ISATE 2015 NAGAOKA

The 9th International Symposium on Advances in Technology Education

A New Insight for Future Engineering and Educational Systems

16-18 September 2015



The 9th International Symposium on Advances in Technology Education

16-18 September 2015, ISATE Nagaoka

KOSEN
National Institute of Technology, Japan

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長岡工業高等専門学校
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About the Symposium

The theme for ISATE 2015 is "A New Insight for Future Engineering and Educational Systems".

16-18 September 2015, ISATE Nagaoka

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 is as follows:

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 NNCT). 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 Kosens in Japan and all polytechnics in Singapore are part of ISATE.

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ISATE 2007 - Temasek Polytechnic, Singapore
ISATE 2008 - National Institute of Technology ,Kumamoto Coliege
ISATE 2009 - Singapore Polytechnic, Singapore
ISATE 2010 - National Institute of Technology, Kagoshima College
ISATE 2011 - Republic Polytechnic, Singapore
ISATE 2012 - National Institute of Technology, Kitakyushu College
ISATE 2013 - National Institute of Technology, Nara College
ISATE 2014 - Nanyang Polytechnic, Singapore
ISATE 2015 - National Institute of Technology, Nagaoka College

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- National Institute of Technology, Japan
- Nanyang Polytechnic, Singapore
- Ngee Ann Polytechnic, Singapore
- Republic Polytechnic, Singapore
- Singapore Polytechnic, Singapore
- Temasek Polytechnic, Singapore
- Nagaoka University of Technology, Japan
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Invited Oral Session

16 Sep 2015 (Wed)

Time	*Title*	*Name*	*Institute*
10:50~	Engaging Today's Millennials using Curriculum based on Chemical Product Design	Mr. Sin-Moh Cheah	Singapore Polytechnic
11:05~	Activites of Global Technology Education in Nagaoka-KOSEN-Toyohashi	Dr. Matsuda Atsunori	Toyohashi University of Technology
11:20~	Academic Awards : Towards the pursuit of T&L Excellence in NP	Ms. Tan Hui Leng	Ngee Ann Polytechnic
11:35~	Safety Design in the Age of Anthropocene	Dr. Mikami Yoshiki	Nagaoka University of Technology
11:50~	Professional Development of Lecturers in Polytechnics: The RP's Experience	Mr. Kiu Cheong Mau	Republic Polytechnic
12:05~	The Mexican Kosen at The University Of Guanajuato: An Innovative Approach in Technological and Scientific Education through International Cooperation	Dr. Elias Ledesma	University of Guanajuato

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10:20~	Developing World-ready Professionals: An outcome-based, practice-driven approach by NYP	Mr. Michael Cheong	Nanyang Polytechnic
10:35~	Developing a Virtual Reality-based Simulation System for Practical Training in Vocational Education and Training	Dr. Eric Liu	Hong Kong Institute of Vocational Education
10:50~	Critical success factors in designing Gamification for Asian tertiary level students	Mr. Jonathan Pillai	Temasek Polytechnic
11:05~	Development if the International Collaborations at the International College, KMIL	Dr. Natthapong Jungteerapanich	King Mongkut's Institute of Technology Ladkrabang
11:20~	Education for Technology Transfer in Higher Education	Mr. Tanasin Yatsungnoen	Thai-Nichi Institute of Technology
11:35~	Faculty Development Program for Nurturing Global Education and Research Abilities	Dr. Iwashita Tsutomu Dr. Akazawa Shin-ichi	NIT, Ariake College NIT, Nagaoka College

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Invited Oral Session

ENGAGING TODAY'S MILLENNIALS USING CURRICULUM BASED ON CHEMICAL PRODUCT DESIGN

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Abstract

This paper offers a curriculum model from the Diploma in Chemical Engineering of Singapore Polytechnic that takes on the challenge of providing an educational context to enhance engagement and meaning for many of our students, which are often referred to as the "millennials". They are often depicted as very different in certain fundamental aspects as compared to students from previous generations. Specifically, the paper shares our approach in using the CDIO Framework (www.cdio.org) in designing a 3-year curriculum to meet this challenge. The approach is also applicable to other engineering programs seeking to re-design the curriculum for similar outcomes. It firstly summarizes the attributed characteristics of today's millennials; and why a different curricular form and focus is necessary, with special emphasis on the context of chemical engineering education. Secondly, the "traditional" approach in chemical engineering education, which is based on chemical process plant design using computer simulation and modeling is outlined, and certain key limitations identified. We suggest that this approach is not particularly effective in engaging students in learning as no chemical plants actually get built. The paper then proposes that chemical engineering education should include the teaching of chemical product design in order to complement the teaching of process plant design. To develop the new curriculum, we introduced various "soft" skills into our diploma via two threads: one by integrating CDIO skills (such as teamwork, communication, thinking skills) in various core modules; and another by integrating C-D-I-O (conceiving, designing, implementing and operating) skills in creating innovative chemical products or systems as students' final year capstone project. The result is a curriculum model that simultaneously delivers two important outcomes: a) students who are motivated to learn chemical engineering as they are able to apply that knowledge for the betterment of the less-privileged members of the community and; b) graduates who are desired by employers for their deep knowledge in chemical engineering and competency in chemical plant operations. This paper also emphasizes certain unique features of the curriculum model highlighting examples of student projects with innovative chemical products.

Keywords: *chemical engineering, chemical product design, sustainable development, design thinking*

Introduction

Singapore Polytechnic (SP) has articulated its mission to be "a future ready institution that prepare our learners to be life ready, work ready and world ready', and that its vision is to nurture "a caring community of inspired learners committed to serve with mastery." These are most appropriate in positioning the institution to respond to today's fast changing world, where the purpose of education has evolved to better prepare students beyond classroom learning and the immediate working world. Education now needs also to equip students with knowledge, skills and attitudes essential for tackling the broader challenges of life in the 21st century.

This is especially important for today's students, often referred to as millennials, which approach their learning and have expectations quite differently from students of yesteryear. Millennials are generally framed as those born between 1982 and 2000, and are attributed to have "different" interests, goals, and learning preferences than students in the past (Taylor & Parsons, 2011). Millennials want to see relevance and meaning in what they are asked to learn and do, and they also like more immediate gratification and recognition - they need to feel like what they are doing is important and that they are on the right track, as perceived by them. Millennials also display a short attention span and are easily distracted. There is therefore a need to engage these students differently. Although he did not use the term millennials, Prensky (2005) refers to these students as those who "tune us out." They live in a world that engages them differently than the world that we experienced. They find school much less interesting than the myriad of devices they carry in their pockets and backpacks. They are growing up in a world in which musicians, movie makers, TV stars, game designers, etc working very hard to earn their attention. When what is being offered isn't engaging, these students truly resent their time being wasted. In more

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and more of our schools, this group is quickly becoming the majority. Their possible motto, metaphorically speaking, is "Engage me or enrage me", and they are "convinced that school is devoid of interest and totally irrelevant to their life" (Prensky, 2005).

Brief Review of Student Engagement

A thorough review of the topic of student engagement is beyond the scope of this paper, and has been provided by Trowler (2010). According to Harper & Quaye (2009), any attempt to engage students is an effort that goes beyond involvement or participation – it requires feelings and sense-making as well as activity. Acting without feeling engaged is just involvement or even compliance; feeling engaged without acting is dissociation. Fredricks, Blumenfeld & Paris (2004), identify three dimensions to student engagement, and we need to engage them on all these dimensions, as explained below:

1. Behavioral engagement: Students who are behaviorally engaged would typically comply with behavioral norms, such as attendance and involvement, and would demonstrate the absence of disruptive or negative behavior.
2. Emotional engagement: Students who engage emotionally would experience affective reactions such as interest, enjoyment, or a sense of belonging.
3. Cognitive engagement: Cognitively engaged students would be invested in their learning, would seek to go beyond the requirements, and would relish challenge.

Pinder-Grover & Groscurth (2009) noted that the most striking differences that millennials bring to the classroom are their preferences for *collaborating*, *connecting* and *creating social change* (italics in original), and cited many research studies supporting this claim. Kuh (2008) suggests using capstone courses and community-based projects to help students learn from one another and address social problems outside the classroom, noting that this approach is useful in achieving two essential learning goals. First, students learn to work and engage problems in the company of others, which means they must articulate their understandings, justify claims, and work together to solve problems. Second, students learn to deepen their understanding by listening to the insights of others, particularly those with backgrounds and experiences different from their own. These approaches form the guiding principles for our present effort.

Traditional and Revamped Chemical Engineering Education

Chemical engineering education had historically focused on the teaching of chemical process plant design, where students used simulation software to model a chemical processing plant to produce a given product of a certain purity based on some given raw material(s). Such a project is typically cast as final year capstone project, as it requires students to integrate various core chemical engineering principles learnt in earlier years, such as fluid mechanics, heat and mass transfer, process control, etc. These subjects are taught as separate core modules, and students are often told: "not to worry, learn these first; they will be useful to you later in your design project." The problem with this approach, besides not being particularly interesting and engaging for millennials, is the fact that no chemical processing plant is ever being built! Although such simulation exercise is useful in assessing students' ability to apply what they had learnt, it left students with a sense of "incompleteness" - whatever design they came up with may looked good on paper, but one can never really know.

In addition, traditional chemical engineering education, as for much of other engineering education curricula, has focused primarily on covering technical content, and failing to sufficiently incorporate the systematic infused teaching of soft skills such as teamwork and communication. This is typically relegated to the responsibility of faculty from the Language or Humanities schools. Issues such as ethics and other attitudinal or behavioral aspects are often not even included in the full-time curriculum programme.

Discussions of Work Done

The general framework for curriculum re-design based on CDIO is shown in Figure 1. The Singapore Polytechnic (SP) design thinking framework was added to complement CDIO, especially during the "conceive" stage. The design thinking approach focuses on three mutually supporting elements (Brown, 2009), namely that of user empathy ("What is desirable to users?"), technical feasibility ("What is possible with technology?") and economic/business viability ("What is viable in the marketplace?"). This move is aimed at inculcating greater user empathy in our students during problem formulation, instead of diving straight into offering a solution that may not meet the requirements of the targeted user. This model allows us to design a curriculum that is able to effectively target all three aspects of student engagement: i.e. behaviorally, emotionally and cognitively. We believe this general framework is applicable to any discipline seeking to engage students in an effective manner.

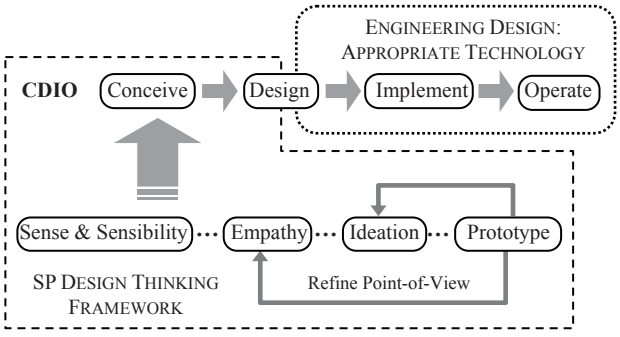


Figure 1. General Framework integrating design thinking with CDIO

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Based on the curriculum framework depicted in Figure 1, the Diploma in Chemical Engineering (DCHE) Course Management Team formulated its own curriculum model for student engagement. Cheah (2008) previously provided a comprehensive account of the changes facing the chemical engineering industry and the education of chemical engineers; as well as the adoption of the CDIO Framework by DCHE to revamp its 3-year curriculum. Also, post this implementation period, further innovations and changes have been made based on pertinent feedback from evaluations (Cheah, Phua & Ng, 2013). A key change to note is the introduction of chemical product design (Cheah, 2010; Cheah & Ng, 2010) and design thinking (Cheah, 2012; Ng & Cheah, 2012, Chua & Cheah, 2013) into the curriculum, whereby students are encouraged to identify areas of needs where solutions are possible via applications of appropriate chemical engineering principles. Specifically, we introduced two new modules, one in Year 1 entitled *Introduction to Chemical Product Design*, and another in Year 2 entitled *Chemical Product Design & Development*. This serves to support the execution of Year 3 capstone *Final Year Project* where students can come up with innovative chemical products for the less fortunate at the bottom-of-the-pyramid. In our core modules, besides teaching students the application of chemical engineering principles in process and equipment design (i.e. the "traditional" approach), we also include applications to chemical product design. For example, in the Year 2 core module *Heat Transfer and Equipment*, our students not only learnt about applications of heat transfer theories to the design of heat exchangers used in virtually all chemical processing plants, which they use in their Year 3 *Plant Design Project*, they also used the same formulas and equations to the design of water heater or a solar cooker that can be used in the *Final Year Project*.

At the same time, we integrated selected "soft" skills into the curriculum, to better develop graduate with certain attributes (e.g., communication, teamwork and thinking skills) desired by the employers. This is achieved by two important threads as explained below:

(a) Infusion of Parts 2 Personal and Professional Skills and Attributes of the CDIO Syllabus (such as critical and creative thinking, hypothesis testing, ethics, information literacy, etc) and Part 3 Interpersonal Skills of the CDIO Syllabus (teamwork and communication) into various core modules. Collectively we refer to these skills as "CDIO skills" and they are introduced via integrated learning experiences which are 3-4 hours of laboratory activities or assignments; which we termed "engineering practice" (Cheah & Yang, 2013).

(b) Infusion of Part 4 Conceiving, Designing, Implementing and Operating Systems in the Enterprise and Societal Context, whereby skills in creating innovative chemical products or systems is introduced. We refer this as "C-D-I-O skills" to distinguish them from the "CDIO skills" mentioned in part (a). These C-D-I-O skills enable our students to carry out chemical product design as fulfillment of the diploma's final year capstone project.

Figure 2 shows the revised DCHE curriculum model incorporating the integration of basic mathematics and sciences (chemistry, biology and physics) modules, core chemical engineering modules (such as fluid mechanics, heat transfer, separation processes, and chemical reaction engineering), and a selection of free electives in Year 3. This supports the development of chemical process design and chemical product design at the end of the 3-year diploma. Where appropriate, chemical product design is further integrated with chemical process design, in learning contexts that require students need to come up with a flow sheet of how the chemical product can be scaled-up for production.

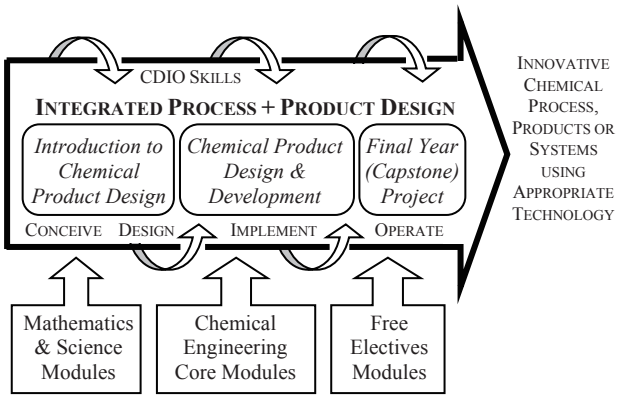


Figure 2. DCHE model for engaging students in chemical product design

Also shown in Figure 2 is the integration of various CDIO skills (shown as curved arrows) such as teamwork and communication, critical and creative thinking, systems thinking, ethics, global mindset, etc into core modules in our curriculum. With CDIO as the basis of our curriculum design, our model therefore emphasizes not just on students being able to integrate their technical knowledge into their projects, but they are also able to consider the economic and societal impact of their design as well.

At this point, it is worth clarifying our notion of "chemical products or systems". This refers to "technology that uses chemical engineering principles" as defined by Shaeiwitz & Turton (2003), which we felt is more appropriate for the outcomes expected of our diploma-level students. We also clarify "innovative" outcome of our approach to mean engineering products and systems that are driven by social, environmental or sustainability issues; and add values to the community-in-need. In other words, anything that is new to the community is counted as innovation, even if similar products are available elsewhere or if the change is an incremental one. Some of these innovative products emerged from the capstone projects include waste-to-gas digester, seaweed-to-fertilizer, rain water harvesting system, insulation material from sugarcane bagasse, pedal-powered filtration unit, and floating toilet system. As will be illustrated later, some of these projects have already been successfully implemented or in process of

being implemented, both locally in Singapore and in various countries in the region, including Indonesia, Myanmar, Nepal and Cambodia.

Figure 1 also shows the use of appropriate technology to drive the "I" (implement) and "O" (operate) phases of CDIO – in delivering innovative chemical product design envisioned in our curriculum outcome. Appropriate technologies – a term attributed to Schumacher (1973) – are usually characterized as small scale, energy efficient, environmentally sound, labor-intensive, and controlled by the local community (Hazeltine & Bull, 1999). The core principle of appropriate technology is to include local communities in technology selection and development, innovation and implementation, all in an environmentally sustainable manner (Tharakan, 2006). Appropriate technologies are often perceived as "low tech" and unimportant, and not usually addressed in engineering education or university research (Sandekian et al., 2007). However, we felt that they are indeed very suitable at the diploma-level, as our students need not master a very high level of technical competencies at this level of study. The students, in fact, proved to be very capable to design and implement a workable product or system consistent with the needs of the poorer sections of the wider global community and within the goals of sustainable development (Chua & Cheah, 2013).

In addition, to further strengthen the three aspects of student engagement, we also linked the outcome of our curriculum model (Figure 2) to the ideals of sustainable development espoused in the Brundtland Report, which explained it as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (UN, 1987). Specifically, as shown in Figure 3, we draw parallels between the three circles of design thinking and three circles of sustainable development.

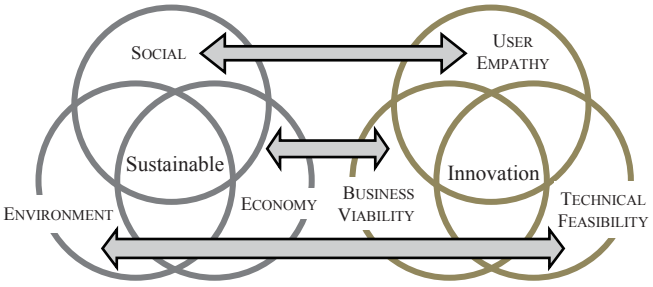


Figure 3. Relationship between elements of design and sustainable development

This mapping process (Figure 3) helped addressed a common problem in many initiatives aimed at addressing sustainable development issues: that they had been narrowly focused only on environmental issues (Kagawa, 2007; Segalas et al, 2010). Nagel et al (2012) had earlier suggested that both design and sustainability are not mutually exclusive, and that if we are to prepare our students to deal with the complex problems of sustainability, we must provide them with a holistic education incorporating all contexts of sustainability. In terms of curriculum design, our model serves as a useful tool that explicitly emphasizes placing equal focus on all three aspect of sustainable development when designing chemical products.

We now share some case studies from recent student final year projects. These are necessarily brief. For more detailed discussion of work done, see the work of Oh & Yang (2014).

Case Study (1): Floatable Toilet System in Cambodia

In this project, our students designed a toilet system that can float on water for a community-in-need in rural Cambodia, which was under threat of poor sanitary condition due to frequent floods in the region, using existing toilet systems which are very rudimentary. The students visited the village several times, the first of which is to speak to the villagers, where they also applied design thinking methodology in order to ascertain the villagers' needs. They then proceed with several iterations of the design back in Singapore and eventually developed a prototype that was tested in Cambodia. With the help of local craftsmen, the floatable toilet was largely constructed from bamboo, a locally available and renewable resource. Besides the floating structure, the team also designed a separation system that removes urine from faeces; an anaerobic digester to help convert the human waste into fertilizers, as well as a system to capture the biogas was produced to be used as fuel. Subsequent visits included gathering feedback from the villagers and making improvements to the system. They also include training for the villagers in using the new system.

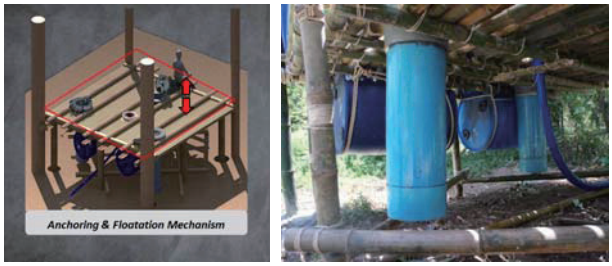


Figure 4. Conceptual Design of Floating Toilet and Portion of the Actual Prototype

Case Study (2): Herbal Soap Production in India

In this project, our students developed a suitable formulation to produce herbal soap using locally available natural resources in Sikkim, India such as sunflower oil, coconut oil, mint and lemongrass. The Yuksam community in Sikkim planted and harvested cardamom to earn a living. A few years ago, a disease struck the cardamom plants and wiped out the entire plantation. The villagers suffered a massive loss of income. Through empathy studies and interviews with the local community, several ideas were conceptualized such as paper and soap making. After several rounds of communication with the local community, it was found

that there was another organization aiding them in a project involving paper making. Hence, our students embarked on soap making, developed a suitable formulation, and renamed it as 'herbal soap' because it utilized plant-based ingredients. This project is still on-going. The next phase of this project is to explore sustainable processes and technology that is suitable to be implemented at Sikkim to produce the herbal soap in larger amounts.

Case Study (3): Pavement Bricks for the Philippines

In this project, our students conducted a feasibility study of converting solid waste into usable and valuable product. In particular, the study focuses on Las Pinas, Metro Manila Philippines, which is one of the densest cities in the world. Newly migrant families live in makeshift squatters, with poor sanitation and environment in the city's dumpsite. A major concern for this community is the lack of proper regular jobs and disposable income. In addition, within the improvisational community, sandbags were used as a substitute to lie on the muddy grounds as walkways. During the monsoon season, flooding in the slums resulted in the sandbags being washed away. Replacement of sandbags is expensive and tedious. Our students formulated a paving brick to replace sand bags; using plastic waste, coffee grounds and gravels all available from the dumpsite. The paving brick prototype was tested by an independent external party, where it passed all the requirements of various applicable Standards.

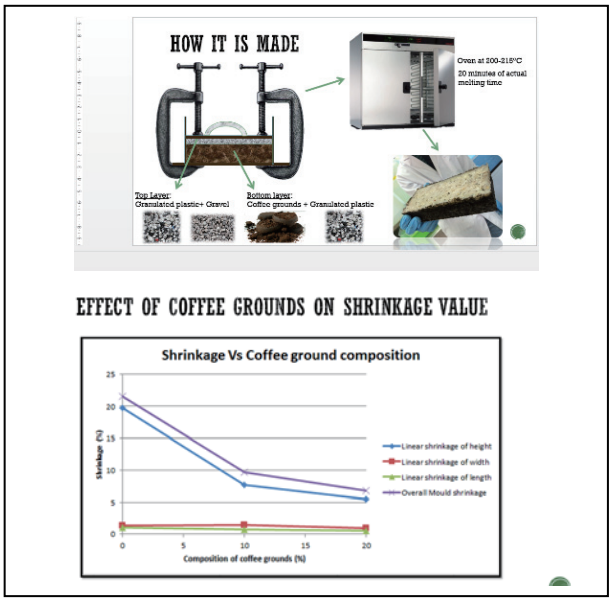


Figure 6. Pavement Bricks from Waste Materials

Discussions

The curriculum model presented in Figure 1 allow us to directly engage students in all three aspects of cognitive (head), psychomotor (hand) and affective (heart) domains of learning that will allow transformative learning to occur (Sipos et al., 2008). Working on sustainability-themed chemical product design projects provided the students with opportunities to connect and collaborate with real people from community-in-need, to solve real-world social or environmental problems using knowledge gained in class, facilitated a high level of self-efficacy for our students (Wals and Jickling, 2002). This, in turn, encourages their motivation and engagement for further learning, hopefully resulting in better attainment overall in the longer term. At present, we only have anecdotal evidence on this, as we did not conduct a course-wide evaluation on our students. Conversations with our students who took part in these sustainability-themed capstone projects suggested that most experienced a high level of engagement in these projects. Many noted that working on such projects had been an eye-opener and an enriching experience for them, and they are now more inspired to make a difference to the less fortunate using their knowledge. They also noted that they are now more appreciative of what they have and not to take things for granted. However, it is probably too early to tell if long-term transformative changes in students' attitudes, values or behavior as envisioned by Elliott (2010) had indeed taken place as we have not yet carried out any formal study on the impact of such curriculum re-orientation.

Conclusions

We have shared a curriculum model built around chemical product design which is able to meet the demands of both employers and students generally referred to as millennials. The curriculum is designed using the CDIO Framework supported by design thinking in the "Conceive" and "Design" phases, and utilizes appropriate technology to realize the "Implement" and "Operate" phases respectively. It is able to effectively engage millennials in their studies and deliver on the "traditional mandate" of our polytechnic education, which is to prepare graduates for the industry.

Acknowledgement

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Activities of Global Technology Education in NUT-KOSEN-TUT

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Abstract

Toyohashi University of Technology (TUT) and Nagaoka University of Technology (NUT) are joining effort with KOSEN (Japanese colleges of technology) to develop global engineering leaders whom possess practical and innovative skills. In this presentation, the roles of TUT in this project and its current activities are presented. In this joint project between NUT-KOSEN-TUT, TUT is mainly responsible for the "Development of global human resources". A brief overview of several core components of the project are as follow: (a) Global internship program through oversea education base in Penang, Malaysia, (b) Global faculty development in collaboration with City University of New York, Queens College (QC), (c) International Conference of Global Network for Innovative Technology in Penang (IGNITE-2014), and (d) International Alumni Joint Meeting in Penang (IAJM-2014). The implementation details and outcomes achieved so far in this on-going project are described as well.

Keywords: *global internship, global faculty development, international conference, international alumni meeting*

Introduction

In the globalized world nowadays, remarkable progress and significant advancements have been achieved which resulted in dramatic changes in our thinking behaviours, economic strategies and industrial frameworks. In order to fulfil new demands and to face daunting new challenges in this era, an innovative and effective strategy development is indispensable to resolve the obstacles in human resources, research and developments. One of the keys lies in education where a reform or revolution of new educational approach and strategies at higher education level would be the only way that could enable such transformation.

