M&L aims to equip students with the knowledge and skills to reason logically, communicate mathematically and apply these skills to solve problems. Students were required to complete 4 and 2 online modules (refer to Table 1) for L&C and M&L respectively (refer to Table 2). They were given a one-week duration to complete each module. Topics for the online modules were selected from the subject curriculum to be covered in the SDL modules and the topics were relevant to the summative assessments that students had to complete in the semester. In addition, the online modules were a replacement of face-to-face lessons, as a strategy to motivate students to complete the online activities.

Table 1 SDL Modules for L&C

Semester	Term	Topic	Design	Software	Implementation
1	1	Presentation Skills	Videos	Swivl, Camtasia	May 2015
	2	Plagiarism & Referencing	Interactive, linear storyboard	Adobe Presenter	August 2015
		Peer-editing	Interactive non-linear storyboard	Articulate Storyline	August 2015
2	3	Lexical Features in Advertising Language	Scenario-based Learning, interactive non-linear storyboard	Articulate Storyline	October 2015
	4	Cohesive Devices in Writing	Game-based Learning, interactive non-linear storyboard	Articulate Storyline	February 2016

Table 2 SDL Modules for M&L

Semester	Term	Topic	Design	Software	Implementation
1	2	Unit 8.6 Word Problems	Interactive, non-linear storyboard	Articulate Storyline 2	August 2015
2	4	Chapter 8 Statistics	Context-based environment	Articulate Storyline 2, video-editing software	February 2016

The next segment describes the strategies that were applied in creating interactive modules, implementation and the results of the surveys.

Language & Communication

In the module 'Lexical Features in Advertising Language' (refer to Table 1), students are given an interactive scenario for active learning. The scenario given was “The Apprentice Challenge” where the student takes on a persona as someone who is completing his training to become a business apprentice. Using an interactive office map, the student has to visit the different parts of the office to learn about the various lexical features. In the module ‘Cohesive Devices in Writing’ (refer to Table 1), students are given a game-based learning for active learning. The game was “The Pirate Wars” where the student has to complete “The Quest for Knowledge” and obtain the “3 Scrolls of Cohesive Devices”. The PFP cohort size in the Academic Year 2015/16 was 210, with most of them 17-years old, and all were required to complete the online module. There were 5 Likert-scale questions and 2 open-ended questions for each survey. Table 3 reflects the survey results of both topics. All data given in Table 3 are in percentage (%). Unanswered responses have not been reflected in the table. Table 4 shows the qualitative feedback from the open-ended questions.

Table 3 L&C Quantitative survey results

Strategy		Scenario-based	Game-based
Number of survey participants		n=184	n=185
Q1. The learning activities help me to understand the lesson topic.	Strongly Agree/Agree	93.5	90.3
	Disagree/Strongly Disagree	4.9	9.2
Q2. I am able to self-manage my time effectively to complete the SDL module within the given period.	Strongly Agree/Agree	97.3	96.3
	Disagree/Strongly Disagree	1.1	4.3
Q3. I am able to understand my mistakes through the feedback given after completing the quizzes.	Strongly Agree/Agree	92.3	96.3
	Disagree/Strongly Disagree	6.0	3.2
Q4. I am confident that I have understood the learning goal before I proceed to self-assess my learning.	Strongly Agree/Agree	94.5	95.2
	Disagree/Strongly Disagree	3.3	3.8
Q5. I am able to apply the knowledge that I have acquired during this SDL module to new contexts.	Strongly Agree/Agree	96.2	95.2
	Disagree/Strongly Disagree	2.7	3.8

Table 4 L&C Qualitative survey feedback

	Scenario-based learning No. of participants = 184	**Game-based learning No. of participants = 185**
9. State one aspect that you liked about this SDL module.	The apprentice challenge is one part which I like about this SDL module because it is engaging and interactive.	The pirate war game was fun and engaging. It allowed me to learn and replay content that I don’t understand.
	I am able to become an independent learner and I am able to learn this topic at my own pace.	I get to manage my own learning at my own time.
	I liked the quizzes to ensure that the students fully understood the topic being taught.	The content is detailed and I am able to recognise my mistakes.
10. State one suggestion that will improve this SDL module.	Increase the number of question to help with better understanding of the topic.	Put more content in the explanation of the methods. I was not able to understand fully for certain parts.

Mathematics & Logical Thinking

In June 2015, the SDL modules for M&L were first designed and developed. The content developer and evaluator took into account elements including interactive features (drag-and-drop, hotspot) and adding personality (using features to capture learners' names). In the module 'Word Problems' (refer to Table 2), students go through five general rules for solving word problems. In the context-based module 'Statistics' (refer to Table 2), students visit a town and access the questions by clicking on the related icons. The first M&L SDL module was implemented in August 2015 for the entire cohort of 210 students, with most of them 17-years old. At the end of each SDL module, students were asked to fill up a survey on self-observation of their behaviour. Each item was assessed using a 5-point Likert scale where a score of 1 denoted 'strongly disagree' and a score of 5 denoted 'strongly agree'. The quantitative results of the cohort are shown in Table 6. It shows that students are generally able to perform the learning activities and obtain the learning objectives. Table 7 shows the qualitative feedback from the open-ended questions.

Table 6 M&L Quantitative survey feedback

	Unit 8.6 Word Problems	Chapter 8 Statistics
Number of survey participants	n = 142	n = 147
Q1. I find the navigation of this self-directed learning module clear.	3.9	4.1
Q2. The page layout of this Self-Directed Learning module is clear.	3.9	4.0
Q3. I am able to manage the activities in the self-directed learning module with the given time.	3.9	4.2
Q4. I am able to self-assess through the quiz and feedback given.	3.8	4.2
Q5. I am able to manage my learning progress through the self-directed learning module.	3.8	NA
Q6. I have achieved my learning objective(s) with the activities in the self-directed learning module.	3.9	4.1

Table 7 M&L Qualitative survey feedback

Interactive non-linear module No. of participants = 142	**Context-based learning No. of participants = 147**
"Giving more examples to questions"	"Include more videos to enhance our learning."
"the content and examples given are good."	"I feel that maybe we should have more interactive games to make the SDL module more enjoyable. I honestly feel that the games allow me to better understand the topic."
"It is a wonderful experience to have mathematics self-directed learning, the school should provide more opportunity for us to learn ourselves."	"We should have more interactive module. It's fun and easily understandable through the activities scheduled for us."
	"This self-directed learning module really helps me a lot to recall and think over again the topics that I am weak in. It also helps me have a better understanding of this topic! (:"
	"I think that the video to explain the practice questions are very helpful. it helped me to understand the 35th percentile is actually 35%"

Findings

Students' comments were gathered in the survey and each comment was carefully taken into consideration for the refinement of the modules and design of future modules. The findings for both subjects are collated and presented in Table 8. In line with the centre's focus on self-management, two areas have been selected for discussion which focused on self-management and self-monitoring. In addition, it is noted that students indicated enjoyment in their learning process.

Table 8 Collated findings for L&C and M&L

	L&C	**M&L**
Time-management	More than 90% of the students indicated 'Strongly Agree' or 'Agree' that they were able to self-manage their time effectively to complete the SDL modules within the give period (**refer to Table 2 Question 4**).	Students indicated a 4.1 on the 5-point Likert scale that they are able to self-manage the learning activities within the given time (**refer to Table 6 Question 3**).
Self-assessment	More than 90% of the students indicated 'Strongly Agree' or 'Agree' that they were able to understand the learning goal before they proceeded to self-assess their learning (**refer to Table 2 Question 6**).	Students indicated a 4.0 on the 5-point Likert scale that they are able to self-assess their learning through the quiz and feedback given (**refer to Table 6 Question 4**).
Enjoyed learning process	Most of the students' responses from the qualitative feedback touched on the enjoyable experience of playing an interactive game or being challenged in the given context or scenario. Students' responses included that the online activities were fun and creative, with visual and audio elements that kept them engaged.	

Overall, the responses from the surveys from both subjects indicate that the students gained skills in time management and self-assessment and had enjoyed the learning process. Students felt engaged through explanatory videos and context-based learning with an interactive and non-linear structure. One area for improvement for both subjects was to include more content in the form of examples and explanation to aid the students in understanding of the concepts. Such findings suggest while technology is a viable platform for SDL, the design of the online activities is crucial in enhancing the students' SDL process. Hence, this adds to the growing body of literature that indicates technology is a suitable mode of supporting SDL.

Conclusion

Based on the academic team's observations, PFP students generally first come to TP with low self-directed learning readiness and without much knowledge in SDL. The team notes however that while the SDL phase for PFP students is currently pegged at a lower degree of self-direction, future research to assess the students' readiness for SDL with a formalised pre-survey could be implemented. In addition, the team notes that the survey completed by students as a reflection upon completion of the online module is designed currently to focus on SDL behaviours and is perception-based. The survey questions could be reviewed in future to add an open-ended reflection question that allows students to reflect on their meta-cognitive process during the learning process and to review their learning strategies while completing the online modules.

With the advancement of technology, CFS draws on the use of technology to support students' learning and incorporates the technological tools into SDL modules. This paper starts with the introduction of CFS SDL process and its focus on using technology to help PFP students build the foundation in SDL through self-management of learning tasks. It goes on to describe two subjects L&C and M&L on their methods, delivery and findings for the modules implemented. In line with the growing body of literature that technology is a suitable mode of supporting SDL, the paper ends off with findings that support the use of technology to enhance SDL, specifically self-monitoring and self-management, together with the direction to revise the survey questions that would include more reflective writing. This would enable students to critically think about their learning process in addition to self-management of learning tasks, so as to encompass the two aspects of SDL, which are "self-direction" and "learning" (Garrison, 1997). Looking ahead, CFS aims to introduce flipped-learning curriculum by using the resources on existing and new SDL modules.

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Topic 5

Industry and Multiple Institutions Collaboration

5101

A TRIPLE JUMP INTO THE FUTURE OF ENGINEERING EDUCATION

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Abstract

In field of Engineering Education, it is essential that university students already during their studies gain competences applicable in the future working life. The techniques generally utilized in industry and especially in the field of Chemical Engineering are in rapid change as new production and analysis techniques are constantly developed. This leads to a need of constant education for the teachers.

A programme called Triple Jump was put up at Turku University of Applied Sciences to offer the staff a chance to update their skills and ascertain they possess the latest know-how in the field. The programme enabled teachers and other RDI experts to work within the industries to expose themselves to new influences and to conquer as much of the information available to provide the students with the most relevant competences required in their future occupation.

In addition to this point of view, the paper discusses the enhanced motivation and the enlarged network of a specific staff member who participated in the programme. The pros and drawbacks of the programme are also discussed.

Keywords: *industry exposure, chemical engineering, CDIO, professional development, motivation*

Introduction

Universities of Applied Sciences have broadened their activities during the last two decades. Reijonen (2014) remarks that former strictly educational organizations are now national and international actors in the fields of education, research, development and innovation. The rapid changes have set high pressure on the teachers working at the universities. Kaljonen (2014) found that teachers are specialists in their own field and their identity is based on the knowledge acquired during university studies and in the working life. The new elements brought to the university teachers' role demand updated skills within several new sectors. Skills like customer-based thinking, creativity, collaboration and general tolerance for uncertainty and inequality are forms of expertise teachers as well as students need to master. All these skills are integrated in the pedagogical toolbox teachers utilize today, which can be summed up with one term: innovation pedagogy. The teachers' future skillset is presented in Figure 1.

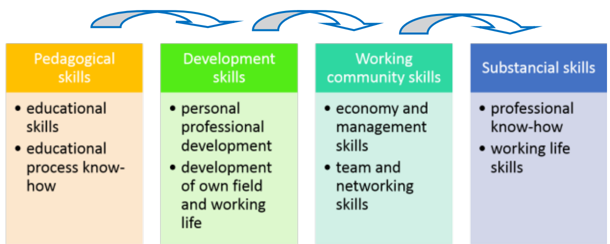

Figure 1. Development of the teachers' professional know-how by Helakorpi (2004).

The teachers' transformation process from strict educational professionals to multitasking professionals with vast, updated knowledge concerning the surrounding industry requires support from the university. A staff exchange programme called Triple Jump was used to enhance teachers' industry exposure at the Department of Chemical Engineering during years 2015–2016. This programme – in combination with an externally financed RDI project – acted as conduit for building up new partnerships between the department and the industry.

The Triple Jump project

The Triple Jump project was a mutual project of Satakunta University of Applied Sciences and Turku University of Applied Sciences, and it was funded by the Finnish Ministry of Education and Culture. The duration of the project was 12/2013–08/2016 with a total budget of 500 000 €.

The project offered teachers and other RDI professionals at the universities involved the chance to co-operate with their working life partners in an intensive and long-term manner, typically from 10 to 12 weeks. The programme consisted of three different steps, of which an individual staff member could apply to the second national step or the third international step. The efforts made at the Department of Chemical Engineering focused on the national step. The first regional step involved the development of project learning environments and was implemented without a staff exchange component.

Destinations of domestic exchanges could be for instance research and development units of companies or research institutions. For international exchange destinations, the RDI units of the strategic international partners of Turku University of Applied Sciences or their regional co-operation organizations were recommended. (Figure 2.)

Figure 2. The scope of the Triple Jump exchange programme.

The exchanges took place during 2014–2016, and the reserved time resource was either used as an intensive period or it could be divided into shorter periods according to the preference of each participant. A long-term part-time exchange was also possible. The case example presented later in this paper refers to a part-time national exchange.

The staff members participating in the programme were selected on the basis of an internal application process implemented by the Triple Jump project management. To fully utilise the project resource during the 2.5-year period, the application process was organised on three different occasions during the life-cycle of the programme.

The national exchange

In the domestic-level exchange, the experts of Universities of Applied Sciences typically participated in research activities in RDI units of different companies and other organizations. The outcomes of the participation included increased skills within newly-formed communities, deepening of shared research and development targets, new research results, accumulation of knowledge and – ultimately – new and more effective RDI collaboration projects.

As a result of the exchanges, the expertise of the university representative and the different forms of co-operation were enhanced and the number of new RDI openings increased. The target organization benefitted from the new information and procedures brought forward by the university representative. During the exchanges, a new, mutual target of research and development operations was created and developed in such a way that the work served the profitability of both parties.

The goal of the experts' visiting periods was to increase practice-driven co-operation, skills and volume in applied research and development work so that the know-how in the area would be more distinctive in the European arena. In other words, these domestic-level operations aimed at promoting the creation of mutual research and development projects and increase in the number of mutual project plans also had a predominantly international context.

The long-term visits to companies, organizations and research facilities deepened the knowledge of the field in question and the practice-driven co-operation in applied research and development work in addition to promoting the understanding of different RDI cultures in the organizations involved. This was seen as a way to create project proposals with better argumentation, higher quality and more valid operational volume in the future.

The intention was that expert exchanges will also enhance student mobility. In that scenario, students would carry out their internships or thesis work in relation to the staff exchanges. This would make the skills of the students visible outside the university while underlining the potential of the students' learning process serving the target organizations interests through carefully lined partial tasks.

Students were utilized as assets already during the exchanges. The RDI project proposals created within the exchange periods ensured that the new knowledge and skills acquired in the personal context would not be limited only to the advantage of the person who participated in the exchange, but that the results of the exchange would also benefit other students and the whole organization concretely through new projects and co-operation contacts.

The application procedure and terms of acceptance

The staff participating in the programme were primarily selected based on the strategic RDI foci of the university – regarding the field in question as well as the specific exchange destination. A person applying for an exchange position had to be able to negotiate with both her own organization as well as the exchange destination on the details of the exchange and present them in a specified application. The procedure created a great deal of freedom to arrange the working life period in a way best suited for the applicant, especially concerning the schedule of the exchange.

The applications were processed qualitatively, taking into consideration at least the following issues divided under three sub-headings:

1) The application was required to report the following
• Destination of exchange, related reasoning and name of the contact person
• Preliminary schedule of the exchange
• Presentation of the RDI project idea
• How far the RDI project idea had already been taken prior the exchange
• How the results of the exchange would be utilized
• How the exchange would benefit our students
• How the exchange would benefit the companies on the south-west coast of Finland
• What the personal occupational development goals were
• The work arrangements during their exchange period
• How they planned to ensure that the duties related to the exchange were fulfilled (see below).

2) On the basis of the working life periods, it was expected that
• An advanced frame of an RDI project with a well-processed proposal for funding was created
• At least one article was written on the substance matter of the exchange
• Both the exchange destination and the person who had been on the exchange answered the feedback survey of the programme.

3) In addition, following themes in the application were seen as an advantage for the applicant
• How the tasks performed during the exchange contribute to one's own work
• What concrete development opportunities related to teaching are available after the exchange
• How the learning processes of master's degree students can be connected to the exchange
• How the exchange period promotes reciprocity, i.e. expert visits from the exchange destination to our organization
• What the challenges and risks of the exchange period are
• How the exchange will affect one's well-being at work.

Enhancement of faculty competence

Faculty competence enhancement has proved to be a real challenge when implementing a CDIO curriculum or similar active learning approach is reported by Loyer and Maureira (2014). Stenroos-Vuorio (2012) reported that especially active learning methods engage students in activities supporting a deeper approach to learning. Constant technological innovations in the Chemical Engineering industry require continuous updating of the staff's skills. To fulfil the requirement of serving as role models of contemporary engineers, staff motivation and know-how should be updated and at top-level.

In the CDIO model, the support for the faculty members to improve their own competence should be provided by the university. The nature and the scope of faculty development varies according to the resources of each programme. Previously mentioned examples of actions to enhance faculty competence include a professional leave to work in the industry and partnerships with industry in research and education projects. These have been reported by Crawley, Malmqvist, Östlund, Brodeur and Edström (2014).

The Triple Jump programme provided some teachers of the Chemical Engineering department the possibility to update their professional know-how in the working life. The programme was combined with another externally financed RDI project (Tekes; Smart Research). Thus the groundwork for solid new partnerships between the department and the industry was built.

Teachers' role in the company

One of the main goals of the exchange programme was to enable the teacher to update the professional know-how relating to a specific field and at the same time offer their know-how to the participating company or other organization. At the Department of Chemical Engineering, three teachers participated in the programme. The objective was to visit the chosen companies for 2.5 months (400 h) each. These periods were originally planned to take place as continuous visits, but at the end the exchange periods were divided into several shorter periods (1–2 days/week) with respect to timetables of the teachers and the companies.

The teachers' work in the industry involved several tasks as ordinary company employees. The most important tasks included the initialization of new laboratories, new analysis instruments as well as quality system work such as updates and modifications of process descriptions and analysis methods.

Outcomes from one of the Chemical Engineering exchanges

The interviewed teacher from the Chemical Engineering department participating in the programme described her tasks in the company as typical start-up procedures of a research laboratory in an RDI company. The tasks included acquisition of new laboratory equipment, validation processes of the new instruments as well as registration of analysis and working procedures.

The teacher's professional know-how was – for example – updated through the acquisition procedures of new analysis instruments, when both instrument specifications and performance needed to be optimized for the company process in question. Composing working procedures for the company as well as the revision of the existing procedures extended the understanding of the company processes greatly. The teacher was additionally given the opportunity to follow the daily activities of several smaller companies located in the same industry park area and also be a part of their decision-making process. The teacher was also involved in the selection of financial funding instruments and the writing process of a financial funding proposal at the company.

Company benefits of the exchange

The experts at Turku University of Applied Sciences typically possess a broad background within industry prior to their affiliation with the university. The companies involved in the exchanges have had the possibility to benefit from this experience. This experience becomes especially valuable as the experts have been an integral part of the company and can apply all their former knowledge to the current content. The teachers' analytical and instrumental skills as well as the experience to manage larger entities was utilized when a new RDI laboratory was established in the example case described above. The new and relatively unexperienced personnel was guided in analysis and communication skills. When new laboratory instruments are operated and procedure development is made, it is of great importance to be able to fluently communicate with an instrument manufacturer.

Turku University of Applied Sciences has now become an even more significant affiliate of the Chemical Engineering industry and has been considered as a consultant as well as a collaborator in further financial funding proposals. Networking with other universities and research companies have increased as a result of the case teacher's stay in the company located in the research park. New collaborations have started with new companies throughout the company networks. The RDI activities of the company have become a permanent part of the curricula at the Chemical Engineering department.

Student participation

As already mentioned earlier, students were an important factor in the exchanges. Through the visiting teachers several students were hired to the companies as trainees. The students were working in the company under teacher supervision doing optional courses, projects, practical training periods or theses.