In the endeavour to foster human resources well equipped with excellent skills for a global society, a joint initiative between Nagaoka University of Technology (NUT), Institute of National Colleges of Technology (KOSEN) and Toyohashi University of Technology (TUT) which is also known as "Tri-Institutional Collaborative/Cooperative Educational Reform Project" is formed under the National University Reform Enhancement Promotion Project supported by MEXT (Ministry of Education, Culture, Sports Science and Technology), Japan.

In our mission to cultivate developed global engineering leaders that possess outstanding practical and innovative skills, two approaches are implemented which are through global internship and faculty development programs. By utilizing our overseas education base, TUT-USM Technology Collaboration Center (in short, TUT-USM Penang), this could be achieved by infusing bilingualism into our program for the students as well as faculty and staff members.

TUT-USM Penang (Figure 1) is an overseas education base in Penang owing to the collaboration between TUT and Universiti Sains Malaysia (USM). It was launched on December 4th, 2013. With the support of USM in regards of orientation and language lessons, the 1st batch of students arrived at Penang for their overseas internship in 2014. Throughout their internship program, their progress and interim report were assessed at TUT-USM Penang. As for Global faculty development program, it consists of (i) Intensive English development, (ii) Lecture delivery in English, (iii) Attending lectures related to each faculty's specialty, and (iv) QC Mentor assignation to ensure efficient learning of faculty members. One of the expectations is to develop research collaboration between QC faculty



Figure 1: TUT-USM Technology Collaboration Center at Penang, Malaysia.

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members/lecturers leading to future joint research projects. IGNITE-2014 was an international conference where latest inventive technological advances and research works in various application fields were presented. Finally, International Alumni Joint-Meeting (IAJM-2014) is also established for the development of alumni networks among NUT-KOSEN-TUT.

Apart of being a platform for "Global human resources development program" and "Tri-institutional Collaborative/ Co-operation Education Reform Project Fostering Globally-Engaged, Practical and Innovation Engineers" TUT-USM Penang also serves as focal point for global education program for ASEAN countries, a gateway for prospective students to study in Japan, and a pivotal point for inter-regional university-industry linkage.

Methods or pedagogy

There methods of implementations for this project are described as follow:

a. Education system and global internship

The overall education system and syllabus were reviewed and taking into account new objectives in the development of global human resources, novel 'Spiral-up Education system' is developed. The enhancements towards global education consist of both fundamental and specialized subject studies, graduation research, language liberal arts, experiments, and internship throughout the path towards post-graduate education as shown in Figure 2. Besides that, global programs such as summer school, short-term stay, exchange, conventions and conferences are also integrated into the education path. Emphasis is given on the international internship where the students have the opportunity to gain first-hand experiences and exposures from Global/Multinational companies with a diverse multicultural background in Penang, Malaysia.



Figure 2: Toyohashi Tech's 'Spiral-up Education System.

b. Global faculty development

In the development of the faculty members (lecturers), a strong collaboration is established with City University of New York, Queens College. The aims are for intensive English development of the faculty members (NUT-KOSEN-TUT) and research network establishment in the related and specific field of expertise. Selected potential candidates will undergo intensive English development program as well as attending the lectures for both undergraduate and post-graduate courses in related field of specialities. The selected faculty members would spend 3 months improving their English competency at Toyohashi Tech before leaving to Queens College, New York, USA for another 6 months. Upon completion of their training, they are required to present their lectures in English at TUT-USM campus at Penang, Malaysia and also to several education institutions nearby. Clear outline of the program is shown in Figure 3.

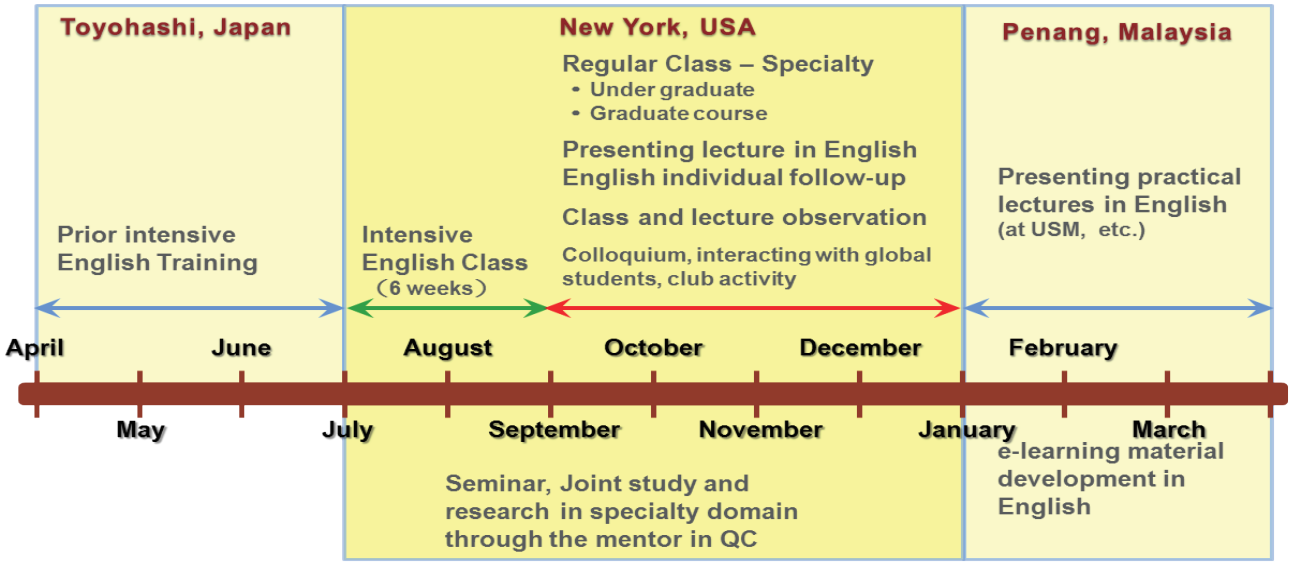


Figure 3: Program outline in collaboration with Queens College for faculty development program.

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c. International Conference of Global Network for Innovative Technology 2014 (IGNITE 2014)

In commemorative of the launching of TUT-USM Penang, the first IGNITE 2013 symposium was held on 5th December 2013[1]. On the subsequent year, IGNITE 2014 was organized with the objective of announcing advanced research findings in various technological fields [2]. TUT-USM Penang was utilized as the venue for the conference which marks its important role as the pivotal education and research focal point for 'Tri-Institutional Collaborative/Cooperative Educational Reform Project'.

d. Development of Joint-Alumni Network among NUT-KOSEN-TUT.

In the initiative to forge and foster strong network with the alumni of NUT-KOSEN-TUT, an alumni gathering was organized to gather not only TUT alumni but also the Tri-Institutional alumni that includes NUT and KOSEN. Alumni from Malaysia, Indonesia, Vietnam, Thailand, Laos and Pakistan were invited to participate in the Overseas Alumni Association Meeting which was held at TUT-USM campus, Penang. An overview of the current status and future development of Tri-Institutional Collaborative Educational Reform Project and Toyohashi Tech were presented. After that, representatives for the Tri-Institutional overseas branch alumni network were nominated and selected in order to lead the overseas alumni associations' administration and liaison with the alumni association in Japan.

Results and Discussion

Following an overwhelming reception for global internship program which was initiated in year 2013, twelve students (10 Japanese and 2 Malaysian students) were dispatched for their global internship in the beginning of Year 2014 for their 2 months internship program in Penang. The students began their internship with a week of orientation at USM as part of their preparatory to adapt to the multicultural local environment in Penang. All the students were dispatched to 10 different companies, namely Advantest Engineering, Toray Industries, Continental Automotive components, Altera Corporation, Keysight Technologies, Ambu, SAM Engineering & Equipment, Mini-Circuits Technologies, Cerca Insight and ISO Technology. Based on the students' field of study, they were dispatched to the companies of similar field respectively. During the internship, the supervisors of these particular students were encouraged to visit and establish a possible industry-university network that would enable future research collaboration. Mid-term and final presentations were done in order to evaluate the students' adaptabilities and progress throughout their internship as shown in Figure 4.



Figure 4: The students in their internship's mid-term presentation in Penang, Malaysia.

As for global faculty development, 10 lecturers were selected and dispatched under this program which was officiated on April 1st 2014 as shown in Figure 5. During their 3 months English pre-training at Toyohashi Tech, the faculty members had attended English program that was specifically customized as part of their training preparatory prior to QC, New York. Throughout this period, communication between the faculty members and students at QC College were also done through video conference calls as part of their English practice and preparation towards life in New York. At the end of their training in Toyohashi Tech, the faculty members gave mock lectures to students and other audience based on their specialized subjects in English. Besides focusing on their English improvisation, emphasis was also put on the prospective research collaborations between the faculty members and also Toyohashi Tech.



Figure 5: Opening ceremony of the Global Faculty Development Program (1st batch).

Throughout their program in New York and Penang, every faculty members shared their thoughts and experiences through periodic reports which are available in Toyohashi Tech's Center for International Education homepage [3]. The English proficiencies of the faculty members before and after the program were evaluated using TOEIC exams which had shown significant scores improvement. In addition, Telephone Standard Speaking Test (TSST) was also used for periodic assessment of their speaking abilities which had shown noticeable improvement as well. In the final stage of their training program, the faculty members were based at Penang and given the opportunity to apply their upskilled English lectures to USM and also other educational institutions. Real time lecture from Penang

was also delivered through Global Innovative Network (GI-Net) for the Tri-Institutions in Japan. From the evaluation tabulated from the attendee of the lectures, satisfactory results were obtained and significant improvements were observed in the lectures delivery by the faculty members. From the collective assessment of questionnaires obtained from students (undergraduate and postgraduate), faculty members of institutions, company employee and others who had attended the lectures; the average assessment score was 4.12 (1: poor ~ 5: excellent) with average attendance of 34 participants per lecture. Figure 6 and 7 show the completion of the faculty members' development program at different stages in New York and Penang, respectively.



Figure 6: Final wrap-up presentation at Queens College, New York, USA.



Figure 7: Closing ceremony at TUT-USM campus, Penang, Malaysia.

IGNITE 2014 which was held from 14th to 16th of December 2014 at TUT-USM Penang not only had attracted tremendous interest from researchers and students from USM and Tri-Institutional collaborative institutions but also participants from multinational corporations industries at Penang. A total of more than 100 participants attended the event inclusive of researches and students from Japan. 70 oral and poster presentations, two keynotes lectures and tutorial sessions were conducted which drew great interest and enthusiasm towards the latest advancement in science and technology. This successful event was also attended by the President of Toyohashi Tech, Dr. Takashi Onishi. Figure 8 shows the group picture taken at the reception of IGNITE 2014 at JEN Hotel [2]



Figure 8: Participants of IGNITE 2014.

In the successful overseas alumni association gathering that was held on 13th December 2014, a total 110 people had turned up for the meeting and gathering which includes 40 alumni from the aforementioned countries, 70 faculty staffs and students (Figure 9). After the latest development of Toyohashi Tech and Tri-Institutional collaborative projected were presented, overseas alumni association branch are established and the representatives were selected for each countries. With the aim of maintaining the strong network between the alumni of the NUT-KOSEN-TUT, the representatives play vital roles in liaising with the alumni headquarters, alumni branch management and future networking activities. Opinions exchange between all alumni members and the staffs with great anticipation towards the current and future development of the Toyohashi Tech in Tri-Institutional Collaborative Project had led to a fruitful event [4]. The overseas alumni branch in Malaysia has been successfully established and with the co-operation of the representatives from other countries, similar establishment will be implemented in other countries in the very near future.

Conclusions

With the overwhelming and fruitful achievements in every aspects of educational development of global internship, faculty develop program, international IGNITE conference, and joint alumni association network; It is envisioned that further development in this direction would enable the accomplishment of the missions set in 'Tri-Institutional Collaborative / Cooperative Educational Reform Project'. As we have already moved into a new fiscal year, the project is progressing with excellent momentum upholding higher expectations and developments in all areas.



Figure 9: Participants at the Joint Alumni Network between NUT-KOSEN-TUT on 13th December 2014 at Northam Hotel, Penang, Malaysia.

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ACADEMIC AWARDS: TOWARDS THE PURSUIT OF T&L EXCELLENCE IN NP

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Abstract

Teaching & Learning (T&L) is at the centre of our work at Ngee Ann Polytechnic (NP). As lecturers, we are expected to develop key T&L competencies to enable us to provide rich learning experiences for our students. A Pedagogical Development Roadmap was drawn up in 2013 to scaffold the enhancement of lecturers' pedagogical knowledge, skills and awareness of educational changes, over the period of their teaching career. The roadmap includes milestone programmes that scaffold a lecturer's teaching career. It also includes milestone programmes which support lecturers as they progress through various academic leadership positions in course leadership and staff development.

Beyond the staff developmental roadmap to enhance the T&L awareness, skill sets, and practices of all lecturers, the Polytechnic has established and evolved a structured approach to identifying, recognising, rewarding, and learning from lecturers who demonstrate their pursuit of T&L excellence through considered efforts to strengthen the learning experience for their students, purposeful growth and sustained professional development as educators, guidance of colleagues in their efforts to enhance the quality of the teaching and learning.

This presentation will outline the key features of NP's Academic Awards framework and how the framework enables the Polytechnic to recognise strong T&L practice in staff, encourage the pursuit of T&L excellence, grow its T&L talent pool, and strengthen its impact on the community.

Keywords: *Rewards & Recognition, Academic Awards, Teaching & Learning Excellence, Professional Development*

Introduction

Teaching Excellence awards have been implemented across many different institutions and at various levels – from local institution awards to national level recognition of teachers. These awards are used to recognised and reward the efforts of teachers in their teaching & learning (T&L) practices, to encourage teachers to pursue innovations in T&L and also to identify teachers for further professional development (Chism, 2006). Ngee Ann Polytechnic (NP), an institution of higher learning in Singapore has also established the Academic Awards with similar objectives - to recognise, reward and share good T&L practices.

This paper will outline the key features of the Academic Awards framework, and how the framework has allowed the Polytehcnic to recongised strong T&L efforts, encourage the pursuit of T&L excellence, grow its T&L talent pool, and strengthen its impact on the community.

Background

NP was established in 1964 as the Ngee Ann Technical College, a post-secondary institution which developed graduates with professional, technical skills. Over the years, the institution's courses have expanded to 49 diplomas from 11 Schools/Divisions with over 16,000 students. The diplomas offered range from Engineering to Life Sciences to Humanities. NP has more than 16,000 enrolled students.

NP's mission is to develop students who are not just global smart professionals but also graduates who are passionate learners with a heart for the community. To achieve this, NP's lecturers must be able develop and demonstrate the appropriate T&L competencies needed to shape a unique NP learning experience that nurtures these outcomes.

NP's Pedagogical Development Roadmap

The NP Pedagogical Development Roadmap (Fig. 1) was re-cast in 2013 to scaffold the enhancement of lecturers' pedagogical knowledge, skills and awareness of educational changes, over the period of their teaching career. All new lecturers who join NP are enrolled into a series of developmental milestone programmes that are aimed at strengthening their T&L capabilities and inculcating a commitment to continuous professional development.

Milestone Professional Development in Education (PDE) programmes are tailored to support the specific role-based T&L needs of lecturers as they progress through their careers, typically within the first 10 years, from beginning lecturer through to lecturers with academic leadership responsibilities for module and course curriculum, academic quality, teaching teams, and change-initiatives. They are designed to anchor and strengthen 4 particular T&L competencies that NP deems critical for it to provide an effective and engaging NP learning experience; designing learning,

managing learning, assess learning and to use Info-Technology for learning.

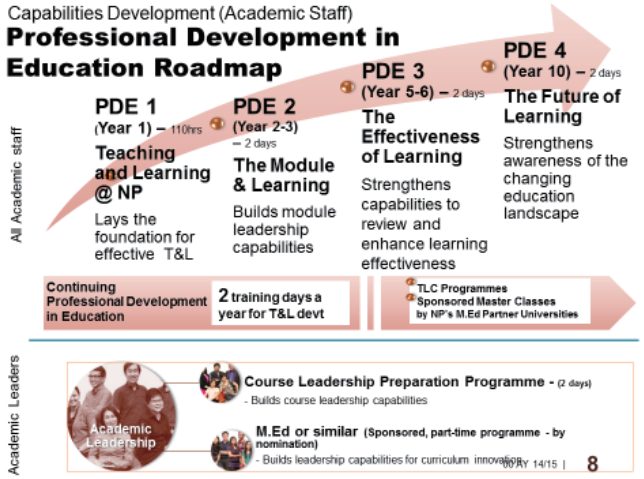


Figure 1 : Pedagogical Development Roadmap

All lecturers progress on this journey of pedagogical development and performance. Some, however, move on to demonstrate a greater interest in and willingness to explore, innovate, and invest extra focus on the pursuit of T&L excellence. Lecturers who demonstrate these traits are recognised for their T&L efforts and achievements via NP's Academic Awards. These awards, in existence in NP since the early 1990s, are presented each year as a form of recognition and reward to lecturers who stand out for their excellence in teaching and learning practices at NP. This intent is very similar to other teaching excellence awards from different Institutes of Higher Education (Chism, 2006, and McNaught & Anwyl, 1993).

NP's Academic Awards Framework

Over the last decade, however, NP has been gradually remaking its Academic Awards Framework to lift its value beyond being just a scheme to recognise efforts and contributions to T&L, to a more purposeful platform for NP to identify T&L talents and nurture these talents into T&L leaders who are able to, in turn, influence and shape the pursuit of T&L excellence in the polytechnic.

A major effort has been to try and shift the perception that the Academic Awards is a contest 'won' by the lecturers who are most 'popular'. The Academic Awards is in fact NOT a competition to be won, but an honour presented to deserving staff who are RECIPIENTS. The Awards framework emphasises a more standards based, self-evidencing quality of awards that focus on T&L impact, continued T&L development and contributions to the T&L growth in others. Lecturers who are able to fulfil the selection criteria will have an opportunity to receive the award, either as individual lecturers or as members of teams.

There are two types of awards – Academic Awards (Teaching Suite) that recognises individuals for their pursuit of T&L excellence and the Academic Awards (Development Suite) that recognise innovative projects involving the design and development of engaging, and effective curriculum experiences and learning materials. There are 2 levels for each award – at School/Division level and at NP level. All awards recipients are selected by Selection Panels convened at School/Division or NP level. The Panels base their selection of award recipients on evidence provided by the individual lecturers or the project team members.

NP presents the awards comprising a certificate, and a cash quantum, at its Graduation Ceremony for the various diplomas. This enables NP to celebrate their T&L efforts with graduates, their parents, and their colleagues.

(1) Key Features of the Academic Awards (Teaching Suite)

This suite comprises two levels of individual awards for the pursuit of excellence by full-time lecturers; the School Teaching Award and the NP Teaching Award.[1]

(i) School Teaching Award (STA)

At the School level, lecturers are recognised for their pursuit of excellence in facilitating effective learning, student development as persons and professionals, and the continuous effort to develop oneself as a teaching professional (Fig 2).

Nominations for the STA are open to staff and students. Staff that receive at least one nomination will be flagged for STA consideration. For the last decade, between 60-70% of full-time staff have been nominated each year. Nominations however, serve only as an initial trigger for consideration and the number of nominations received by each lecturer has no bearing on the final selection which is evidence-based.

STA recipients are selected by a School Selection Panel, which comprises School Senior Management and Reporting Officers of the lecturers nominated for the Award as well as the School/Division Awards Co-ordinator. The Panel reviews the evidences of each nominee which must include a teaching portfolio, feedback from students, validation comments by reporting officers, and a lesson observation report. Each School/Division can select up to 10% of their academic staff headcount to receive the STA, subject to Principal's endorsement. Over the last 10 years, 574 STAs have been presented to deserving lecturers who have demonstrated the traits recognised by the award.

(ii) NP Teaching Award (NPTA)

Lecturers who have, over time, evidenced strong fulfilment of the 3 STA criteria, may be on the School's Selection Panel watch list for the NPTA if they continue to demonstrate innovative T&L thinking, as well as the ability to influence the T&L growth and innovation efforts of others (Fig 2). They may then be recommended by the School's Panel for NPTA consideration by an NP Selection Panel.

[1] Adjunct/Associate Lecturers who demonstrate the pursuit of excellence in T&L are also recognized through a separate Associate Lecturer Teaching Award.

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An NP level Selection Panel comprising Senior Management of the Polytechnic, past Award recipients, and Awards Co-ordinators,[2] are invited to review the evidences for each nominee against the stated criteria before selection of the year's NPTA recipients. There is no cap on the number of nominees or recipients for NPTA and there can also be no Award recipient for the year if none of the nominees meets the NPTA selection criteria. The final selection list must be endorsed by the Polytechnic's Principal. Since the establishment of this award in 2007, there have been 8 recipients with 2 being repeat recipients of this top award.

The following figure summarises the criteria for the STA and the NPTA.

School Teaching Awards	NP Teaching Awards
Facilitating effective learning : Strategies & techniques	Innovative T&L thinking and influencing teaching and learning growth and innovation in others
Development of Students	
Development of self as a teaching professional	

Figure 2: Summary Criteria for STA & NPTA

(2) Key Features of the Academic Awards (Development Suite)

The Academic Awards (Development Suite) recognises and rewards efforts by lecturers to design and develop innovative and effective curriculum experiences and learning materials. These efforts are usually team-based.

The awards are selected based on a set of 4 criteria – innovative T&L design concept, relevance & appropriateness of the development, value & impact, and the pursuit of excellence.

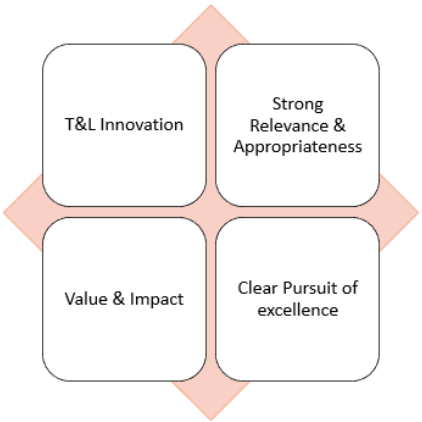


Figure 3 : Academic Award (Development Suite)

[2] Awards Coordinators oversee the Academic Award processes in their School/Division. Their role is to develop School/Division's T&L excellence, to nurture and develop T&L talents to support nominees in the evidencing for the Awards.

Teaching teams with such projects may submit their documentation of evidence through their School/Division for a first step evaluation review by an NP Evaluation Panel, made up of a representative from every School and Division, which will review the merits of the project against the criteria. This Panel will then submit its evaluation critique to an NP Selection Panel comprising Senior Management, past Award recipients, and Academic Awards Coordinators, for the final review and selection.

There are two categories of Academic Awards (Development Suite) – the School Academic Development Award (SADA) and the NP Development Award (NPADA). NPADA is further divided into 3 levels - Silver, Gold and Platinum. The criteria for selection for both SADA & NPADA are essentially the same (see figure 4 below). The key difference is that an NPADA-level project is a significant step-up from SADA level projects in terms of the quality and impact of innovation.

At School/Division level (SADA), the T&L innovations are usually learner-centered developments that are new to and have had a change-impact on T&L practices within the School/Division. These would however tend to be of smaller scope and may be variations of developments that can be found in other Schools/Divisions at NP. At NP level (NPADA), the projects must be able to demonstrate "breakthrough" qualities that are potentially scalable/transferable for even wider impact on other Schools/Divisions in the institution.

Criteria	SADA	NPADA
T&L Innovation	• Innovative features that enhance students' learning in the subject/module • Development of Learner centred learning approaches/elements	• Hallmark features that are unique to the course/discipline/profession
Relevance & Appropriateness	• based on grounded T&L strategies • well suited and effective for its defined audience, purpose and context • relates learning to real-world context	• Effective integration into curriculum to achieve the learning outcomes of course
Value & Impact	• Promote thinking and development of 21st century skills • Promote greater students' learning engagement with the content/subject/learning experience • Sustained positive feedback	• Promote holistic and professional development • Improves and transforms the T&L practices of the School/ Course • Potential to be replicated
Pursuit of Excellence	• Use of evaluative tools to determine the effectiveness of the development • Evidence of continuous improvements	• Engagement with stakeholders' as part of the continuous improvement process

Figure 4 : Criteria for SADA & NPADA

As with the teaching suite, recipients of this award must first be endorsed by the Principal. A total of 25 deserving projects found to have amply demonstrated the criteria. have been awarded over the last 10 years.

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Key Features of the Post-Awards Feedback Exercises

At the end of the Academic Awards cycle each year, a series of feedback exercises is conducted with the range of awards stakeholders. This enables the feedback to trigger and shape on-going T&L development of lecturers, projects, and T&L capabilities in Schools/Divisions.

(i) Post-Award Feedback for Academic Awards (Teaching Suite)

Regardless of whether they have been selected to receive the Award for the year, all lecturers who have received at least one nomination to be considered for the year's award will receive a nomination report. This report consists of nomination ratings against key desired attributes and comments by nominators. This serves as feedback for reflection as well as a form of recognition and motivation for the 60%-70% of staff who get nominated by students and peers each year.

The portfolios of evidence submitted by nominees as part of the Academic Awards exercise provides the management with feedback on and insights into the T&L strengths in each School/Division. An analysis of the portfolios is done by the Academic Awards Administration team, and a summary of the pattern of T&L strengths and potential areas for further development of the year's award recipients is discussed with each School/Division for information and onward staff development planning.

(ii) Post-Award Feedback for Academic Awards (Development Suite)

As with the Academic Awards (Teaching Suite), all projects submitted for Academic Awards (Development Suite) for the year's Awards consideration will receive detailed developmental feedback based on the comments and observations made by the NP Evaluation and Selection Panels. The Academic Awards Administration team will meet with the project team members and their School/Division Academic Awards Coordinators to update and share this feedback so that it feeds forward into and shapes onward improvements and enhancements to each project.

Identifying & Developing the Academic Talent

Receiving the NP Academic Awards is not the end of the journey for lecturers. Rather, it is the start of the next developmental journey in their pursuit of T&L excellence. This is signalled through discussion with recipients about opportunities which are identified for them to help them further develop their T&L competencies and to enable them to contribute to various academic initiatives. Opportunities are also created to enable them to share their experiences and expertise with colleagues within their Schools/Divisions, in NP, and even beyond.

Based on their T&L strengths as profiled in their teaching portfolios and the academic development project submissions, Schools/Divisions are able to identify potential expertise to lead or 'champion' new T&L directions, contribute to T&L innovation and change efforts, and provide T&L advice and input to curriculum teams. Some recipients may be also asked to undertake roles such as mentor to potential academic award recipients or to serve as Academic Awards Evaluation or Selection Panel members responsible for reviewing, critiquing and giving developmental feedback to submissions of evidence for the STA or the Academic Awards for development.

(i) Practicum Pedagogical Coaching

With effect from 2014, the Polytechnic has formalised a Practicum Pedagogical Coaching process as an integral practicum component of the PDE 1 programme for all new academic staff.

Pedagogical coaches must have amply demonstrated their pursuit of T&L excellence including an openness to innovate, and a willingness to further develop their T&L knowledge and skills. These are critical attributes the Polytechnic wishes to see modelled for new academic staff.

The STA recipients offer a natural pool of T&L talent from which to identify candidates with strong potential to serve as pedagogical coaches. They are then provided with training and development to enable them to provide appropriate, constructive, and timely interventions, feedback and suggestions to build pedagogical confidence, thinking, and considerations in the new staff and to model good T&L thinking and competencies for them. (Tan & Yap, (2012) & Tan, Viswanathan & Williams (2015).

(ii) Representatives of NP's T&L Strengths and Efforts

Recipients are identified based on their T&L strengths are given the opportunity to be representatives of NP's T&L strengths and developmental efforts on a range of platforms. These could include Joint-Polytechnic T&L projects, international conferences, and symposia. They provide recipients with new developmental opportunities to interact with, learn from, and share NP's T&L strengths and projects with the wider education community. Such opportunities enable the awards recipients to gain fresh insights into educational trends and research, strengthen their understanding of learning, and establish contacts with communities of educators. Awards recipients are then expected to bring these new understandings and fresh insights back and seek ways to share with and influence T&L practice in the NP community.

Next Steps in Academic Awards

Since the inception of the awards in 1996, the structure of the Awards has gone through a number of reviews, and with each review, the standard and rigour of the awards have been lifted. Correspondingly, the quality of STA recipients and the Academic Awards (Development Suite) projects have also strengthened over the years. However, there is still more to be done to further strengthen the framework.

(1) External Review

While the Awards have gained strength and rigour over the years, it has remained very much an internal awards process. It is timely to seek external input which could provide NP with new perspectives on alternatives and fresh ways to further leverage on the framework to grow the T&L talent pool and NP T&L capabilities.

(2) Insights into T&L Strengths

At institutional level, there is a rich store of T&L insights, practices and innovation captured in the teaching portfolios and academic development project documentations submitted for STA or SADA/NPADA considerations. These are currently being stored intact in a database. This information, if it could be better coded and analysed, would enable the Polytechnic to draw significant institutional insights on its Teaching strengths and innovation quotient for onward planning and development of its staff and its programmes.

(3) More systematic approach to Recipients' Post-Award Development

At present, the post-award roles possible are varied in terms of involvement and impact and they are not undertaken equally by all Awards recipients. A more structured programme for Award recipients would ensure that staff with potential and interest in T&L development will have the opportunity to do so. This would also allow promising STA recipients to work towards the NPTA as they gain recognition and credibility for their contribution towards the development of T&L at NP.

As for the NPTA recipients, larger opportunities can be identified for them to influence T&L policies and practice within NP and beyond. The Polytechnic is currently identifying more strategic ways to leverage on the talents of its NPTA recipients.

(4) More deliberate efforts to influence the development of all teaching staff

While the on-going development of the Awards recipients is a key feature of the Academic Awards Framework, these development efforts benefit primarily the recipients who are already the top 10% of NP's academic staff strength. While the Framework does include features to encourage and enable this top 10% to influence the development of the wider T&L community, there is a need to design more deliberate strategies, beyond the current Pedagogical Practicum Coaching of new hires, and sharing of fresh ideas from conferences and other platforms, to enable this group to have a greater influence in shaping the T&L practices of all teaching staff.

Conclusions

The Academic Awards in NP are not popularity contests and neither are they merely tokens of recognition for lecturers who have done some good T&L work in the year. The Polytechnic has taken deliberate steps over the last 10 years to systematically strengthen the NP Academic Awards Framework to ensure that it is purposefully developmental – of awards recipients, projects, Schools/Divisions and the larger teaching body.

Despite having made significant steps in improving the rigour and robustness of the framework, the Polytechnic recognises that there is still more that can be done and it has outlined 4 aspects it intends to look into. These include getting external inputs on its framework, making institutional meaning of the volume of awards data that it has collected over the years, having a more systematic approach to post-award development efforts for recipients, and a more deliberate approach to enabling these recipients to influence the development of all teaching staff and ultimately, further strengthen the quality of its programmes and graduate outcomes.

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SAFETY DESIGN IN THE AGE OF ANTHROPOCENE
-An Indispensable Component of Engineering Education-

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Abstract

Human impacts on earth became so apparent and reached beyond the level which could not sustain its autonomous stability. In addition, the author recoginize equally serious possible impacts of human activities on our life, namely man-made-things became direct threats to the daily life of the people. While man-made-things have ensured the safety of peoples' life, have improved the quality of life, and have contributed the extension of the frontier of mankind, at the same time, man-made-things not only destruct the inherent autonomy of the natural environment, but also may intensify the violence of nature, and may accideentally and unintentionally harm people, and even they may intensify the violence of malice. Engineers, as desiners of man-made-things, have to consider full range of possible impacts of their designed products and services to avoid such possible harms. The author identifies four areas of safety design to be considered by engineers. 1) safe design of products and services not to harm people, 2) safe design of products and services (especially infrastructure) not to intensify the violence of nature, 3) safe design of products and services not to be mal-used by intended criminals and terrorists, 4) safe design of products and services not to undermine the autonomy of natural environment. This is the extension of Krutzen's idea of Anthropocene and it seems coherent to the definition of harm given by the recent version of ISO/IEC Guide 51. The author will give a historical review of harms and threats to mankind, and then introduces four aspects of safety with several sets of examples. The author believes this set of design principles will become an neccesary element of engineer education and practice in the coming years, characterized by the concept of Anthropocene.

Keywords: *Anthropocene, safety design, man-made-things, artifacts, threats to mankind, engineering education, Paul Krutzen, system safety, system safety engineer examination*

Introduction

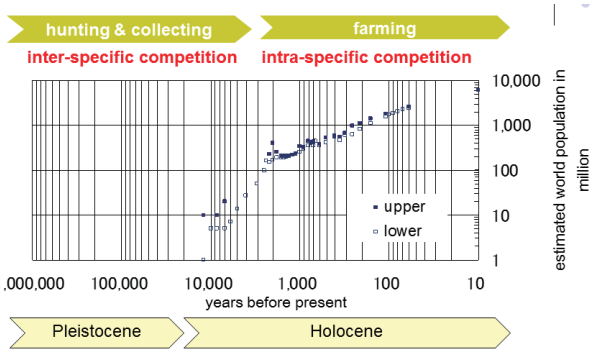
At the turn of the century, Paul Jozef Crutzen, a Dutch Nobel prize winning atmospheric chemist, proposed using the term *'Anthropocene'* for the current geological epoch to recognize the central and critical role of mankind in geological and ecological processes of this planet (Krutzen, 2000). The current geological epoch is called *'Holocene'* and it started 11,700 years ago. Although Krutzen did not say anything about from when Anthropocene started, some suggest to date back to the beginning of the Holocene and some suggest the beginning of the industrial revolution.

In addition to the human impacts on earth's environment, the author recoginize other equally serious impacts of human activities on our life. It is man-made-things' impacts on safety. Man-made-things became direct threats to safety of the people.

While man-made-things have ensured the safety of peoples' life, improved the quality of life, and contributed the extension of the frontier of mankind, at the same time, man-made-things not only destruct the inherent autonomy of the natural environment, but also may intensify the violence of nature, and may accideentally and unintentionally harm people, and even they may intensify the violence of malice. Engineers, as desiners of man-made-things, have to consider full range of possible impacts of their designed products and services to avoid such possible harms to our life.

Historical Overview of Therats to Mankind

The Bureau of Census of the United States has a good collection of scholarly works on long range historical estimates of world population. Figure 1 shows those estimates. Markers show upper and lower range of the estimates.



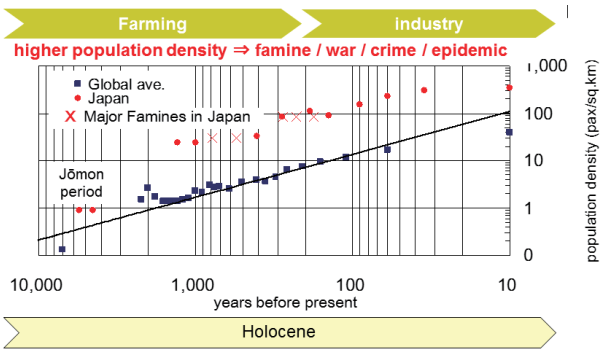
Source: U.S. Bureau of Census, Historical Estimates of World Population (Collections of studies by various scholars)

Back

Figure 1 Population Growth, livelihood and the mode of comepetition

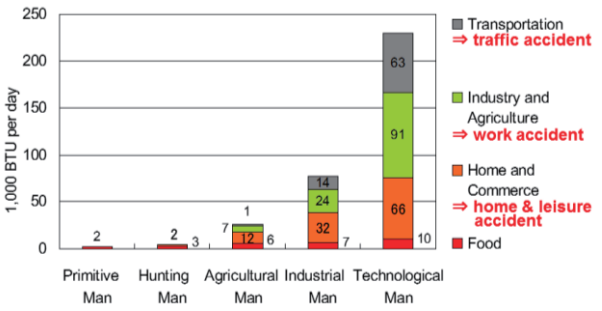
According to the studies of anthropologists, mankind in the age of hunters and collecters requires space of one square kilos to survive. The land surface area of the earth is 150 million square kilos. It means that hunting and collecting can sustain maximum 150 million populations on the globe. It is interesting to find that when the estimated population of the world reached to that upper limit, people found another way of livling to earn their livelihoods. And through this change, the inter-specific competition has transformed to intra-specific struggles over land and foods.

Figure 2 shows changes of the global population density during last 10,000 years. The population density go beyond the limit of one person per square kilos around two or three thousand years ago. The population density of Japan was checked too. Throughout almost whole time period, population density of the people in the land of Japan has been ten times higher than the world average. Because of that, sometimes we suffered by famine.



source: Global average/U.S. Bureau of Census, Japan / H. Kitoh (2000) , History of Japan seen from the population [in Japanese]

Figure 2 Population Density Growth



Source: Cook, The flow of energy in an industrial society, Scientific American 1971

Figure 3 Energy Consumption per Population

When the population density increases, by the help of farming, it creates another problem, lack of foods. War is another outcome, and crimes and epidemics too. Mankind began to face another kind of threats along with the increased population density.

Finally, life became dependent on high level of energy usage after the industrialization. The higher the nergy usage, the larger hazards we have to have. Energy itself is a source of harms. A primitive man consumes only 2000 kcal per day. It's just enough to sustain bio-chemical process of human body, metabolism. And today, we consume almost one hundred times larger energy per person. And those energies are used for transportation, agriculture and industry, commerce and lighting or heating at home. (Figure 3) famous Japanese physicist, Torahiko Terada once wrote:

"When the human race was still in its primitive stage and people lived in rugged caves carved out of the mountain rock, they would not have been bothered by most earthquakes or storms, and they had no structures that could be destroyed by the forces of nature." Just as wild animals and birds are able to withstand earthquakes and storms, so too would those uncivilized people have been able to survive with remarkable ease the natural disasters occurring year in and year out, and thus to maintain their social groups. ... Recovery from disasters was an individual matter as well, and there would have been no disasters from which individuals could not recover."

We can summarize that there are three sources of threats to mankind. Nature, mankind itself (mal-intention of mankind) and man-made things. Nature appears as threats to us in the form of floods, earthquakes, volcanic eruption, and etcetera. And recently, more precisely in the age of the Anthropocene, nature appears as much serious and complex threats to us.

Mal-intentions of people have also became more and more serious sources of threats. Struggles over land of foods appeared as very primitive forms of violence in old days, but nowadays crimes or terrorism can make use of man-made things such as weapons, and intensifying the result of malice in terrible magnitude.

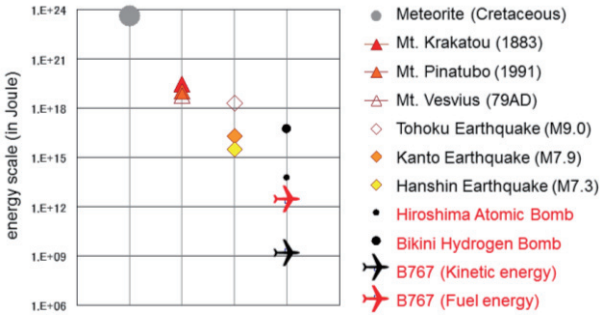


Figure 4 Energy Level Comparison – Nature and Man-made-things

Man-made things also have unintended side effects to harm people. Jomon people in ancient Japan had nothing that could be destroyed by earthquakes. But now we have many things that could be destroyed. Terada Torahiko, a Japanese famous physicist, wrote many inspiring essays seventy years ago (Terada, 1938). He talked about disasters which hit Jomon people a thousand years ago. They must be the same magnitude as today. But the damage created by those today is far more serious than the old day ones. Because man-made things accumulate energy, and once something happens it crushes. Another aspect is civilized society itslef is the fact that very complex structures, and more vulnerable

to disaster. Because of these reasons, violence of nature has been the trouble to us for long years, but now very much intensified by the leverage effect of man-made things.

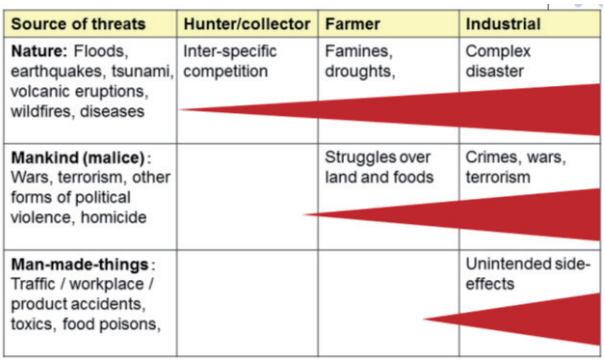


Figure 5 Man-made-things intensify the magnitude of harm to mankind

To cope with those different kind of threats, mankind has developed various measures. Against the violence of nature, various kind of civil works has been carried to protect people's community from disastrous effects of natural violence. City planning, disaster prediction technique and insurance systems are other examples of those traditional measures. And currently Business Contingency Planning (BCP) is widely cultivated by companies and infrastructure managers. (Table 1) Against the destructive effects of human acitivities onto the self-autonomy of nature, wide range of environmental measures begun to be implemented at global scale, such as green house gasses (GHGs) reduction efforts, global pollutants management, etc. Against the malice of people, criminal code, police system, national defense has been the traditional menu. But recently various type of dual-use technology control scheme has been invented and been implemented, such as Wassenaar Arangement, Missile Technology Control Regime (MTCR), in addition to various other types of dissemination control schemes of weapons. And against unintended harmful side effects of man-made-thing, safety standards, safety regulation, and various kind of safety management techniques have been developed during last couple of decades.

Table 1 Measures to cope with the threats of man-made-things

Type of threats	Traditional measures	Additional measures
Nature, violence of	Civil works, city planning, disaster prediction, insurance, etc.	Business Contingency Planning (BCP)
Nature, destruction of the autonomy of	Threats were negligible before industrialization	Management of GHGs, pollutants, etc.
Malice of	Criminal code, police, national defense, religion, ethics, education, etc.	Dual-use technology control
Man-made-things, unintentional effects of	Threats were negligible before industrialization	Safety standards, safety regulations, safety management

How Global Society is responding?

Then how the international community is responding to these issues? All four type of threats are global in nature. So that the responses to these require concerted action of all players of the international community.

The authors have developed a metric to measure the level of commitment to selected global issues (Lien et al., 2014a and 2014b). It is called Global Support Index (GSI). It is based on the analysis of the ratification data of countries to more than one hundred multilateral conventions on various global issues. The conventions covered by this ratification database are shown in ANNEX I. There six policy domains, Human Rights (H), Peace and Security (P), Trade, Commerce & Communication (C), Environment (E), Intellectual Property (I), and Labor (L). Under these domains, there are also sub domains, such as Arms Control and Disarmament, Non-Nuclear Zones, Non-Nuclear Proliferation, Cybercrime and Terrorism (preceding four sub-domains belong to P domian), Trade and Commerce, Transportation and Communication, Measurement and Technical Standards (belong to C domain), Environment, Nuclear Safety (belong to E domain), and Basic Labor Rights, Occupational Health and Safety (belong to L domain). Under these sub domains, more than hundred multilateral conventions are covered. These conventions are considered sufficient to describe major global policy agenda given in Table 1.

SGI is a weighted average of wach country's support level (= 1 if the country has ratified the convention at given year, and = 0 when not yet ratified) to specified multilateral conventions. In the case of global environment area, ten multilateral conventions are selected to describe the country's behavior in this policy domain. World Heritage Convention (WH), Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Ramsar Convention (Ramsar), Convention on Migratory Species (CMS), Vienna Convention for the Protection of Ozone Layers (Vienna), Basel Convention (Basel), Convention for Bio-Diversity (CBD), UN Framework Convention for Climate Change (FCCC), Prior Information Consent Convention (PIC), and Pertinent Organic Pollutant Convention (POPs).

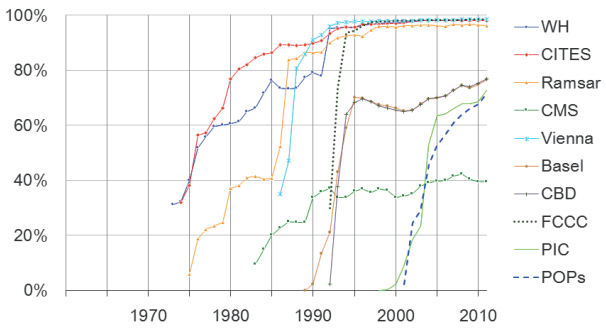


Figure 6 Global Support Index (SGI), Environment

In the case of Arms Control and Disarmament sub domain, nine conventions data are collected, namely, Hague 1899 and 1907, Geneva, Partial Test ban Treaty (PTBT), Non-Nuclear Proliferation Treaty (NPT), IAEA Safeguard (IAEA), Biological Weapons Convention (BWC), Chemical Weapons Convention

(CWC), Comprehensive Test Ban Treaty (CTBT), Australia Group (AG, Nuclear weapon related technology export control), Missile Technology Contril Regime (MTCR), and Wassenaar Arrangement (WA). Figure 7 shows SGIs of those ten conventions.

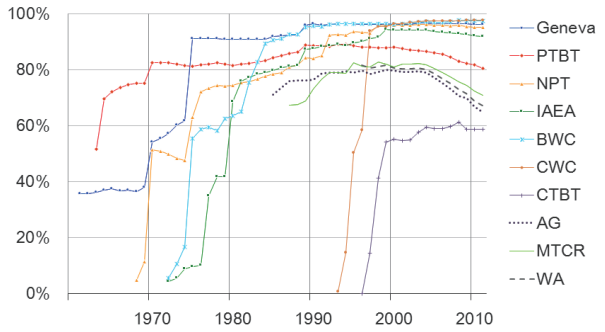


Figure 7 GSI for Disarmament, Arms Control and Dual-use Technology Control Sub-Domain

In the sub-domain of Cybercrime and Terrorism, fourteen conventions data are collected, namely, Aircraft, Unlawful Seizure, Civil Aviation, Diplomatic Agents, Hostages, Airport Protocol, Maritime, Fixed Platform, Plastic Explosives, Terrorist Bombings, Terrorist Financing, Nuclear Terrorism, Nuclear Materials, and Cybercrime. Figure 8 shows GSIs of those fourteen conventions.

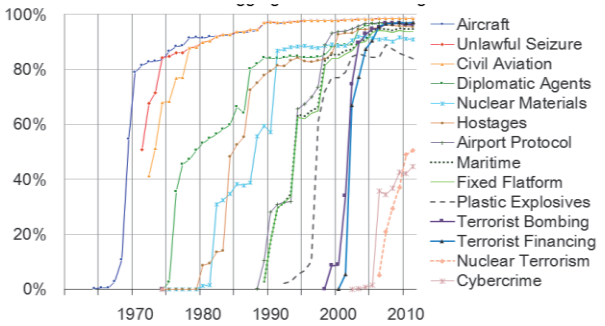


Figure 8 GSI for Cybercrime and Terrorism Domain

In the case of nuclear safety sub-domain, Early Notification of a Nuclear Accident (CEENA), Assisstance in the Nuclear Accident (CACNARE), Convention on Nuclear Safety (CNS), Safety of Spent Fuel Management (JCS). And GSI for this domain is shown in Figure 9.

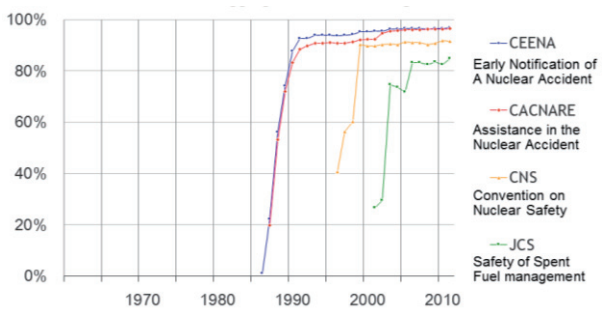


Figure 9 GSI for Nuclear Safety

Quick review of above mentioned four figures reveals that in every policy domains, global community is very swiftly responding to these policy issues, such as global environment, arms control, cybercrime and terrorism and nuclear safety. These correspond to the various types of threats to mankind, distruction of the autonomoy of nature, malice and man-made-things, described in the Table 1.

Safety Design: An Indispensable Component of Engeer Education

The paper first reviewed the historical transformation of various types of threats to mankind and then reviewed historical development of responses of the global community to several policy domains. The responses are measured by Global Support Index (GSI). Here in this section, the paper finally presents our university's response to this situation in the context of engineering education.

Nagaoka University of Technology (NUT) has been offering a series of unique, safety focused education programs since 2002 (For detail, see ANNEX III). At first, *Mechanical Safety Engineering Course* was launched in 2002 as a cource attached to Mechanical Engineering Department at NUT.

Later in 2006, it was renewed and its scope was expanded from just *mechanical safety* to *system safety* (DOD, 1969). This program, *Professional Master Program for System Safety*, was created as a specialized educational program for professional engineers. While student size of the program is small (15 intakes per year), many professionals who are working in industry and government agencies, specialized in safety engineering and safety management, has enrolled to this program. The educational component structure of the *System Safety Course* is given in ANNEX II. There are three layers, principles, common safety tools, and safety of specialized sectors and subjects.

Six year later in 2012, another safety related educational program was launched in the field of nuclear engineering. Its name is *Master Program for Nuclear System Safety*.

In addition to that NUT is working together with industry expert and established completely third party qualification scheme for *system safety engineers*.

The recognition of NUT behind these recent development of its educational programs is that safety design became an indispensable component of engineer education. Engineers should be trained to understand and design various man-made-thngs to properly manage various types of hazard described in this paper. Especially, evidence-baced risk analysis is the basis of all safety design and authors are trying to develop such risk analysis framework (Zhang, 2015). Traditional thiking of engineers are typically focused on performance, cost, new functions, efficiency, etc. But safety consideration in design is becoming more and more important and indispensable in the age of Anthropocene.

Conclusions

Human activities reached to the magnitude which could destruct the self-regulatory mechanism of nature. In addition to that, man-made-things have appeared as direct threats to lives of people through various channels. Global society is responding to cope with this situation by establishing and enforcing global governance schemes in various policy domains such as environment, dual-use technology control, safety, etc. According to the author's analysis, the global community has been responding very swiftly to emerging global policy issues relating to threats created or enhanced by man-made-things. There is a growing recognition about better governance of unintended side-effects of man-made-things.

Nagaoka University of Technology is also responding to these issues and has launched a series of educational programs focused on safety and succefully developed an educational components structure for these educational programs. The author believes that these conponents should be shared by other educational institute engaged in engineering education of young and adult engineers.