The collaboration between the example case company and the university has created new workplaces as three of the graduated university students have been hired as permanent staff to the company. Although the exchange programme has finished the collaboration is still ongoing, and the externally funded research programme, where both the company as well as the university are participating, involves several students working with their practical training or theses.

Results and discussion

In the interview with the case teacher, both pros and cons were reported. The teacher's report showed that during the exchange her professional assertiveness was increased. Success in production problem-solving as well as consultation in decision-making processes contributed to the increased feeling of motivation. A break in the "normal" work was valued and it was experienced that in new surroundings fresh ideas could thrive. This supported all activities at the university significantly.

Company contacts were rated as important and valuable as they provide relevant real-world examples and challenges to university students. Through the teacher, the exchange programme provided students a possibility to study in a real working life environment solving real problems.

Needs for improvement were also indicated. The exchange could have been more effective by having the exchange as one long period. This exchange was carried out as several shorter periods (1–2 days per week) due to practical matters. This arrangement caused some problems in the company as well as in the university, as the short exchange visits stretched across a long period excessively prolonged the tasks at the company. On the other hand, the teacher had to take care of the teaching at the university when not working at the company. This raised the number of the teacher's weekly working hours and did not offer the possibility to fully concentrate on either of the tasks.

The program can be improved by focusing on the teachers working hours. Better coordination between the teacher and the university program time schedule organizer would lead to a more time efficient exchange period.

Conclusions

The exchange programme model has proved to be a success and very profitable model when external funding is available for the activities, but the real challenge lies in embedding it in the every-day processes of a university. It seems clear that systematic exchanges require systematic funding, which these days is a rarity. The solution to the challenge requires adopting many mutually compensating operational models with one clear goal: to smoothly and steadily increase the amount of time the university staff spends working outside their home institution. These strategies can include for example new kinds of advanced partnerships with key companies in the region, reciprocal visiting expert models and emphasising staff exchanges in RDI project proposals.

The general comments based on the feedback forms from the participating teachers also indicate that the programme was successful and most of the targets set in the beginning were reached. Networking between the companies and the university has increased, leading to a continuous collaboration within RDI activities. The department curricula has been changed and it now includes RDI study units such as CDIO and Capstone, which get their content straight from the working life. In the continuous curricula development work, the target has been set to provide the companies with future employees possessing the actual knowledge and skills the companies really need.

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THE SYSTEM MAKING OF "TECHNOLOGY" LEARNING WITH LOCAL PEOPLE AND STUDENTS

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Abstract

In recent years, the manufacturing educational methods are reconsidered in many universities, national institute of technologies and so on. Because many Japanese manufacturing fields have required many technical engineers that can do anything practically. So we thought that teachers have to educate more practical "monodukuri (=manufacturing)" educations for students. Therefore, if suitable themes that are in hometown of each school are selected, students can try with much interests about that. In addition, if many citizens can learn technologies of world heritages in our hometown, that chance are very effective for an engineering education as a regional contribution.

In these points of view, in this paper, the system making method which local people and students can learn together about technologies of world heritages that is called "Miike coal mine", is reported. Authors have investigated them and executed some trials since 2007. So these heritages were approved as a world heritage in 2015 by ICOMOS (International Council on Monuments and Sites). Therefore, the people of Omuta and Arao city that is hometown of Ariake kosen have much interest for them especially at present.

The main trials that authors carried out are as follows;

[1] Investigation and model manufacturing of the Miike port gate
[2] Investigation and design of the large scale coal mine shaft tower
[3] Lectures of "coal mine technology" for local people and students

By these trials, the techniques that had been used at old machines and equipments of 100 years ago were investigated and researched. After that, the technical models to lecture about these mechanisms and systems was designed and manufactured by students and many local people. So, authors had some lectures of "coal mine technology", to show these contents for many local people and students as a basic engineering educations. This educational system is very simple and effective for people who do not specialize in an engineering. So, it will be thought that the system making of technology learning is very important in the future.

Keywords: *mechanical engineering, technology learning, monodukuri (= manufacturing), world heritage, industrial heritage, coal mine, local people*

1. Introduction

Young people who have learned in national institute of technology especially have to take a skill of "monodukuri (= manufacturing)". Because technicians that graduated from national institute of technology are expected to become an immediate contribution to companies in the future. So to train great students that take high level skills, teachers have to consider the education program of monodukuri. In our previous trials, teachers of national institute of technology, Ariake college (The following college name are shown Ariake kosen,) considered some programs of mechanical practice, graduation research and mechanical design to make students that take those abilities.

In the point of these educational backgrounds, authors paid attention to the machines and equipments

Figure 1 Interview about Miike coal mine for citizen (Miyahara coal mine, Omuta city)

Figure 2 Overview of Miike port gate (Japanese industrial heritage)

Figure 3 Research about mechanisms and structures of Miike port gate by students and company engineers

that had been used in Miike coal mine, supported Japanese energy industry until 1997. In Omuta and Arao city that is hometown of Ariake kosen, have some industrial heritages of that. In addition, a lot of engineers who had worked in there until the close of coal mine are taking an active part now. Thus, it is thought that our college has the system what can learn the "principle" from "local and real person", these are very superior engineering materials for the student who learnt the technology and engineering in kosen. Actually, students had a chance to hear about coal mine techniques, histories and so on, as shown in Figure 1. Moreover, if the citizen can learn the technology of local heritages, it was thought that it becomes the big chance to have much interests for local industries.

In this paper, some approaches that were tried with local people and students are introduced. And the results of system making of technology learning for students and citizen are shown.

2. Results and Discussions

2.1 Manufacturing of technical model to learn technologies clearly - Miike port gate model -

Authors started the research about industrial heritages, like as machines, techniques and buildings of Miike coal mine at 2008. First of all, the technical model manufacturing of Miike port gate were tried.

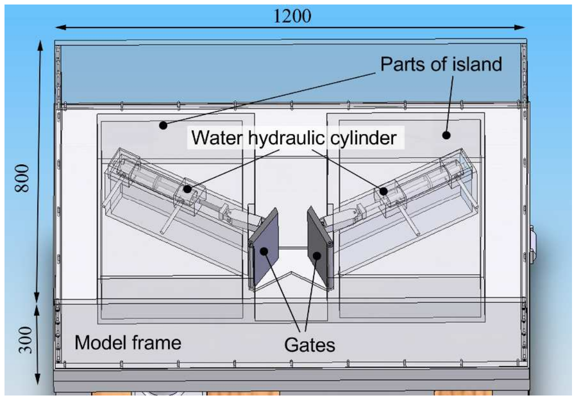

Figure 4 Schema of designed Miike port gate technical model with 3D CAD system

Figure 5 Overview of the Miike port gate technical model

Figure 6 The situation of explanation about the technical model to general citizen by a student

This is a first trial that is asked from NPO "Omuta and Arao coal mine fan club" that performs preservation activity and researches.

Figure 2 shows the overview of the Miike port gate. As shown in figure 2, that structure is simple and does not look so old. However, actually, this gate is the oldest building which has been used in Japan yet. So we thought that it has interest mechanisms, structures and so on, because it is old building which was made at about 100 years ago with the English coal mine techniques. Therefore we decided to manufacture the Miike port gate technical model to show these special techniques in graduate researches.

This trial is tried to do as the graduation research for 5 years grade students, so it takes about 1 year, from

April to March in next year. Figure 3 shows the situation of investigation about those things with a student and a company engineer. Students could communicate with engineers in technical conversations about mechanical structures and mechanisms of gate movement. In this interview, follow specifications of these gates are found.

(1) Width of gates = 29.2 m
(2) Height of gate = 9.2 m
(3) Weight of gate = 91.3 ton

Based on these results, students designed technical model that is shown in Figure 4 with 3D CAD system. Sizes and scale of this model are about 800 mm * 1,200 mm * 300 mm, and 1/100 scale respectively. The part of hydraulic cylinder is designed 1/10 scale to express for understanding easily. This technical model is mainly consist of 3 parts of the gate technical model, chassis of model, water flow and electrical control systems. This model is made from transparent acrylics to be able to be easy to see from outside.

Figure 5 shows the Miike port technical model in the state filled water. Finally, this technical model is consisted of over 100 parts include an electrical control system which is one unit. It can be said that the model made in this trial is easy to understand mechanisms and structures of the gate, because a frame, hydraulic cylinders, islands and so on are made from transparent acrylics as shown in Figure 5.

After the technical model completed in our college, that technical model was donated to the public institution “Omura coal industry and science museum” in Omuta-city. Figure 6 shows the situation of the communication with a student, children and their father. It finds that the height of this model is just good for children’s eyes as shown in Figure 6.

2.2 The local symbol making with "Local factory", "Kosen" and "City office" - Coal mine shaft tower -

In recent year, authors have a opportunity of consultation about coal mine machines, equipments and techniques from some person or companies, because some trials of Miike coal mine have been tried. These themes are very valuable contents, sometimes we can obtain a very precious document.

As a result of that, the large scale local symbol making project that requested from Arao city office was carried out in 2011. This project was tried as a cooperative of "local factory", "kosen" and "city office". In this trial, students of Ariake kosen design the structures and materials of large scale monument of Manda coal mine 2nd shaft tower. Next manufacturing and assembling processes that are based on these design was carried out in local factories. Final, Arao city office set up it on the front of main station, as a ceremony of Arao city 75th anniversary. In this time, these processes are shown.

First, teachers, students and Arao city officers investigated the real Manda coal mine 2nd shaft tower. Figure 7 shows an overview of measuring of real tower structures. In this investigation, we used 300 mm and

Figure 7 Field investigation in the real tower

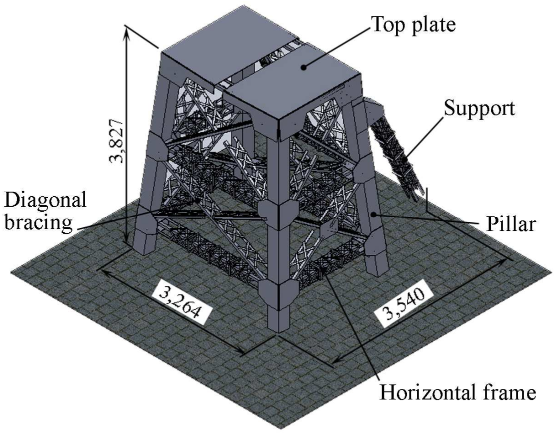

Figure 8 Manda coal mine 2nd shaft tower monument 3D image designed by 3D CAD

1500 mm scale, a laser distance meter and vernier callipers to measure height, length, width of structure materials and so on, as shown in Figure 7.

The specifications of 2nd shaft tower measured by this field investigation are follows,

(1) Height of main tower = 18.9 m
(2) Widths of main tower = 7.4 m * 10.8 m
(3) Main structure: Lattice structures
(Structured by angle steel, flat bar with rivet and bolts)

Figure 8 shows the overview of designed the Manda coal mine 2nd shaft tower monument with 3D CAD system in until November. Students designed the large scale object to express follow two concepts.

(1) The forcible model for expressing the history
(2) The precise model for getting to know high technologies of 100 years ago

As a result, the main tower monument materials are used structure steels and stainless steels to prevent metallic corrosions. The large scale object was designed about 1/4 scale, designed monument sizes are 3.3 m width * 3.6 m length * 3.9 m height, and that weight is 4 tons respectively.

This project was started by a request from Arao city, so students could have a chance to explain to the mayor of Arao city about their monument design concepts and images that they created, as shown in Figure 9. By this discussion, a manufacturing start of the Manda coal mine 2nd shaft tower monument designed by students was finally decided in December 2011.

Figure 9 Explanation of monument design plan for the mayor of Arao-city

Figure 10 Parts of large scale monument in Shin-ei ironworks Co. Ltd.

Figure 11 The member of monument manufacturing project with tower monument

Figure 12 The coal mine technical lecture for general citizen in local community center

After monument design, fabrication and installation of that are started by local factories at the end of March. Overview of manufacturing monument in companies is shown in Figure 10. In ironworks factory, materials of monument were prepared and fabricated. The monument that had been previously assembled, and after that, it was resolved once and in the galvanization coating company coated for each parts. Teachers and students went to these companies to observe these processes which can not see usually. Therefore we could have valuable experiencew in this project.

Figure 11 shows the picture of this project member taken in front of Manda coal mine 2nd shaft tower monument. An Arao city officer planed this project, students designed large scale monument, and teachers managed a project schedule and manufacturing face plate. So companies fabricated this monument. This project which had been executed for 10 months was a valuable experience as a regional contribution.

2.3 Learning system of "local technologies" with local people and students

In this paper, two cases that works with students about Miike coal mine equipments were shown. And the place and system making of a communication with students and citizen is introduced in these investigation and researches. It was thought that it wanted citizen also to learn in this chance, the technology learning of not only our learning. Finally, we thought that we want citizen to be the fun of coal mine technology, so lecture course which is called " It's difficult but tt's very interesting, - The technology of coal mine that engineer investigated it ! -" is carried out in city public hall by planning of the Omuta city board of education. In these lectures, more than 20 participants have a lecture of about 1 hour, and some technologies and trials are explained with many pictures and real items. Figure 12 shows the overview of lecture in 2014. Some of participants are the retired teacher who had thought architecture, the engineer who had worked in coal mine in that time. Therefore, in the case what they asked us searching questions about technology and structure of coal mine, difficult answers were shown. Especially, because the point that the author did not understand about it had been shown, the answer to it was able to be obtained. Therefore authors had a great chance to learn and search local technologies with local people and students. It is thought that the theme setting that many people are interested in is very important as a learning system with local people and students.

3. Conclusions

In this paper, the system making method which local people and students can learn together about technologies of world heritages that is called "Miike coal mine", was shown. The main conclusions obtained are as follows;

[1]To make the place that students can learn with much interests for something, a selection of local themes that students know well is the best way. So many chances what students can see and research in real place are obtain.
[2]It is thought that achievements of students become so huge with interests and knowledge, if mentioned themes like as a large scale object making and a technical model making of coal mine machines and equipments are selected.
[3]It will be able to obtain the chance to learn about local technology continuously by making the place that not only students and teachers learn it in kosen, but also the local people can learn together.

Authors have taken pictures with the person who can try and research something together. So we believe that these pictures will become a "human data bank" in our future. Then, by using this data bank, it is thought that we can create an environment to be able to learn with students and people continuously such a coal mine technique in the future.

Acknowledgements

The technical contributions of Yutaka building Co. Ltd., Kyusyu OM Co. Ltd., Shin-ei ironworks Co. Ltd., Mitsui mining Co., Ltd., Omura coal industry and science museum and NPO “Omuta and Arao coal mine fun club” are also acknowledged. These works were supported by the subsidy of Japan Post service 2008 and technical and industrial association of Ariake wide area grant-in-aid for local industrial support research in 2010 and 2011.

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Joint VPET Programme at Higher Diploma Level

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Abstract

In 2008, Vocational Training Council (VTC) collaborated with Shenzhen Polytechnic (SZPT) in the introduction of a Higher Diploma in Electrical Services Engineering. As part of the collaboration, Hong Kong Institute of Vocational Education (IVE) students spent 2 out of 6 semesters studying at SZPT, and upon graduation, they were given 2 awards from VTC and SZPT separately. In co-ordination for the graduates of the New Academic Structure in 2012, VTC revamped all Higher Diploma Programmes as 2-year, 5-semester structure. The Higher Diploma in Electrical Services Engineering course was revamped and became a stream of the Higher Diploma in Electrical Engineering programme.

This programme aims to provide students the technology, skills and related statutory requirements in the electrical services industries both in Mainland China and Hong Kong SAR. Upon graduation, graduates will be awarded with the Higher Diploma in Electrical Engineering by VTC, and also be awarded with the Higher Education Qualification Certificate (Electric Automation Technology) by SZPT.

All new intake Higher Diploma students in Electrical Engineering will study the same teaching modules in semester 1 and 2. In semester 2, students may apply for the Electrical Services (ES) Stream programme which is collaborated between the Department of Electrical Engineering, IVE (Haking Wong) and SZPT. Students who are admitted in the ES stream programme will have their study in IVE (Haking Wong) in semester 3; and then in SZPT in semester 4 and 5. During their study, students are required to attend the examination of National Occupational Certificate in Electrical Maintenance (Intermediate Level).

Keywords: *Vocational and Professional Education and Training, Dual Award, National Occupational Qualification Certificate, Registered Electrical Worker.*

Introduction

At the turn of the 90's, the electrical industry in Hong Kong has been shifting from manufacturing to service oriented industry and, from the graduate surveys in the past three years, we envisage the trend will continue because a large number of the graduates take up jobs in E&M services organizations and local large engineering projects. With rapid economic development in the Mainland China and ever-increasing interactions between the Mainland and Hong Kong, it is expected that more and more local electrical services workers will work in the Mainland, especially in Guangdong area. In response to the anticipated demand, the course is designed to enable students to grasp the technology and the statutory requirements of electrical services in both the Mainland and Hong Kong by assigning students to study at professional institutions in these two places within the two years so that students upon graduation can be well prepared to work as electrical services professionals in the Mainland as well as in Hong Kong.

VPET in Hong Kong and Mainland

Vocational and professional education and training (VPET) prepares people for future development by providing them with professional knowledge, practical skills and appropriate attitudes. For electrical engineering industry, there are specific requirements for practitioner in the trade.

In Hong Kong SAR, all workers engaged in electrical work in fixed electrical installations must be registered with the Electrical and Mechanical Services Department (EMSD). The purpose is to ensure that such work is carried out only by qualified electrical workers. Electrical work means the work in relation to the installation, commissioning, inspection, testing, maintenance, modification or repair of a low-voltage or high-voltage fixed electrical installation and includes the supervision and certification of the work and the design of the installation. Examples of fixed electrical installations are distribution boards, wiring installations and lighting fittings, etc. that are fixed in a premise.

Therefore, VTC's VPET programmes in electrical engineering was required to be accredited by EMSD so as to meet the academic requirement of Registered Electrical Workers (REW) for the corresponding grade of electrical works.

In Mainland China, the graduates needed to pass the trade assessment before joining the workforce. For participation in the electrical industry, students are required to pass the intermediate level of the National Occupational Qualification Certificate Test (NOQ).

The Joint Programme

In 2008, VTC collaborated with SZPT to offer a dual award programme for secondary school graduates in Hong Kong SAR. The programme was offered by the Department of Electrical Engineering, IVE (Haking Wong) of VTC. The duration of the programme was three years. Since there was no linkage between the education system of Mainland China and Hong Kong SAR, students were required to attend an entrance examination organized by SZPT. The entrance examination was held in IVE (Haking Wong). The programme comprised six semesters, in which, students needed to study in IVE (Haking Wong) for four semesters and two semesters in SZPT. The generic and foundation modules would be mainly delivered by IVE (Haking Wong). SZPT was engaged in delivering vocational modules in electric automation technology whereas IVE (Haking Wong) would deliver vocational modules in power, machines and electrical installation. Upon graduation, students would be awarded with the Higher Diploma in Electrical Services Engineering (HDESE) by VTC and Higher Education Qualification Certificate (Electric Automation Technology) by SZPT.

In order to fulfil the graduation requirement of SZPT, students were required to attend the following examinations:

- Practical English Tests for Colleges (Level B)
- National Occupational Qualification Certificate in Electrical Maintenance (Intermediate level)
- Computer Office Software Applications (Intermediate level)

In 2006, the Education Bureau of Hong Kong SAR had implemented an education reform for secondary school education. One of the major reforms was to convert the 5-year secondary school structure into a 6-year secondary school structure. Under this New Academic Structure, students need to take a new public examination: The Hong Kong Diploma of Secondary Education (HKDSE). This examination serves the dual functions of an exit assessment for secondary school education as well as selection for admission to higher education.

In co-ordination for the graduate of the New Academic Structure in 2012, VTC revamped all Higher Diploma Programmes as 2-year, 5-semester structure. The Higher Diploma in Electrical Services Engineering programme was also revamped and becomes a stream of the Higher Diploma in Electrical Engineering programme. Students who are admitted in the Higher Diploma programme of Electrical Engineering (Electrical Services stream) will have their study in Hong Kong for semesters 1, 2 and 3 and then in SZPT for semesters 4 and 5. Comparing with that of the previous 5-year secondary school structure, graduates of the new 6-year secondary school structure are exempted from the entrance examination of SZPT, Practical English Tests for Colleges (Level B) and Computer Office Software Applications (Intermediate level). However, students are still required to pass the examination of the National Occupational Qualification Certificate in Electrical Maintenance (Intermediate Level) in order to fulfil the graduation requirement of SZPT.