Acknowledgements

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ANNEX I List of Multilateral Conventions used for Global Support Index (GSI) Analysis

Domain	Sub Domain	Conventions in acronyms or shortened names
H: Human Rights	Human Rights	Slavery, Genocide, ICERD, ICESCR, ICCPR, ICCPR Protocol 1, War Crimes, ICSPCA, CEDAW, CAT, Apartheid in Sports, CRC, ICCPR Protocol 2, MWC, CRPD, Disappearance
P: Peace and Security	Arms Control and Disarmament	Hague 1899, Hague 1907, Geneva, PTBT, BWC, CCW, CWC, CTBT, APM
	Non-Nuclear Zones	Tlatelolco, Rarotonga, Bangkok, Pelindaba, CANWFZ
	Non-Nuclear Proliferation	NPT, IAEA
	Cybercrime and Terrorism	Aircraft, Unlawful Seizure, Civil Aviation, Diplomatic Agents, Hostages, Airport Protocol, Maritime, Fixed Platform, Plastic Explosives, Terrorist Bombings, Terrorist Financing, Nuclear Terrorism, Nuclear Materials, Cybercrime
C: Trade, Commerce & Communication	Trade and Commerce	IMF, WB, GATT, WTO
	Transportation and Communication	ITU, UPU, IMO, ICAO
	Measurement and Technical Standards	Metre, ISO, IEC, TBT
E: Environment	Environment	FAO, ICRW, WH, CITES, LC72, Ramsar, Air Pollution, LOS, CMS, Vienna, Montreal, Basel, CBD, FCCC, Kyoto, PIC, POPs
	Nuclear Safety	CEENA, CACNARE, CNS, JCS
I: Intellectual Property	Intellectual Property	Paris, Berne, Madrid, Hague, UCC, Rome, UPOV, WIPO, Phonograms, PCT, TRIPS, LTL, WPPT, WCT
L: Labor	Basic Labor Rights	C29, C105, C87, C98, C100, C111, C138, C182
	Occupational Health and Safety	C13, C45, C62, C120, C115, C119, C127, C136, C148, C161, C162, C167, C170, C174, C176, C184, C187, C139, C155

ANNEX II Structure and Components of System Safety Education

<table>
<tr><td colspan="2">Category</td><td colspan="7">Educational Components of System Safety</td></tr>
<tr><td colspan="2">Principles</td><td colspan="7">Introduction to System Safety (History, Human Rights, Principles)</td></tr>
<tr><td rowspan="3">Common Safety Tools</td><td rowspan="3">Management Tools / Engineering Tools</td><td colspan="2">Technology and Public Policy
Intellectual Property Rights
Safety and Law
Industrial Safety Laws</td><td colspan="3">Safety management
International Standards and Safety Evaluation
International Standards and Safety Technology
Certification and Accreditation
Exercise II
Exercise III</td><td colspan="2">Technology Management
Risk management
Exercise IV</td></tr>
<tr><td>IEC 60204</td><td>IEC 61508
ISO 13849</td><td>ISO 12100</td><td>Risk Analysis
Fault Tree Analysis (FTA)
etc.</td><td></td><td></td><td></td></tr>
<tr><td>Electrical Safety and EMC</td><td>Safety-related Information Communication System and Control System</td><td>Safety Design of Industrial Equipments</td><td>Risk Evaluation
Safety Logics
Exercise I</td><td>Ergonomics</td><td>Structural Safety Analysis</td><td>Fire & Explosion</td></tr>
<tr><td colspan="2">Safety of Specialized Sectors, Subjects</td><td></td><td></td><td></td><td>Noise and vibration
Robotics</td><td>Occupational Health and Safety Management</td><td></td><td>Meddical Safety</td><td></td><td></td></tr>
</table>

ANNEX III Chronology of Safety-Related Events at Nagaoka University of Technology, Japan and the World

Events at Nagaoka University of Technology	YEAR	Events in Japan and World
Mechanical Safety	2001	Ministry of Health and Labour, Guideline for Comprehensive Safety of machines
Graduate Course for Mechanical Safety	2002	
	2003	ISO12100 Food Safety basic Law
	2004	Chuetsu Earthquake
	2005	Occupational Safety law amended, Risk Assessment become maddatory for manufacturers
Professional Graduate program for System Safety	2006	Consumer Safety Law amended, Reporting ofSerious Accidents become mandatory
	2007	Chuetsu-oki Earthquake
Research Center for Safe and Secure Society	2008	
	2009	Consumer Affairs Agency (CAA)
System Safety Engineer (SSE) Qualification System Launched	2010	
Annual Bulletin *Study on Safe and Secure Society*	2011	Tōhoku Earthquake (M9.0) and Tsunami
Master Course for Nuclear System Safety	2012	
	2013	
JST/RISTEX supported program on Evidence-based advanced risk management project started	2014	
	2015	

Back

PROFESSIONAL DEVELOPMENT OF LECTURERS IN POLYTECHNICS: THE REPUBLIC POLYTECHNIC'S EXPERIENCE

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Abstract

Republic Polytechnic (RP) has adopted problem-based learning (PBL) as the main pedagogy to achieve its mission of graduating practice-oriented and knowledgeable professionals for Singapore. This necessitates an integrated academic professional development programme that builds the competencies and capabilities of the lecturers to successfully implement this educational innovation. This presentation shares RP's experience in implementing a professional development programme to support lecturers in facilitating PBL since 2002. Specifically, two key features of the programme are discussed: [a] a structured training roadmap and [b] extensive peer coaching practices, which contributed significantly to the success and long term sustainability of the professional development programme.

Keywords: *Professional development, polytechnics, lecturers, training roadmap, peer coaching*

Introduction

The mission of polytechnics is to prepare students to graduate as practice-oriented and knowledgeable middle-level professionals able to contribute to the technological and economic development of Singapore. This is critical today with the rapid advancements in technology and a knowledge-based economy. Students need to be equipped with industry-relevant knowledge, and 21st century competencies such as problem solving and higher-order thinking skills, working collaboratively and life-long learning skills to enable them to stay relevant, resilient and competitive (Graham, 2012). A key pre-requisite to high quality education and training for students is high quality teaching by well-trained academics (Caena, 2011; Darling-Hammond, Holtzman, Gatlin, & Heilig, 2005).

Professional development in polytechnics

All polytechnics in Singapore have put in place professional development programmes for their lecturers. Each polytechnic has a staff development unit responsible for such programmes, also known as the centre for educational development, centre for professional and leadership development, learning academy or teaching and learning centre. The strong emphasis on nurturing high quality education and a culture of continuous learning is evident when all polytechnics collaborated to jointly create a professional development competencies framework for polytechnic lecturers in 2014. Six competency domains relevant to the current educational and industry landscape were developed: curriculum design and development, facilitation of learning, assessment for and of learning, holistic student development, dual professionals and reflective practitioners. This competencies framework is timely as it provides guidance on the focus areas and programmes needed for professional development of polytechnic lecturers.

Professional development for problem-based learning (PBL)

Educational institutions adopting PBL around the world recognised that professional development of faculty is a key driver for successful PBL implementation. However, the longer term effectiveness and sustainability demand the astute juggling of multiple interrelated factors including formal requirements for training, institutional support for innovation and continuous learning, human resource incentives and policies, and the design and execution of the professional development programmes based on several key principles (Avalos, 2011; Kolmos, Du, Dahms, & Qvist, 2008). Studies on the effectiveness of professional development to support PBL had distilled five guiding principles in many successful programmes (McLean, Cilliers, & Van Wyk, 2008; Schreurs & De Grave, 2010).

The first principle of effective professional development is for theory-based programmes. In PBL, constructivist learning, collaborative learning, self-directed learning, reflective learning, adult learning and instructional design principles (De Graaf & Kolmos, 2003) provided useful theoretical framework for the design and development of the training programmes..

The second principle is longitudinal programmes integrated with practice, feedback and peer support rather than one-off training events. A change of mind-set about knowledge, teaching and learning is needed to implement the PBL approach, and this happens progressively over time. Moreover, it takes time and efforts to plan, apply, reflect and improve on PBL practices in lessons (Norman & Schmidt, 1992).

The third principle is flexibility in the use of instructional methods to best achieve the professional development outcomes. Four types are common: workshop, coaching activities, work-based learning, and e-learning. They can be used singly or in combinations.

The fourth principle is choice of programmes targeting the needs and experience level of faculty members. Novice lecturers benefit from a broad-based preparatory programme while experienced lecturers have a choice of areas to deepen their competencies and address knowledge and skills' gaps. Lecturers could further specialised as experts in specific domains.

The final principle is a systematic and quality approach in designing professional development programmes, starting from needs assessment, developing the materials, delivering the programme, and evaluation and feedback. The trainers of the programme must also demonstrate domain expertise and good role modelling of PBL practices.

Professional development of lecturers in RP

RP's professional development programme is guided explicitly and implicitly by the factors and principles mentioned in the previous section.

Goh (2012) described the early phase of the PBL professional development programme in RP from 2002 to 2003 as centred on formal and informal discussions among pioneer staff over the aims of education, educational trends and industry's feedback on competencies of polytechnic graduates. Establishing a shared educational philosophy was essential to formulate RP's own model of PBL, contextualised to the Singapore's educational system and characteristics of students (Yew & O'Grady, 2012).

When the framework and lesson structure of RP's PBL were formalised, the challenge was implementing intensive foundational training for lecturers on classroom facilitation. Reviews and evaluations of the early training programmes soon revealed the need to add more training areas, in curriculum design, understanding youths, and academic leadership. Feedback also suggested that lecturers felt overwhelmed by the introduction of many educational theories; instead they wanted more practice, feedback and peer support to integrate ideas and strategies learnt from training to their PBL lessons. The more experienced lecturers at this point have also started to ask for more varied and new training areas to further their professional growth as educators. This is expected as lecturers being adult learners prefer training that is perceived to be practical and directly relevant to their work (Brookfield, 1986).

Informed by the lessons learnt in the early years and relevant theories of adult learning, work-based learning and PBL, the various professional development activities were consolidated and sequenced into the first academic training roadmap in 2009. The training roadmap continues to be reviewed and evolved in 2012 and 2015, and now forms an integral part of RP's professional development programme.

Given that PBL is practiced across all diploma programmes in RP, there is a need to articulate the standards of facilitation and assess the competencies of lecturers against those standards. In 2003, a certificate in facilitation programme was launched which incorporated a teaching portfolio, assessment of video recorded lesson based on the criteria in the PBL facilitation standards, and a panel interview for the candidate to articulate the evidence of good facilitation practice and demonstrate critical reflection of practice (O'Grady & Ong, 2007). In tandem with the certification of facilitation programme, a peer coaching framework was also established where certified facilitators could observe and provide feedback to improve the facilitation skills of lecturers preparing for the certification (Goh, 2012).

In 2006 and 2014, similar certification programmes were extended to certify staff in the design of PBL problems and lessons employing other pedagogical approaches.

Considering the professional development programme at RP as a whole, two salient features have taken into account the multiple interrelated factors and embodied many principles of effective professional development programmes: [a] a structured training roadmap, and [b] extensive peer coaching practices. The next sections elaborated on the training roadmap and peer coaching practices in their current form at RP.

Structured Training Roadmap

A structured training roadmap charts the various types of programmes that develops lecturers for different academic roles and diverse student-centred practices, signposts key professional development milestones, and affords pathways for higher career aspirations and life-long learning. The training roadmap should also be robust and responsive to meet the demands of the various stakeholders in the polytechnic, changing organisational needs and educational landscape.

Training roadmap in RP

The training roadmap allows RP to be strategic and systematic in achieving the outcomes of the professional development programme, by developing lecturers who are able to:

- apply learner-centric pedagogies and leverage technologies to enhance their teaching and learning practices;
- apply principles of adult learning and youth psychology to motivate and engage their learners of diverse needs and abilities;
- adopt appropriate frameworks and incorporate professional practices and industry standards in the design of curriculum and assessment; and
- engage in continual professional development to keep abreast with industry and pedagogical trends.

Longitudinal plan for professional growth

Professional growth of lecturers requires a longitudinal effort, where the training needs change with the roles and experience levels of the lecturers (Guskey & Yoon, 2009). For new lecturers, the training roadmap maps out the workshops and learning activities

to equip them with the essential knowledge, skills and values to carry out their academic functions. This is pertinent as while the majority of new lecturers might possess substantial industry experience, they lack the pedagogical, curriculum and assessment groundings. More importantly, RP's PBL approach is a significant departure from their past educational experience that necessities adoption of different beliefs and enactment of new roles in teaching and learning. These include curriculum centred around problems and applying knowledge and skills, teaching focusing on facilitating learning and assessment of both the outcomes and the process of learning.

As lecturers gain experience, the professional development workshops and activities focus on deepening their competencies as facilitators, developers of curriculum and assessment and module managers. A quality benchmark for effective teaching and learning is for the lecturers to attain the certificate in facilitation. Lecturers could also opt to specialise and undergo certification in problem crafting and lesson design.

For experienced lecturers who continue on to assume academic leadership roles such as programme chairs and certification panel members, a tailored training programme supported with peer coaching by existing leaders is put in place to help them gain the institutional knowledge and expertise needed for their new roles.

Professional development milestones and continual learning

The training roadmap lays out significant professional development milestones for lecturers. The first is the completion of 84 hours of foundation training. The next milestone is the certification of facilitation to the institution's standards of effective teaching and learning within a stipulated time frame. Certified lecturers are offered pathways to gain formal qualification through the articulation to a specialist diploma in applied learning and teaching and sponsorship to complete a master's degree in education. All lecturers are provided with an annual training budget and are expected to be engaged in at least 20 hours of academic professional development yearly, to further develop their teaching capabilities and to keep up with educational trends.

Flexibility and variety in what to learn and how to learn

The training roadmap caters for flexibility in the training areas and activities to achieve the professional development outcomes. The choice of training areas include teaching practices, curriculum and assessment, pastoral care, adult learning, module and programme management, educational technology and research. The contents developed are informed by well-established theories and practices in each area. Four main training activities are used singly or in combinations: workshop, peer-coaching, work-based learning and e-learning. E-learning or blended learning are now being used extensively to mitigate the clash between time to attend training physically and other work responsibilities. E-learning affords lecturers the flexibility to learn at their own time, place and pace.

Open to pedagogical and instructional innovations

RP's pedagogical approach is anchored on PBL. However, there is flexibility to introduce other innovative pedagogies that can best achieve specific learning goals. Over the years, case-based learning, cognitive apprenticeship, experiential learning, interactive seminars, project-based learning and skills based learning have been included in the repertoire of professional development courses for lecturers. Emerging instructional strategies and tools such as flipped-classroom, peer instruction and the use of e-portfolio and online social media platforms for learning are also introduced in short hands-on workshops.

While lecturers are encouraged to experiment, implementation of any new teaching approach is planned and studied carefully to ensure that it benefits students' learning and achieves the desired module outcomes. A work-based learning approach is usually adopted (Boud & Solomon, 2003), where a small group of lecturers involved in the implementation and staff developers collaborate to conduct lesson studies and evaluation research, to determine and report on the efficacy of the teaching innovation.

Responsive to external and internal needs

The training roadmap has to be responsive to external changes in education and future employment landscape. For example, a key recommendation of the Applied Study in Polytechnics and ITE Review (ASPIRE) Committee (2014) was to strengthen the education and career guidance efforts in the polytechnics. In response to this, workshops and training activities were swiftly developed, training lecturers to help students access accurate, up-to-date information and make well-informed education and career choices for their future.

In a study on new lecturers who have completed the foundational professional development programme at RP, Lim and Choy (2014) found that lecturers needed more support in the assessment of students in a PBL environment. This is not surprising as assessment is a complex and frequently high stake area in education (Nitko & Brookhart, 2011). Based on a training needs analysis, a comprehensive series of nine workshops were developed to train lecturers, covering the design, conduct, review and report of assessment. Peer coaching was also introduced to help new lecturers gain the skills and confidence to carry out continuous assessment of students. This example demonstrates how a gap identified internally through research was addressed in the overall training roadmap for lecturers.

Peer Coaching Practices

Peer coaching is a way for lecturers to help fellow lecturers to improve teaching or learning situations. It is

collaborative in nature and commonly utilises a three-step process (Robbins, 1991; Showers & Joyce, 1996):

1. Pre-observation discussion on focus of coaching
2. Observation of actual practice
3. Post-observation debrief and reflection to improve practice.

Practices similar to peer coaching include peer review, collegial observation and lesson study. However, peer coaching differs from mentoring in being confined to improving a specific practice, of shorter duration, non-judgmental in outcomes and can be done by anyone skilled in the practice, not necessarily a senior staff mentoring someone junior (Gottesman, 2000). For peer coaching to be successful, there must be mutual trust among lecturers to reflect on a current practice and to participate in collegial efforts to make improvements to practice (Lieberman & Miller, 2000).

Peer coaching in RP

Peer coaching in RP follows the three-step process mentioned above and is implemented at various levels. It supports new lecturers in acquiring the requisite knowledge, skills and disposition to effectively facilitate PBL lessons. For experienced lecturers, peer coaching provides guided practice, formative feedback and reflection on practice to support them in attaining certification to RP's teaching and learning standards. Peer coaching for academic leaders provides the role-modelling and institutional knowledge to prepare them for assuming peer review and coaching roles.

All peer coaches undergo a "peer coaching: developing and reflecting on practice" workshop to equip them with the knowledge and skills to coach their colleagues. The training coordinator in each school matches the lecturer to be coached with a suitable peer coach, and the number of coaching sessions and timeline are agreed upon. Administrative support is provided with online forms to ease the recording of the pre-, post-, and observation data. Peer coaches and lecturers being coached are both awarded professional development hours as an incentive and recognition for their efforts and time invested in the learning activity.

Benefits of peer coaching in professional development

Peer coaching helps sustain professional development efforts as lecturers who have acquired the skills become potential peer coaches for other lecturers (Joyce & Showers, 1982). At RP, peer coaches increase the pool of staff developers available that are not only skilled in coaching but have the same subject matter expertise as the lecturers being coached. This allows for deeper understanding of the conceptual and contextual challenges of teaching in the discipline, and better coaching outcomes.

Studies have shown that peer coaching works as the transfer from training to practice is direct, can be done as part of work and during work hours, which is the essence of work-based learning (Garet, Porter, Desimone, Birman, & Yoon, 2001; Showers & Joyce, 1996). In RP, peer-coaching and work-based learning activities have also been consistently ranked by RP's lecturers as the most useful professional development activities (Lim & Choy, 2014). They have been introduced progressively in more areas such as training to develop new diploma programmes and to design alternative instructional and assessment strategies.

Peer coaching also increases the buy-in of the professional development programme in RP as lecturers reap benefits from improving their own teaching and learning practice, and becoming active contributors helping their colleagues to succeed. Lecturers also "walk the talk" of engaging in continuous learning, just as they expect their students in PBL to do (Gottesman, 2000).

Peer coaching has been an extensive and successful practice in support of RP's certificate in facilitation programme. A study by Goh (2012) has found peer coaching to be the key contributory factor in raising the first attempt success rate from 55% to over 70%. Since its inception in 2003, over 400 lecturers have attained the certificate in facilitation (Goh, 2014).

Future Developments

Professional development of lecturers at polytechnics will continue to evolve, needing regular reviews to check its relevance and to respond to shifts in internal and external educational environments.

Emerging educational technology such as immersive virtual environment, interactive, collaborative online platforms and learning analytics tools promise significant affordances in the teaching and learning of 21st century competencies (Avalos, 2011; Schreurs & De Grave, 2010). Lecturers will need to be trained to harness and implement them effectively in their lessons.

The training roadmap is likely to incorporate more train-the-trainer programmes in response to the national SkillsFuture Council (2015) initiatives. Lecturers will need to be equipped with the knowledge, skills and acumen to co-develop curriculum, teaching and assessment practices with industry partners.

There will also be increasing focus on accountability of professional development programmes, to justify the investment of time and resources. Research on the impact of professional development will move from not only studying the satisfaction level, learning and behaviour changes of lecturers, but to the more complex outcomes of changes in organisational practice and impact on students' learning (Desimone, 2009).

Conclusion

This presentation shared the experience of RP in implementing a professional development programmes for lecturers to support educational innovations such as PBL. Specifically, it highlighted two key features, a structured training roadmap and extensive peer coaching practices which contributed significantly to the success and long term sustainability of the professional development programme. The insights discussed may be of value to educational institutions that are enhancing

their professional development programmes for supporting lecturers in their pursuit of academic excellence.

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THE MEXICAN KOSEN AT THE UNIVERSITY OF GUANAJUATO: AN INNOVATIVE APPROACH IN TECHNOLOGICAL AND SCIENTIFIC EDUCATION THROUGH INTERNATIONAL COOPERATION

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Abstract

The National High School System in Mexico provides capabilities for developing mathematical-logical thinking and communication skills, for the students to continue university studies. The Technical education offered in our country is mainly oriented to equipment operation, with occasional participation in solving or analyzing problems found in the industries. In The Bajio region, central Mexico, are being placed increasingly Japanese automotive assembling industries and many suppliers. This arrival has impacted the local economy and is requiring highly skilled professionals. Hence, the University of Guanajuato (UG) and Nagaoka University of Technology (NUT) designed a Technological High School Program with and International Profile, similar to the Japanese Kosen system. It is expected that the graduates from this program will be capable of solving complex problems by using a solid scientific and technological knowledge. In the beginning, two areas will be offered: Materials Science and Mechatronics, plus a consistent formation in fundamental scientific areas, engineering, human sciences, communication, and teamwork. Moreover, some short stays in industries will be carried out. The students will become fluent in English and Japanese languages for technical and daily communication. The students will be exposed to the Japanese culture through video conferences and seminars from Japan, and it count on with volunteer Japanese professors in Mexico. Moreover, Mexican students could carry out short stays in the Kosen's institutions in Japan. The overall program will last five years. The graduates after concluding the program could follow their bachelor studies at UG, or at NUT, or to work in the industry. This program will be supported by the Division of Natural and Exact Sciences, the Division of Engineering, and the High School System located in Guanajuato city and Salamanca city, from the UG, Mexico. From Japan, NUT, as well as Nagaoka and Oyama Colleges from the Kosen system, have recently celebrated a cooperation agreement with the UG. The Mexican Kosen is the first academic program of its kind offered in Mexico, where highly skilled professionals must count on with a strong scientific, engineering and language preparation. This way UG and NUT contribute to the development of the state of Guanajuato, Mexico.

Keywords: *Kosen, Mexican Kosen, high school system, mechatronics, materials science, international education*.

Introduction

According to the "Education to Employment: Designing a system that works" report by McKinsey & Co., in (Mourshed, D. Et al. 2014); which embraces nine countries, including Mexico, two related world crises are confronted: high levels of unemployment and a shortage of individuals with critical job skills. However, the governments have had difficulties to develop effective responses or even to define what they need to know.

The Organization for Economic Cooperation and Development (OECD) reported that there is more than one individual between 15 to 24 years old that are not employed nor are attending to school or are in training (OECD, 2012). Moreover, at a worldwide level, the International Labour Organization (ILO) estimates that 75 million of young people are unemployed. At the same time, there is a shortage of people with critical skills (ILO, 2014).

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In countries like Germany, Saudi Arabia, USA, Brazil, India, Morocco, Mexico, Turkey and the United Kingdom, only 43% of employers agreed that they could find workers with sufficient labor training. The McKinsey Global Institute (Mourshed, D. 2014) estimates that there will be a global deficit of 85 millions of workers with high and medium work skills.in 2020.

Over the recent years, in the state of Guanajuato, Mexico, a variety of companies have been established. The Study of Labor Market carried out in Guanajuato (2013 reported that of 320 companies surveyed, from four economic sectors, 71% of them are from the manufacturing sector. Moreover, it has led to the installation and opening of transnational corporations and, it is generating new jobs. These companies concentrate mostly in the auto parts sector with 77.34% out of them, followed by the leather and footwear, metal, and plastic industries (Secretary of Sustainable Economic Development, 2013).

A strategic dimension of the Development State Plan of Guanajuato 2035 indicates that there should be an education for competitiveness and effectiveness and training for work (Secretary of Sustainable Economic Development, 2015). This report entails the necessity of formulating and updating the study programs to provide education with quality at the high school and university levels, which it is efficient and relevant for international, national and state development.

In Mexico, the high school studies provide competencies and skills to pursue university studies or to integrate into the labor force.

An educational institution should be monitoring its environment and anticipate changes in its environment. Therefore, the higher education institutions should make contributions by designing innovative educational programs to drive the social and economic development of its inhabitants.

Therefore, the goal was to design a Technological High School Program with and International Profile (BTPI), similar to the Japanese Kosen system. It is expected that the graduates from this program will be capable of solving complex problems by using a solid scientific and technological knowledge.

In the beginning, two areas will be offered: Materials Science and Mechatronics, plus a consistent formation in fundamental scientific areas, engineering, human sciences, communication, and teamwork.

Methodology

Focus group to elaborate the proposal. A focus group developed this proposal. The members were from Directorate of the School of High School System; Directorate of Academic Cooperation; Department of Educational Model, and professors from the Departments of Electronic and Mechanical Engineering from Campus Irapuato-Salamanca and the Department of Chemistry from Campus Guanajuato. Moreover, Nagaoka University of Technology, Japan, also contributed to putting together this proposal.

Analysis of educational and industry needs. To know the requirements of the educational sector to prepare labor force; data from the Ministry of Public Education (SEP, 2014), the National Institute for Educational Evaluation (INEE, 2013), Ministry of Education of Guanajuato (SEG, 2014): Sustainable Economic Development Secretariat of Guanajuato (SEDS, 2013) were analyzed. Similarly, some officials attended several sessions of the Automotive Cluster of Guanajuato (CLAUGTO) to know desirable competencies of technicians and middle managers of this sector.

Access to Education. The Ministry of Education through the undersecretary of middle higher education estimates that in 2018, at least 80% of people will count with high school studies (SEP, 2013). Therefore, the University of Guanajuato has proposed to create a new high school program called Technological High School Program with International Profile (Bachillerato Técnico con Perfil Internacional, BTPI, by its Spanish acronym). This program is also denominated like Mexican Kosen. This way the University of Guanajuato is responding to the growing demand for skilled professionals in the automotive industry related areas: metal-mechanics and materials science.

Industries arrival impact. At present, there are many automotive industries settled in the state of Guanajuato, as well as the part suppliers are arriving. This situation is attracting more foreign investment due to the competitive situation for economic development. Besides, the Bajio region in the central part of Mexico offers an excellent connectivity with the American border, as well as there are skilled workers in the booming developing industry.

Results and Discussion

Structure of the Technological High School Program with International Profile. The overall program will last five years: the High School System will offer the first three years, and the last two will function with the participation of two Guanajuato University divisions. After completing the five-year program, the participants could continue their bachelor studies at the University of Guanajuato, or at the Nagaoka University of Technology (Figure 1).

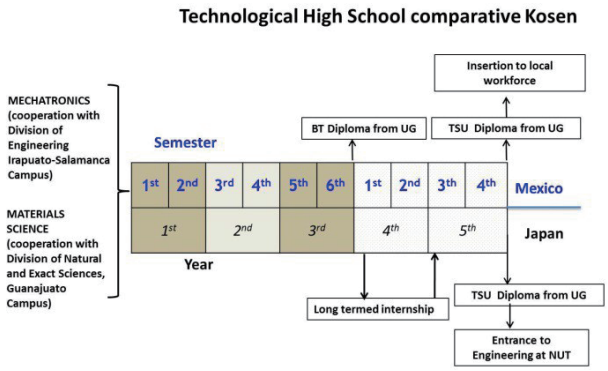


Figure 1. Course development and BTPI functioning.

The BTPI program will have two orientations: Mechatronics, which will be offered in Salamanca High School and Materials Science in Guanajuato High School. This program has four main education areas (Figure 2).

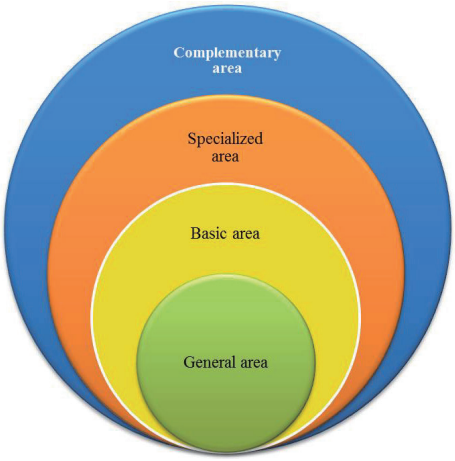


Figure 2. BTPI Curricular areas.

General area. The activities are focused to promote the personal development, social responsibility, creativity, and entrepreneurial spirit, as well as to develop cultural and intercultural skills.

Basic area. This area constitutes the BTPI Education Program nucleus. The area is made up of specific courses that will help the students to developing the specific skills to cope efficiently with different settings and situation throughout his/her life. The subject include mathematics, fundamentals science, communication, social sciences, English and Japanese languages, sports and cultural activities and management.

Complementary areas. The student will perform research under the professor guidance. Students will attend conferences, as well as industries stays, academic contests, and cultural events will be included to complement their personal and professional profile development.

Specialized area. The students will take either subject from Mechatronics or Materials Science that will allow them to perform in their professional life or to continue university studies. The subjects include practical workshops and experimentation in laboratories.

This program operates according to academic credits. Besides, the applicant and graduate profiles will be described later. Faculty from Japan and Mexico will participate to achieve the program goals in technical, human, cultural and language aspects.

Credits system. One academic credit corresponds to twenty-five hours of student work, inside and outside the classroom. The total number of academic credits is 136 for the BTPI.

Applicants profile. The student must possess knowledge of mathematics, physics, chemistry and English. The student must also show the capability to communicate effectively orally and in writing. The applicant must be willing to teamwork and show the desire to learn about other cultures.

Graduate profile. After finishing the program, the student will be able to solve current problems in industry. They will be aware of production processes for its improvement. Students will know the fundamentals of the different types of materials and the use of simple tools, as well as automated equipment. Graduates will show leadership skills and teamwork and intercultural abilities. It is expected that at the end of 6 semesters, the graduate shall communicate in their mother tongue as well as English and Japanese.

Faculty. Professors from UG hold M.Sc. and Ph.D. degrees in their specialization areas, as well as the ability to teach in English. Professors from Japan will also participate through short and long stays as well as by video conferences.

Languages: Spanish, Japanese, English languages will be utilized as a medium of instruction to put in practice theoretical skills, as well as the cooperation between professors from both countries. The students will accomplish 800 h of Japanese language, including basic courses as well as the specialized technical language. Native Japanese teachers will participate in this Program. The stays in Japan would help to develop the intercultural awareness and to practice the foreign languages in a natural environment (Figure 3).



Figure 3. Main features of the BTPI from UG. The program also integrates the exposure to Japanese culture through short and long stays in Japan and video conferences and participation of Japanese guest professors.

Support and international collaboration. This program will be supported by professors of the Division of Natural and Exact Sciences and the Division of Engineering, and the High School System located in Guanajuato city and Salamanca city, from the UG, Mexico. From Japan, Nagaoka University of Technology, as well as Nagaoka and Oyama Colleges from the Kosen system, will provide support. These institutions have recently celebrated a cooperation agreement with the University of Guanajuato.

Program approval. This Program was approved by the University of Guanajuato government bodies after submission of the complete curriculum description.

Conclusions

The Technological High School System with International Profile at UG will contribute to the UG internationalization goals by preparing highly skilled professionals to foster technology development in education institutions and industry. Our graduates will also work with a deep sense of social responsibility.

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The BTPI is the first academic program of its kind offered in Mexico, where highly skilled professionals must count on with a strong scientific, engineering, and foreign language preparation. This academic program is an example of international collaboration among Japanese Higher Education Institutions and the University of Guanajuato.

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University of Guanajuato, Nagaoka University of Technology and Nagaoka and Oyama Kosen authorities are acknowledged of their strong support for developing the BTPI (Mexican Kosen).

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Developing World-ready Professionals: An outcomes-based, practice-driven approach by NYP

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Abstract

NYP adopts an outcomes-based and practice-driven approach to pre-employment education and training for its 16,000 full time students, to better prepare them for work and life, equipping them to be life-long learners and to contribute to the technological, economic and social development of Singapore.

NYP has, since its inception in 1992, implemented training environments and systems based on the Teaching Factory® concept, where students undergo training in environments emulated after real industry settings and norms. This approach has helped students to gain practical knowledge about industry practices and work models as they are learning the specialist skills of their chosen domains.

Internship is one other significant pillar of the outcomes-based and practice-driven training approach. All NYP students must undergo internship in their final year of study. The regular internship is from 10 to 12 weeks in duration, coupled with a capstone project to last a full semester. This model strikes a good balance for students to gain some in-depth understanding of the industry and job roles relevant to their chosen disciplines, as well as helping them to further consolidate their training and hone their project development skills.

The Enhanced Internship Programme offers longer internship durations of up to 24 weeks or longer to allow even deeper immersion of the interns into the industry environment and practices. Other enhancements over the regular internship programme include (1) More stringent and specific outcomes defined jointly by the host organisations and NYP and (2) Closer and more regular interactions between internship mentors from both sides to give inputs to the formative learning and training process of the interns to achieve the learning outcomes.

Collectively, the key elements and concepts of the outcomes-based and practice-driven pre-employment training approach in NYP have helped its graduates to be more work and market ready.

Keywords: *Outcomes-based, Practice-Driven, Pre-Employment Training, Teaching Factory, Internship, Polytechnic*

Introduction

In Singapore, polytechnic education has the primary mission to train work-ready technologists and mid-level professionals to support the technological and economic development of Singapore (Chan L.M., 2008).

The 5 polytechnics collectively offer a comprehensive range of mainstream and niche courses in domains including business, design, engineering, health & life sciences, information technology, media, psychology and optometry.

The number of polytechnic graduates each year has steadily risen from around 20,000 in 2009 to more than 24,000 in 2013 (“Education Statistics”, 2014). A significant number will enter the work force immediately, with the rest either serving national service or pursuing further studies.

Polytechnic graduates are much sought after by industry, with about 89% finding employment within 6 months of graduation in the last 2 years (“Polytechnic Graduates”, 2014). They are in demand because the practice-oriented nature of polytechnic education has helped them develop relevant and specific work skills to the jobs that they are trained for.

Nanyang Polytechnic (NYP) was set up in 1992 to join the three earlier polytechnics set up in Singapore. Some of NYP’s key missions are: (1) to provide quality pre-employment training (PET) to school leavers; (2) to provide relevant continuing education and training

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(CET) to working adults; and (3) to provide value-added industry services to companies and businesses.

NYP has 7 schools and about 1,400 staff, offering 52 full-time diplomas to about 16,000 students. NYP also offers a wide range of continuing education and training programmes to adult learners, at the diploma, specialist diploma and advanced diploma levels as well as customized professional development programmes.

PET is a milestone programme for many youths in Singapore and a key pillar of NYP's core business. This paper presents a high-level view of the outcomes-based and practice-driven approach adopted by NYP to train its PET graduates to be more work-ready.

Training Concept and Approach

NYP aims to develop all-rounder graduates with the attributes described in Figure 1 below.



Professionally Proficient	The NYP Graduate is knowledgeable and skilled in his field of study so as to apply them effectively in workplace. The graduate possesses multi-disciplinary perspectives, and has the passion for lifelong learning.
Competent in 21st Century Skills	The NYP Graduate has essential skills for sustainable personal and professional development. The graduate is able to appreciate issues and recognise impacts and opportunities in a globalised environment in his continual pursuit of excellence.
Innovative & Enterprising	The NYP Graduate thinks critically and is ready to recognise challenges and embrace them as opportunities. The graduate is able to generate creative ideas, exploit resources and develop practical approaches to create innovative solutions.
Socially Responsible	The NYP Graduate recognises and upholds personal and professional ethics. The graduate is able to appreciate and respect cultural and intellectual diversities and is caring and compassionate to the community.

Figure 1: NYP graduate atributes

These attributes are expected to form as a result of consolidated student learning outcomes from all the curricula and co-curricular learning throughout the diploma programmes.

NYP adopts an outcomes-based and practice-oriented approach to teaching and learning. This approach is guided by the NYP Integrated Objective/Outcome-based Teaching and Learning Framework (iO^{2}B) and anchored by principles of Contextual Teaching & Learning.

The iO^{2}B framework is shown in Figure 2. The graduate attributes provide both the source inputs and 'end-in-mind' to drive the derivation of learning outcomes, progressively filtering from the higher-level course learning outcomes to module and detailed instructional learning outcomes.

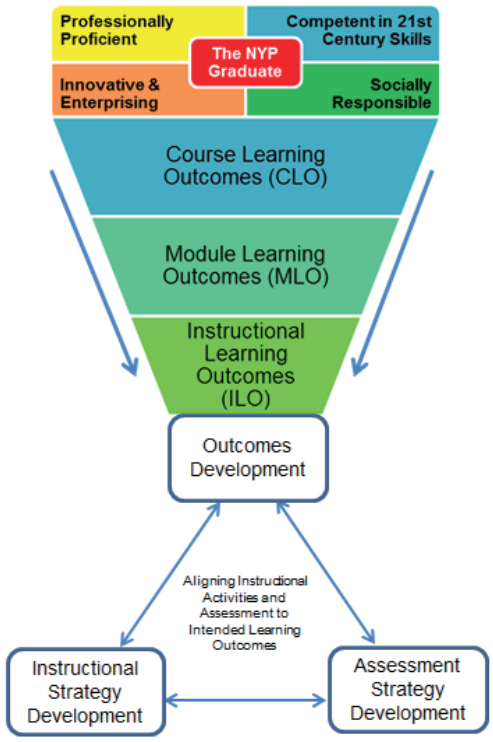


Figure 2: NYP iO^{2}B framework

The iO^{2}B framework takes reference from the Triangle of Effective Learning (Biggs, 2003) represented in Figure 3. The Triangle of Effective Learning shows that teaching and learning is enhanced by the constructive alignment of explicit articulation of learning outcomes, appropriate use of instructional activities that support those learning outcomes, and assessment strategies that allow the students to demonstrate skills and knowledge expressed in those learning outcomes.

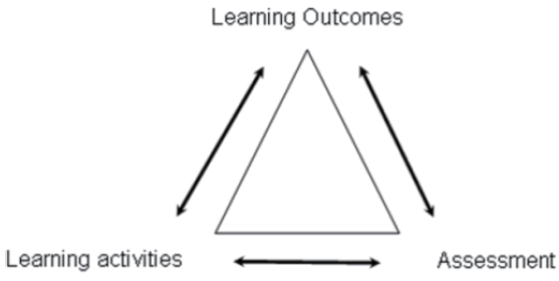


Figure 3: Triangle of effective learning

Three levels of learning outcomes are defined: (1) Course Learning Outcomes (CLOs), (2) Module Learning Outcomes (MLOs) and (3) Instructional

Learning Outcomes (ILO). The CLOs are established from context-specific intent and synthesized with the NYP Graduate Attributes. The MLOs and ILOs are then designed and developed to support the CLOs to ensure constructive alignment of stages of teaching and learning, and assessment. A 'Curriculum Map for Outcomes and Objectives' helps to make this alignment explicit to ensure that the intended CLOs are realized by the MLOs, which in turn resulted from the ILOs being accomplished. Figure 4 illustrates curriculum mapping of the different levels of outcomes, with direct relationships depicted by solid lines and in-direct relationships depicted by dashed lines.

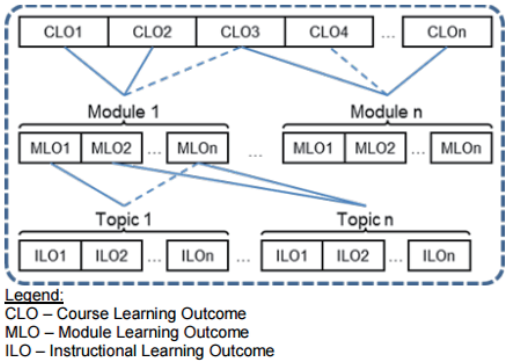


Figure 4: Curriculum Mapping of Different Outcome Levels

Curriculum mapping is very important as it helps to ensure alignment of the cascaded ILOs, MLOs and CLOs to realise the course outcomes. It also ensures that the course architecture (division into the modules) is balanced, optimal and effective.

Though the Curriculum Mapping of ILOs, MLOs and CLOs ensures that the strategic educational intents are addressed, it does not provide information on timing or sequencing of modules within a course. This information can be visually presented, for example, as an Integrated Course Map, illustrated in Figure 5.

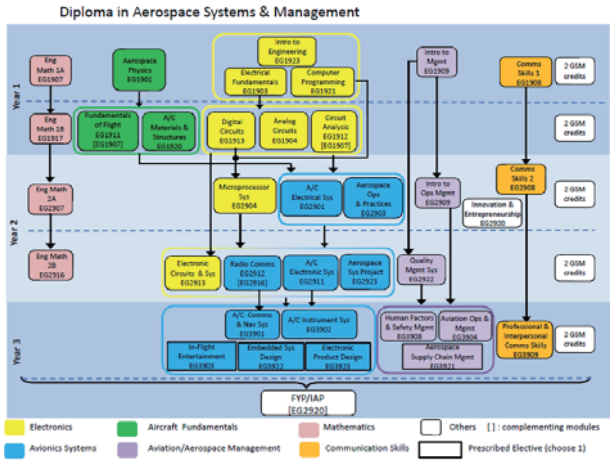


Figure 5: An Integrated Course Map

Many of NYP's PET courses have developed their corresponding course maps which provide a clear road map to help lecturers identify ways in which the integration of skills and multidisciplinary connections are to be made, for example, by mapping the specified learning outcomes to modules and co-curricular activities that make up the curriculum.

The iO^{2}B framework provides the conceptual and implementation perspectives of outcomes-based teaching and learning in NYP. Underpinning and complementing this framework to deliver on the outcomes are the practice-oriented training methodologies and programmes which NYP has developed or adapted.

The "Teaching Factory®" (TF) concept of teaching and learning was conceived, developed and implemented in the early 80's. It was first used and refined in the training institutes then under the Economic Development Board (EDB) of Singapore. When some of these institutes were absorbed into NYP in 1992, TF continued to evolve in NYP under its originator, Mr. Lin Cheng Ton, who had moved from EDB to become the founding principal of NYP. TF has now become the hallmark concept of NYP's teaching and learning (Ho E., 2009).

Figure 6 illustrates the TF concept and its 8 fundamentals

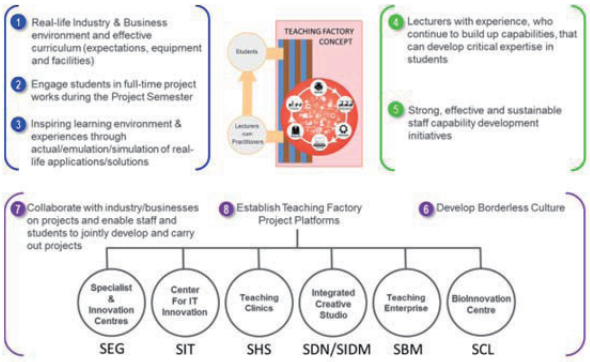


Figure 6: Teaching Factory Concept

TF encapsulates all the core elements of Contextual Teaching and Learning (CTL). Figure 7 shows how TF manifests itself in CTL.

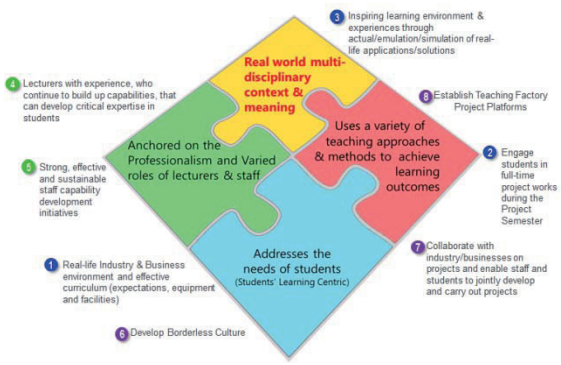


Figure 7: TF and CTL

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In essence, TF provides an industry-like, project-infused training environment with real-life requirements, state-of-the art equipment and facility design and institution management to optimise competency and expertise development of students.

An important and integral TF component is the industry project platform whereby staff and students work closely as a team on real-life industry problems with cost, quality, and time constraints, and which often require multi-disciplinary skills residing in different NYP schools. This produces key outcomes that include: (1) continuous development of staff capability to enable further acquisition of more advanced skills and training of critical expertise in students, (2) a more inspiring and engaging learning environment for students, and (3) further development and reinforcement of a borderless work culture across departments and schools.

TF drives organisational excellence and is underpinned by (1) a wealth of innovative ideas and concepts; (2) a strong, progressive and supportive organisational culture; (3) strong and deep capabilities; and (4) an extensive network of partnerships. These success factors feed off each other and work in concert to provide a firm platform for TF to be implemented in different schools, with their diverse range of needs and contexts in teaching and learning.

TF has manifested itself in various forms such as specialist centres in the School of Engineering, Centre of IT Innovation in the School of IT, Teaching Enterprise in the School of Business Management, Teaching Clinics in the School of Health Sciences, Bioinnovation Centre in the School of Chemical & Life Sciences and Integrated Creative Studio in the School of Design and School of Interactive & Media Design.

Beyond the classroom, the Internship Programme has been an integral part of NYP's PET course structure to nurture work-ready graduates. NYP facilitates internship opportunities to all students in every graduating cohort (i.e. students in their final stage of study, as illustrated in Figure 8, the diploma structure from the School of Engineering below.)

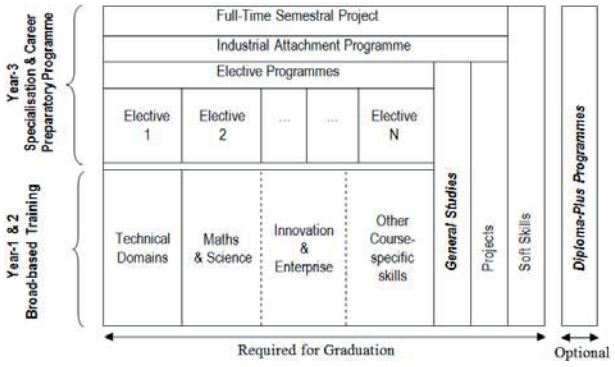


Figure 8: Generic Engineering Diploma Struture

Internship is an intensive and impactful learning experience. A well-strucutred, quality internship programme will encourage students to gain and deepen relevant skills and help cement their aspirations to pursue a long-term career in the industry. In contrast, an ineffective implementation or an unpleasant internship experience or both may diminish the perceived values of work-based experiential learning.

NYP's Framework for PET Internship Programme stipulates a set of Intended Learning Outcomes to be defined based on four key objectives of career preparation – (1) relating or applying knowledge and skills to work practice; (2) deepening skills relevant to a career in a chosen discipline; (3) gaining a broader perspective and knowledge of the industry, players, and careers in respective professions; and (4) recognising the reality of the work environment and the importance of work values and culture.

The Internship Programme and final year project work (or its equivalents) are critical elements in the professional development and career preparation of NYP students. There are two generic models adopted in NYP, as shown in Figure 9. Model 1 is a combination of a 12-week internship programme and a 12-week final year project work. Model 2 is a 24-week internship programme with substantial project-based learning. Notwithstanding the model adopted, the full 24-week period constitutes the career preparatory programme in NYP.

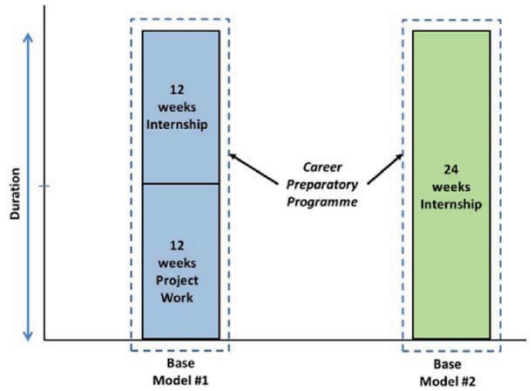


Figure 9: The Career Preparatory Programme

Among the 2 models, the majority of students go through model 1 while model 2 is gaining traction and acceptance with host companues offering internships.

A more structured, longer duration internship programme, designed and managed with clear learning outcomes in mind, benefits all parties involved. The student interns will have more meaningful immersion experiences and be able to develop deeper skills in, and appreciation of, the industry sectors relevant to their courses of study. For the industry partners, it could help in their talent scouting and staff recruitment when high-performing interns become employees after graduation. For industry sectors or nature of work that come with steep learning curves, a longer duration internship programme strikes a good balance between the training and productive stages of the internship cycle.

Discussions

The School of Engineering (SEG) of NYP was one of the early adopters of outcomes-based training in NYP. The TF Concept was implemented from the very beginning and refined over the years. Complementary concepts such as Accumulated Experience Sharing (AES®) and Integrated Technology Teaching and Learning (ITL) were spawned along the way.

AES® is a knowledge management system that systematically captures project development experiences and knowledge abstracted from significant projects and organises them for easy reference. It provides a rich repository of project cases- with documented design concepts, challenges, solutions, and technology applications. This repository is shared with staff and students, who use the knowledge in their projects, further generating more project cases for the repository, as illustrated in Figure 10 below.



Figure 10: Accumulated Experience Sharing

The ITL concept, on the other hand, ensures that students not only master key technologies in their chosen specialisation, but also learn how different technologies are integrated into real world systems and applications. To achieve this outcome, skills and knowledge learnt from different modules and years of study are woven and integrated. Figure 11 illustrates the integration of skills across modules and years of study.

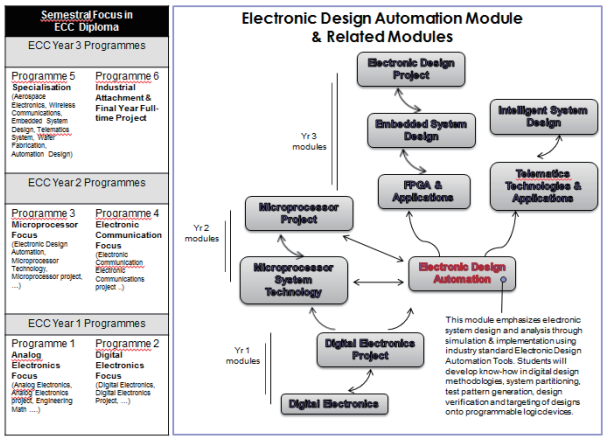


Figure 11: Integration of skills training

In 2009, SEG started adopting the CDIO model for 5 of its courses. The results and positive experiences from both lecturers and students in the initial phase provided the affirmation and impetus for CDIO to be adopted by all 11 diploma courses and 2 programmes in SEG. NYP became a CDIO collaborator in 2011.

As of April 2015, all the SEG courses implementing CDIO have been self-assessed to have achieved level 3 or higher in compliance in the 12 CDIO standards.

The CDIO framework and the TF concept have many things in common. Both are oriented towards training work-ready engineers and both advocate providing the appropriate teaching and learning context, activities, facilities and environment to meet the goal. Projects, active and experiential learning also feature prominently in CDIO and TF.

SEG has also been working closely with a number of industry partners to provide more structured, and meaningful, internship programmes to the students. The demand for SEG interns has outstripped supply in the last 3 years. The interns have given positive ratings and feedback about their internship experiences. There have been job offers made, and taken up. Some companies are even willing to offer scholarships to get a head start in the talent scouting process.

Conclusions

The outcomes-based and practice-oriented approach adopted by NYP for pre-employment training has so far proven to be effective in producing work-ready graduates. It will continue to evolve to stay relevant in the midst of changing training needs and learner profiles, emergence of new tools and platforms for education, and new insights from educational research.

Acknowledgement

This paper would not be possible without the assistance and support rendered by the management of Nanyang Polytechnic, its School of Engineering and the Centre for Professional & Leadership Development.

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Developing a Virtual Reality-based Simulation System for Practical Training in Vocational Education and Training

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Abstract

Virtual Reality (VR) technologies replicate a virtual environment to provide users a sensory simulation of the environment being presented. In Hong Kong Institute of Vocational Education (IVE), we are developing a VR-based Simulation System having four screens surrounding a user to simulate an immersive environment commonly known as the cave automatic virtual environment (CAVE). The contents projected on the four screens are 3D in nature and the user has to wear a pair of 3D glasses in order to sense the "depth". Through a motion detector embedded in the glasses which detects head motion of the user, the system is able to interactively update the screen contents according to the head motion and give the user immersive sensation. The user can also interact with objects in the virtual environment with different kinds of user interface where appropriate.

The objective of the VR-based simulation project is to apply the virtual reality technologies for practical training in vocational education and training (VET). The system is applicable to various applications in engineering areas including simulation of any workspaces for operations and maintenance training in electrical and mechanical services. For example, the system can simulate the workspaces of a lift or an escalator, an air compressor room, a power plant, etc. Workplace training is considered essential and beneficial to VET students in addition to practical training in school settings. Nevertheless, in some workplaces, the environment is full of danger and inappropriate operations can result in severe casualty. The VR-based simulation project manages to provide a solution for practical training in VET that can 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 present details of the design concept for developing the VR-based simulation system. With the first application that is being developed on the system for preparing students working in a typical hospital's plant room, we also share some initial findings and results, and discuss possible future works.