Upon successful completion of this joint programme, graduates will be awarded with the Higher Diploma in Electrical Engineering (Electrical Services) by VTC, and the Higher Education Qualification Certificate (Electric Automation Technology) by SZPT.

Programme Design

Vocational and Professional Education and Training, VPET, is defined as a comprehensive term referring to those aspects of the educational process involving, in addition to general education, the study of technologies and related sciences as well as the acquisition of practical skills, attitudes, understanding, knowledge relating to occupations in various sectors of economic and social life.

More important, the design of VPET prepares young people for lifelong learning and to be a responsible citizen.

The theme of the Higher Diploma in Electrical Engineering (Electrical Services stream) programme follows the direction of VPET, it is a balanced design of generic and vocational elements. The curriculum of this programme consists of three parts:

- Generic – it prepares students the generic skill to support their studies and further development. The content incorporates vocational English language, vocational Chinese language, mathematics, information technology and whole person development.
- Foundation – it provides students the basic science and engineering skill to support the vocational modules of "Electrical Services" stream and "Electric Automation Technology". The content incorporates engineering science, engineering mathematics, electrical theory, electrical engineering principles, instrumentation and measurement.
- Vocational – it provides students the knowledge and skill for "Electrical Services" stream and

"Electric Automation Technology". The content incorporates knowledge based modules and practical skill modules.

Furthermore, the students are required to carry out at least 91 hours of industrial attachment (IA) as graduation requirement. Through IA, students can have a chance to integrate the knowledge learnt in school and then apply it in the working environment which enhanced students' future employability.

Academic and Industrial recognition is important for a VPET programme. The programme meets the corresponding recognition in Mainland China and Hong Kong SAR. In Mainland, the programme meets the National Occupational Qualification whereas in Hong Kong, the programme attains the following recognitions:

- Level 4 of the Qualification Framework by Hong Kong Council for Accreditation of Academic and Vocational Qualifications (HKCAAVQ);
- Academic requirement of associate member by the Hong Kong Institute of Engineers, HKIE; and
- Academic requirement of Registered Electrical Worker (Grade B), by the Electrical and Mechanical Services Department (EMSD) of Hong Kong SAR.

Programme Implementation

The programme has 347 Credits with 3475 notional learning hours including 1378 contact hours and 2056 self-study hours. Among the contact hours, 45 % is practical orientated.

The delivery of the programme follows the general two-year five-semester structure under IVE's higher diploma programme. The corresponding study pattern/load of each semester was:

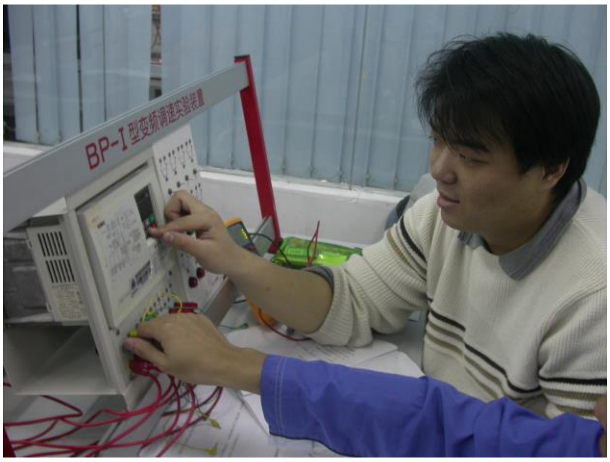
Semester	Contact Hours	Self-study Hours	Notional Learning Hours
1	299	378	685
2	312	418	740
3	234	271	510
4	273	395	680
5	260	594	860
Total	1378	2056	3475

Students study the generic, foundation and "Electrical Services" stream modules in semester 1 to 3 and "Electric Automation Technology" modules in semester 4 and 5. Therefore, students would be stationed in SZPT campus in semester 4 and 5.

Snap Shot @Study

Photos of students' practical training at various workshops:

Siemens Step 7 PLC Training in SZPT



Electrical Drive Training in SZPT

High Voltage Switchboard Training in IVE (Haking Wong)

Underground Cable Detection Training in IVE (Haking Wong)

Electrical Installation Training in IVE (Haking Wong)

Fault Finding Training on Motor Control Panel in IVE (Haking Wong)

National Occupational Qualification Certificate in Electrical Maintenance (Intermediate Level) Assessment in Progress in IVE (Haking Wong)

Conclusions

Graduates of this joint programme are able to obtain dual awards by VTC and SZPT. They are also equipped with essential vocational skills for the electrical industry both in Mainland China and Hong Kong SAR. They also gain the following extra advantages as a result of staying in SZPT for their study in semesters 4 and 5:

- become more fluent in Putonghua
- better in understanding the way of life and thinking in China
- great variety of extra-curricular activities in sports, music, volunteer services, and so on leading to better social network and enjoyable campus life
- good chance to develop better interpersonal skill in order to deal with problems possibly met in daily life and studying

Hong Kong was named the Special Administrative Region of China since July 1997, there were quite a number of programmes specially designed for business and/or law in Mainland China in Hong Kong SAR. However, the joint programme is the first one in engineering field. It is targeted to prepare graduates who are ready for work in both Mainland and Hong Kong SAR.

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EDUCATIONAL TRAINING JAPAN-KOREA JOINT PROGRAM FOR THE MANUFACTURING CONTROL SYSTEM

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Abstract

The National Institute of Technology, Japan (hereinafter called KOSEN) and Omron Corporation (hereinafter called Omron) – in collaboration - launched a new educational training program in 2011. The training program is called "Control Skill Educational Camp" (hereinafter called Camp) and is held once a year. In 2016, this training program will be held as a Japan-Korea Joint program in order to deal with recent rapid globalization for the first time. Many students from across Japan apply for the Camp every year, and only the students who have passed the screening tests may participate in the Camp. The students who passed get together, build some teams which consist of 3 or 4 students each including both Japanese and Korean students, and address the problems with the manufacturing control system for a week, by way of competition. The 3-axis-robots are provided for each group by Omron as the hardware for their training system. The students mainly develop their original software to control the robots. There are two main purposes in this training program. One of them is to develop the knowledge and skills of the participating students concerning the manufacturing control system. The other one is to develop personal growth which will lead to having a positive attitude and great communication skills. In this program, very challenging problems are imposed on the participating students. The students discuss and have to try very hard to solve the problems in each group. There is an enormous amount of information which will be needed to solve the problems, so it is extremely important that they do cooperate with each other in order to be able to finish their work assignments by the end of the Camp which is held for one week. Tremendous effort will be required to communicate with foreign students not only because of the different languages but also the cultural differences. On the last day of the Camp, the students present their own strategy and control algorithm which are implemented into the robots, and demonstrate the developed control system. During the course of this year, it can be expected that participating students acquire the ability to deal with engineering globalization through the Joint Camp.

Keywords: *Educational program, manufacturing control system, 3-axis-robot, competition, collaboration, group work, globalization*

Introduction

The joint project between KOSEN and Omron was launched in 2008 and has been running for 8 years. The purpose of the project is to educate many engineers to be familiar with the manufacturing control system.

The project began with seminars which were held with the purpose of developing manufacturing control skills for teachers at KOSEN. The seminars were organized and conducted by Omron, and they are composed of basic (fundamental principles and usage of control equipment) and practical usage (technical skills). Many teachers at KOSEN participated in the seminars and acquired a lot of new technical skills. After the seminar, some of the participating teachers started new training classes to learn practical manufacturing control skills at their KOSEN. However, almost all of the classes comprise only about 8 or 10 hours per year, it might be quite difficult for the students to get sufficient practical skills in such a short learning time.

The next powerful proposal by Omron to KOSEN was to have a "Camp" for students which is implemented for a week during the summer vacation. The participating students can learn the practical control skills during the camp, and they can have more than 40 hours of practice, which is plenty of time to get all of the practical skills. The students can acquire not only technical skills, but they can also gain experience in developing their original control system by using the acquired control knowledge. The final goal of this Camp is that the students can design and develop a control system which complies with the specification presented as their challenging problem. The process of developing their control system is a PBL (Problem Based Learning) scheme which will be successfully conducted by the collaboration of teachers of many KOSENs and Omron. In 2016, as a new attempt to deal with the rapid globalization, the camp will be held as a Japan-Korea joint program.

What is the Control Skill Educational Camp?

The Control Skill Educational Camp is a practical manufacturing control training course provided by Omron, and organized by KOSEN. The camp is described as follows:

1) Educational training program for the study of the manufacturing control system.
2) It was launched in 2011 as a collaboration between KOSEN and Omron.
3) The purpose is to inspire the students of KOSEN to develop their ability and skills on their own.
4) The students of KOSEN work on the challenging assignment throughout the week in the team.

The Camp consists of the three steps as shown in Figure 1. The first step is to learn about basic sequence control which can be acquired in the application assignment for the Camp. Only the students who have passed the evaluation of the application assignment can participate in the second step of the Camp which is to acquire the basic motion control skills through the previous assignment to serve as the fundamental techniques in the third step. The third step is to master the practical skills by the control apparatus manufactured by Omron.

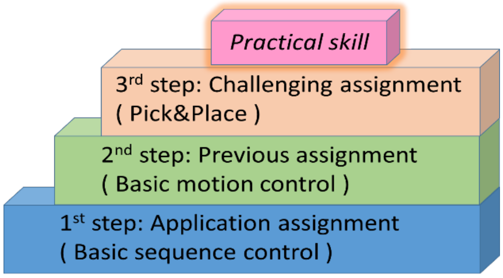

Figure 1 The three steps of the

The procedure of the Camp is shown below:

(1) Advertise the Camp to all of the KOSEN across Japan.
(2) Screen the submitted application assignment by the Camp staff.
(3) The students who passed the screening work on the preparation study for about one month.
(4) Get the students who passed the second step at the Camp venue together, some teachers of KOSEN and employees of Omron hold lectures to the students about some control techniques.
(5) The students work on the challenging problems in the group.
(6) On the last day of the Camp, the students present their achievements as a group effort.

The style of the Camp is to be able to work in groups. It can promise that the participating students learn how to keep a positive attitude and appropriate way to acquire communication skills. The Camp is also recognized as an internship for primarily the 4th grade students. That means, the 4th grade participating students can get KOSEN subject accreditation.

Preparation study for the Camp

Figure 2 shows the basic motion control learning system for the 2nd step of the Camp explained in the previous section. The main controller is the PLC (Programmable Logic Controller) named "SysmacNJ" which has a high-speed processor released by Omron in July 2011. SysmacNJ can synchronize control together with the other control instruments, such as servo-motors, inverters, vision sensors, etc. A large amount of the control signal can be transferred via EtherCAT (Ethernet for Control Automation Technology) at great speed.

As shown in Figure 2, which is the control apparatus for the 2nd step, SysmacNJ is connected to the two servo drivers. The servo drivers control the motion of the turntable and belt respectively. Students can learn by using this apparatus primarily three things as below; 1) setting of parameters to control these servo motors appropriately, 2) programming of position and velocity control of the servo motor, 3) synchronized motion control of the turntable and belt together.

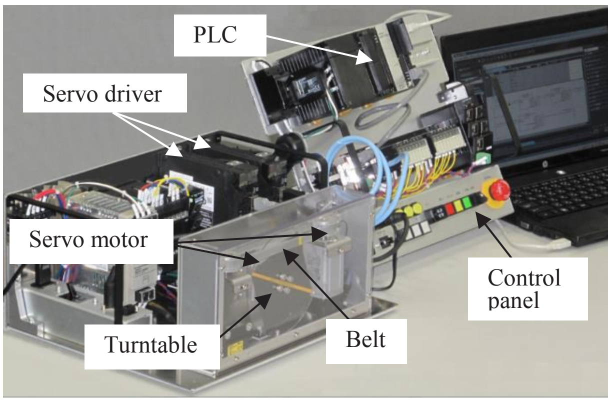

Figure 2 Basic motion control learning system

The basic motion control learning system is delivered to the participating students with manuals which describe the usage of the control system. After the students received the control system, they study completely on their own for about one month. This means that the participating students are expected to start the Camp with sufficient knowledge about the basic servo control to be able to acquire the practical manufacturing skills in the Camp.

The apparatus of challenging assignment for the Camp

Figure 3 shows the apparatus which is used in the challenging assignment as the 3rd step of the Camp. This control apparatus was manufactured by Omron in 2013 as a "Pick & place" control learning system which is intended to be used in the seminar for KOSEN teachers.

The apparatus consists of; PLC (SysmacNJ), servo drivers, XY-table (the motion is controlled by the servo motors), a vision sensor, and a chuck which is moved by the DC-motor attached on the Y-axis.

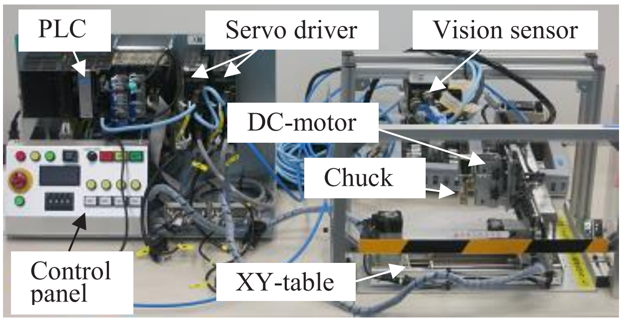

Figure 3 Control apparatus for challenging assignment

The challenging assignment is prepared for the participating students to acquire the practical manufacturing control skills. Students create programs to control the apparatus to satisfy the control specifications which are given in the challenging assignment. To complete the assignment by the end of the Camp, the students will need to assign their tasks to each members of the group, plan the schedule, and discuss control algorithms. It means that to achieve their assignment, positivity is required strongly.

Every year, the Camp staff (consisting of KOSEN teachers and Omron employees) evaluate the control systems designed by the participating students. By the results of the evaluation, it is obvious that all students achieved very high skills with the practical manufacturing control techniques, and obtained the necessary group work skills.

In 2016, 14 Korean and 10 Japanese students will participate in the Camp, and there will be constructed 7 groups which are mixed groups of Korean and Japanese students. They will surely meet with difficulties in communicating with each other because of different languages and/or cultural differences. They will need to work hard to achieve the purpose of the Camp. It is expected that all of the students will learn and understand the necessity to be able to communicate with engineers in different countries.

Evaluation by using the rubric table

All of the participating students are evaluated by the staff of the Camp based on the rubric table. The evaluation items are listed below:

A. Items of skill of the control equipment
   - A-1 Sensing system
   - A-2 Usage of the vision sensor
   - A-3 Positioning control
   - A-4 Velocity control
   - A-5 System integration

B. Items of general working skill
   - B-1 Independence
   - B-2 Responsibility
   - B-3 Theoretical intellect
   - B-4 Problem recognition
   - B-5 Teamwork
   - B-6 Leadership
   - B-7 Communication skill
   - B-8 Consensus formation and information collection

All of the evaluation items have the same evaluation levels as below:

- Level-1 Knowledge / memory
- Level-2 Understanding
- Level-3 Applying
- Level-4 Analysing
- Level-5 Evaluating
- Level-6 Creating

The evaluation by using the rubric table was started in the Camp in 2014 to analyze the educational effects of the Camp in a quantitative way. The items of the evaluation were modified every time after each Camp to be suitable to evaluate the growth of the students. Such modifications might make it difficult to compare the growth of students with past Camp. But the modification of the rubric table in the first few years is important for long period evaluations in the future. Referring to the analysis of the evaluation, the staff of the Camp improved the management style and the challenging assignment. There are still not any longitudinal data to show the improvement over the years. It can expect that the growth of participating students will be shown a few years later, after the modification is completed.

The Camp in 2015 - "Sway control"

The Camp has a different call name every year. In 2015, the name was "Sway control".

Back-ground story: Please imagine that a crane is transporting a hanging load. If you simply move the crane, sway will be caused and it will make it very difficult to place the hanging load at a designated position. In this

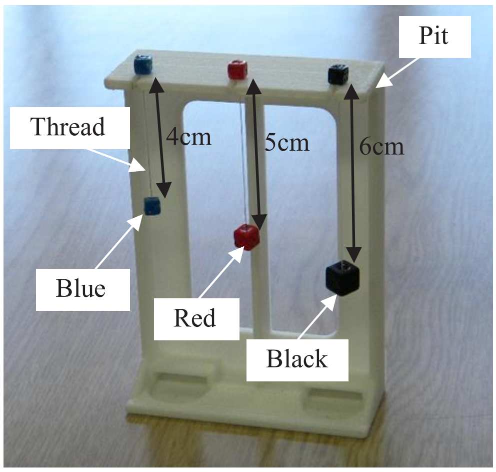

Figure 4 Three hanging dice pair with different length threads

case, a sway suppression control technique will be important to transport the load as quickly as possible.

In this camp, the transportation by a crane is emulated by the three-axis-robot. Figure 4 shows the challenging assignment of sway control of three small hung dice. There are small dice on the top of the pit in three different colors. Another three different color and different size dice are hung by means of a white thin threads, these lengths are 4, 5, and 6cm respectively. It means, the sway periods of each color die are different.

The procedure of the challenging problem is shown below:

1) Detect the color of the dice to get the thread length. It means, sway control is possible only by getting the length of the thread.
2) Get the hole positon on the turntable just before the transportation of the dice by the vision sensor which is installed right above the turntable. The turntable is turning all the time, it is required to estimate the hole position by sensing the rotation angle of the turntable.
3) Grasp the dice on the pit and move the hung dice to the right above the hole.
4) Drop the dice to the hole as quickly as possible. If you just wait until the sway amplitude is getting small without control, of course it would take a long time to drop the dice into the hole. It means that the students need to manipulate the three-axis-robot not to excite sway of the hanging dice.

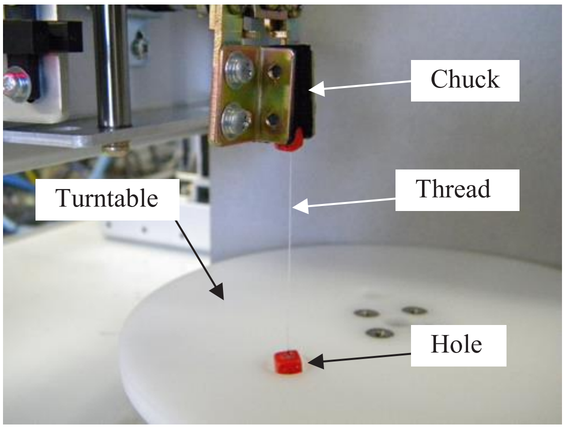

Figure 5 Transportation of the dice with sway control

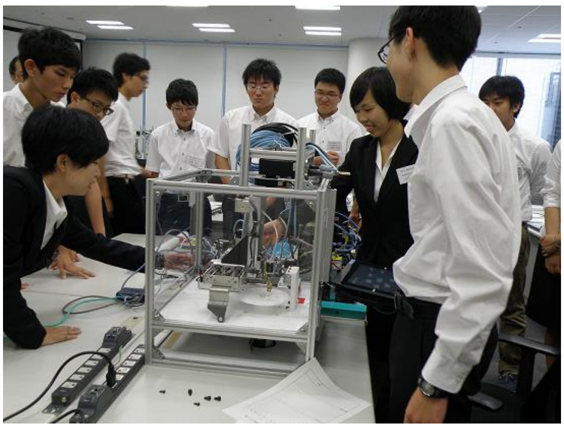

Figure 6 Presentation on the last day of the Camp

Figure 5 shows that the chuck is grasping the small above dice and transporting the hanging dice to drop into the hole of the turntable.

Figure 6 shows the presentation on the last day of the Camp. A group is presenting their achievement. A student of the group is showing the motion and explaining their control strategy. The other people were surrounding these students to see the presentation, and asked some questions or gave some advice.

Conclusions

In 2016, the Japan-Korea joint program named "Control Skill Educational Camp" will be held for 10days from July 24th until August 2nd . This is an Omron and KOSEN collaboration project. The Camp has been held since 2011, and this is the 6th Camp. Many KOSEN students apply to the Camp every year, and approximately 15 to 18 students participated in the Camp in their summer vacation. The Camp is always very tough work because; 1) the students have to study practical manufacturing skills, 2) they have to design their original control system to meet with the required specifications, 3) they have only one week for the study and design.

The Camp was held only for Japanese KOSEN until 2015. Korean students also had their own training course to learn practical manufacturing techniques at Omron in their summer vacation. It was similar to the Camp of KOSEN. After the end of the Camp in 2015, the teachers at KOSEN, who are the staff of the Camp, proposed that Omron have the Camp together with Korean students. The Omron employees were happy to immediately accept the proposal.

The Camp will be held at the Omron Kusatu facility in Japan in 2016. From the 2nd grade regular course to the 2nd grade advanced course students at KOSEN will participate in the Camp. The challenging assignment is; "Place the items on the table in the weight order by using the seesaw as quickly as possible". The most important factor to win will be the ordering algorithm and the accuracy of the motion control. The performance highlight will be very quick motion of the 3-axis-robot, and good teamwork of Korean and Japanese students. The staff of the Camp strongly expect that the Camp will be useful to the students, and profitable for their future.

Acknowledgements

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A PROJECT TO CREATE A HANDBOOK WITH A VIEW TO PROMOTING CROSS-CULTURAL COMMUNICATION AND UNDERSTANDING

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Abstract

Living in a multi-cultural society today, it is beginning to be difficult for us to co-exist and understand people with different backgrounds only with the foreign language acquisition. We need to develop not only language skills but also the ability to understand and deal with the multi-cultural situations. Concerned with this matter, many universities and Kosen schools are now planning some cross-cultural exchange programs in order to promote cross-cultural communication.

However, teachers who are in charge sometimes have different backgrounds and experiences, which can make it hard to organize the programs from the beginning by themselves. On the other hand, some experienced teachers know how to manage the program efficiently. Therefore, if we shared our own knowledge and experiences, it would be much easier for anyone with different experiences to carry out the projects. In one handbook, our shared knowledge and experiences are sorted in chapters so that any teachers in charge with different experiences can refer to it anytime they need help, directions and useful tips on projects.

If there were a useful handbook to refer to, teachers who lack the experience in managing these events could start the programs smoothly, and then it would help teachers organize them and save time.

The creation of this handbook would broaden the possibilities of conducting cross-cultural programs. It could contain various kinds of methods in order to make a PDCA cycle, to-do lists, case studies in the past, and experiences with reflections for the revision. In this handbook we could share our own experiences and know-how would give us a good start for the project to be carried out effectively.

Consequently, understanding different cultures are closely related to globalization. With this handbook, we could promote not only English education but also cross-cultural understanding. The detailed plans, the procedure, expected benefits, and future visions are to be presented in this paper.

Keywords: *handbook, case study, cross-cultural understanding, cross-cultural communication, cross-cultural exchange programs*

Introduction

The idea of creating a handbook has been on our mind since 2012 when we first met at a conference. Our need to promote cross-cultural communication and understanding has a lot in common. In this multi-cultural society where there is increasing demand to acquire foreign languages and skills of cross-cultural communication, there seems to be an urgent need to have a handbook which would make our work more efficient and effective.

Therefore, our big “if” has appeared in our minds. “If” we have such a handbook which contains our shared experiences and knowledge, it could light our way and lead us to better procedure of cross-cultural education. This idea sprouted from such an ideal in our ordinary teaching lives.

At present, it is difficult to find this type of handbook. Of course, there have been many handbooks for foreigners working for Japanese companies but it is difficult to find the one for exchange students studying in Japanese universities, pointed out Matsumoto (2004). In addition, as far as we know, a handbook for the promotion of both cross-cultural communication and understanding with both teachers and students points of view has not existed. It could be a challenge to explore such a new horizon in this handbook project.

The Purpose of this Handbook Project

This handbook project has two main purposes: one is to promote cross-cultural understanding; the other is to have the students acquire how to deal with and accept cultural differences through English education.

The completion of this handbook will not only broaden our cross-cultural education but also promote English education.

This handbook should contain our shared real experiences and case studies, from which further developed skills are suggested. Case studies should indicate some reliable solutions when we face problems.

With this handbook, even young unexperienced teachers could be in charge of planning and carrying out cross-cultural events. They can refer to the handbook whenever or wherever they need. Using this handbook could lead all teachers to the reduction of labour and the high cost performance.

The Procedure of this Handbook Project

There are 5 steps of this project are as follows.

The 1st Step: Produce the Handbook

This handbook has 10 chapters where any teachers in charge, no matter how experienced they are, can easily refer to, launch a new project, follow the procedure, and find solutions.

Figure 1: The planned contents of chapters

Chapter	Contents
1	Provide a framework for workout to understand different cultures
2	Promote the active learning method for cross-cultural understanding inside and outside classes. Produce teaching materials.
3	Instruction for how to make a presentation in English as Education for International Understanding
4	Workout for English speech and presentation contest
5	Plans and procedure for homestay program
6	Make a To-Do list in order to promote partnership with sister schools.
7	Provide a framework for effective Skype sessions with partner schools
8	Methods of planning and holding international exchange events
9	Methods of open lectures on cross-cultural and English education for the community contribution.
10	Case studies and solutions

The 2nd Step: Produce the Textbook

As a source of this handbook, we are planning to produce a textbook along with teaching and learning materials, which contain a syllabus, class schedule, quizzes, exercises, assignment sheets and so on. This methodical textbook is organized for 15 classes in a semester, so the handbook can be more effective, when used systematically with the textbook as one unit. As they are associated and related with each other, it can be feasible to introduce the viewpoints into our daily classes, especially into cross-cultural education.

Using the handbook and textbook together, we can conduct cross-cultural education smoothly and just arrange what we need according to the situations and purposes of the project.

We'll set 3 different levels which can match the various levels of students' ability.

The 3rd Step: Nurture the Students

Both Kure College and Sendai College cooperatively research students' reactions through questionnaires and hearing. Students also write a paper on what ideas, questions, and discovery they have. Collecting and integrating their reaction and feedback, we'll analyse what to amend in order to create a practical and sustainable handbook and textbook.

Both the students and teachers cooperate and nurture each other, which can bring an interactive reciprocal environment both for research and education.

The 4th Step: Presentation and Output

As a development from the 3rd step, the students prepare for the presentation in an international conference with the teachers. Both the students and teachers have cooperation in writing proceedings and papers to give a presentation to a conference.

At this step, it would become quite necessary for the students to develop their English skill. Giving this chance of presentation to the students can be essential training and motivation for them to improve their English presentation skills.

The 5th Step: Reflections

From the 1st step through 4th step, we'll make a report as a summary. Through the stream of the production of a handbook, a textbook, materials, and presentations as output, we'll have reflections and look back on all the procedure we've done.

The students can also get involved in this step so that we can share all of our viewpoints and develop future perspectives.

Results and Discussions

This project has just started and we are now midway. Let's take an example of chapter 8. The following figure is a to-do list for an international exchange party, a welcome party held in Kure College.

Figure 2: A simplified example of to-do list for the international party

Date	✓	1	2	notes
Apr 10		Reservation for the party room	Invite the principal	
Apr 27		Program schedule making	Invitation Attraction	Tell the exchange students
May 10		Plans: get approval from the academic affairs department	Ask the principal to make a speech	Decide the number of guests
May 12		Announcement in a meeting & to school	Invitation for Kure teachers & students	Games Slides Camera

May 25		Guests' name list & name cards	Poster	Confirm food order & schedule
		Seat arrange	Stationery	
Jun 1		Reminder emails	MC	
Party		Setting	PC	Projector

In June, 2016, this party was held for the purpose of welcoming 8 exchange students studying in Kure College. As preparation for the party, a to-do list was made.

This party is held every June every year but the person in charge changes quite often according to staff transfers within Kure College. It could be labour saving to have a to-do list like this for any new teachers to refer to if necessary.

After the party in a teachers' meeting, we have reflection to revise this to-do list for the next year, sharing ideas. In this way, we can pursue a better outcome to hold international exchange events more smoothly in a labour-saving way.

Conclusions

This handbook project is a borderless project in a sense because not only teachers but also students cooperate with each other, blending their own ideas and reflections with each other. Through this project we nurture ourselves for promoting better ways of cross-cultural communication and understanding.

We can expect 3 great prospective benefits by making this handbook.

First, this handbook is associated with a textbook and some materials, so all teachers, including unexperienced ones, can conduct lessons based on the realistic, experienced, and practical instruction plans suggested in the handbook.

Second, it is always possible to arrange this handbook according to different needs for anyone.

Third, this handbook can be utilised not only in students' cross-cultural education but also training for teachers.

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SkillsFuture Mentors Orientation Programme: Establishing an Effective Partnership in Workplace Mentoring

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Abstract

SkillsFuture is a national movement to provide Singaporeans with the opportunities to develop their fullest potential throughout life, regardless of their starting points. Through this movement, the skills, passion and contributions of every individual will drive Singapore's next phase of development towards an advanced economy and inclusive society. In Singapore, the 180,000 local small and medium-sized enterprises (SMEs) make up 99% of the enterprises and contribute to nearly half of the GDP. As SMEs employ 70% of Singapore's workforce, these enterprises play a significant role in the development of Singapore's future and to create good jobs for Singaporeans.

In his 2015 budget speech, Singapore's Deputy Prime Minister Tharman Shanmugaratnam remarked, "Developing our people is the key challenge in SkillsFuture. It is to help uplift ... our SMEs, and involve them in this process of skills development. This will not happen naturally – many of our SMEs lack their own training capacity and are unable to plan for the future."

This paper shares the experience of Republic Polytechnic (RP) in establishing an effective partnership with a government agency (i.e., SPRING Singapore) to help SMEs strengthen their capability development and talent management through the SkillsFuture Mentors Orientation Programme (SFMOP) designed by RP.

Keywords: *SMEs, Effective Partnership, Capability Development, Talent Management, SkillsFuture Mentors Orientation Programme*

Introduction

Singapore is undertaking a number of reforms to be a pivotal hub in the global economy. The liberal immigration policy that once contributed to economic development of Singapore is undergoing change in the face of political pressure stemming from people's dissatisfaction of the hiring of foreign workers (OECD, 2013). The government is tightening entry conditions for foreign workers while encouraging foreign entrepreneurs and investing heavily in developing the human capital of Singaporean workers (OECD, 2013). SkillsFuture is a national movement to provide Singaporeans with the opportunities to develop their fullest potential throughout life, regardless of their starting points. Through this movement, the skills, passion and contributions of every individual will drive Singapore's next phase of development towards an advanced economy and inclusive society (SkillsFuture Council, 2015).

As part of this national effort, the government has lent strong backing to SMEs. These SMEs account for over half of the total enterprise value and employ nearly 70% of the workforce. Their rise, though, has been largely driven by government policy which has funded them and boosted the growth of their domestic market (OECD, 2013). There are now questions as to how sustainable the SME policy is in the long term.

Dilemma Faced by SMEs in Singapore

In Singapore, the 180,000 local SMEs make up 99% of the enterprises in Singapore and contribute to nearly half of the GDP (SPRING Singapore, 2016). As SMEs employ 70% of Singapore's workforce, these enterprises play a significant role in the development of Singapore's future and to create good jobs for Singaporeans (SPRING Singapore, 2016). However, due to the tightening foreign labour market since 2010, SMEs, which are the lifeblood of the economy, have struggled with the manpower shortage issue as well (Chan & Heng, 2012).

As Singapore continues to sharpen its competitive edge as a knowledge-based economy, the development of specific knowledge and skills is needed to help Singapore become a global knowledge capital and consolidate its leadership position in key knowledge-intensive industries (Economic Development Board, 2015). One solution is to strengthen the training and capability development of SMEs. Another solution is to engage in long term workforce planning. Workforce planning is a very common human resources practice for organizations of all sizes. With the right planning, a company can benefit through improved employee engagement and productivity while maintaining a healthy balance sheet.

With the further tightening of Singapore immigration passes on the horizon (Hawksford Singapore, 2012), businesses and the government must work together to ensure that a proper balance is maintained in order to keep the economy on a path towards sustainable growth.

Effective Partnership for SFMOP

In 2015, a national movement "SkillsFuture" was launched to address the human capital concern in Singapore. The SkillsFuture Council, led by Deputy Prime Minister Tharman Shanmugaratnam, coordinates and drives a national effort to help Singaporeans develop skills relevant to the future, and build a future based on the mastery of skills in every job.

There are four key areas of focus under the SkillsFuture Council:

1. Helping individuals make well-informed choices in education, training and careers.
2. Developing an integrated, high-quality system of education and training that responds to constantly evolving industry needs.
3. Promoting employer recognition and career development based on skills and mastery.
4. Fostering a culture that supports and celebrates lifelong learning.

Importance of Partnership between Government and Educational Institutes

Based on the four key areas of focus, SkillsFuture initiatives create a seamless pipeline for the students to transit to the workforce. For example, the Enhanced Internship programme and Earn & Learn programme (ELP) are the two initiatives introduced to respond to the 2nd key focus area identified by the SkillsFuture Council as mentioned above.

In order to safeguard the success of the integrated education and training system, educational institutes need to work closely with businesses (i.e. SMEs) in terms of designing industry-relevant curriculum, providing structured on-the-job training, and assigning experienced mentors to support the learners' learning. In this context, collaboration plays an important role in promoting an effective partnership between the government (i.e., SPRING Singapore) and educational institutes (i.e. RP) in building the capacity of the SkillsFuture mentors who will be deployed by SPRING Singapore to assist the SMEs involved in this integrated education and training system in enhancing their talent management and mentoring scheme.

Workplace Mentoring – Solution for Human Capital Issue and Talent Management

In the "2015 Talent Shortage Survey" conducted by Manpower Group (2015), it was observed that the working population is declining, thus forcing employers to select from shrinking talent pools. To address this issue, employers need to foster a learning culture within their organizations and encourage employees to own their careers. It was also highlighted in this report that businesses can no longer count on maintaining a sustainable competitive advantage over decades, but must be prepared to identify and achieve more transient competitive advantages (Manpower Group, 2015). The ability for organizations to succeed hinges on talent recruitment, staff management and retention.

A good staff management programme should be complemented with effective workplace mentoring (Short, 2014). Mentoring is an incredibly powerful tool for individuals within an organization as they prepare to move into a new role and/or take on new responsibilities (Sarri, 2011). Today, many companies are turning to coaching and mentoring programmes as a talent management strategy. These programs harness the value of internal employee resources to develop others. This not only saves time, and lowers cost, but also increases overall employee satisfaction. In fact, 71% of Fortune 500 companies offer mentoring to their employees (Association for Talent Development, 2009). This observation is corroborated by research that claims that mentors bring added value interventions that make a difference in the long-term success of the business (Sullivan, 2000).

SkillsFuture Mentors Orientation Programme

The Purpose and Intention

As the government agency to support SMEs' business development, SPRING Singapore recruited SkillsFuture Mentors to help develop the mentoring competencies of the ELP company mentors in performing their role. In this regard, SkillsFuture Mentors play a significant role in coaching and mentoring the SME staff who may be subject matter experts but not equipped with the relevant knowledge and skills to be an effective mentor at the workplace.

In 2015, SPRING Singapore engaged RP as its strategic partner to train 400 SkillsFuture Mentors for SPRING by 2018 to support this national movement. The intent of this customized SFMOP training is to help develop the SkillsFuture Mentors' knowledge, skills and attitude in facilitating SMEs' capacity building with regard to employee learning and engagement.

The Programme

The SFMOP is a 24-hour customised programme and delivered in a modular style called "learning bytes" of 4 hours each. These learning bytes are delivered via classroom instruction, role plays and observed practice of giving constructive feedback. The SFMOP comprises the following 6 learning bytes based on the learning outcomes identified by SPRING Singapore for its SkillsFuture Mentors:

1) Orientation to SME culture and work-study system
2) Interpersonal and motivational skills
3) Coaching and mentoring (theory)
4) Coaching and mentoring (practice)
5) Curriculum design
6) Design learning plans and task lists

Since November 2015, RP has conducted three runs of SFMOP for SPRING Singapore. A total of 68 participants have completed the 3-day programme and were certified as SkillsFuture Mentors. Some of them have since been deployed to mentor the SMEs through a matching process managed by SPRING Singapore.

In order to gauge the effectiveness of the programme in meeting its objectives, a summative SFMOP survey was carried out for each of the three runs (i.e., Nov 2015, Feb and Mar 2016). Preliminary data suggests that participants are clearer on their role as a SkillsFuture Mentor following their enrolment in the SFMOP. In addition, they appreciate the SFMOP as a platform to know and learn from their fellow SkillsFuture Mentors:

Table 1: Participants' Feedback on the SFMOP

Benefits of SFMOP	Participants' Feedback
Role Clarity as a SkillsFuture Mentor	*Showed me all the requirements and scope of being a SkillsFuture Mentor.*
	It has provided me with the skills and knowledge to enhance my role as a SkillsFuture Mentor.
	Helped in diagnosing gaps that can improve SMEs' lead capabilities.
	Highlight importance of human career development.
	Gives me a big picture on SkillsFuture and prognosis of implementation obstacles
Networking and Peer Learning	*The course allows for networking and peer learning from fellow SkillsFuture mentors.*
	Hearing all the different applications from the peers was good and insightful.
	Learnt new ways of doing things from fellow mates and certainly will apply when appropriate.

Conclusions

SMEs are an important part of Singapore's economy. The challenges posed by manpower shortage are especially pronounced because Singapore is a small country. In the television programme "Let's Think About It – SkillsFuture as a National Movement" broadcasted on 24 April 2016, the Deputy Prime Minster, Mr Tharman Shanmugaratnam, defines SkillsFuture as being "about every enterprise having teams of people who are focused on mastery. It's about us being able to make the most of life together". He also highlighted that SkillsFuture as a 'culture change' will only happen if the employers and educational institutions work together with the government to support this national movement.

SMEs rely heavily on skilled workers and increasingly face rising costs and manpower shortage. The SFMOP is a part of RP's efforts to support the continued success of the SMEs and Singapore in the 21st century. As the Prime Minister of Singapore, Mr Lee Hsien Loong, said in his 2015 National Rally speech, "If we want to go far, we have to work as a team". It is hoped that this partnership can witness the continued success of Singapore in the next 50 years.

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Report on Workshops of Career Plan in International Exchange Program

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Abstract

Recently, the engineering industry is rapidly promoting internationalization. The education that cultivates engineers with a global vision is becoming more important. In order for Japan to compete in the increasingly competitive global marketplace, engineering career education before the graduation from higher education institution is becoming more vital.

National Institute of Technology (NIT), Tomakomai College began an exchange program with Technological and Higher Education Institute (THEi) of Hong Kong for advanced course students last year. 9 students participated in this program, and visited local companies, construction sites in Hong Kong, and deepened exchanges with THEi students.

During this program, we conducted a series of workshops on career planning among Hong Kong and Japanese students. The topics of workshops were as follows.

1) Advantages and disadvantages of the respective working environments for engineers

2) Work-life balance of engineers

The students from both sides could express their opinions about the respective careers and working environments in their countries. We compared the results between the Hong Kong and Japanese students and it became clear that Hong Kong students have more aggressive motivation for building up their career and working abroad. These workshops triggered the students of both sides to consider more deeply their career plans. Also, Japanese students recognized that technical qualifications and educational background are more valuable for engineers in Hong Kong than in Japan.

This international exchange program proved to be a very important opportunity for engineering students to develop their global visions and career planning.

Keywords: *Global Engineer, Career Education, Career Plan, Exchange Program, Workshop*

1. Introduction

In 2013, the Japanese government announced the “Japan Revitalization Strategy”. One of the key components of the strategy is to promote Japan’s infrastructure exports. The engineering industry is getting more internationalized and it is becoming more necessary for engineers to have a global vision. Based on this background, higher education institutions for technology are dedicated to cultivating international-minded engineering students. To expand the global vision of students, it is very important to provide students with opportunities to exchange their opinions with students from other countries who are of their same generation.

National Institute of Technology (NIT), Tomakomai College began an exchange program with Technological and Higher Education Institute (THEi) of Hong Kong for advanced course students in 2014. In August 2015, 9 students of NIT visited THEi in Hong Kong through the exchange program. During this program, we conducted a series of workshops on career planning among Hong Kong and Japanese students. From the result of these workshops, we identified that Hong Kong students have more aggressive motivation for building up their career and working abroad. In addition, these workshops triggered the students of both sides to consider more deeply about their careers. In this report, we will discuss how these workshops brought the students deeper consideration to develop their global visions and career planning.

2. Workshop Contents

The number of total participants in the workshops was 16 students (9 Japanese students, 7 Hong Kong students). The breakdown of the participants is shown in Table 1. All Japanese students were year 3 and Hong Kong students were year 2 to year 4 students, and they were around 20-24 years old. Table 2 summarizes their major fields. We divided them into 3 groups which consist of 5 to 6 students each. The following were the topics of the workshops.