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

Introduction

Cave automatic virtual environment (CAVE) is generated using computers giving users visual and audio simulations. Users are impressed with a feeling that they are inserted into the virtual environment. Each user usually is provided with a pair of stereoscopic glasses 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-mount instrument to detect the orientation of the head. The contents of the screens are view-dependent that is 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

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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.

Project initiative

Traditional hands-on training for students is limited to workshop environment. In case of emergencies such as fire or leaked gas, trainees might not be able to perform necessary actions due to lack of training in unfamiliar situations and this could lead to catastrophic consequences. An immersive virtual reality 3-D environment can help trainees to get familiar with different situations in multiple work sites with the use of scenario exercises. The use of simulation training has been used and proved extremely useful for decades in transportation industries in the form of flight, train and car simulators. However, simulation training for other industries is not widely used due to high development and maintenance cost. The situation has been changing in recent years as technological advancements in necessary hardware and software have significantly lower the cost to create an interactive virtual reality-based (VR) simulation and visualization system.

In order to provide vocational education and training (VET) a means to improve its effectiveness of training, Engineering Discipline of Hong Kong Institute of Vocational Education (IVE) is initiating to develop an interactive VR-based simulation system equipped with a projector-based CAVE system. The system aims to create 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.

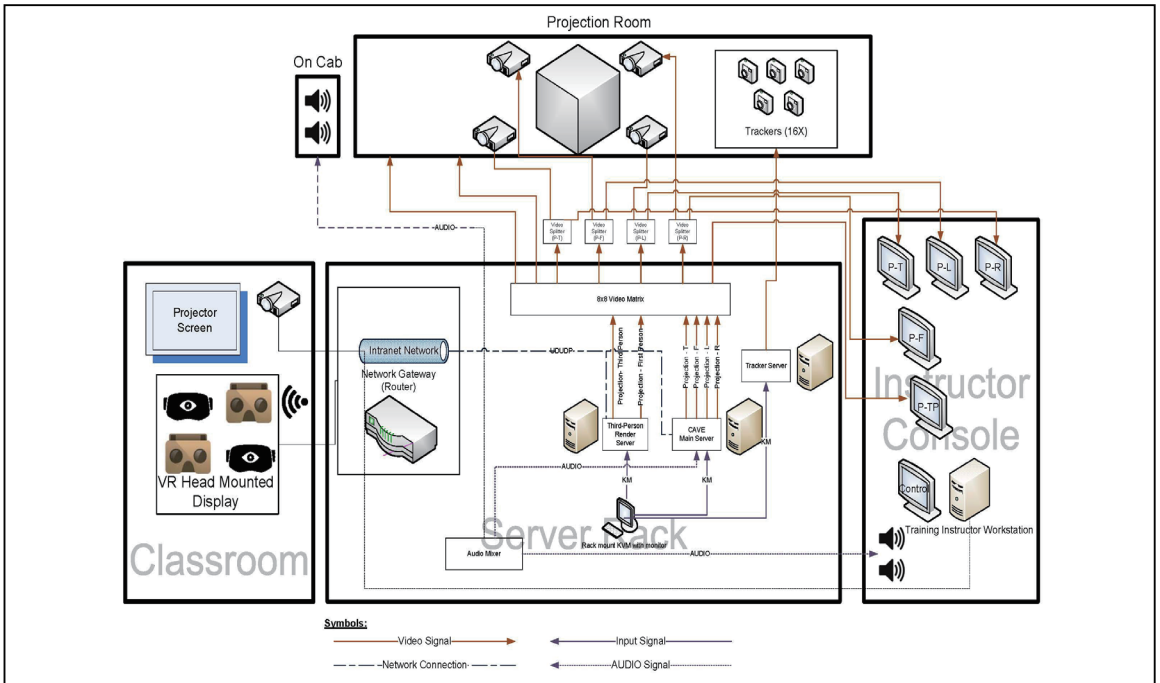


Figure 1, proposed system architecture and design of our CAVE system

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System design

The interactive VR-based simulation system comprises four major hardware components: Scenario Control System, Tracker System, Image Generation System and Projection System. Figure 1 summarizes the proposed system architecture and design.

The Scenario Control System allows trainer adding and editing scenarios using the trainer instructor workstations. The workstation is also connected to multiple displays to simulate a control room console with display for plant room system status and plant room system schematics. Trainees are required to inspect the schematics to identify maintenance work required and locate the fault. Each trainee will be given a pair of LCD shutter glasses and enter the projection room to start the training. The projection room has a cube-looking structure with four screens: front, left, right and floor screens. For each screen, there is a stereoscopic projector projecting stereo images onto the screen which is 4m x 2.75m in size. Figure 2 shows the projection room.



Figure 2, the projection room with four screens: front, left, right and floor screens

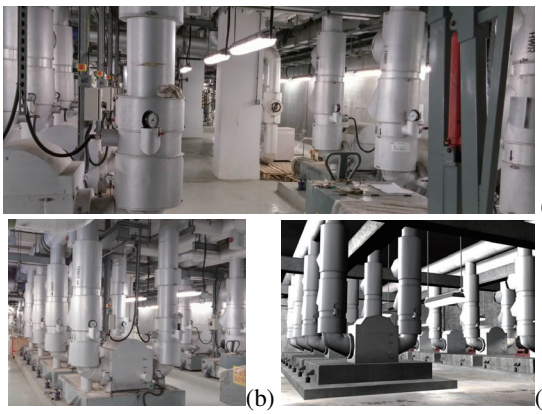
The Tracker System consists of 12 infrared cameras installed in the projection room and connected to the tracker server. The cameras are used to detect positions and orientations of trainees in the projection area in real-time and the tracker server sends information to the Image Generation System. Upon receiving position and orientation signals, the Image Generation System renders computer graphics accordingly and updates the view contents that should be seen by the trainee in the reality. Finally, the Projection System projects rendered views onto the screens and combines with surround sound system to create an immersive virtual reality environment. This coordination among different sub-systems accounts for the interactivity between the trainee and the virtual environment. Figure 3 shows a stereo image projected onto one of the four screens. Note that the stereo image appeared to be blurred as the left view and the right view are overlapping each other. This gave a feeling to the trainee that he was walking on a crane high on the top of a building.



Figure 3, a stereo image was projected onto a screen giving the 3D sensation to the trainee that he was walking on a crane high on top of a building

Pilot application

Applications based on our VR-based simulation system are broad which can include various kinds of training programs. As a start, we plan to develop learning contents for plant room maintenance. We simulate a plant room environment with reference to an engine plant room of Tsuen Kwan O Hospital in Hong Kong as shown in Figure 4. We captured some pictures of the plant room and our engineers programmed the virtual environment with 3D Unity Game Engine to simulate the environment. Our 3D models have three different levels showing different extents of environmental details.



(a) (b) (c)

Figure 4, the engine plant room of the Tsuen Kwan O Hospital in Hong Kong is used as the reference for building the virtual plant room. (a), and (b) are the actual views of the plant room and (c) is the generated virtual environment using the 3D Unity Game Engine.

In the pilot application, we design several scenarios for electrical and mechanical maintenance in the plant room and they can be classified into three categories: safety, maintenance and other. For example, for the safety category, we have scenarios of handling unknown fluid on floor and carrying out atmospheric test in a confined space. For the maintenance category, we have scenarios of handling situations of a drop in air-flow, water leakage of condenser water pump strainer, and pressure drop on compress air system. We also have scenarios of lifting water pump which belongs to the other category. Figure 5 shows the scenario with some chemical fluid on the floor of the engine plant and a screenshot of the procedure in handling the fluid. The

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trainee has to deploy safety procedures step by step to tackle the situation.

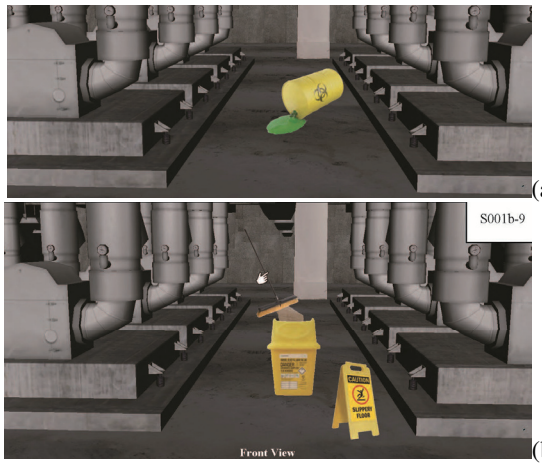


Figure 5, (a) a scenario with some chemical fluid on the floor in an engine plant room, and (b) a screenshot of the procedure in handling the fluid.

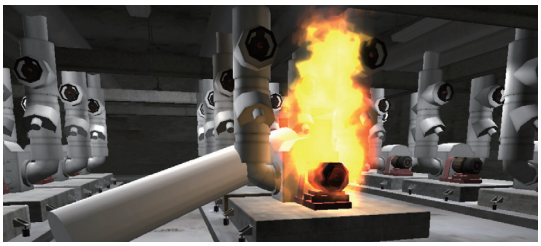


Figure 6, a scenario with fire hazard in a virtual engine plant room

Another example demonstrating the simulation of fire hazard is shown in Figure 6. We also have some augmented reality (AR) application for training purpose. Figure 7 shows the AR application simulating the water flow in the pumper.

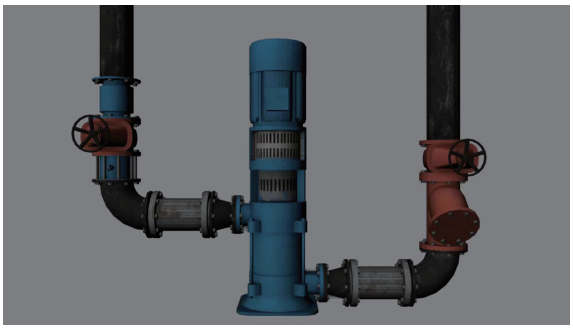


Figure 7, augmented reality application simulating the water flow in the pumper

Initial findings and results

We completed designing and implementing several scenarios for the training program including the incidences of unknown fluid on floor, air flow drop of fresh air handling unit, water leakage of condenser water pump, and pressure drop on compress air system. The progress of the program depends on action taken by the trainee. For example, if the trainee did not note the unknown fluid on the floor and step on it, he will slip himself and fall as shown in Figure 8.

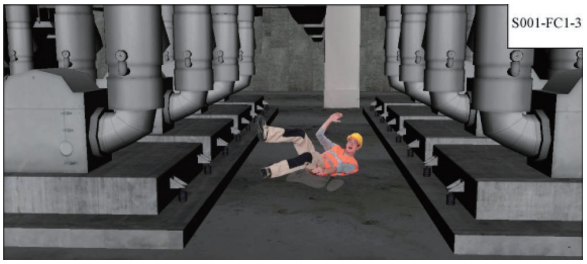


Figure 8, trainee stepped on the unknown fluid and slipped.

Another example is the water leakage of the condenser water pump scenario. After replacing the damaged gasket, the three bolts of the strainer flange have to be all halfway screwed up before fully screwed up as shown in Figure 9. Otherwise, water leakage will occur later in the testing stage. Therefore, trainees taking different actions result in different outcomes. This valuable experience can surely impress the trainees with consequences associated with different actions. To evaluate the effectiveness of the VR training system, we invite the trainees to complete a questionnaire before and after the training.

Currently, the learning contents under development are expected to be ready for use by September 2015. In the future, we will study effectiveness of the training program by means of collecting feedback from two groups of students, with one group using the VR-based simulation system while the other group not using being the control group.

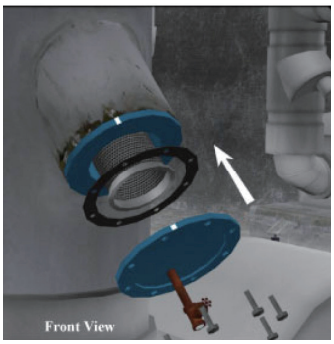


Figure 9, after replacing the damaged gasket, the three bolts of the strainer flange have to be all halfway screwed up before fully screwed up. Otherwise, water leakage will occur later in the testing stage. Different actions result in different consequences.

Conclusions

In conclusion, the Engineering Discipline of Hong Kong Institute of Vocational Education has been developing a VR-based simulation system which is equipped with a projector-based CAVE system. The pilot application is operation and maintenance training

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for plant room maintenance. The simulation nature of the system being developed manages to maximize safety and minimize risk of the training. The system facilitates emergency scenarios including fire hazard and gas leakage to be included in the hands-on training program for students. Without the simulation system, students can hardly have similar training in workplace or practical training in school settings. As a result, they may not be able to perform necessary actions owing to lack of proper training and result in catastrophic consequences.

Several scenarios are designed and implemented. During training, students can perform a range of actions which can influence the progress of the training program and results in different consequences. These valuable experiences surely can well impress the students and well accomplish the training objectives.

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Critical Success Factors in Designing Gamification for Asian Tertiary Level Students

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Abstract

This study explores the use of lesson gamification as a strategy for teaching and learning in a first year, level two subject at a Polytechnic in Singapore. The aim of the study was to provide educators key aspects for gamification which could augment their design of their own gamification classroom experiences. The research focused on gathering student and teacher perspectives on their experience of lesson gamification and its impact on learning and engagement. Through the perspectives gathered, the study also sought to identify the critical factors that contributed to the successful implementation of lesson gamification.

The data for this study was gathered through classroom observations, online surveys and interviews with the students and lecturer undergoing the subject. The findings from the data presented the view that gamification generally enhanced the experience of the lesson and resulted in increased student engagement in comparison to a non-gamified lesson. The data surfaced several success factors featuring prominently in student and lecturer feedback. The sources of these factors emanated from the role of feedback and game-likeness of lesson gamification. The findings culminated in a meta-analysis and four pillars of recommendation.

The majority of existing studies in the field of gamification have focused on quantitative data collection (Hamari, Koivisto, & Sarsa, 2014), in contrast, this study has based its research methodology around a primarily qualitative approach in order to gain a deeper understanding of the student and teacher perspectives of lesson gamification. In identifying the critical success factors for gamification, the study also explores some of the unique cultural nuances specific to Asian students in relation to the design of a gamified lesson.

Keywords: *gamification, game-elements, game-based learning, technology, pedagogy, games in education*

Introduction

The way we teach, learn and interact with students is evolving with a shifting educational landscape. The ubiquity of information communication technology and our increasing reliance upon it are influencing our pedagogical approaches and strategies (Coleman, 2012; Crook, 2012). In the face of a changing educational landscape some critics postulate that we now, "face a generation of students who regard the school curriculum as irrelevant" (Barab, Pettyjohn, Gresalfi, Volk, & Solomou, 2012). Today's students, "digital natives" are challenging institutions to adopt new strategies in order to remain current and maintain student engagement. As such, there is an increase in educators exploring new and novel ways of piquing their students' interest by leveraging on their familiarity and engagement with social media and game technology (Kolikant, 2010).

The use of gamification is one such strategy that leverages on today's students' interest in games and technology to engage them. Across most literature, the definition of gamification is most cited as, "the use of game-play mechanics for non-game applications" (Deterding, Dixon, Khaled, & Nacke, 2011). While this definition has been expanded upon, in existing literature, there remain a few commonly used definitions which remain similar yet cover different aspects of the core concept. The working definition in this study took into account the common core concepts across gamification definitions whilst expanding upon a combined definition from Kapp (2012) and Deterding et al.,(2011). Adapting the working definition from Kapp (2012) and Deterding et al. (2011) would better frame the definition, in the context of education and technology. As such, the working definition of gamification used in the study is: *"the use of game play elements or game-based mechanics, aesthetics and game thinking in a non-game application augmented by technology to engage people, motivate action and promote learning and solving problems."*

Background Literature

There is a substantial body of literature that covers the domain of games in education. This literature includes various approaches such as surveys, case studies and mixed methods research (Ke, 2008). A vast

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majority of the literature has focused on the efficacy and benefits of the use of games in education (Hamari et al., 2014). Within the last 15 years, there have been a range of studies involving the meta-analysis of literature (Fengfeng, 2008; Hamari et al., 2014; Sitzmann, 2011). These studies present similar patterns that expound the benefits of game use in education. In a recent meta-analysis of game based literature where 65 studies were examined, it was found that students who were exposed to game related lesson deliveries showed a positive impact on their learning. The study noted an 11% increase in declarative knowledge, a 14% increase procedural knowledge and 9% higher rate of knowledge retention (Sitzmann, 2011). A key characteristic of learning through the use of gamification or game-based learning is that students actively learn and consistently confront a problem and work out a solution (Annetta, Cook, & Schultz, 2007). Expanding on the role of games in education, Van Eck argues (2007) that problem solving in games is the "highest level of learning" we can strive for (p. 279). The problem solving mechanics often built within game-based strategies allow for both scaffolding and formative feedback throughout the learning process.

While there are studies which focus on the efficacy of lesson gamification, they seem limited in their ability to identify the specific elements and the extent to which lesson gamification actually impacts students (Erenli, 2013; Kapp, 2012; B. Kumar, 2012; R. Kumar & Lightner, 2007; Monu & Ralph, 2013; Muntean, 2011; Nicholson, 2012). For example, student perspectives of the different elements or how lesson gamification enhanced their learning experience. Along the same lines, while many researchers extoll lesson gamification's usefulness in attracting students, few studies are able to pinpoint how exactly they attract students or why they attract students (Muntean, 2011). The studies seem to cater to a more teacher centric view of assessing lesson deployment, as opposed to evaluating its "stickiness" or how the deployment of gamification has impacted on the amount or nature of student engagement. Additionally while the studies encapsulated student views, their focus was often the educators as the primary utilizers of the games in education as a strategy. Finally, while the efficacy of gamification was extolled across the majority of studies, the studies were often situated in the context of a western based institution, with significantly fewer studies on Asian students.

Method

In this study, a constructivist approach was adopted. It is argued that a constructivist approach to research is one that draws the researcher close to the subject of study and takes into consideration the possibilities of multiple perspectives and provides meaningful understanding of what is being studied (Lodico, Spaulding, & Voegtle, 2010). The case study approach lends itself as such an approach. Utilizing such an approach in this study allowed for deeper perspectives based on multiple sources of evidence building towards a deeper understanding (Gillham, 2000). In addition, the leveraging of case studies offered the ability to explore more "complexities" that may be "beyond the scope of controlled approaches" (Gillham, 2000, p.11). While a generally constructivist approach was adopted to gain insights into perceptions and qualitative feedback, the methods included both quantitative and qualitative methods. The use of multiple methods within the case study was also a key consideration to the approach in this study. It is gleaned that the mixed methods used within this study, would provide data with "different sight lines" and a richer depth to the perspectives gathered in this research. (Wiersma & Jurs, 2008, pp. 308–309). Pertinently, it is also argued that the mixed methods are employed to address the need for triangulation or "checking" of data. (Fraenkel & Wallen, 2006).

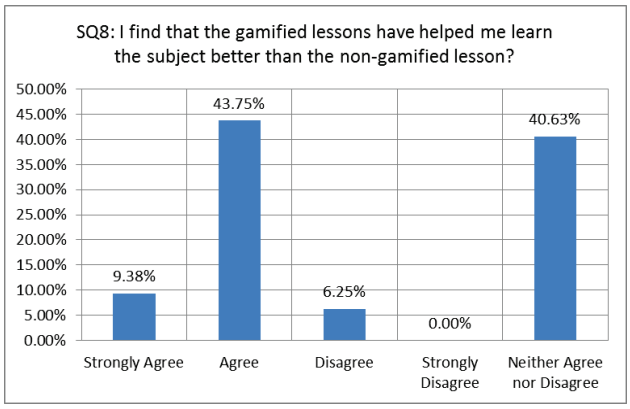
Upon consideration of the established research methods, the following methods were adopted for this study; non-participant observation, online survey and interviews. It was gleaned that these methods would provide a holistic view of the different perspectives and nuances. Additionally, these methods are congruent with a constructivist approach to research. The study was implemented within the context of a polytechnic in Singapore. The participants were tertiary students enrolled in their first year of studies. The total size of the cohort was 91 students allocated into four classes. Based on the availability for the classes to be observed and students interviewed, two of these classes were selected to be part of this study. Classroom A (21 students) and classroom B (23 students) totalling 44 students. For this study, both groups underwent two non-gamified lessons, followed by two gamified lessons. Also participating in this study was a single lecturer, who was involved in the facilitation of the lessons. This lecturer had no prior experience of delivering a gamified lesson, though the lecturer had previously taught a non-gamified version of the subject. While the non-gamified lessons in this subject were carried as per the subject's original lesson plan design, the gamified lessons were newly designed for the purpose of this study. The design of the lesson was based on the lesson framework identified by Kapp (2012). In using this framework, key learning outcomes and activities were identified which were then re-packaged as a gamified lessons.

Results and Discussion

Gamification enhances student learning

In exploring how lesson gamification had enhanced student learning, several key findings arose. The first overarching perception was that students generally found that lesson gamification enhanced their learning with 53.13% of students agreeing in the online survey and a majority of qualitative responses from students and the lecturer corroborating this view. Students shared the view that "more learning" had occurred.

Figure 1- Survey- Comparison of Learning (Gamified Perspective)



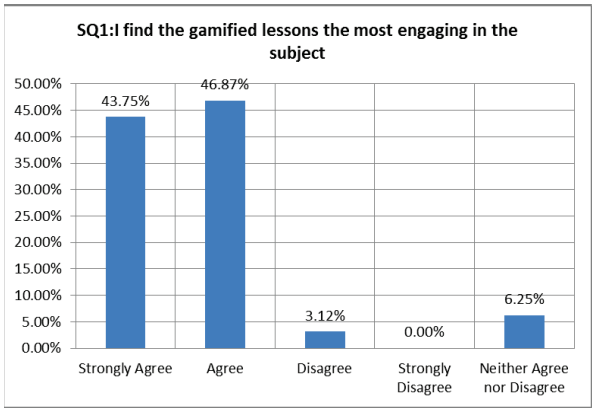
Three distinctive threads emerge from the students' response of "more learning". More learning was predicated on active learning, where scaffolding and learning with their classmates and aspects of cultural relevance, namely technology and competition appealed to the cultural nuances of the students. These views were corroborated with the opinion of the lecturer and across the survey, interview and observation instruments. These subthemes help to shed greater light and patch gaps in existing literature, which have gone under-rationalised and under-examined as they have not elucidated on what mechanics within lesson gamification actually serve to enhance learning. (Cheong, Cheong, & Filippou, 2013; Domínguez et al., 2013; Hamari et al., 2014)

The findings present a congruent picture in regards to technology and its relevance to today's students (Kapp, 2012; Prensky, 2001). Pertinently, this study reveals a perspective unique to Asian students. Upon first glance, the students' qualitative responses highlight a strong inclination towards the competitive aspects of the lesson gamification. Students equated the competitive and game like nature as a draw factor which motivated them to "learn more". Further analysis of their responses reveal that part of this draw and correspondingly concerns, relate to the concept of competition and "loss of face" for the students. As literature suggest, the concept of loss of face and competiveness are unique cultural nuances to Asian students (Hwang, Ang, & Francesco, 2002)

Gamification engages students

The theme of engaging students also conveyed an overarching view which extolled lesson gamification as a strategy that is more engaging in comparison to a non-gamified strategy. The survey data 90.2 % of students agreed with this perspective.

Figure 2- Survey- Level of Engagement (Gamified Lessons)



The student perspective of engagement was consistent when triangulated across data from the various instruments as well as against the lecturer's perspective on student engagement. Two pertinent sub-themes are materialized in the findings; enjoyment in learning and going beyond the required learning in the classroom for lesson gamification.

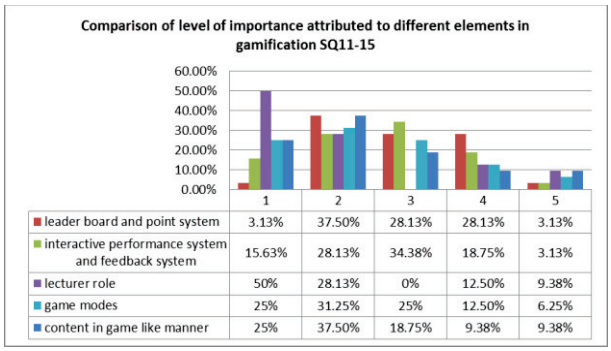
When probed further on how lesson gamification impacted their engagement in the class, students related their engagement to experiencing "fun" and "joy" in the classroom. Students differentiated their engagement in the gamified class and the non gamified class to the concept of enjoying the learning process in the gamified experience. In relation, if we were to contrast this against the theoretical background of the roots of play in pedagogy, the findings highlight the links between, play, fun and education (Rieber, 1996).

Student perspective on success factors for a gamified class

In the study, the factors causative to the successful implementation of lesson gamification were articulated. While several differing success factors were highlighted, there were three key aspects which featured prominently. From the students perspective, these were the role of the lecturer, the game modes particular mechanics that augment collaborative or social elements and the leader board and point system. These aspects were triangulated across the various instruments. In the findings, from the lecturer response, similar aspects were highlighted, with game-like content being the additional factor highlighted by the lecturer.

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Figure 3 Survey- Comparison of Importance between Gamification Elements



	1	2	3	4	5
leader board and point system	3.13%	37.50%	28.13%	28.13%	3.13%
interactive performance system and feedback system	15.63%	28.13%	34.38%	18.75%	3.13%
lecturer role	50%	28.13%	0%	12.50%	9.38%
game modes	25%	31.25%	25%	12.50%	6.25%
content in game like manner	25%	37.50%	18.75%	9.38%	9.38%

In carefully considering the success factors identified, underlying these success factors are several key threads. The facilitation and role of the lecturer was pertinent from the standpoint that the feedback and the gamification lesson experience remaining game-like seemed crucial to students. Similar to the importance of lecturer in lesson gamification, the preference to the point system and the leader boards appear similarly connected to the student's preference for mechanics which link to feedback in their learning process. Based on existing theories of students "self-worth", literature suggest that information on students' performance and ability are often crucial to students (Covington, 1998, p. 15).

Expounding from the success factors and the findings presented in this study. Four key pillars can be identified to guide the design of a gamified lesson. Pillar 1- Game-like experience, Pillar 2- Feedback, Pillar 3- Levels, Pillar 4- Social.

The game-like experience which relates deeply with today's student is crucial (Kapp, 2012; Prensky, 2001). As such, it is pertinent to consider all elements when designing lesson gamification, for instance if it offers a game-like experience. The overall game-like experience would also entail careful consideration towards terminology in content, the use of technology aids such as the role of the lecturer as a "game master" as opposed to a facilitator in the classroom. From the findings, it can be ascertained that feedback within lesson gamification is a crucial component of the gamified experience to students (Domínguez et al., 2013; Erenli, 2013; Kapp, 2012). Even when considering systems that support the development of lesson gamification, this should be considered carefully. For example, in choosing a leader board system, does the system allow for feedback and presentation of points which are indicative of student's performance or work in class? Similarly the choice of mechanics employed and the elements within lesson gamification should also carefully consider the role of feedback within them. In relation to feedback, levels or levelling within gamification can be crucial. As educators, if we believe that students construct knowledge and build upon their existing knowledge, implementing a levelling system or mechanics that support scaffolding content would be crucial. The social implications and elements in designing lesson gamification cannot be ignored. When considering mechanics or the design of the lesson, considerations should be given to the students' preference to work and study in teams. In addition, adequate consideration should be given to students concerns of being marginalized or "losing face" by being situated in "weaker teams".

Conclusions

It is imperative to gain a deeper understanding of the cultural nuances in relation to the students experiences of gamification that would augment lesson gamification, further engage students and enhance their learning experience. It is pertinent to consider the cultural nuances that are specific to Asian students. Therefore, when designing gamified lessons, the social cultural consideration should be applied to all aspects of the learning experience. For example, grouping of students and being aware of the impact of "loss of face" and the social dynamics between the students. In addition, employing mechanics which align towards working in teams or collaborative modes would be useful. Similarly, the technology supporting gamification would be equally important in augmenting a competitive, game like environment in the classroom which the findings suggest that Asian students have a preference towards. Considering the game-likeness, it would also be pertinent to consider the gamefulness as Deterding et al., 2011 suggest. The implications of this would mean that careful consideration is employed in the design of the lesson and the role of the facilitator. It is pertinent that the facilitator be familiar with the game mechanics employed and game terminology to supplement the student's experience of being immersed in a game-like experience. In relation to student's cultural nuances, students' background and prior learning experiences should also be carefully considered. Measures within the design of lesson gamification or before the conduct of the lesson should be employed to address the transition into such an approach as lesson gamification can be a stark contrast from their previous experiences of learning and potentially hamper its effectiveness.

Gamification however is still seen as a new and recent trend (Hamari et al., 2014). There still remains many areas which require further exploration and investigation. In my opinion, one of the key areas which should be investigated further is the specific use of game mechanics and its efficacy. While there is existing literature on lesson gamification, (Domínguez et al., 2013), the specific aspect of game mechanics and its impact on students remain understudied. In addition, it would be beneficial to further study the social implications attached to gamification. I believe that studying this further would shed more light on student's preferences in lesson gamification from a social

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standpoint and would greatly impact the technology utilized to augment lessons.

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DEVELOPMENT OF THE INTERNATIONAL COLLABORATIONS AT THE INTERNATIONAL COLLEGE, KMITL

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Abstract

The paper summarizes the past, present, and future development of various international collaborations and related activities at the International College, King Mongkut's Institute of Technology Ladkrabang (KMITL), Thailand. The aim is not just to provide a summary of information but also to share the authors' first-hand experiences and the lessons learned from initiating and running various collaborative activities at the International College, KMITL. Since its founding in 1960, KMITL has long been one of Thailand's leading universities in the fields of science, engineering, and technology. The International College was established as an academic unit within the university responsible for offering degree programs in English. This has helped opening up the university to students from around the globe. With all the instruction held in English, this has also created opportunities for academic collaborations with universities abroad. The College has been actively working on various forms of cooperation with its partner universities outside Thailand and has also been actively seeking new partners to work with. So far, the College has been offering a number of degree programs in collaboration with institutions abroad, including an undergraduate program in Software Engineering with the University of Glasgow (UK), a double-degree Master's program in the management of resources and environment with TU Bergakademie Freiberg (Germany), a Master's program in Automotive Engineering in collaboration with NSTDA (Thailand) and Tokyo Institute of Technology (Japan), and a Master's program in computing for the Southeast Asian students who are supported by JICA in the AUN/SEED-Net project. Other international activities organized regularly at the College include student exchange, summer internships, short-term study trips, and summer school programs. In the paper, we shall briefly explain the development of our collaborative activities, and discuss related issues.

Keywords: *international collaborations, double-degree programs, joint-degree programs, student exchange, credit transfer, internships*

Introduction

King Mongkut's Institute of Technology Ladkrabang (KMITL) is a public research university in Thailand, with a long reputation of expertise in the fields of science, engineering, and technology. With more than 24,000 students and 950 full-time academic staff members, it is also currently one of the country's largest science and technology universities. Today, the Institute comprises 12 academic units, offering more than 150 degree programs at undergraduate, Masters, and doctoral levels in diverse disciplines in science, engineering, information technology, agriculture, architecture, and management.

Since its establishment in 1960 with support from the Japanese Government, KMITL has been actively cooperating with academic institutions and organizations worldwide on various academic and research programs. In the year 2000, the International College was established as an academic unit within KMITL with the primary aims of offering degree programs that are taught entirely in English and providing an international study and research environment for its students and staff. Currently, the International College is offering two Bachelors-degree programs, namely: Bachelor of Engineering in Software Engineering and Bachelor of Science in Engineering and Technology Management, and three Masters programs, namely: Master of Science in Logistics and Supply Chain Management, Master of Engineering in Automotive Engineering, and Master of Engineering in Computing in Engineering Systems.

As part of the management team of the International College, the authors have been involved in initiating, developing, and overseeing various collaborative activities between the International College and its partners abroad for more than 6 years. In what follows, we will provide a summary of our collaborative activities and a discussion on related issues.

Collaborative Degree Programs

The International College has been offering a number of degree programs in collaboration with its partner universities abroad, as can be summarized below.

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1. *Collaborative Undergraduate Program in Software Engineering*
Partner: University of Glasgow, UK
Program type: 4-year undergraduate program
Degree: BSc (Hons) in Software Engineering by University of Glasgow
Cooperation: Students in the B.Eng. in Software Engineering program at KMITL who have completed Year 2 with a GPA of 3.25 or higher and satisfy the University of Glasgow's English language requirement are eligible to transfer their study to the University of Glasgow in Year 3.
Financial matters: The student pays the tuition fee at the normal rate at KMITL in the first two years and pays the fee at a reduced rate at the University of Glasgow in the last two years.

2. *International Management of Resources and Environment (IMRE)*
Partner: Technische University Bergakademie Freiberg, Germany (TU Freiberg)
Program type: 2-year Masters program
Degree: M.Sc. in Environmental Management of Resources and Environment by KMITL and MBA in Environmental Management of Resources and Environment by TU Freiberg
Cooperation: To qualify for double degrees, students in the IMRE program at KMITL or the IMRE program at TU Freiberg are required to (1) spend at least one semester at the partner university and take a specified list of courses and (2) pass the thesis examination where the examination committee consists of members from both universities.
Financial matters: For KMITL students, the tuition fee at the normal rate is payable to KMITL in all semesters. For TU Freiberg students, in accordance with the German government regulations, there is no tuition fee, but the students are liable to pay a "semester fee" in every semester except for the semester the students are in KMITL. The semester fee covers the use of facilities within the campus and the transportation within the city and the surrounding areas.
Note: Due to the shift in the semester times at KMITL and the introduction of the regulations on quality assurance for Thai universities, this program is currently suspended.

3. *TAIST-Tokyo Tech Masters Program in Automotive Engineering*
Partners: National Science and Technology Development Agency, Thailand (NSTDA), and Tokyo Institute of Technology, Japan
Program type: 2-year Masters program
Degree: Master of Engineering in Automotive Engineering by KMITL and Certificate of Completion issued by the TAIST-Tokyo Tech Consortium
Cooperation: TAIST, standing for "Thailand Advanced Institute of Science and Technology", is a scheme of cooperation among NSTDA and its partner universities in Thailand and an academic institution outside Thailand to develop the Thai human resources. TAIST-Tokyo Tech is the first implementation of this scheme, where NSTDA, Tokyo Institute of Technology (Japan), and four selected Thai universities collaborate in education and research. One collaboration is to offer Masters programs in various fields where the courses are jointly taught by visiting lecturers from Tokyo Institute of Technology and the local staff. Based on its expertise in automotive engineering, KMITL has been selected by TAIST-Tokyo Tech to offer the Master of Engineering Program in Automotive Engineering. The first year of the program consists of lecture held at NSTDA in Bangkok. In the second year, the students in the program conduct research under joint supervision of researchers or professors from NSTDA, KMITL, and Tokyo Institute of Technology. Each student works in a research lab either at NSTDA or at KMITL in the second year.
Financial matters: All Thai students in the program are provided with scholarships from NSTDA, which cover the tuition fees for the entire period of their study. For foreign students, similar scholarships are provided by the International College.

4. *AUN/SEED-Net Masters Program in Computer and Information Engineering*
Partners: Tokai University, Toyohashi University of Technology, and Hokkaido University, Japan
Program type: 2-year Masters program
Degree: Master of Engineering in Computing in Engineering Systems from KMITL
Cooperation: AUN/SEED-Net project was established from a cooperation between ASEAN and the Japanese government with the aim of promoting human resources development in engineering in ASEAN countries. Currently, there are 26 universities in Southeast Asia and 14 leading universities in Japan participating in this project. One of the numerous activities initiated in this project is the scholarships for graduate students from ASEAN countries to do research at one of the member universities, called a "host university", where each student is jointly supervised by academic staff in the host university and a professor from a Japanese supporting university. KMITL has been a host university in the area of computer and information engineering. The Japanese supporting universities in this field are Tokai University, Toyohashi University of Technology, and Hokkaido University. The ASEAN students who select KMITL as their host university will join the Master of Engineering Program in Computing in Engineering Systems at the International College. They will take courses in this program at the International College and be supervised by academic staff in the International College or other faculties within KMITL and co-supervised by a professor from one of the three Japanese supporting universities mentioned.
Financial matters: All students in this program are provided with full scholarships under the AUN/SEED-Net project. The advisor of each student may also apply for additional funding from AUN/SEED-Net (under the so-called "Collaborative Research Program") to support the research project that the student is working on.

All these collaborative degree programs have been running successfully, with the exception of the IMRE program which is currently suspended due to the term-

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time mismatch and the quality assurance regulations recently enacted by the Thai government. These latter problems in the IMRE program illustrate the difficulties and the risks in running a double-degree or a joint-degree program. Such a program is required to conform to the academic regulations of all the collaborating universities as well as the national academic regulations of the countries where the universities are located. The change in the regulations on any side could affect the program and could require the modification of the program curriculum and the agreements. It is not surprising that collaborative degree programs require considerably more administrative work than ordinary programs.

Our collaborative Masters programs are examples of the programs which include collaborations on research. In fact, this is one of the objectives of the programs. We require every student to be co-supervised by academic staff from KMITL and its partner universities to encourage research collaborations. In general, this has been very successful. The programs have helped created new joint research projects and generate satisfactory amount of joint publications every year. However, in some cases, there has not been much cooperation among the co-advisors. We believe this is due to the insufficient communication among the staff. This problem will be solved by requiring more involvement from the co-advisors from start to finish and allocating and/or seeking funding for each student and their principal advisor to visit the research lab of their co-advisor.

Student Exchange Programs

Student exchange is one of the activities that the International College has been actively promoting. By a student exchange program, we mean a program agreed and organized by two universities (called a *bilateral exchange program*) or by more than two universities (called a *multilateral exchange program*) that enables students from one of the universities (called the *home university*) to study for a certain period, such as one semester or one year, at another university (called the *host university*) in the agreement. Typically, during the exchange period, the exchange students pay the normal tuition fee at their home university, while spending their time studying at their host university. They are still responsible for their living expenses and other additional expenses, such as traveling expenses, visa fees, insurances, etc., unless they receive scholarships or financial support from the home university, the host university, or some third-party agency.

When working on a student exchange agreement, a number of issues need to be sorted out and agreed. We summarize some important issues below.

Possible exchange periods. Both parties need to agree on the minimum and maximum lengths of exchange, for example one semester or one academic year. Moreover, as the term times of the universities involving in student exchange may differ, we need to check the academic calendar of each university carefully to come up with possible exchange periods, where the student going on exchange during such periods can continue their study at their home university in the subsequent semester after finishing their exchange study.

Limit on the number of students. Both party needs to agree on the maximum number of exchange students they can accept in each semester.

Credit and grade transfer. The credit systems in different universities are likely to be different, especially for universities in different countries. Each party should study the credit system of the other party and come up with a rule or formula for credit conversion that are agreed by both sides. Usually, the number of credits for a course is related to the number of contact hours (i.e. the hours that the student needs to be present in classes) or the number of learning hours (i.e. the contact hours together with the expected hours of self-study) a student needs to spend on that course in one semester. For example, suppose one credit in University A corresponds to h_A contact hours in one semester and one credit in University B corresponds to h_B contact hours in one semester. Assuming that the amount of workload during one contact hour in one university is equal to that in the other university, we may adopt the following formula:

$$\frac{1}{h_A}\ \textit{credit at University A} = \frac{1}{h_B}\ \textit{credit at University B}$$

or

$$1\ \textit{credit at University A} = \frac{h_A}{h_B}\ \textit{credits at University B}.$$

Another approach is to assume that within one typical academic year the amount of student workload in one university is the same as that in the other university. Then we perform credit conversion based on the total numbers of credits in a typical academic year in the two universities. This is the approach adopted by the *European Credit Transfer and Accumulation System (ECTS)*, which stipulates that the workload in one year corresponds to 60 ECTS credits (European Commission, 2015). For example, suppose in a typical academic year the total number of credits taken by a student in University A is t_A and the total number of credits taken by a student in University B is t_B. By the mentioned assumption, these two numbers represent the same amount of workload. Therefore,

$$t_A\ \textit{credits at University A} = t_B\ \textit{credits at University B}$$

or

$$1\ \textit{credit at University A} = \frac{t_B}{t_A}\ \textit{credits at University B}.$$

Similar to the credit transfer, both parties need to agree on how to convert the grade (or other form of evaluation results) an exchange student obtains in a course at the host university into a suitable grade in his/her study record at the home university. The simplest method is for both parties to provide a meaningful textual description of each grade and then convert the grades based on their descriptions. More precise methods may utilize the statistics of the student grades in a course, such as the percentage of the students obtaining each grade, or perform the conversion based on the percentile rank of the student's score. To facilitate credit and grade conversion, a number of standardized credit transfer scheme have been introduced. For example, the ECTS system (European Commission, 2015) has been developed and widely adopted by countries within the European Union. The

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University Mobility in Asia and the Pacific (UMAP), an organization founded by the governments of a number of countries within the Asia and the Pacific region, is currently developing the *UMAP Credit Transfer Scheme (UCTS)*, which is intended to be used as a standard credit conversion scheme by universities within the Asia and the Pacific region (UMAP Secretariat, 2010; SEAMEO RIHED, 2012). These credit transfer schemes provide a standard credit and grading system, to which each university can relate its own credit and grading system. The university can work out how many credits in the standard credit system correspond to one credit in its own system and how its grading scale relates to the standard grading scale. With this information available from all universities under the exchange agreement, conversion of credits and grades becomes much more straightforward.

Course articulation. This involves matching the courses in the home university with the equivalent courses in the host university. Each party should compile a list of the courses the exchange students may take and perform a matching of the courses in one list with the equivalent courses in the other list. To facilitate this course equivalence matching, the learning outcome of each course should be clearly written, as it is more effective to compare two courses based on their learning outcomes than to compare the actual topics taught by the instructors of the two courses.

Requirements for participating students. To ensure that every student participating in the exchange program is capable of succeeding in the courses he/she is taking at the host university, the minimum requirements that each exchange student must satisfy should be agreed. This may include the minimum overall GPA when the student is applying or the minimum grades for certain courses. Also, if the host university is using a language of instruction that is not a native language of the student, a requirement on language proficiency should be introduced.

Accommodations. The two parties should either provide a suitable accommodation for the exchange students or, in the least, assist them in finding a suitable accommodation before they arrive. Also, the agreement should spell out whether the cost of accommodations will be covered by the universities or by the students themselves.

Application procedure and exchange schedule. The two parties should agree on the application procedure and schedule. Application forms and guidances should be prepared and made available to the students. The most important document is the *learning agreement*, which lists the courses (and credits) the exchange student is planning to take at the host university and the equivalent courses (and credits) at the home university. The learning agreement must be signed by the responsible staff at both the home university and the host university prior to the start of the exchange. The overall schedule of the exchange should also be planned and agreed by all parties. In particular, it should be agreed when the students' exam scores and/or grades from their study at the host university should be reported back to the home university.

The International College has recently signed an agreement with Frankfurt University of Applied Sciences in Germany to facilitate and promote student mobility between the two institutions. The College is also currently in discussion with a number of other universities. We find that, despite the good intentions from all parties involved, there are a number of obstacles which could cause difficulties in developing a successful student exchange program. One problem is the mismatch in the term times. This limits the possible exchange periods. A related problem is the mismatch in the course availability in each semester. In most universities, many courses are offered only in a certain semester, not all year round. Therefore, the courses that a student doing a one-semester exchange can take are limited. The student would then need to take the courses they missed while they were on exchange at some later time. This could make the exchange program unattractive for many students.

Due to the differences in the academic calendars, the exam periods in the host university and the home university may be different. Some universities may even administer an exam only once a year instead of every semester. In this latter case or when the exam period in the host university ends later than the start of the next semester in the home university, a separate exam could be organized earlier for the exchange students or be organized at the home university instead. Also the submission and announcement of grades for the exchange students may take place later than the normal schedule at the home university. The course reports and other documents required for quality assurance purposes in the home university would then need to be prepared and submitted separately. All these require special administration and cooperation from the relevant departments at both universities.

The most common problem in student exchange programs is the reciprocity condition. Whether it is written out explicitly in the agreement or implicitly understood by both parties, a successful student exchange program requires that an equal (or similar) number of students from both universities participate in the exchange. The party who constantly receives exchange students but never sends out students may consider the exchange program unfair and opt to terminate the agreement. To solve this problem, the two universities need to work together to find a way to encourage students to participate in the exchange. This could be a PR campaign to help students in one university know more about the other university and about the exchange opportunity. A summer school, or a similar event, where the students in one university have a chance to visit the other university, could be organized. The less popular university could help make the exchange more attractive by introducing more exchangeable courses, providing free or discounted accommodations, and organizing cultural activities. More importantly, both universities should get feedback from the past exchange students and act accordingly to improve the students' experiences during their exchange in the future. Another plausible solution is to find more exchange partners to join the program, thus creating a *multilateral exchange program*. Alternatively, both universities may consider joining existing multilateral student exchange networks, such as ISEP or Erasmus.

Studying in another country requires considerable adjustment on the part of the student in a short period of time. The student could experience a culture shock when they arrive, have difficulty in getting along with others

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and in a different style of teaching and learning, be more interested in travelling than studying, and, when coming back, experience a re-entry culture shock. As studied by Gullahorn and Gullahorn (1963), these are common problems experienced by travellers. To alleviate these, the host university should organize orientation activities, enabling the exchange students to learn how to seek help and get to know each other and meet with the local students.

Short-Term Training/Internships

Every undergraduate student at the International College is required to undertake an internship at least once in a summer semester (June - July) in companies or research labs. Typically, students do internships when they finish Year 2 or Year 3 (or both). The College encourages and supports students to find their internship hosts outside Thailand. This is so that the students will also gain cultural experiences from working in another country, in addition to technical knowledge and skills. KMITL has agreements on student summer training/internships with many colleges and universities in Japan. Under these agreements, the International College has been sending students to work in research labs in Japan every year. The colleges and universities which have agreements with KMITL also sent their students for short-term training in KMITL every year. The students are not charged any fee from the host university, but normally they are responsible for their living expenses during the internship period. Depending on the agreement, KMITL and the partner colleges/universities in some cases provide financial support for the students, including, for example, free or discounted student accommodations or daily allowances. Every year, we received universally positive feedbacks from both the students and their internship supervisors. Based on this positive outcome, the International College aims at increasing the numbers of students, both outbound and inbound, participating in short-term training programs.

The problems we had in running a short-term training program are similar to those occurred in student exchange (e.g. the term-time mismatch and the reciprocity condition). But as there is no course equivalence matching or credit transfer involved, it is usually easier to initiate and manage.

Short-Term Study Trips

Every year, the International College organized a short-term study trip, lasting 5 - 10 days, for its students and staff to visit academic institutions outside Thailand. The primary objective is to provide an opportunity for students and staff of the International College to learn about universities/colleges in other countries. The International College staff can meet with the staff at the host university and discuss on possible collaborations. The International College students and the students at the host university also have a chance to do activities together, such as attending classes or working on laboratory exercises in groups. The International College provides partial financial support for the students joining a study trip, either with its own money or from the support by a third-party agency, such as the Thai government or a government agency in the country we are visiting. As the students need to pay the rest of the expenses by themselves, participation in a study trip is voluntary. In the past, about 10 - 15 students joined each study trip, accompanied by 2 - 3 staff members.

Joint Organizations of Summer Schools

The International College plans to organize a summer school program jointly with a partner university regularly. The primary objective is to draw the expertise of the staff of the International College and its partners to provide a short course covering a topic of current interest. The target audiences include university students and researchers from anywhere in the world. The summer school also provides a forum for the staff and the participants to share their knowledge and experiences. The participants will have a chance to visit the campus of the host university and meet with the lecturers or researchers at the International College or its partner universities, and learn about the study programs offered. This can help attract the students to come back to the host university to do exchange study or short-term training or join a post-graduate program.

At the time of writing (July 2015), the International College and Frankfurt University of Applied Science (FRA-UAS) are jointly organizing a summer school on urban sustainability in Bangkok. We receive financial support from the German Academic Exchange Service (DAAD). The summer school spans three weeks, consisting of lecture sessions taught by staff from KMITL and FRA-UAS and day trips in and around Bangkok. There are 20 university students and researchers from various countries participating in the summer school. The summer school is part of the activities initiated and organized by Southeast Asian Center for Urban Sustainability (SEACUS), a research unit at the International College established in cooperation with German International Cooperation (GIZ).

Educational Quality Assurance

Every university is subject to some form of quality assurance. Universities within the same country typically have similar quality assurance practice, especially if there is a national framework or guideline on quality assurance within the country. But across the borders, the quality assurance practice could vary significantly. This could cause difficulties and, in most cases, more work when developing and running a collaborative degree program or student exchange program.

In 2009, the Ministry of Education of Thailand enacted the Thai Qualifications Framework for Higher Education (TQF) and required all degree programs offered by Thai universities be revised to conform to this framework (OHEC, 2006). TQF is a rigorous framework, introduced to standardize and assure the quality of the degree programs offered by higher-education institutions in Thailand. In practice, a number of standardized documents are required to be produced for each degree

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program. A *program specification* containing the detail of the program, such as the name of the degree given, the objectives, the program structure, the study plans, the list of courses and their descriptions, etc., must be produced for each program and submitted for approval by the relevant university committee and the Ministry of Education. For a collaborative degree program, the Ministry of Education recommends that the detail of the collaboration be spelled out in the program specification. Consequently, any change to the program from either university in the collaboration could require a modification to the program specification and subsequently a re-approval from the authority. This could be a long and tedious process. On the part of the course instructors, a *course specification*, which is essentially an extended course syllabus, must be produced for each course before the course is offered. After the exam, the instructor is to produce a *course report* summarizing the offering of the course in that semester, including the deviation from the course plan (if any), the grade summary, and the problems occurred. In case of student exchange, where some students take courses at another university that are equivalent to certain courses offered at the home university, a course specification and a course report must be produced for each of those courses too. This requires cooperation from the instructors of such courses at the host university to provide the necessary information in a timely manner.

To minimize the work, when developing a collaborative activity that is subject to the quality assurance process of either university, it is advisable that the two parties agree on what information is needed to be shared and when. Forms could be prepared in advance to facilitate information sharing.

Funding Opportunities

The governments of many countries provide funding for international academic activities. The German Government, through its German Academic Exchange Service (DAAD) provides financial support for a wide range of collaborative activities between German universities and universities in developing countries. These include, for example, funding for the development of a collaborative degree program, the organization of a summer school, a symposium, or a workshop, and the organization of a short-term study trip. The Japanese Government, through Japan International Cooperation Agency (JICA) has been offering financial support for academic activities between universities in Thailand and Japan for many years. A prominent example is the AUN/SEED-Net project which provides a huge array of scholarships and grants for its member universities in Southeast Asia and Japan. The UK government, through the British Council, has recently introduced the Newton Fund, which provides funding for academic and research collaborations with UK universities, as well as travel grants for university staff in other countries to attend educational conferences and professional development seminars or workshops in the UK. Similarly, the US government, through Thailand - United States Educational Foundation (also known as "Fulbright Thailand"), has initiated many grant programs for staff and student exchange between Thai and American universities. The Thai government, through the Office of the Higher Education Commission (OHEC), has signed bilateral and multilateral agreements with many countries to provide funding for academic cooperation, including staff exchange, student exchange, and joint research. OHEC also regularly organizes seminars and workshops on various topics on international academic cooperation.

Conclusion

Developing successful academic collaborations is not an easy task. It requires commitment and support from all parties to overcome the obstacles and solve various problems that come along the way. Very often, changes in the organization are required at many levels, from the university regulations to operations down to the IT support systems. We believe all these changes are necessary if the university is going to internationalize. As part of the management team of the International College at KMITL, it has been our responsibility to convince the management of the university, the academic staff and the support staff that what we doing are worth the effort. Furthermore, as in any collaboration, all parties need to be open-minded and willing to explore various options. But it is important that academic quality and integrity are not sacrificed in the process.