- Topic 1 Advantages and disadvantages of the respective working environments for engineers
- Topic 2 Work-life balance of engineers

On both topics we assigned some key words in both English and Japanese to encourage their discussions.

Table 1 Grades and Genders of the participants

Grade (Bachelor)	JPN (NIT)		HK (THEi)	
	Male	Female	Male	Female
Year 2			1	3
Year 3	8	1	1	
Year 4			1	1

※Advanced course year 1 in NIT equals to Bachelor year 3 in THEi.

Table 2 The major fields of the participants

Major Field	JPN (NIT)	HK (THEi)
Civil Engineering	1	3
Environmental Engineering		4
Mechanical Engineering	4	
Electrical and Electronic Engineering	1	
Computer Science and Engineering	3	

2.1 Procedure of Workshop (Topic 1)

The workshop of topic 1 aimed to compare the differences in working environments of engineers between Japan and Hong Kong. We conducted the workshop by the following procedure.

1) Give each group a worksheet (Figure 1) which has blank boxes for "Good points", "Bad points" and "Working time".
2) Students of both sides write down the average working time, overtime, holiday of both engineers and general office workers in their countries.
3) Give each group sticky notes with key words of working conditions as shown in Table 3.
4) Japanese students divide these key words into "Good points" and "Bad points". Hong Kong students also do the same with sticky notes in different color. They can add some other key words.
5) Japanese students choose 3 key words in particular from "Bad points" as "Necessary for improvement". Hong Kong students also do the same.
6) Based on these results, Japanese students and Hong Kong students discuss the following questions.
・Why do you think it is a good point or a bad point?
・How can we improve those bad points?
・What is the ideal workplace for you as an engineer?
7) Make a presentation on the result of each group.

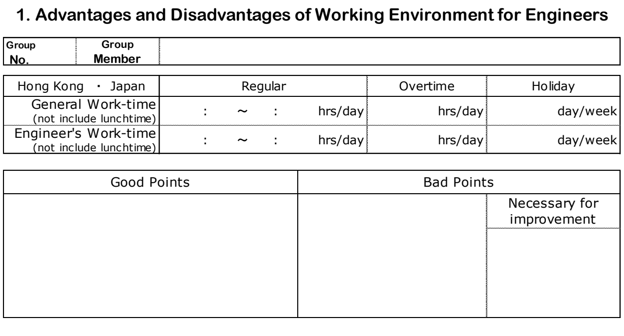

Figure 1 Worksheet of Topic 1

Table 3 The key words of Topic 1

・Employment rate	・Working hours
・Job change	・Shift-work
・Salary	・Holiday
・Global	・Qualification is required
・New Technology	・Job transfer
・Safety	・Family-support
・Specialized knowledge	・Accident compensation
・Responsibility	・Employee's benefit
・Few women	

2.2 Procedure of Workshop (Topic 2)

The purpose of topic 2 is the awareness of differences of career plans and life plans as an engineer between Hong Kong and Japan. The procedure was as follows.

1) Give each group a worksheet (Figure 2) which has a table of "age" and "life events" in horizontal axis and "monthly salary" in vertical axis.
2) Give each group sticky notes with key words of career plan and life plan as shown in Table 4.
3) Each student puts these notes in cells. They don't have to use all notes and they can also add key words other than those in Table 4.

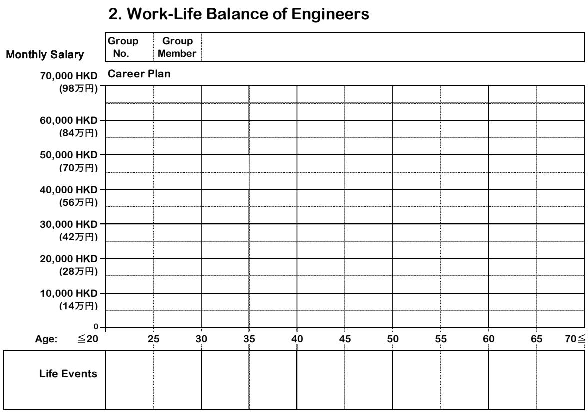

Figure 2 Worksheet of Topic 2

Table 4 The key words of Topic 2

Career Plan	Life Plan
・Job-hunting	・Graduation
・Start working	・To get a Master degree
・Start a business	・To get a Doctor degree
・Job change	・Having my own house
・Retirement	・Buying my own car
・Work abroad	・A child birth ×4 pieces
・President	・Child care leave
・Director	・Family care leave
・Section Chief	・Marriage
・Assistant manager	・Return to university ※
・To get a Qualification	・Study abroad ※
・Return to university ※	
・Study abroad ※	

Picture 1 Discussion in the Workshop

Picture 2 Presentation in the Workshop

4) Students make the best life plan and career plan for themselves considering the results of each student's plan. (Using sticky notes in different color)
5) Make a presentation on the best life plan and career plan for each group.

3. Results of the questionnaire

The results of the questionnare for the workshops are shown in Table 5 to Table 7. Each question is ranked by five-grade evaluations: (1) not at all to (5) very much or very well. Table 5 and Table 6 show student's impression for the workshops. Table 7 is about the communication and the exchange of their opinions with oversea students.

3.1 Assessment of Working Environment for Engineer (Topic 1)

From the discussion of both Hong Kong and Japanese students, it was clear that working hours of an engineer is longer than a general office worker in both countries. However, some working conditions of Japan, such as the number of holidays, are better than Hong Kong. Japanese engineers get two days off a week while most Hong Kong engineers get only one day off a week. Through their discussion, most of the students thought of "Employment rate", " Salary", " Global" as good points of an engineer job. On the other hand, all the groups selected "Working hours", "Holiday" as items of "Necessary for improvement". The results of Q1 in Table 5 show that they found the similarities and differences of work conditions in places other than their own countries. In addition, the result of Q3 shows that most students agree that it is important for them to know more about the work conditions of other countries during their school days. They showed the following as the reasons: "it provides more choice when making decision", "it lets us to have more choices and protection when working abroad", and "it broadens our horizons".

3.2 Assessment of Work-Life Balance of Engineers (Topic 2)

In topic 2 of the workshop, both Japanese and Hong Kong students put the key words about their career plans at the intersection point matching their ideal age and monthly salary on the worksheet (Figure 2).

Table 5 Results of Questionnaire for Topic 1

Q1. Were you interested in the similarities and differences of work condition for Engineers between Hong Kong and Japan?

Very much <<	5	4	3	2	1	>> Not at all
JPN (NIT)	2	6	1			
HK (THEi)	2	5				

Q2. Were you able to obtain a better image of your ideal work place?

Very well <<	5	4	3	2	1	>> Not at all
JPN (NIT)	1	6	2			
HK (THEi)	1	5	1			

Q3. Do you think it is important for university students to know about the work conditions of other countries than your own country?

Very much <<	5	4	3	2	1	>> Not at all
JPN (NIT)	1	6	2			
HK (THEi)	1	5	1			

Table 6 Results of Questionnaire for Topic 2

Q4. Were you interested in the similarities and differences of career plan and life plan between Hong Kong and Japan?

Very much <<	5	4	3	2	1	>> Not at all
JPN (NIT)	3	6				
HK (THEi)	3	4				

Q5. Do you think it is important for students to consider their career during their school days?

Very much <<	5	4	3	2	1	>> Not at all
JPN (NIT)	5	2	2			
HK (THEi)	5	2				

Q6. Have the values about your career changed through exchanging ideas and thoughts with students in other countries?

Very much <<	5	4	3	2	1	>> Not at all
JPN (NIT)	1	4	3		1	
HK (THEi)	1	3	2	1		

By comparing the career plans between Hong Kong and Japanese students, it could be seen that the monthly salary of engineers for new graduates in Hong Kong is higher than Japan. In addition, monthly salary in Hong Kong increases rapidly after the students obtain more engineering qualifications. On the other hand, in the career plan made by Japanese students, salaries do not increase so much even after the students obtain those qualifications. In this way, Hong Kong students tend to have more motivation for getting qualifications for the purpose of their careers.

In their ideal life plan, the goal of life of Hong Kong students often includes having their own houses. Most of them consider about how to earn more money and how to save money to buy a house in their life. On the other hand, Japanese students tend to prefer having family and children as their goal of life. A major reason of such differences could be related to the expensive cost of living in Hong Kong. Therefore, money has become a very important motivation for Hong Kong students.

The result of Q4 in Table 6 shows that most students recognized the similarities and differences of career plans and life plans between Hong Kong and Japan in this workshop. In addition, Q6 shows that some students changed their values about their career through this discussion.

We got the following comments from the students.

・“I could recognize that the qualification is very important for an engineer in some countries.”

・“In Japan, the meaning of the work is for developing bigger family, but in Hong Kong it is only for having our own house.”

Through these discussions, we could see that the students were able to widen their visions and were motivated to consider more deeply about their own career planning by engaging with the engineers in the making in different countries.

3.3 Assessment of Communication with overseas students

We considered the effectiveness of communication with overseas students in the workshop in terms of internationalization education. We asked all participants three questions about the communication. The results are shown Q7 to Q9 in Table 7.

The first question Q7 was about the difficulty level of the workshop in English. Almost all the Japanese students answered that it was difficult or very difficult while Hong Kong students seemed not to feel the discussion in English so difficult. Considering that Hong Kong students always use English as the official language, it is not surprising that Japanese students had more difficulty in communicating in English. The discussion in English made Japanese students recognize their English level.

The second question Q8 was about the effectiveness of key words given in advance on each topic. Almost all the students answered that English key words were useful or very useful. As for Japanese students who had

Table 7 Results of Questionnaire for Communication

Q7. Were you able to communicate in English with students in other countries?

Very well <<	5	4	3	2	1	>> Not at all
JPN (NIT)	1	1	4	3		
HK (THEi)	2	4	1			

Q8. Were the keywords given in each topic useful for group work and discussion?

Very much <<	5	4	3	2	1	>> Not at all
JPN (NIT)	4	2	2	1		
HK (THEi)	1	5	1			

Q9. Do you think this discussion of work conditions, career plan, and life plan with students in other countries would be useful for your career?

Very much <<	5	4	3	2	1	>> Not at all
JPN (NIT)		8	1			
HK (THEi)	3	4				

only a limited English vocabulary, the key words saved them the trouble of finding English words in a dictionary. The key words also made it easier for both Japanese and Hong Kong students to communicate with each other because they could understand what the others were talking about when looking at the sticky notes with the key words. In addition, the key words helped the students have a concrete image for work conditions and work-life career. Only in their vague idea, it would have been difficult for them to keep the point of the discussion. In this way, the key words worked well as a kind of visual aids.

Finally, we asked whether the students thought that the discussion during the workshop in English would be useful for their future career (Q9). All the students except for one student answered that it would be useful or very useful in the future. One of Japanese students responded, “It can be useful when I work overseas in the future.” Some of Hong Kong students responded, “It can help me to consider more possible plan” and “It provided me with better image.”

The results mentioned above are summed up that giving the key words in advance was useful for both schools’ students in the discussion on the specific topics in English, and that exchanging their ideas about work conditions and work-life career clarified the difference and gave them a good chance to rethink their future life and career differently.

4. Conclusion

Through the series of workshops, we found out that they had the helpful effect of making the students consider their career more deeply and widen their global vision. As teachers engaged in the education to cultivate international-minded engineering students, we insist that it is very important to provide students with opportunities to exchange their opinions about work environments, career and life plans with other countries' students so that they can develop their global visions and career planning.

Acknowledgements

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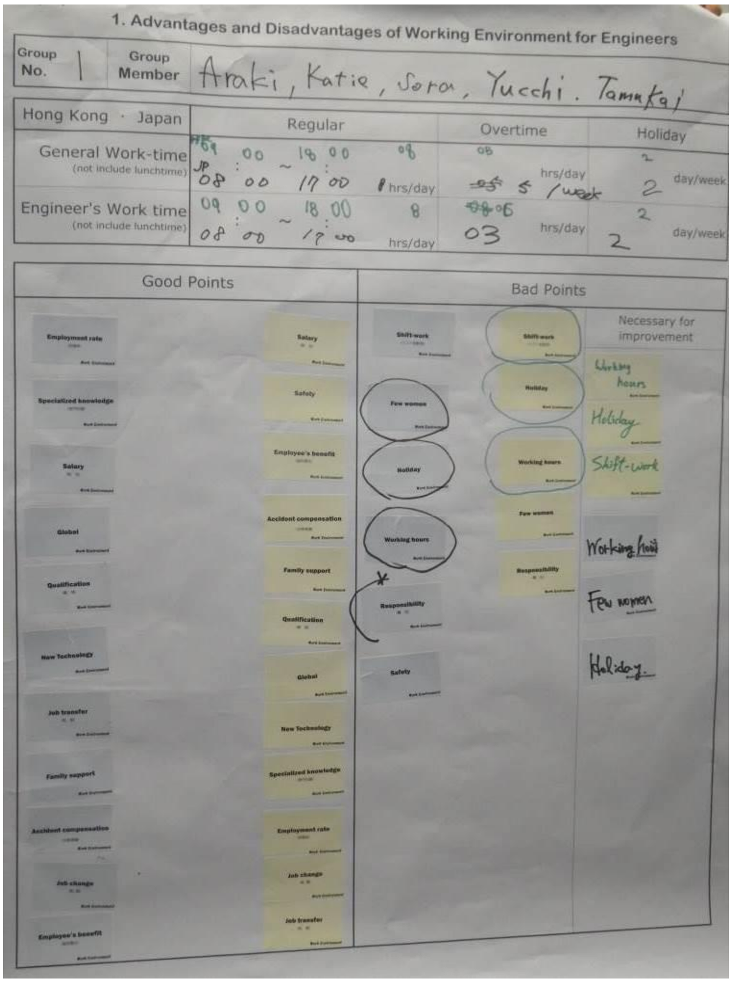
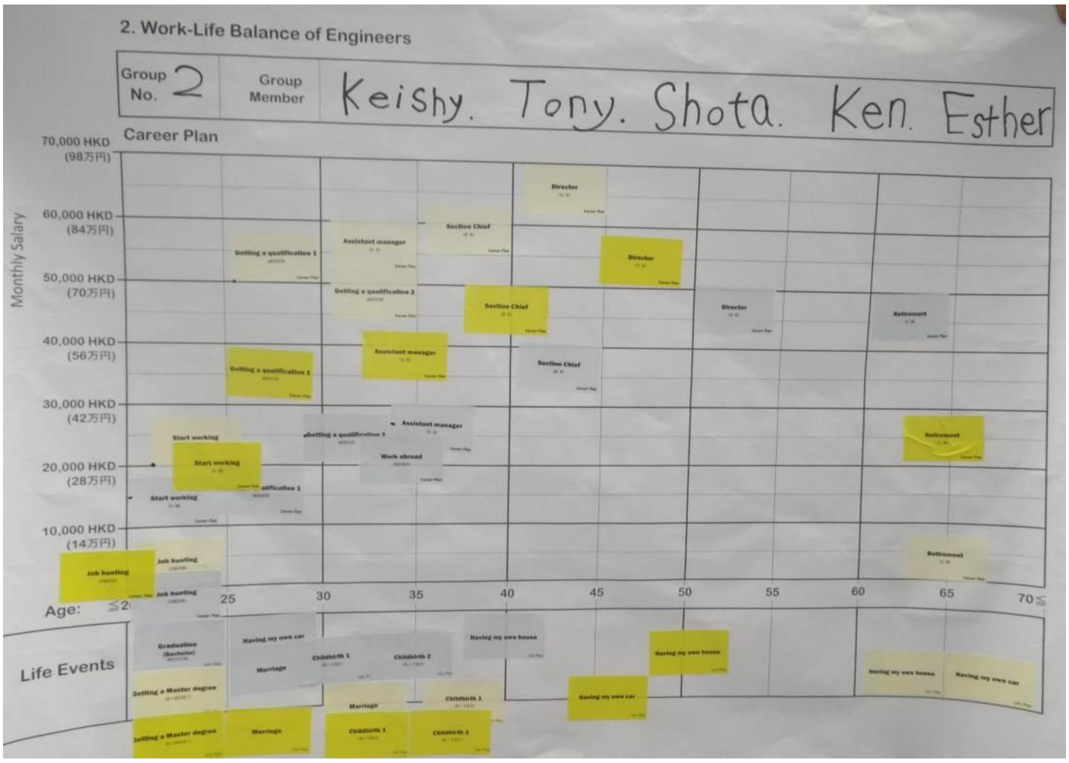
An example of worksheet of Topic 1



An example of worksheet of Topic 2



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OVERSEA COMMUNITY PROJECT IN CAMBODIA WITH TEMASEK POLYTECHNIC

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Abstract

Akashi College conducted the first overseas community project (OCP) in Cambodia in March, 2016, where some voluntary activities were conducted together with Temasek Polytechnic, School of Humanities & Social Sciences in Singapore. Temasek Polytechnic originally launched the project in 2012 with the aim to enrich their students' beyond their own diploma studies. Temasek Polytechnic apply their technical skills to improve the well-being of the people they serve, and in doing so, nurture a sense of empathy and compassion, develop social and emotional competence, and grow to be effective leaders and team players in society. Akashi College aligns with the philosophy of this program and joined the OCP program of Temasek Polytechnic. A total of 24 students from Temasek Polytechnic, and 3 staff were involved in the March 2016 run of the OCP. From Akashi College, four students, one fourth-year and three third-year students, took part in the program. The leader of the OCP team was a student of Temasek Polytechnic, who captained the international students' team very well.

The program consists of four projects. Project 1 is to conduct Educational Program at Chikreng Secondary School which was built by Japanese support. Project 2 is to renovate classrooms at Chikreng Secondary School. Project 3 is to distribute donated items among poor villagers or the similar program. Project 4 is to understand the past and the present of Cambodia in Phnom Penh. Through the OCP program, students learnt a lot and satisfied the objectives mentioned above.

By conducting this program together with Temasek Polytechnic students, international cooperation was achieved. Through this first OCP, we also found some ideas to improve the OCP program. In this paper, we present the details of the OCP program and suggest some educational benefits. Although many kinds of overseas training have been conducted at each College of National Institute (NIT) of Technology recently, the OCP should be one of the strongly recommended programs to foster the global human resources.

Keywords: *Service Engagement, International Institutions Collaboration, Social Collaboration in Education, Student Motivation, Overseas Training*

Introduction

The overseas training of Akashi College is classified in two categories and is enriched every year. The first one is a foreign language training. The first foreign language training was carried out in New Zealand in 2007, and it has been held annually during spring break. In recent years, the participant of the training is gradually increasing. Currently this type of training is enlarged and is held in Australia and Canada. The content of the training is to learn English at a language institute or to take a class at a local high school. The objectives of this overseas training are improvement of the linguistic ability and to give stimulation of globalization to younger students. The second overseas training of Akashi College is an internship at the partner institution. For example, about five students are dispatched to Gadjah Mada University in Indonesia every year, and we have sent out students to Ho Chi Minh City University of Technology in Vietnam, UC Irvine in USA, IIT Kanpur in India, University Federal do Rio Grande do Sul in Brazil, et cetera. In this training, students are expected to not only learn language but also engineering skills and/or experience cooperative work. In March 2016, we started a new overseas training in Cambodia, which is called an overseas community project (OCP). Some voluntary activities are mainly conducted in this program. Temasek Polytechnic originally launched the project in 2012. By joining the program of Temasek Polytechnic, Akashi College successfully started the new program. Through the OCP program, students could learn a lot. Especially, in the area of international cooperation by working together with Temasek Polytechnic students from Singapore. Through this first OCP, moreover, we conceived some ideas to improve the OCP program further. In this paper, we introduce the details of Temasek Polytechnic, School of Humanities & Social Sciences' OCP program and suggest the educational benefits from being involved in such a program.

Background of OCP project

In Akashi College, the active learning and the global education are propelled positively as two pillars of the educational reforms. Under this situation, we surveyed what kind of skill is scarce in our students by using the PROG, which is a test provided by Kawaijuku Educational Institution to measure the generic skills of human resources. As a result, it was found that the competency ability is slightly lower compared to the same age students of universities. Although the vague tendency was always discussed, the tendency was indicated by data clearly and the implementations of countermeasures have been discussed. Hence some activities, which require decision-making in cooperative work, are sought.

On the other hand, the objectives of the OCP project of Temasek Polytechnic are as follows: Enrich the acquired learning of students beyond their own diploma studies, through community service in Cambodia. The students of Temasek Polytechnic apply their technical skills to improve the well-being of the people they serve, and in doing so, nurture a sense of empathy and compassion, develop social and emotional competence, and grow to be effective leaders and team players in society. The objectives are just what we have been looking for, and we are aligned with the philosophy of this program. Moreover, the cooperative work with Temasek Polytechnic is effective for global education. Therefore, Akashi College decided to join in the OCP program of Temasek Polytechnic and started a new overseas training program.

History of OCP of Temasek Polytechnic

Table 1 shows the historical record of previous OCP projects of Temasek Polytechnic. The OCP project of Temasek Polytechnic is conducted twice every year, in spring and autumn. The spring project of 2014 was cancelled because of the insurgency in Cambodia. About 30 students participate in the project every time, and about three staffs accompany the students to facilitate student learning. Temasek Polytechnic has accumulated a great deal of know-how by completing many OCP projects, and a sophisticated program was carried out. Some students have even participated in the OCP project multiple times and because of a sense of fulfilment and satisfaction from the project.

Table 1. The historical record of previous OCP.

	Year	Period	No of Students	Staff
1st	2012	19-25 March	25	2
2nd	2012	2-9 October	34	2
3rd	2013	2-9 April	21	2
4th	2013	1-8 October	30	2
5th	2014	9-17 October	34	3
6th	2015	31 March - 8 April	34	2
7th	2015	1-9 October	33	3

Outline of OCP 2016

The total number of participants from Temasek Polytechnic in the March 2016 OCP was 24 students, and 3 staff who accompanied the students and facilitated student learning. Four students, one fourth-year and three third-year students, took part in the program from Akashi College, and the department of all students of Akashi College was incidentally Architecture. The leader of OCP team was a final year student of Temasek Polytechnic, who led this team of international students very well.

The OCP project was held in Kampong Kdei, which is 200km north-northwest from Phnom Penh. All participants did a homestay in the village. Figure 1 shows the appearance of homestay house. Every student and staff stayed at the house. The first floor is for female students and staff, and the second floor is for male students and staffs. Figure 2 shows the state of the second-floor room. There is one room and it is not divided. The mats for bed are laid on the floor, and we slept there. Three meals were served by the host family. The dishes were a light Chinese food style and suited Japanese tastes.

Table 2 shows the schedule of the OCP in March 2016. Akashi College joined the spring OCP project due to the school calendar of Akashi College. The schedule of the OCP project 2016 ran from March 21 to March 30. It never rained during the period of the program since it was the dry season in Cambodia.

The program consisted of four projects. Project 1 involved conducting Educational Program at Chikreng Secondary School (CSS) which was built by Japanese support. Project 2 renovated classrooms at CSS. In Project 3 students distributed donated items among poor villagers or similar program. Project 4 helped students to understand the past and the present of Cambodia in

Figure 1. The appearance of homestay house.

Figure 2. The state of the upstairs room

Phnom Penh. In this paper, the details of the project 1, 2 and 3 are described.

All the participants did a 12 km walk so as to know the state of the village on the first day. The highest temperature of the day exceeded 40 degrees Celsius. It was the third day since we had arrived there, and the season was still cold in Japan. Therefore, the walk was the toughest activity of all the programs as we had to adjust to the weather change. Unfortunately two female students of Temasek Polytechnic abandoned the walk due to the difficulties faced during the walk, though every student of Akashi College completed the full distance.

Table 2. The schedule of the OCP, March 2016.

Day 1	21-Mar	Movement from Japan to Phnom Penh
Day 2	22-Mar	Phnom Penh to Kampong Kdei Join Temasek members
Day 3	23-Mar	12km walk round Kampong Kdei Visit HIV Village
Day 4	24-Mar	Activity at Chikreng Secondary School
Day 5	25-Mar	Activity at Chikreng Secondary School HIV Village
Day 6	26-Mar	Activity at Chikreng Secondary School Donation drive at a poorer village
Day 7	27-Mar	Activity at Chikreng Secondary School Donation drive at a poorer village
Day 8	28-Mar	Closing Ceremony & Sports Exchange at Chikreng Secondary School Visit of Old Market
Day 9	29-Mar	Leave for Phnom Penh Visit of S21 and Killing Field Final debriefing session
Day 10	30-Mar	Visit of Independent Monument, Imperial Palace and Central Market Leave for Japan

Activity at Chikreng Secondary School

Figure 3 shows the appearance of Chikreng Secondary School (CSS). This school was built with Japanese support in 2010. Although the building was built not so long ago, many parts of building were already damaged because of the poor quality construction work and a severe climate. Therefore, the renovation work of the building was assigned as a duty. There were two tasks assigned for the building renovation. One is the tiling of classroom floor, and the other is the painting of building. Figures 4 and 5 show the pictures of work being carried out. The room was hot and stuffy, and some works required manual strength. The work was exhausting, but the students decided on rotation of roles by themselves, and carried out their responsibilities promptly.

In the midst of the project, we decided to contribute to another project after one of the daily reflection meetings. That was the water pipework. The running water had been coming around the school but water was not supplied into the school since there was no water pipe. They had drawn the water of the restroom with a bucket from a nearby water reservoir. Figure 6 is the picture of the ceremony to celebrate the completion of the water pipework. This construction was considered as a contribution that improved convenience and sanitary aspects for the children of the school.

Another activity at CSS was to conduct the English and physical education lessons. Figure 7 is the picture of the English class. Because teaching English was a bit difficult for Japanese students, they played a supporting role in the lessons. We were impressed by how the

Figure 3. Chikreng Secondary School.

Figure 4. The tilework at CSS.

Figure 5. The painting work at CSS.

Figure 6. The ceremony of water pipework completion

Cambodian children participated in the class and the enthusiastic manner in which Temasek Polytechnic students conducted the lessons.

For future OCPs, I suggest that students of NIT can also conduct scientific experiments using local materials to increase children's interest in Science. Additionally, there are many things that we can also do as a NIT student to help CSS with the respect to the school renovations. For instance, there was a well in the school. The well could not be used because a pump was out of order. The repair of the pump is a suitable task for the students of NIT.

We hope that our students will also know that they are in a blessed environment. Most of these children at CSS cannot continue their education further due to economic reasons. They are also currently studying in deficient educational facilities. This experience might enhance the learning motivation of our students, when they realize how fortunate they are. Figure 8 is the group photo after the closing ceremony. Some students and children shed tears at the closing ceremony, which showed they had built up friendship with each other.

Donation drive

Donation drive was to distribute donated items among poor villagers. Mr. Ly Heng, who is the host of homestay and local agent of a voluntary service, played an important role in this donation drive. He found appropriate donation destinations, and considered various situations. Our students seemed to be very impressed with the donation drives at the HIV village and the dumpsite. The HIV village is where the HIV patients were isolated. Five people were living there when we visited, and tragically, the number of people

Figure 7. English class at CSS.

Figure 8. Group photo at CSS after closing ceremony.

living the village has gradually been decreasing. Mr. Ly Heng was supporting the HIV village too. Figure 9 is a picture of the dumpsite. People lived on a pile of refuses. People lived hardily in this severe environment. It appeared that some people were infected with HIV and others were also infected by stepping on a used medical needle.

From a view point of accompanying staff, sorting through the donation items was most impressive work. The host family helped with the work, too. Figure 10 is a picture of this sorting task. This work was the largest-scale cooperative work. Moreover, the work was through international cooperation of three countries (Japan, Singapore, and Cambodia). The leader of the OCP team led this international team very well. He is, himself, a final year student of Temasek Polytechnic.

Debriefing session

Throughout the OCP period, a debriefing session was held every night, and the debriefing session took an

Figure 9. The picture of dumpsite.

Figure 10. Sorting task of donation items.

Figure 11. The final debriefing session.

important role. Figure 11 is a picture of debriefing session. Several students shared incidents of the day that left the biggest impression on them at these sessions. The sessions were well facilitated by the student leader of the OCP. All students needed to reflect on what they want to report beforehand since the leader designated the presenter randomly. This impromptu sharing promotes the communication skills of students because they have to summarize what they want to say clearly. Recently, placing importance on reflection is attracting a great deal of attention. The OECD put the spirit of reflectiveness as the heart of key competencies that students are expected to acquire. The debriefing session embodies reflectiveness, and helped to deepen students' learning. Incorporating opportunities for reflections in debriefing sessions are indispensable for experiential learning.

Through the debriefing, the students learn leadership and acquire communication skills. Incidentally, the Japanese students were informed who would be designated to speak before hand because impromptu English speech was difficult for our Japanese students. They keenly realized that more English study was necessary to convey their opinions. All students delivered the speech at the final debriefing session. Some students began to cry as they were touched by what they have seen and gone through. These tears show the meaningfulness of the OCP and the project was good for the body as well as the mind.

Conclusion

In this paper, the OCP with Temasek Polytechnic was introduced. Although the OCP was tough for both the mind and body, students learned a lot of things such as the competency, cooperative work, actual situation of a developing country, et cetera. Furthermore, by conducting the program with Temasek Polytechnic students, our students learned an international communication skill. When starting a project mentioned this paper, our students will have more to gain when it is conducted with a foreign country. The OCP together with a foreign country should be one of the strongly recommended programs to foster development of global human resources.

Acknowledgements

We express our thanks to Mr. Ly Heng, his family and others for supporting the OCP project.

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SOME EXPERIENCES OF EDUCATIONAL CO-OPERATION IN PRODUCTION TECHNOLOGY BETWEEN HELSINKI MUAS AND ABB COMPANY

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Abstract

Our paper will present longtime educational collaboration activities between Helsinki Metropolia University of Applied Sciences (HMUAS) and the Helsinki Factories of ABB company. ABB is producing electric motors and generators, etc. Here the co-operative partners are Mechanical Engineering Department (ME) of HMUAS and the Induction Motors Factory (IM) of ABB Company. The first author of the paper started his sabbatical years at IM factory in August 2000. This was an early start of deeper co-operation. We are focusing here on the studies of production technology. We will introduce co-operation activities (CDIO) of four different study (project) levels: industrial training, industrial internship of 400 hours, innovation projects, and final thesis work for graduation. We will show some study results from the four different levels. Students have been working together with high level specialists of IM factory solving problems of the production as well as developing production processes. Our purpose is to show how fruitful this method of studying technology is. At the IM factory HMUAS students have had a big role for instance in adjusting important technologies like Kaizen (Continuous Improvement Process) or 5S of Toyota Production System (TPS) into practice. Many of the participating students have earlier been working in the IM factory as summertime or part-time workers. So they already have good information about products and technologies being used in the production. We will show our methods for reaching together successful results. Many times student's graduation thesis work has been a continuity of earlier works made for IM Factory. For a number of students projects made for ABB has been a road to be recruited after graduation. Students have become well prepared for the challenges of work when starting the working life. Time needed for starting to be a productive worker has been dramatically shortened. According to the positive experiences during the last 12 years we strongly suggest to all educational institutions a wider and deeper cooperation with all kinds of industrial companies.

Keywords: *educational partnership, co-operation, internship, innovation project, CDIO, PBL*

Introduction

Any private customer could be extremely happy if he could have a chance of *testing the product from three to six months before buying it*. This has been reality in the co-operation between the ME department of HMUAS and the Induction Motors Helsinki Factory (IM) of ABB Company. In fact, ME has given IM this opportunity of testing potential young engineering professionals before recruiting them. In the following this will be shown very successful for each counterparts by discussing about some most typical cases and examples during the last 12 years.

The CDIO Approach in HMUAS

HMUAS is the largest University of Applied Sciences in Finland. It offers education in the fields of Technology, Healthcare, Arts, and Culture. Engineering studies are offered in 30 degree programs for about 8300 students. HMUAS was formed in merger of its forerunners EVTEK and STADIA in 2008.

The Civil Engineering program of STADIA started the CDIO process for third year students already in 1996 (Haapaniemi and Sammallahti, 2015). There are now several hundred companies in co-operation with HMUAS. The project work is always a R&D (research and development) work, and the subjects are given by the companies. All third year students are working, usually in pairs, in a company for two days a week during spring semester. Companies pay for the work for HMUAS. Students get 10 ECTS credit points (ECTS, European

Credit Transfer System). To be able to participate in the project work the students must pass most (some 85%) of the 1st and 2nd year courses.

EVTEK started the process of adopting CDIO in 2005. The goal was to apply CDIO Initiative to all engineering study programmes. Schrey-Niemenmaa et al (2010) present the early steps included, for example, several surveys such as stakeholder expectations, execution surveys and quality assurance. In the early phase, described in Schrey-Niemenmaa et al (2009) all existing engineering programmes were evaluated to identify success factors and development needs, a change agent network was created, emphasis was put to systematic data collection and analysis, and plan was made how to implement these into practice. In merging to HMUAS the CDIO main concepts were introduced to all engineering programs. Ikonen et al (2009) introduce one step to adapt CDIO syllabus in HMUAS was the implementation of the Challenge Based Learning (CBL) project in Embedded Engineering education. Project Based Learning (PBL) is heavily used in HMUAS as can be seen in Piironen et al (2010) and Piironen et al (2011). HMUAS joined CDIO collaboration in 2008; since then HMUAS has used the CDIO principles in all engineering study programs. Examples of CDIO type functions are 1st year orientation project, 3rd year multidisciplinary innovation project, and 4th year graduation thesis project. In addition to these three steps there is technical training for all engineering students and internship for fourth grade students of production technology.

Orientation project (5 ECTS credit points): In the first year's Orientation or introductory project student will learn project working and brainstorming skills. Orientation project is carried out actively and experimentally in co-operation with companies; it will give students a realistic vision from their future profession. The goal is to motivate students for the long journey ahead.

Technical training (30 ECTS credit points): During the four years of studies engineering students have to make five months (20 weeks) technical training in an industrial company. This is arranged partly during the study semesters and partly during the holidays like summer. Training is full time productive work and a salary is paid.

Innovation project (10 ECTS credit points): In the third year's Innovation project students will learn working in mixed multidisciplinary teams (e.g. students from technology, culture and healthcare) and develop innovations together with companies and/or public sector. In innovation project students are responsible of the entire project; teacher's role is to activate and coach.

Internship (15 ECTS credit points): in the autumn semester of fourth study year the production technology students are working 400 hours in a factory in all kinds of development projects together with the specialists of the company. Company people are actively teaching the students the functions of the factory as well as the most important and modern methods for developing the production processes.

Graduation thesis work (15 ECTS credit points): The fourth year's Bachelor thesis project is carried out together with companies and/or public sector, this project is carried out individually or in a small team. The subject for the project is originated from a real problem or challenge.

Four levels of studies in metalworking industry

In the following the co-operation activities (CDIO) of four different study levels are introduced: technical training, innovation projects, internship of 400 hours and final thesis work for graduation.

1. Technical training

This is compulsory 5 months (30 ECTS credit points) for engineering students (from 1st year to 4th year of studies):

- mostly summer time work, May-June-July-August, during the holidays of full time workers - 50 training students per year at ABB Helsinki
- productive work in a specified working area - on-the-job training in the production, after which working independently
- salary is paid
- during the second summer some students will work as work managers, then in product design, in quality department, in supply section, etc.

2. Innovation projects

Innovation projects (10 ECTS credit points) were started at spring semester 2012 (Siltala et al, 2016):

- 3rd year students, from November to April
- main themes: *safety, effectivity and quality*
- meant for taking bigger steps in process development
- 3 to 4 project subjects (groups) each year, 3 to 5 students in a group -> 12 to 15 students innovating for ABB every year
- activities are innovation projects with a wide range; for example planning layout changes

The work is done *mainly at the university* and the students visit the factory only 3 to 4 times during the working period:

1st visit (one day): general discussion about the subjects with company specialists; safety lectures, factory tour; each group will select their project subject

2nd visit: status of the work will be discussed, students will present their ideas, work managers and development engineers will attend the meeting, road to go will be selected and discussed

3rd visit: results of the work will be presented at ABB

4th meeting: results of the work will be presented in a public afternoon seminar at HMUAS

Between the 1st and 4th steps the specialist of ABB are available for communication and meetings with the students.
Examples of Innovation project themes:

- Lifting and turning device for the bearing shield of electric motors (safety and effectivity)

- Methods of moving the motor between process steps (effectivity)
- Developing a device for putting the bars inside the rotor and locking them (safety and effectivity)

- Designing the layout of final testing place (development suggestion from a customer)

- Automation for the incoming of material into the assembly field (effectivity)

- Ergonomic planning of the rotor core laminations stacking (safety)

- Preliminary planning of the preparation area of painting shop and the investment in painting (safety and effectivity)

- Designing of part assembly area (cost saving)

- Developing the cleaning process of sleeve bearings (quality)

- Improving the functions and material flow of the pipelines of sleeve bearings (effectivity)

- 5S plan for the yard around the factory (effectivity)

3. Internship

Co-operation between HMUAS and ABB in internship was started at autumn semester 2004. Now ABB will take 4 students per year, could take even 8 in the future. The *principles* of internship are:

- 400 hours (15 ECTS credit points) project work
- 2 students (4th year fall semester) working together as a pair
- threshold is low -> easy to get started - training in the production departments (about 20% of total time) 1-2 weeks in a section, then changing to another section in order to get acquainted with the production process, work managers are giving guidance
- after that common CIP (Continuous Improvement Process) education is given
- then independent studies (about 10% of total time) of production documentation and the methods of developing production process, especially LEAN principles, CIP, 5S, 7 Wastes of Production, 4Q (ABB's own development method), TPM, Process Flow Chart, VSM (Value Stream Mapping), etc.
- then starting some smaller development projects and after that a bigger one

Agreements
- official agreement between HMUAS and ABB
- official agreement between the student and ABB
- ABB gives working clothes and shoes
- ABB pays travel costs and offers the lunch
- students are insured by HMUAS
- salary is not paid -> freedom to transfer the student easily to different sections of production - student does not have pressure for being successful in his work. Learning and opportunity for showing his abilities and a chance for getting a job are the "incentives" of the student.

Contents of internship
Core of the work is *development of production processes* - no acute themes or problem solving. Some examples of themes:

- designing and applying new and more productive devices for production process
- checking the status of work instructions, product manuals and up-to-dating them
- disturbance logging
- CIP projects in incremental steps
- implementing 5S principles into different sections of production process
- arranging material logistics inside the factory
- creating instruction rules for user maintenance (TPM), testing them and making the rules better - this is one part of visual management implementation which consists of monitoring tables for production control, CIP and TPM (Total Productive Maintenance)

Throughput time models (13 all together) will be taught as well as WIP (Work in Process) thinking and such. Among others, students will attend meetings of investment projects.

The work managers on the shop floor and selected people (trainers) will act as teachers. They teach new people in order to be able to work effectively in the factory.

Guidance in the project work is given by the teams of production development and quality & process development.

Rules
General working rules are the same for full time workers and for students, but student's working hours are not controlled.
Students will keep a diary about the work contents and hours, and this will be part of their final reports to the university. Students are evaluated by the responsible specialist of ABB.

4. Graduation thesis

Graduation thesis works (15 ECTS credit points), were started in 1994. ABB factory will take 5 students (4^{th} year) per year for the graduation thesis work two of them being students of production technology.
These works are wider in scope than the other projects, but *the results have not been as useful as* of those of the 400 hour projects and innovation projects.

ABB's motivation for the co-operation

Results from the company's point of view:
- production development with very low cost
- excellent and a low risk way of recruiting new engineers: low cost , mistakes by recruiting wrong people are almost non-existent
- economic goal: gain/effort > 1
- after graduation the student is ready to start being active and productive in his work - there is no need for a long study period inside the company
- the student already more or less knows the products, production process and the people designing, developing and running them
- taking care of company's responsibility for the society, - good name and reputation of the company for instance among the students the becoming specialists

HMUAS's goals for co-operation activities

HMUAS is responsible for educating up-to-date high level engineers for Finnish business and industry. Without a very close co-operation with surrounding industrial companies this could not be possible. HMUAS cannot give training and project subjects like ABB's to be made inside the university campus. There are not such real-life situations or highly specified people managing the designing and production of an electric motor for instance.

Co-operation with companies like ABB is adding the knowhow of the teachers and forcing them to use the most modern contents in teaching.

Student's motivation

in training, innovation projects, internship and graduation thesis at ABB:

- learning by doing in real-life situation, which cannot be arranged at the university

- all the important steps and processes in making a product can be seen and experienced

- the opportunity to see and feel if this profession is good , if the company is ok, if the spirit of doing in the company is ok, etc.

- gives the student better possibilities for employment in the future

- bringing changes in the production is a socially demanding task - student will learn social communication skills especially during the 400 hours internship project.

Directions for the future

- this should be a HR (Human Resources) process in the future - now it is too much depending on the will and activity of very few people
- students of product design, machine automation, environment and energy engineering, economics, etc. are welcome
- more opportunities for international exchange students (Haapaniemi et al, 2013)
- international relations and possibilities of HMUAS should be more clearly known in the company - summertime workers from abroad could be invited in co-operation with HMUAS
- more active reporting of the activities and results of the co-operation
- reward (bonus system) according to the benefits of the results of innovation and other projects
- inside the company the project subjects should be more closely related to the strategic steps of the company development.

Discussion

The four steps of real-life studies at ABB IM factory have so far been very successful for students of production technology on the road of becoming active mechanical engineers. Student's motivation is high for learning outside of the school buildings in real-life situations.

Working with industrial companies keeps the educational institutes up-to-date with the applications and solutions of new technologies.
This way ABB has got many talented young engineers in a very intellectual recruitment process for the development of production processes.

Conclusions

When starting active co-operation between HMUAS and ABB 12 years ago the whole classroom of 17 students made their internship at the Induction machine factory of ABB Helsinki.
Now annually some 15 students will make their innovation projects in this factory, often continuing with the internship (4 students per year) and graduation thesis work. Until now more than 60 students have done the 400 hours internship project and at least two of them every year have made their graduation thesis. More than one student each year has been recruited after the graduation. So 12 to 15 students have got a full time work by walking this road (Fig.1). *We have reached a win-win-win situation*:

Training -> Internship -> Innovation project -> Graduation thesis -> Trial period of 4 months -> Full time worker of ABB

Fig. 1 One of the roads to become a full time worker of ABB company

Acknowledgements

We are grateful to large number of Finnish companies, especially to ABB Helsinki, which has given opportunities to apply CDIO for educating engineers of HMUAS.
ABB Helsinki factory is a model place for installing the four levels of studies: technical training, innovation projects, internship and graduation thesis work. The results of this co-operation are excellent. We have to continue and make it even better.
This will be a very promising road to success for engineering industries.

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RECENT PROGRESS OF INTERNATIONAL ACTIVITIES IN NATIONAL INSTITUTE OFTECHNOLOGY (NIT), TSURUOKA COLLEGE

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Abstract

National Institute of Technology (NIT), Tsuruoka College has been enhancing its international activities, such as accepting short term foreign students in our school and sending our students for English training, short term research program, etc. These activities have been carried out with kind collaborations of the foreign higher education institutions. Through these efforts, the number of the students who visit foreign country is increasing dramatically and exceeded sixty last year.

This paper will discuss the effects of these programs, especially for the enhancements of student's motivations and the improvements of their English abilities.

Keywords: *Student Exchange, Study visit, Intercultural Exchange, English Training, Communication Ability, Motivation Enhancement*

Introduction

In National Institute of Technology (NIT), Tsuruoka College, we, members of the office of international exchange affairs, have been worked for enhancing international activities under the supervisions of our presidents in these years. Our basic activities are accepting short term foreign students in our school and sending our students for English training, short term research program, etc. with kind collaborations of the foreign higher education institutions in France, Finland, Thailand, and Singapore.

As a first step, we started more accepting foreign students in our school and made them study in our laboratory under the advising of our professors. They also lived in our dormitory with our students. These situations give more opportunity to our students to talk with foreign people and know the difference of the mutual cultures, which gives our students more interests in foreign cultures and more desires of communication abilities.

Secondly, we planned more foreign programs for our students to study English abroad; especially we concentrated in encouraging younger age students to apply. The periods of these programs are about 10 days to 2 weeks; however, we consider they are the adequate periods for our students because many of them are their first visits in foreign countries. We chose Singapore as a visiting country and planed English training programs with collaborations of Ngee Ann and Temasek Polytechnics and from 2015 we start to plan these English programs twice a year. Beside these programs, we also prepared much longer programs visiting Thailand, France, and Finland as a research program. Some of them are performed as consortium activities of Tohoku KOSENs (NIT, Colleges).

Through these efforts, the number of the students who visit foreign country is increasing dramatically and exceeds 60 students last year. In this paper, we will discuss our programs in detail and the effects of the programs, especially for the student's motivations and the enhancements of their English abilities.

Methods

We summarized the number of the accepted and sent students to foreign countries to reveal the enhancement of our international activities. In addition, we also made interviews to our students, who joined our projects and surveyed their score before and after the visits to investigate the effects of foreign country visits of our students on their ambitious,

Results and Discussion

１． Transition of numbers of accepted and sent students in these years

Figure 1 shows the transition of the number of accepted students to our college. The definitions of "short" and "long" term visits are one or two weeks and more than one month, respectively. The short term visit is a kind of study tour, which involves more than 10 students accompanied with their teachers. On the contrary, the long term visit is more research oriented. They visited our college by themselves and studied experiments in our laboratories.

As can be seen in fig. 1, the number of students who visited our college is increasing, which makes our college more internationally. We made an effort to enhance cross-cultural relationships between the visited foreign students and our students. Some of our students made their decisions to apply foreign country visit because of this cross-cultural relationships at our college.

Additionally, we also had some fruitful results. One long term visit student published his research paper based on his research in our college with our professor. The other case is a female student who entered the Graduate school of Yamagata University in Japan, after her graduation of university. The reason why she choose Japanese graduate school was she liked Japan and Japanese culture very much during her stay in our college and a professor of our college, who was an adviser when she was in our college, introduced an suitable professor at Yamagata University for her future research. In this way, the acceptance of the foreign students has good influence not only for the foreign students but also for our students.

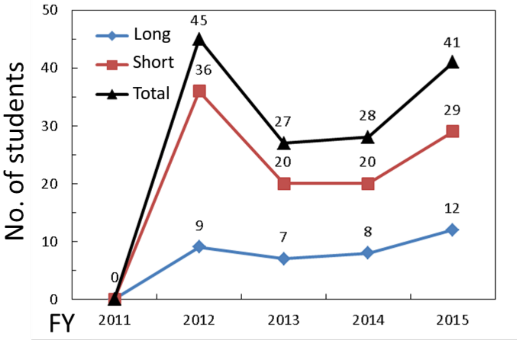

Figure 1 The transition of the number of accepted students to our college with fiscal year (FY).

Figure 2 shows the variation of the number of students sent to foreign countries. The definitions of “long” and “short” term are the same as those of the accepted students.

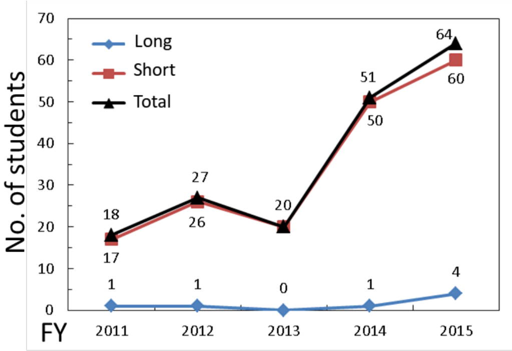

Figure 2 The transition of the number of sent students from our college with fiscal year (FY).

As can be seen in this figure, the number of students who visited to foreign countries has been increasing dramatically. In 2015, it reaches 64, which means about 5% of our students went abroad using our programs a year. In addition, long term visits are also increasing despite they must feel some difficulty to visit long terms because of their tight curriculums.

We consider this kind of experiences would make some influence on their future scope as future engineers, especially for the younger students under 18. Thus, we made case studies by surveying some students who visited foreign countries.

2． Case studies of our visited students

We interviewed three students who went abroad as Cases A to C and surveyed their scores as follows;

1. Case A

Case A is a male student who attended the Singapore study trip in Ngee Ann Polytechnic on March 2015. It was his first experience for going abroad. His parents were pleased to have this opportunity, because they considered the cost of 240,000 yen was reasonable and the program was trustful as a school program. He got the 100,000yen scholarship from Yamagata Prefecture.

His purposes for going abroad are

1. Want to see the different country
2. Want to make many friends
3. Want to improve English.

When he was in Singapore, he felt very comfortable and had a lot of fun. Easy transportation, variety of food, friendly students, multi culture society, and so on. That experience made him positive attitude to the global opportunities. He went to the King Mongkut's Institute of Technology Ladkrabang (KMTIL), Thailand to develop his research in only 5 months after his Singapore experience. In addition, he is planning to attend the summer program of Tai-Nichi Technical University (TNT) in Thailand in this summer.

The progress of his English grade and overall score in the class is summarized in Table 1. His motivation for studying English is very strong now. His TOEIC score is now 510, he is studying English especially developing vocabulary for getting at least 600. He would like to take a master degree, and work for the Japanese company abroad branch. His career goal is to be a bridge person between Japan to other countries.

Table 1 Result of survey of Student Case A

	English grade	Class rank
Former year	Excellent	5 out of 40
The year going abroad	Excellent	3 out of 40
Later yeard	Excellent	13 out of 42

2. Case B

She is a female student attended the Singapore study trip in Ngee Ann Polytechnic on March 2015. It was her first trip going abroad. At first, her parents were surprised to hear about her decision because they considered the cost of 240,000 yen was too expensive and they did not have any oversea experiences. She persuaded her parents and she paid a part of the program cost by herself. Her scholarship was 30,000yen from NIT, Tsuruoka College funding based on the donation by Yoshino Gypsum Co., Ltd.

Her purposes for going abroad were

1. Want to see the different country

2. Want to make many friends
3. Want to improve English, same as other students.

She enjoyed her time in Singapore and made a lot of friends. She still has contacts with them via the Social Networking Service (SNS). She was impressed by Singlish, Singaporean's quick speech, beautiful night view, many gardens in Singapore.

The progress of his English grade and overall score in the class is summarized in Table 2. Her motivation for studying English became stronger. She enjoys watching movie with its original language, listening to the American music with thinking its lyrics, watching CNS without seeing the Japanese translations. Now her TOEIC score is 440, she challenges to take 700 in her college study.

She goes to Nagaoka University of Technology and plans to take a master degree. Her career goal is finding a research job and collaborates to foreign company.

Table 2 Result of survey of Student Case B

	English grade	Class rank
Former year	Excellent	5 out of 40
The year going abroad	Excellent	3 out of 42
Later yeard	Excellent	2 out of 43

3. Case C

A male student attended the Colorado study trip in the U.S.A. on March 2013. It was his first trip to abroad. At first, his parents didn't understand why he wanted to go to the U.S.A. His parents had never been to abroad and the cost of the program was about 450,000 yen was very expensive. He negotiated his parents and joined to the program instead of taking driver's license, used money on his overseas experience. He was very pleased when he received 100,000 yen scholarship from school, which was a funding based on the donation of Yoshino Gypsum Co., Ltd.

His purpose for going to the U.S.A is "curiosity". He hoped to see something new and make a chance to start studying English. His experience in the U.S.A. was just "shock". According to him, it was his turning point in his life. Because of visiting the solar power system in Colorado, he decided to study at the upper school. Through 2 weeks experiences, he learned the importance of conveying his idea to others not only speaking English but also non-verbal communication and strong will.

The progress of his English grade and overall score in the class is summarized in Table 3.

Table 3 Result of survey of Student Case C

	English grade	Class rank
Former year	Excellent	2 out of 38
The year going abroad	Excellent	2 out of 38
Later yeard	Excellent	3 out of 38

Nowadays, English is very important communication tool. He tries to improve his English skill for making presentation at the international conference and communicate with foreign researchers. His TOEIC score is 565. He is planning to go to the master degree course at Nagaoka University of Technology, and has possibility to take doctor course, also. Both of his parents are high school graduates. He explains and negotiates his future plan with parents.

As can be seen in these three cases, foreign country visits affect the ambitiousness of the students and the scope for their future life plans. We believe the visits would give the good influences on their life. We believe continuing this kind of programs is quite important to make our student's mind more internationally.

Conclusions

In this paper, we discussed the effects of the international collaborations on our collegee and our students and found they are very effective to enhance international activities, which are required ability for mordern engineers. In addition, a new collaboration with foreign countries like a continuous work with foreingn institutions with publishing papers had been arising as a side effect. We consider this kind of collaboration is indispensable for our professors to satisfy their research accomplishements.

We also surveyed three students and found their foreign country visits in their younger ages quite affect building their future plans and affect their ambitiousness. In addition, we consider the changes of the personality of these students would also make some influence to students who were not going abroad. We believe this kind of foreign country visit in the youth stage is quite effective to grow future engineers who can work globally and continuous work on the international collaborations is quite important to make our college more internationally.

In conclusion, we consider we still need to continue our program not only for our students but also for our professors.

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THE SECOND COLLABORATIVE TRAINING PROGRAMME BETWEEN NIT, NAGAOKA COLLEGE AND ADTEC MELAKA IN PRACTICAL DESIGN AND MANUFACTURING

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Abstract

National Institute of Technology (NIT), Nagaoka College and Advanced Technology Training Centre (ADTEC) Melaka signed an academic exchange programme on November 6, 2014. ADTEC Melaka is fully governed by Manpower Department (JTM) of the Ministry of Human Resources, Malaysia. The first collaborative training programme between Nagaoka College and ADTEC Melaka was conducted from May 11 - June 5, 2015. The aim of this programme was to assist ADTEC Melaka lecturers in developing the robot using current technology. In ensuring the effectiveness of the training, project based approach which includes planning and developing of the robot mechanism had been used in cooperation with the Nagaoka College's lecturers using the college's facilities. The detail of the training programme was reported by Nakamura et al. (2015) at ISATE2015. This paper reports the second collaborative training programme between Nagaoka College and ADTEC Melaka in practical design and manufacturing. Fifteen students and two professors of Nagaoka College visited ADTEC Melaka to attend the second collaborative training programme which was conducted from August 21 – September 1, 2015. The aims of the second collaborative training programme were to give Japanese and Malaysian youth students the opportunity to know each other and to gain learning experience through problem-based learning approach. This training programme covered a fundamental and hands-on experience on design, fabrication, programming and operation of a robot.

Keywords: *Collaborative training, Problem-based learning, Robot competition, LEGO mindstorms, Line trace*

1. Introduction

The Manpower Department is one of 13 departments in the Ministry of Human Resources, Malaysia. The responsibilities of the Manpower Department are to provide skills and educational training for secondary school graduates and workforce, maintaining good relationship with the industry to ensure employability of its graduates, and to improve the quality of its instructors/lecturers.

The Manpower Department's Training Institute or Institusi Latihan Jabatan Tenaga Manusia (ILJTM) was founded to carry out pre-employment skills training programmes in order to fulfill the nation's industrial sector needs. At present, there are 27 technical institutes consisting of 20 Industrial Training Institutes (ITI), four Advanced Technology Training Centres (ADTEC) and one Japan-Malaysia Training Institute (JMTI).

ADTEC Melaka was erected under the 7th Malaysia Plan and commenced operations in 2001. It is one of four ADTECs in Malaysia. The first students' intake was on January 2002 with 88 students as the pioneer batch. ADTEC Melaka was officiated by the former Prime Minister of Malaysia, Tun Abdullah bin Haji Ahmad Badawi, who was the then Deputy Prime Minister, on 11th January 2003 in the presence of Melaka Chief Minister Y.A.B Datuk Seri Hj. Mohd Ali Bin Mohd. Rustam.

ADTEC Melaka offers technology programmes at Diploma and Advanced Dioploma levels. The curriculum for all programmes are designed to have 60% practical and 40% theory. There are six full time courses offered to students which are as below:

Diploma in Production Technology
Diploma in Mechatronics Technology
Diploma in Telecommunications Technology
Diploma in Computer (Systems) Technology
Diploma in Automotive Technology
Advanced Diploma in Production Technology

NIT, Nagaoka College was established in 1961 under the Ministry of Education, Culture, Sports, Science and Technology, Japan. Based on the Japanese Government's policy, all 55 National Colleges including Nagaoka College were incorporated as a new single legal entity in 2004 and are now under the umbrella of the National Institute of Technology, Japan. However, each college maintains its independent authority.

Nagaoka College is an established College of Engineering, focusing on Mechanical Engineering, Electrical and Electronic Systems Engineering, Electronic Control Engineering, Materials Engineering and Civil Engineering, which strives to produce young practical engineers of ability in a five-year higher education system along with two more years Advanced Courses to meet the strong demand from industry.

Nagaoka College and ADTEC Melaka have signed an academic exchange programme on November 6, 2014. The first collaborative training programme between Nagaoka College and ADTEC Melaka was conducted from May 11 – June 5, 2015. This collaborative training programme was project based approach on the SolidWorks and TETRIX robotics. The aim of this programme was to assist ADTEC Melaka lecturers in developing the robot using current technology. In ensuring the effectiveness of the training, the project based approach which includes planning and developing the robot mechanism has been used in cooperation with the Nagaoka College's lecturers using the college's facilities within four weeks. This training programme actively engaged the participants in design using SolidWorks2014, prototyping with ink-jet and FDM type 3D printers, programming and controlling LEGO and TETRIX Robotics.

2. The second collaborative training programme

The second collaborative training programme between Nagaoka College and ADTEC Melaka in practical design and manufacturing was conducted from August 21 – September 1, 2015. Fifteen students and two professors of Nagaoka College visited ADTEC Melaka to attend the second collaborative training programme. The aims of the second collaborative training programme were to give Japanese and Malaysian youth students the opportunity to know each other and to gain learning experience through problem-based learning approach. To foster originality and ingenuity of students, Nagaoka College and ADTEC Melaka students worked together to participate the robot competition. The programme schedule of the second collaborative training is shown in Table 1. The major activity of the second collaborative training programme was group work to build a robot using LEGO robot. Besides that, there were a factory tour at Hino Motors Malaysia and sightseeing in Kuala Lumpur city to enlarge students' knowledge or information about Malaysia.

Table 1 Programme schedule of second collaborative training.

August 21, 2015 Friday	**1:30 – 5:30 pm**	**Nagaoka City → Narita City**
August 22, 2015 Saturday	**11:20 am - 5:45 pm**	**Narita Airport (Jal 723) → Kuala Lumpur International Airport**
	8:00 pm	**ADTEC Melaka Guest House**
August 23, 2015 Sunday	**9:30 – 11:30 am**	**Melaka Zoo**
	12:00 – 1:30 pm	**Lunch**
	2:00 – 5:30 pm	**Sightseeing in World Heritage Site, Melaka City**
August 24, 2015 Monday	**9:00 – 10:00 am**	**Opening Ceremony Campus Tour: Administration Office**
	10:00 – 12:00 pm	**Campus Tour**
	12:00 – 2:00 pm	**Lunch**
	2:00 – 5:00 pm	**Grouping – 5 Groups Group Work using LEGO Robot.**
August 25, 2015 Tuesday	**9:00 – 12: 00 pm**	**Group Work using LEGO Robot**
		Lab / Workshop Tour
	12:00 – 2:00 pm	**Lunch**
	2:00 – 5:00 pm	**Competition Briefing Group Work using LEGO Robot**
August 26, 2015 Wednesday	**9:00 – 5:00 pm**	**Factory Tour: Hino Motors Malaysia**
		Lunch
		Army Museum Upside Down House
August 27, 2015 Thursday	**9:00 – 12: 00 pm**	**Group Work using LEGO Robot @Campus Satellite**
		Lab / Workshop Tour
	12:00 – 2:00 pm	**Lunch**
	2:00 – 5:00 pm	**Group Work using LEGO Robot**
		Lab / Workshop Tour
August 28, 2015 Friday	**9:00 – 12: 00 pm**	**Group Presentation Competition using LEGO Robot Closing Ceremony**
	12:00 – 2:00 pm	**Lunch**
	2:00 – 5:00 pm	**Free Time**
August 29, 2015 Saturday	**9:30 – 5:30 pm**	**Sightseeing of Putrajaya**
		Prime Ministers Official Residence
		Lunch
		Check into Hotel
		Sightseeing in Kuala Lumpur City
August 30, 2015 Sunday	**9:30 – 5:30 pm**	**Sightseeing in Forest Research Institute Malaysia (FRIM)**
		Lunch
		Batu Caves
August 31, 2015 Monday	**9:00 – 5:30 pm**	**Tour of the City (Independence Day Ceremony)**
		Lunch
	6:00 – 7:00 pm	**Dinner**
	10:50 pm	**Kuala Lumpur International Airport 22:50 (Jal 724)**
September 1, 2015 Tuesday	**7:05 am**	**Narita Airport 7:05**
	9:27 – 12:14 pm	**Narita Airport → Nagaoka City**

On carrying out the robot competition, we made a few safety guidelines as safety is the most important issue to continue the robot competition in the future. Therefore every participant has a duty of developing robot safety. On the ethical aspect, keeping workplace safety is a must because and it will not only minimize the delay of robot development but also promote the completion of robot according to the schedule if unexpected incident occurs. Every participant in Nagaoka College and ADTEC Melaka must conform to the "Importance of Safety" guided in the rulebook provided by Nagaoka College and ADTEC Melaka Robot Competition Committee. All participants must build the robot under sufficient safety measures.

During the group work using LEGO robot, fifteen Japanese students and ten Malaysian students took part in the training programme. They were divided into five teams. Each team was comprised of five students: three students from Nagaoka College and two students from ADTEC Melaka as shown in Figure1.

Figure 1 Each team consists of five students: three students from Nagaoka College and two students from ADTEC Melaka.

The game field for the robot competition is shown in Figure 2. The game field consists of an area having the dimension of 1200 mm x 2400 mm made from emulsion painted plywood. There are two obstacles (rings) in which the robot has to avoid. Each ring has the dimension of 12 mm width with 200 mm for the inside diameter. Only three students in each team are permitted to enter the game field.

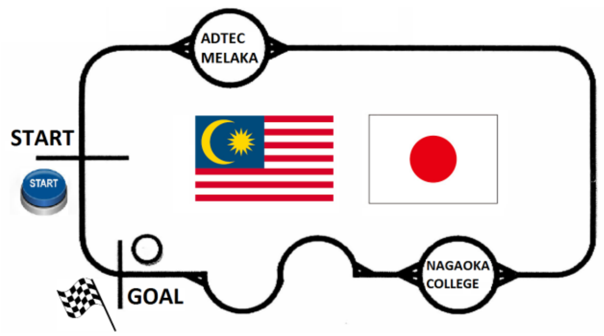

Figure 2. Game field for robot competition.

There are also game rules developed for the robot competition. To participate in the robot competition, each team must construct an automatic robot using LEGO robot (Mindstorms EV3). Each game must be completed within three minutes with one automatic robot per team. The automatic robot must move around the circuit from start until end of the flag. The automatic robot must avoid two obstacles in the circuit. The game is completed and ended immediately if any automatic robot kicks the ball at the end of the circuit. The first team to arrive at the end line wins the match regardless of the time remaining. If neither team achieves the match within three minutes, the team with more scores wins the match.

The three-minute game will start right after the one-minute preparation time after referee gives a set up signal. The automatic robot must start at the start line. Once the automatic robot starts, team members are not allowed to touch the robot.

If any of the teams requests for "Retry", it must be acknowledged by the referee. Once "Retry" request is granted, the team member must bring the robot that needs to be retried back to the starting line and restarts the robot as soon as possible.

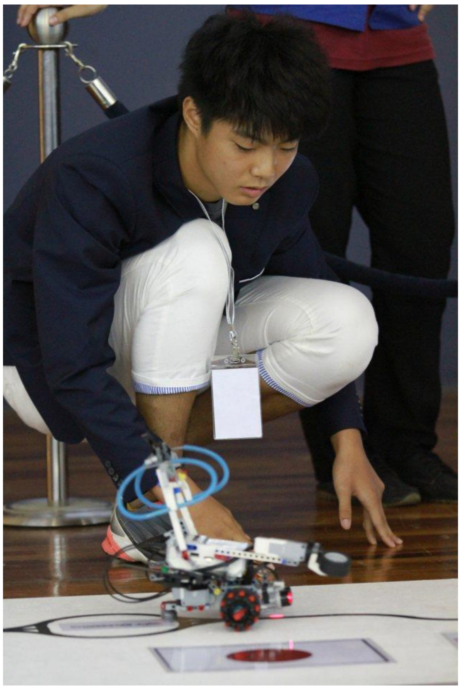

Figure 3 Robot competition.

For the scoring rules, the team will gain points when the robot successfully avoids obstacle in the circuit (30 points/obstacle), kicks the ball (10 points) and reaches at the end line (30 points). The violation of the game is defined if any robot moves out from the game field or starts before referee's whistle or signal. Ten points will be deducted for these violations.

During the robot competition, referee judges the winner by acknowledge the first team to reach at the end line and manage to kick the ball. If the two teams reach at the end line and kick the ball at the same time or neither team reaches within three minutes, the winner is decided by the total scores after points deduction in that match (if any). Figure 3 shows one scene in the robot competition.

On August 26, 2015, the students of Nagaoka College and ADTEC Melaka visited Hino Motors Malaysia as shown in Figure 4 and Figure 5. Today, Hino Motors is Japan's No.1 diesel truck maker and one of the world's leading manufacturers of medium and heavy-duty vehicles with exports to more than 140 countries around the world. The person in charge of Hino Motors Malaysia showed the students how to manufacture several types of vehicles. He told the students that Malaysia is quickly growing as Hino's third major ASEAN market, and expected to continue growing as a major market after Indonesia and Thailand. Indonesia and Thailand are currently growing to become regional core production bases and the ties between these bases will be strengthened to optimize the production and supply structure within the region.

Figure 4 Hino Motors Malaysia.

Figure 5 History explanation of Hino Motors Malaysia.

At the end of programme, Nagaoka College students went to Kuala Lumpur for sightseeing. Figure 6 shows canopy walkway in the Forest Research Institute Malaysia (FRIM). FRIM is founded in 1929 and one of the leading institutions in tropical forestry research in the world. The institute sits on a 545-ha site adjacent to the Bukit Lagong Forest Reserve in the Kepong municipality, 16 km northwest of Kuala Lumpur.

After returning to Japan, the students who took part in the second collaborative training programme held a presentation about the programme on October 31, 2015. Figure 7 shows the presentation about the second collaborative training programme. The students shared their experience with Nagaoka College's students,

Figure 6 Canopy walkway in the Forest Research Institute Malaysia.

Figure 7 Presentation about the second collaborative training programme.

parents and the college's staff. Students' feedback mentioned that the collaborative training programme gave them a rare oppotunity on interaction with foreign students and they had very significant educational benefits, such as improving communications skills and stimulating motivation for learning English. All students hope that they can go to ADTEC Melaka and Malaysia again if the chance arises.

3. Conclusions

In order to conduct the second collaborative training programme between Nagaoka College and ADTEC Melaka in practical design and manufacturing, fifteen students and two professors of Nagaoka College visited ADTEC Melaka. The aims of the second collaborative training programme were to give Japanese and Malaysian youth students the opportunity to know each other and to gain learning experience through problem-based learning approach. This training programme covered a fundamental and hands-on experience on design, fabrication, programming and operation of the robot.

This programme is the second step to develop strong relationship between Nagaoka College and ADTEC Melaka. There is also a plan to have another mutual exchange programme between both institutes this year.

Acknowledgements

We sincerely appreciate Ms. Chin Phaik Yoong, Director General of the Manpower Department of the Ministry of Human Resources, Malaysia, giving us the opportunity to do the collaborative training programme.

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Promotion of JICA project for Human Resources Development in Vietnam through Kosen model

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Abstract

In economically developing countries in Asia, introduction of a Japanese engineering educational model is attracting attention for improvement of education and research quality. A human resources development (HRD) project aimed at promoting Kosen education is in progress at the Industrial University of Ho Chi Minh City (IUH) in Vietnam through the Japan International Cooperation Agency (JICA) with support from the National Institute of Technology (NIT). From the start, NIT, Akita College has been involved in this project. Two of the authors have provided technological support to IUH as long-term experts in diverse fields including engineering education, research activity, industry–university cooperation, and employment assistance. Furthermore, IUH has established a new course: the "High Quality College Program (HQCP)". As part of the technical transfer in active learning associated with the project, we shall introduce educational events such as robot contests, which have become a feature of the NIT in Japan, to Vietnamese industrial universities.

Keywords: *HRD project, design competition, technology transfer, educational event, KOSEN education*

1. Introduction (JICA Project)

Vietnam has shown remarkable economic and industrial growth during the last decade. Further growth is expected as the Vietnamese government aims to become an industrialized country by 2020. To promote industrialization, the promotion of industries related to energy and industrial chemicals has become an important issue. Development of human resources for practical and creative engineers has become an extremely important issue as well. However, in Vietnam, the development and training of engineers with advanced knowledge and skills has not been emphasized. Because training courses of practical engineers are extremely limited throughout the country, shortages of highly skilled engineers are growing increasingly severe. In this context, the government of Vietnam requested that the government of Japan carry out technical cooperation projects for human resource development for the heavy chemical industry, especially the petroleum refining industry. Following the request, a Japanese technical cooperation project "The Project for Human Resources Development for Heavy-Chemical Industry at Industrial University of Ho Chi Minh City" was initiated by JICA in collaboration with its Vietnamese governing agency, the Ministry of Industry and Trade (MOIT), as well as the National Institute of Technology in Japan. The project is designed to assist IUH headquarters in Ho Chi Minh City (IUH HCMC), in particular its branch in Thanh Hoa (IUH TH), in supplying competent production engineers who can ensure the productive operation of large heavy chemical plants through the capacity development of IUH lecturers and improvement of related training programs. As for the Japanese side, the National Institute of Technology acts as a coordinator and NIT, Akita College has been selected as one institution for practical work. Two teachers of NIT, Akita College were dispatched to Vietnam in succession as long-term experts for each 1 year and were subjected to technical guidance in Vietnam. The Project, intended to develop a model education program that provides practical and creative engineers, was started in November 2013 as a three year plan.

This paper provides an overview of the project. Then it describes details of our activities and the current state of the project. Finally, we describe efforts and issues related to the project.

2. Kosen Model

First of all, the project specifically emphasized promotion of the following five areas to introduce the Kosen-style education: "safety", "theoretical improvement", "experiments and practical training", "research activities", and "collaboration with industry". Five working groups corresponding to each area were established at both the IUH HCMC and the IUH TH (Later, five WGs were consolidated into three WGs: safety education, research activities, and collaboration with industry). To improve the activity, we continuously applied the Plan, Do, Check, Act (PDCA) cycle. Progress has been monitored using PDCA cycle status sheets in order to promote the improvement activities. Figure 1 presents a sample of the monthly progress and result sheet.

ACTION PLAN OF JICA-IUH PROJECT AT IUH TH

May 2016

Group	Activities	Result	Progress				Upcoming plan
			×	↻	✓	R	
Safety	PJ2: 5S program at campus	3. GREEN – CLEAN – BEAUTIFUL MOVEMENT BETWEEN KOSEN CLASSES Implementation time: from Dec 2015-Oct 2016.					
		- Summarize April		D			
		- Continue in May		D			
	- General activities of group	- Implemented safety checking at experimental classes.		D			
		- Point, mark specific places for equipment in laboratories.		D			
		- Financial proposal for safety contest which will be organized in August		D			

Figure 1 Monthly progress and result sheet.

2.1 Establishment of Kosen Course

Under those circumstances, it was decided to establish a new curriculum called the High Quality College Program (HQCP) in October 2014. Actually, HQCP incorporated some elements of Japanese Kosen education programs. HQCP introduced practical and creative programs focused on wedge-shaped education to help students to improve their learning skills. Curriculum emphasizing scientific experiments, workshop training and practical manufacturing skills. And lecture phase and experiment phase were presented in an organically interrelated manner to generate an upward spiral of knowledge and ability. Five-year consistent engineering education from age 15 is one feature of Kosen education, but IUH chose to integrate the Kosen-style education into the professional college course as HQCP, which is three-year education from age 18. So, it is required to be clear the difference between HQCP and other existing courses. また At the time of preparing a new curriculum, the project advised to be able to introduce the curriculum which can satisfy the standards of the Japanese Accreditation Board for Engineering Education (JABEE).

2.2 Educational improvement

Regarding teaching methods, IUH Thanh Hoa has begun applying Problem-based Learning (PBL) in classes to strengthen students' thinking skill. The project dispatched teachers to several Japanese Kosen (NIT, Tsuruoka College, and others) to learn PBL education in a practical manner. After the teachers experienced a concrete introduction example of PBL in the training, they prepared a lesson which effectively combined passive learning and active learning. Then students studied the lesson conscientiously. The university holds faculty development (FD) meetings at regular intervals to share educational improvements in the university.

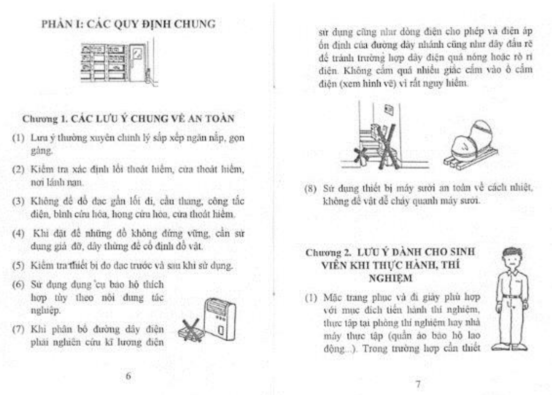
As part of the technical transfer in education improvement, we shall introduce educational events such as robot contests. They have decided to carry out a design competition at IUH TH as a trial. The competition theme, chosen as "Chemical cell car design competition", was made to be a content to work collaboratively with students of the chemical course and the mechanical course in IUH TH. The students were expected to fabricate a competition car that was propelled by a self-made chemical cell, based on their ideas and concepts for a given problem. It was also expected that they competed for technical capabilities, creativity, and team work through the competition. Rules were also fixed, but IUH TH did not have the know-how to operate these competitions. We struggled with schedule coordination. Furthermore, chemical cell cars were not completed on schedule until just before the competition begins because of limited funds for competitions and other difficulties. On the competition day, more than 60 students entered the competition. It was completed successfully. The IUT TH students mutually competed in ideas and technology. Therefore, it became a good opportunity for them to experience the fun of producing chemical cell cars with their own hands based on their own ideas. They were able to recognize the importance of coming up with ideas and were able to share the delight of 'Monodzukuri'. The design competition was expected to be a great achievement not only for the students, but also for the teacher. Figure 2 presents a photograph of the competition.

Figure 2 Photograph of the Competition.

As one of the working-group activities, the project focused on safety education. Safety awareness was not especially high at IUH TH initially: students did not wear white coats and proper shoes during experiments conducted in chemical laboratories. The project introduces 5S activity to understand the reasons for that disregard of safety. Working groups related to safety education created safety posters to improve safety awareness. Understanding of the need for personal protective gear has gradually improved through posters displayed in laboratories.

The WG edited and created a safety manual with reference to the safety manual published at Kosen. The new safety manual has been distributed to new students and is being utilized in the safety activities. Furthermore, the working group undertook efforts to participate in safety activities held at enterprises. Figure 3 shows part of the IUH-created safety manual.

As part of collaborative activities, the establishment of "Technical Assistance Center (tentative name)" is being prepared at the IUH TH. At the technical assistance center, an X-ray diffractometer (XRD), gas chromatograph, liquid chromatograph, Fourier transform infrared spectroscope (FTIR), atomic absorption spectrophotometer and an existing ultraviolet and visible spectrophotometer will all be available. It will be possible to construct cooperative relations with companies and other universities through sample analysis. In addition, the equipment is expected to accelerate research activities. Figure 4 shows the new XRD analyzer.



PHẦN I: CÁC QUY ĐỊNH CHUNG

Chương 1. CÁC LƯU Ý CHUNG VỀ AN TOÀN

(1) Lưu ý thường xuyên chỉnh lý sắp xếp ngăn nắp, gọn gàng.

(2) Kiểm tra xác định lối thoát hiểm, cửa thoát hiểm, nơi lánh nạn.

(3) Không để đồ đạc gần lối đi, cầu thang, công tắc điện, bình cứu hỏa, hong cứu hỏa, cửa thoát hiểm.

(4) Khi đặt để những đồ không đứng vững, cần sử dụng giá đỡ, dây thừng để cố định đồ vật.

(5) Kiểm tra thiết bị đo đạc trước và sau khi sử dụng.

(6) Sử dụng dụng cụ bảo hộ thích hợp tùy theo nội dung tác nghiệp.

(7) Khi phân bổ đường dây điện phải nghiên cứu kĩ lượng điện

6

sử dụng cũng như dòng điện cho phép và điện áp ổn định của đường dây nhánh cũng như dây đấu rẽ để tránh trường hợp dây điện quá nóng hoặc rò rỉ điện. Không cắm quá nhiều giắc cắm vào ổ cắm điện (xem hình vẽ) vì rất nguy hiểm.

(8) Sử dụng thiết bị máy sưởi an toàn về cách nhiệt, không để vật dễ cháy quanh máy sưởi.

Chương 2. LƯU Ý DÀNH CHO SINH VIÊN KHI THỰC HÀNH, THÍ NGHIỆM

(1) Mặc trang phục và đi giày phù hợp với mục đích tiến hành thí nghiệm, thực tập tại phòng thí nghiệm hay nhà máy thực tập (quần áo bảo hộ lao động...). Trong trường hợp cần thiết

7

Figure 3 Safety manual (IUH version).

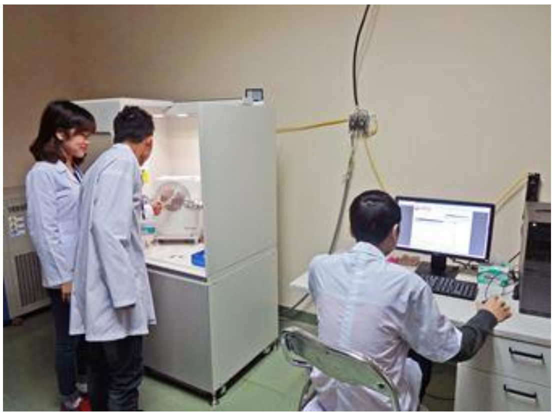


Figure 4 XRD analyzer.

IUH has established a collaboration network with local industries and local communities for human resources development, in particular Nghi Son Refinery and Petrochemical (NSRP), for which Idemitsu is one of major investors. JICA experts have visited enterprises to explore job opportunities for prospective IUH TH graduates. Information obtained through those activities is expected to help the Project promote industry partnerships during the project implementation period. In order to assist employment of graduated students, It is necessary to increase opportunities for students to come into contact with local industries. Therefore, the project is actively promoting internship programs aimed at developing practical engineers trained at production site.

2.3 Difficulties in proceeding the project

During execution of the project, some problems became apparent. One problem is the difference of working styles in Vietnam and Japan. It is difficult to conduct project activities, in part because IUH Thanh Hoa lecturers often moonlight to supplement their incomes, so they do not always stay on campus. In addition, the project implementation structure has not been firmly established at IUH yet. IUH might need to consider structural improvements of their management system.

3. Expansion of project activities to other domestic educational institutions

As the project's achievements at IUH TH were highly recognized, MOIT decided to expand Project activities to other educational institutions. As part of the activities, IUH TH started receiving teachers from other educational institutions under MOIT as trainees for practical understanding of what the Project was doing for application of the Kosen education. As second step, the Project started to directly instruct 3 more target schools in various regions in Vietnam to disseminate Kosen education: Phuc Yen College of Industry, Vinh Phuc province in the North; Hue Industrial College, Hue province in the Central and Cao Thang Technical College, HCMC in the South. The schools have high potential and strengths. The Project is trying to instruct them on not only the methods basically applied at IUH TH but also more suitable methods which reinforce their own strengths. In case that the school has strong relationship with enterprises, the Project instructs it to listen to enterprises' demands carefully in order to send suitable students who satisfy those demands. In case that the school has excellent teachers, the Project instructs it on student research activities such as Engineering Design Education. The schools have high ownership and motivation. The Project expects the schools will become key schools which will disseminate and instruct further schools on Kosen education.

Conclusion

We described an overview and the current state of the project. Although some problems exist in the project, JICA has allowed the project term to be extended. New long-term experts were dispatched from NIT, Ube College. The Project is continuing. We're expecting that IUH proactively and continuously carry out project activities on its own.

Acknowledgments

We would like to express our appreciation to all personnel related to the project.

Presenter Index

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K

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KOSEN
National Institute of Technology, Japan

NANYANG
THE INNOVATIVE POLYTECHNIC

NGEE ANN
POLYTECHNIC

REPUBLIC POLYTECHNIC
DISCOVER. TRANSFORM. ACHIEVE

SINGAPORE POLYTECHNIC

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