In the future, the International College will continue to develop existing collaborations to allow more students and staff to participate, as well as exploring further collaborations, such as a joint-degree program, a staff exchange program, and a multilateral exchange program. Ultimately, we would like these collaborative activities to be an integral part of the students' experience at the International College.

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Education for Technology Transfer in Higher Education

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Abstract

In ASEAN countries, Japanese companies have established factories and produce a large number of products. And many higher education graduates will contribute for technology transfer between Japan and ASEAN countries. Additionally the product development has been carried out in the factories of the respective countries in recent years.

However, in the current higher education, it is hard to say that doing these technical ability educational activities, such as to have the students that enable technology transfer. Japanese students, eventually, have a role in the transfer of Japanese technology abroad. Foreigner students from ASEAN countries want to get job in Japanese companies in their home country to transfer technology. But, it is a current curriculum that is not enough to follow up also demands of these students in higher education. In higher education, time to incorporate the curriculum on technology transfer is coming. In this paper, we try to analyse by the following procedure about technology transfer, especially Intellectual Property Right.

Keywords: *Intellectual Property Right, Technology Transfer, Thailand, Japan*

Introduction

In ASEAN countries, Japanese companies have built and run a large number of factories. And many of university graduates will work for technology transfer between Japan and ASEAN countries. Additionally the product development has been carried out in the factories of the respective countries in recent years.

For Technology Transfer, we have thought that students need high technics for industrial, especially making products, on some of engineering subjects. The other side, there are not enough lectures about Intellectual Property Right (IPR) and Re-engineering (RE).

When students can learn more technology transfer skills, IPR and RE contribute their work to invent new products. But there are not enough curriculums for IPR and RE for in most of ASEAN University including Japan. Especially students don't have enough knowledge of IPR although IPR is a one of important literacies for Technology Transfer.

Why does knowledge of IPR contribute to technology transfer? It is easy to answer this question. New technology is founded on layers of former engineer. We can use another's patent invented over 20 years passed. There is no product to be born without the contribution of the precedent researcher. Therefore, because we make a patent map to grasp a precedent patent, in the case of the product development, we start in Japan and perform product development after having understood existing inventions.

For these technology transfer and product improvements, knowledge of IPR (such as patents, inventions, trademarks) would be required. International students who will be coming back to their home countries graduated from universities will require knowledge commensurate also, will have to not simply take advantage of the technology that they have learned in the initiative, and exert their skills also for IPR management. Likewise among the Japanese students, its graduates to shape in overseas factories increases are expected knowledge of intellectual property globally is essential at the same time.

1 Overviews of Japan

1.1 Intellectual Property Policy in Japan

Japanese government proposed the "Nation Declaration Policy by Intellectual Property" in 2002.

Prime Minister Junichiro Koizumi made a policy speech on the strategic use of intellectual property at the Diet on February 4, 2002. He announced that Japan was to become an "Intellectual Property Country," a country endeavouring to make intellectual property a key driving force behind the national prosperity.

The first point to be discussed is the Japanese IP policy. The word "Intellectual Property Right (IPR)" is defined in the IP Basic Act article 2-2 as below.

The term "intellectual property right" as used in this Act shall mean a patent right, a utility model right, a plant breeder's right, a design right, a copyright, a trademark right, a right that is stipulated by laws and regulations on other intellectual property or right pertaining to an interest that is protected by acts.

Table 1. Strategic Policies of IPR Country in Japan

1998	Patent Office published "the Standard Textbook for Studying Industrial Property Rights" and started "School Assistant Programs for IPR Education."
2001	METI established "IPR Curriculum."
2002	PM Koizumi speech "Intellectual Property Country" (February) Intellectual Property Strategy Formulation Guideline (July) Intellectual Property Basic Act (November)
2003	Intellectual Property Strategic Program 2003 announcement
2011	MEXT added IPR education to industrial, commercial and agricultural high schools.

The guideline of the Strategic Formulation of the Intellectual Property of July 2002 led to the enactment of the IPR Basic Act in December. Since 2003, "The IP Strategic Program" has been published. The issues on IP education at National Institute of Technology (NIT) and higher education were first mentioned in this publication. (Table 1) How has the IP education been introduced to NIT?

IPR education, the Japanese scholars as well as students had to say enough educational content and are also provided (INPIT 2010). As pointed out in (Yoshii 2012) in particular, systematization is insufficient intellectual property teaching of college tuition from the standpoint subjective of supervising teachers only be expanded curriculum has not been sufficiently built up there. As compared with the educational institutions in Taiwan and Singapore that use up the curriculum actively and problem solving techniques, there is the state of affairs we are not yet saving up with the level of Japan this. As long as promote the internationalization of college future, the time has come for us to regard the curriculum to be the global standard even for intellectual property education and, to understand the current state of intellectual property in the ASEAN countries.

Most NIT students cannot understand the IPR legal system exactly, because of its complexity. So the IPR has been taught as a special subject only few NIT had IPR subjects.

Now it is difficult to carry out the IPR Strategic Program due to the disorganized offices at the Japanese Government. It is commonly thought that administrative duties and policymaking are handled by the Ministry of Economy, Trade and Industry (METI). METI controls its sub-organizations and administrates the Japanese patent policy formulated by them. For example, the Patent Office, one of the METI sub-organizations, is an administrative office for patents, design registration, and trademarks. The National Center for Industrial Property Information and Training (INPIT), another sub-organization, was organized to run the Industrial Property Digital Library (IPDL).

In 1998 the Patent Office was aware of the importance of IP education and has published "Standard Textbook for Studying IPR" and supported school programs for IPR education. Based on this textbook, the Patent Office and IPDL made "the Standard Curriculum for IPR" and started "School Assistant Programs for IPR Education."

Although METI and its sub-organizations have contributed greatly to the dissemination of IP, METI has not given enough opportunity to students to study IP at school. Because of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) having authority over educational divisions, METI could not disperse IPR to schools. Until 2002, the Japanese education system did not have curricula on IPR, and MEXT did not have a plan to train teachers in the subject in the secondary education system. Only few teachers have been aware of importance of IPR and they have taught this subject without licenses. In fact, there are only nine lines mentioned of IPR among 230 pages in the most used Japanese social science textbook for secondary educational students.

Since IP education at higher education is in the early stage, there are several issues accompanying the start of new education. Osaka Kyoiku University started a program called "the Education System for Teachers to Teach IPR" in 2005. The Patent Office and Yamaguchi University also conducted a study: "the Research Project of IP Education at the University" in 2006.

Professors can teach to them high technology skill and many awareness from their aspect. But there is not enough lectures of "creating new idea" like Mindmap, QC circles or more.

1.2 IPR Education in Japan

How has IPR education been conducted at higher education in Japan, especially in NIT? According to the syllabus of NIT, 8 out of 61 schools (13 %) have IPR subjects. But the number of NIT joining the "School Assistant Programs for IPR Education" is 15. About half of those schools have no lecture titled IP but teach IPR in lectures with different names or in club activities. Looking at the actualities from a different standpoint, lectures in NIT are separated into two types: "Product-based teaching (PBT)" and "Classroom based teaching (CBT)." Generally, PBT consists of product developing and CBT consists of teaching IP legal system and knowledge of application for a patent. In NIT, many of the IPR lectures given are PBT. (Table 2)

One of the best PBT is a lecture at Tokuyama NIT. Tokuyama NIT is the pioneer in the present situation surrounding the IPR education. Kadowaki (2008) says, Tokuyama NIT has twenty-four students doing patent application for five years and they donate a part of

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benefit to IPR education. Its students can create products with advices of teachers having experience in enterprise.

Table 2. Details of IP education lectures in NIT

Year	Product-based teaching	Classroom-based teaching
2006	10	3
2007	10	3
2008	10	3
2009	10	3
2010	12	3

Source: INPIT (2007:2008:2009:2010:2011)

Most of NIT has taught IPR by "the Standard Textbook for Studying Industrial Property Rights" with the "IPR Curriculum." With the use of this textbook, most students can understand the concept of IPR with only twenty-five hourly lessons. Additionally, this textbook is given from INPIT for free, so students taking PBT lectures can use free textbooks.

IPR educations by both PBT and CBT have given opportunity for students to understand IPR. Now there are many IPR education lectures at NIT. In 2007, INPIT researched when the teachers had begun to study IPR. The results are shown in Table 3. It must be noted that many of the teachers at NIT have no experience or license of IPR education.

Table 3. Timing of teachers studying IPR in Japan

	High School	NIT	Total	%
In the school days	7	4	11	10%
Employment in enterprise	15	9	24	20%
Employment in NIT	31	6	37	32%
On this Program	32	2	34	30%
Aftertime	9	0	9	8%
Total	94	21	115	100%

Source: INPIT(2007), p. 23

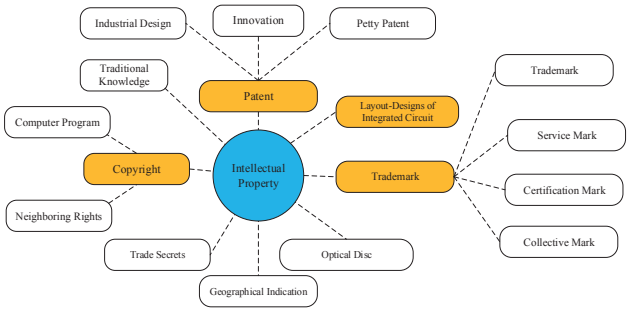
There is a further point, which needs to be clarified. The IPR curriculum established by INPIT lacks some points. This curriculum is good for students to understand IPR legal systems in a short time, but it has no guidance on "creating new idea."

2 Overviews of Thailand

2.1 Intellectual Property Policy in Thailand

Department of Intellectual Property (DIP) of Thailnad established in 1992 under the supervision of the Ministry of Commerce. The strategy is the main organization for the protection of intellectual property rights, enhance its competitiveness and sustainable trade. DIP's main task was. The organization is the main hub of the country of registered patents. Coverage in both domestic and international. And foster creativity Management and exploitation of intellectual property in terms of commerce.

Chart 1. Intellectual Property Right in Thailand



From the diagram showed the dip is responsible for intellectual property in several categories such as Patent, Copy Trademark, Layout-Design of Integrated Circuit, etc. For example, in 2014 through the filing of an application for registration of the property. Issues in the invention (Invention) and design (Design) Over 12,007 entries and a number of intellectual property that has been listed total 3,763 entries from a record dating back over the past years from 2010 to 2014 found that the number of registrations. Intellectual property is increasing in Table 4.

Table 4. Statistics of Patent Application and Granted in Thailand

	2010	2011	2012	2013	2014
Invention	772	900	1,008	1,149	1,286
Design	1,332	1,253	2,107	2,858	2,477
Total Patent	2,104	2,153	3,115	4,007	3,763

(Unit : Number)

Source: Department of Intellectual Property (2015).

In Thailand, the government has continued making "National Economic and Social Development Plan (NESDP)" since 1961. 11th NESDP, from 2012 to 2016, emphasize the importance of IPR strategy.

> *Promote registration, utilization and protection of intellectual property rights in order to encourage research, innovation, creativity and local insight that benefit commercial applications to help drive the economy.*
> *Source: 11th NESDP (2012:86)*

But other side, there is not enough way to spread IPR strategy in Thailand.

2.2 IPR Education in Thailand

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According to the education in Thailand, we found that student's faculty of engineering require to work at foreign company or industry, especially in Japan. Japan has better technology and engineering in the world. Nowadays, Japan was established a lot company in Thailand. Therefore, the student needs to apply job in Japanese's company or industry, especially in Thailand.

At the present, Thailand has 156 universities and institutions of higher education, 43 universities of the private university group. From the information survey on websites' of each faculty of engineering of private university group, we found that a few RE and IPR subjects in course of faculty of engineering as shown in Table 5.

Table 5. IPR and RE course of Private Universities in Thailand

	RE	IPR	RE&IPR	Total
Number	2	6	1	43
Percentage	4.16%	12.50%	2.32%	100%

From the Table 5, we summarized them as follows: We found three parts from 43 private university group as 1) 2 universities have RE subject at 4.15%, 2) 6 universities have IPR subject at 12.50%, and 3) only one university has IPR and RE subjects at 2.32%.

Only one university has IPR and RE subjects. Thus, a few universities promote these subjects which have important knowledge to transfer technology from abroad. Especially, student's faculty of engineering has direct knowledge and understands in technology transfer. Therefore, students who graduate without sufficient did not have knowledge to transfer technology from abroad.

IPR is one of the most important knowledge to transfer technology, which includes only "required subject" in faculty of law or law failed. This subject excludes in "required subject" of engineering, but include only "elective course".

3 Analyse of Situations

For this research, we had some interviews for six Japanese companies in Thailand from 6th June to 22nd June. We can get bellows information about hiring and skills of IPR;

At First, graduate appointment, Lifetime employment, seniority wage system is not popular hiring in Thailand. So they don't train their workers to get a abilities for IPR. If they need to use IPR, they hire legal service for IPR. They do not need to hire patent agents or worker having knowledge of IPR in their company.

Secondly, they don't need to invent in Thailand. Most of technology inventions come from foreign countries and most of patents are moved from foreign countries to Thailand by Patent Cooperation Treaty (PCT). (See Table 6)

Thirdly, there is enough attention to IPR in Thailand. When inventors, including universities, get patents, they need for 10 years or more. This application system is not given enough benefit for the company. These situations are supported by social consensus.

Table 6. The number of patent applications in Thailand 2011

	Company	Nationalities	Number
1	Honda Motor Co. Ltd.	Japan	137
2	Panasonic Corp.	Japan	72
3	Thailand National Science and Technology Development Agency	Thailand	69
4	Mitsubishi Electric Corp.	Japan	41
5	Thailand Institute of Scientific and Technological Research (TISTR)	Thailand	39
6	Chiangmai University	Thailand	38
7	Kao Corp	Japan	37
8	Sanofi Sa	France	36
9	F Hoffmann-La Roche Ltd,	Switzerland	35
10	Sumitomo Rubber Ind. Ltd.,	Japan	33
10	Unicharm Corp/	US	33

Source: Patent Office of Japan (2013)

Conclusions

Although, the government of Thailand determines the strategy of Intellectual Property filed, including promoting, and service information about knowledge and patent to people. At the present, the patent in Thailand is becoming larger. Thus, people are also becoming larger to realize on Intellectual Property. The difficult problem is people who did not know how to transfer technology from ASEAN countries to Thailand.

Especially, private universities in Thailand did not include IPR subjects in "required subject" of faculty of engineering that effect to student's who graduate did not have knowledge and expert in technology transfer from ASEAN countries, especially Japan.

Acknowledgements

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FACULTY DEVELOPMENT PROGRAM FOR NURTURING GLOBAL EDUCATION AND RESEARCH ABILITIES

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Abstract

This paper describes the first year faculty development program for nurturing global education and research abilities in detail and what the authors, the first participants, have done. In the program, we stayed at Toyohashi University of Technology (TUT), Japan for three months, Queens College (QC) of the City University of New York, USA for six months and Penang, Malaysia for two months. The number of the participants in the program was eleven: one from TUT and ten from KOSEN chosen from different colleges. Also, our specialty was different. We mainly focused on improving our English skills through English language training in TUT. We collaborated with professors of TUT in terms of doing research. After that, we went to QC to enhance English skills for providing students with engineering education in English and cultivate global perspectives. Consequently, we took not only a course for English language training, but also some regular courses of Fall Semester and special courses designed for our program. We also collaborated with QC professors and some of us established a strong relationship with them for research purposes. Finally, we went to Penang to teach our speciality in English to Malaysian students in Universiti Sains Malaysia and Politeknik Seberang Perai for example, making use of what we studied at TUT and QC. According to a survey, we found that most of them seemed to be satisfied with our lectures. In addition, we developed an educational tool for teaching in English, which was especially for KOSEN and TUT teachers. What we did in Penang were considered to be our results in the program. Through the program, we were able to not only make a network of people involving the professors of TUT and QC but also create a strong network amongst ourselves from different Colleges of KOSEN. The paper also discusses our future development and possibility.

Keywords: *Teaching in English, Faculty Development, Globally-Oriented Human Resources, One-Year Training Program, Queens College, Penang, Lecture in English*

Introduction

The globalization has been expanding more and more not only in the business world but also in the education field especially in recent years. Currently, Japan is in desperate need of global human resources. Toyohashi University of Technology (TUT) thus focuses on addressing this need from an "engineer education" viewpoint. TUT is playing a leading role in that area of education, through cooperation with Nagaoka University of Technology (NUT) and National Institute of Technology (NIT: KOSEN), by providing an environment where students can gain a global perspective and heightened awareness of multicultural coexistence through on-site overseas experiences, as well as providing state-of-the-art technologies. In the trend, the Ministry of Education, Culture, Sports, Science and Technology selected "Tri-Institutional Collaborative/Cooperative Educational Reform Project - Fostering Globally-Engaged, Practical and Innovative Engineers-," jointly implemented by TUT, NUT and KOSEN in 2012. One of the main purposes in the project is to nurture globally-engaged practical engineers who will become pioneers of the new era, and "Faculty Development Program for Nurturing Global Education and Research Abilities" for teachers of KOSEN and TUT started accordingly as a part of the project in 2014.

This paper describes the first year (2014) program in detail and what we, the first participants, have done because this type of educational training program, which is for teachers of higher education institutions, is rarely conducted in Japan. In that sense, it is worth introducing the program. In the first program, we stayed at TUT, Japan for three months, Queens College (QC) of the City University of New York, USA for six months to improve our English skills for providing students with engineering education in English and cultivate global perspectives. Subsequently, we went to Penang to teach our speciality in English for Malaysian students making use of what we studied at TUT and QC. The activities at each place are mentioned in this paper. The paper also discusses our future development and possibility.

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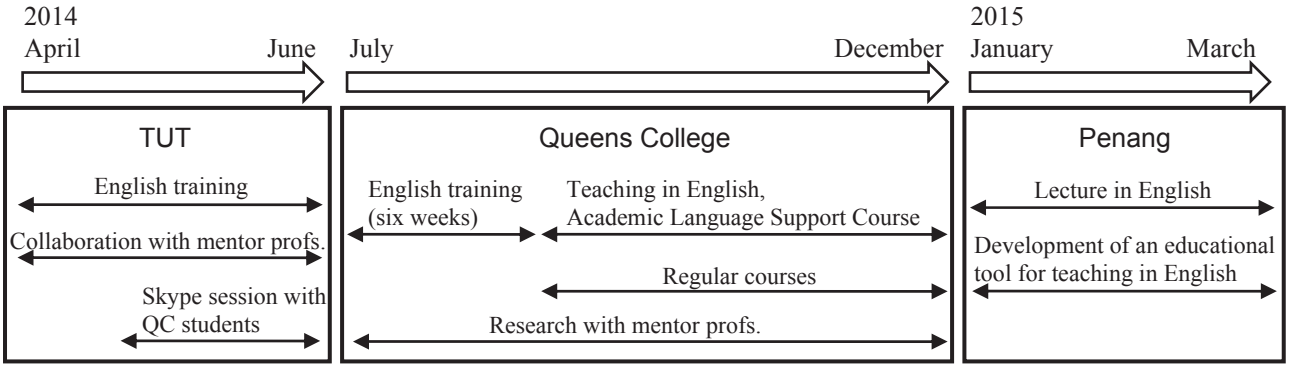


Figure 1. Time schedule of the first year program

Schedule and Participants of the Program

The time schedule of the first year program is shown in Figure 1. As mentioned in the above introduction, we stayed at TUT for three months from April to June, at QC for six months from July to December, in Penang for two month from January to the beginning of March.

The number of the participants in the program was eleven: one from TUT and ten from KOSEN chosen from different colleges; KOSEN has 51 colleges (55 campuses) all around Japan. Also, our specialty is different such as mechanical, electrical, computer, chemical, bio and civil engineering, information technology, and architecture. We basically did not know each other before staring the program, but we had spent one year together among all three places. Since this kind of thing does not happen in not only KOSEN but also other higher education institutions, this should be one of interesting points in the program.

Program at TUT

In this section, our activities in TUT are described. Before going to QC, the participants of this program went through a training program in TUT from April 2nd to June 20th, 2014. There were essentially two missions at TUT. One was taking English training courses by ALC education Inc. and the other was collaborating with mentors for research purposes. To support this training program, we also had a mentor for English learning, and practiced English with students or former students of QC during Skype sessions.

English Training Program by ALC

The English training courses by ALC consisted of several intensive courses, which were completed in one or two days, and regular courses. Among many courses provided in this program the following courses are covered in this paper: Global Vision, Teaching IN English, and Effective Writing from the intensive courses, and Academic Writing, Academic Skills & Reading, Active Communication, Presenting & Logical Speaking, and Teaching Simulation from the regular courses. After completing these courses we were required to give a mock up lecture, which was called Showcase Wrap-up.

We took Global Vision at the beginning. The lecturer worked at a human resources and institutional development consultant gave us a global mindset and reassuring our purpose to take the program. The course was helpful to enhance our motivation to go through this program.

In Teaching IN English we learned a lot of tips about teaching in-class lectures in English as non-native English speakers. It included designing courses, motivating students, encouraging participation, teaching diverse students, providing learning skills. Of course, we performed demo lectures of our specialized academic fields. Through doing this training, we recognized the strength and weakness of our own lecturing skills.

In Effective Writing we learned some techniques required for academic writing, which included controlling formality and politeness, sentence construction, parallel structure, expressions of numbers and ranges, discrepancies in nuance between Japanese and English words, and basic rules for English writing such as itemization, punctuations and spacing.

Most of the regular courses were held once a week. One of the regular courses was Academic Writing. We learned how to write essays, especially basic structures of essays including paragraphs, topic sentences, supporting sentences, concluding sentences and thesis statements in this course. We also learned how to choose topics, gather ideas, organize the stories, review and revise them. Although writing essays is a fundamental writing skill even for children grown up in Western countries, we rarely learned such organized writing methods in our childhood in Japan. These skills were really useful for us to construct clear and logical writing. Actually, writing an essay was an important subject in a placement exam held in the English training at QC.

Another regular course was Academic Skills & Reading. This course focused on effective comprehension of the gist of information in English by listening and reading. When we listened to or read stories in English, all of the information was not always important; therefore, it was important for us to know the technique to obtain the gist of the information effectively. One of the important techniques in reading was the process of surveying, skimming and scanning. At first, we grasped the rough ideas about what the

articles were telling at a glance in surveying. Thus, we obtained more precise ideas by skimming, in which process we obtained the rough information just by reading headings or topic sentences. If we need specific information, we could scan them very quickly by concentrated on the specific words. We can use the processes in combination with signposts, which means the words or phrases by which we could expect what the writers are going to write in the following sections. For example, when the writer describes, "The most important thing is…," the following part should be the main idea. Of course, we can also use this technique in listening. Moreover, the signposting is quite a powerful technique because it can also be used to attract the attention of the readers and audience.

Active communication was the course in which we learned how to make good relationships with other people and express ourselves through conversation. We made pairs or groups and talked with each other in English according to several topics such as greeting, building relationships, making opinions, and narrating past events. A lot of typical phrases which were frequently used in each situation were provided to facilitate the conversation. One of the merits of this course was to eliminate our mental barriers to speaking in English by continuously making conversation somehow.

Presenting & Logical Speaking was the course for enhancing our presentation skills. We learned a lot of skills, which were important for making effective presentations. Those included not only how to create the contents of presentations but also the techniques of delivery, postures and discussion. Actually, we gave presentations in front of the class, and received feedback commendations and recommendations.

In Teaching Simulation we gave presentations assuming the lectures we were doing in our schools. Similarly to the Presenting & Logical Speaking, we also received feedback commendations and recommendations from the class. The demo lectures became the base of our last task in TUT, Showcase Wrap-Up Presentation.

Showcase Wrap-Up Presentation was held on June 19th, 2014. Every participant gave his mock up lecture mainly to teachers and students of TUT. Total time assigned to each presenter was 25 minutes, including 20 minutes presentation and 5 minutes discussion. We gave various styles of lectures individually by trying to take advantage of what we had learned in the whole courses, e.g. active learning and interactive communication with the audience.

For the final part of the training program by ALC, we took Global Vision again through a discussion about our future work to make sure of our motivation for the forthcoming programs in QC and Penang

English Mentor System and Skype Sessions

One mentor for supporting English learning of KOSEN teachers was provided from TUT. The mentor, who was British, worked at TUT as an English teacher. He occasionally talked personally with us and gave advice not only for English learning but also for our lives in TUT. He also planned Skype Sessions that we were able to talk directly with native English speakers: students or ex-students of QC in this case, in terms of Skype, one of the major online videophone services. Although the time difference between New York and Japan was almost half a day and we had difficulties to arrange the time for conversation, the activity was helpful for us to train our conversation skills and to know the information about the life in New York in advance. Some of the participants established good relationships with them and met them in the U.S.

Collaboration with Mentors of TUT

All the participants from KOSEN were assigned to mentors chosen from the professors of TUT. The mentors were selected in consideration of the specializing fields of the participants. The aim of this mentor system was to support the participants during their stay at TUT and hopefully to establish mutual connections for the collaborative work in the future. The relationships between the mentors and KOSEN teachers depended on the extents of matching in their research fields and academic interest. Some of them actively participated in the lab activities of their mentors such as lab seminars and experiments.

Program at QC

The program at QC is mainly divided into five parts:
1: English training: English Learning Institute (ELI)
2. Research with mentor professors
3. Regular courses
4 Teaching in English (TiE)
5. Academic Language Support Course (ALS)

English Learning Institute (ELI)

We had participated in the ELI's program in the first six weeks at QC. ELI of QC is a comprehensive academic program for learning English as a second language. At first, we had to take a placement test. According to the remarks, students including us were classified into seven levels. The number of students was about 10 to 20 per class. We attended class 24 hours a week (Monday to Thursday) for approximately six weeks. There were two classes of three hours each day, and four teachers taught four classes, i.e., writing, reading, and two speaking and listening classes, respectively: each class was conducted twice a week.

In terms of writing, writing essay was required to improve students' writing skills at each level because it was one of the most important skills at the higher education institutions in the U.S. It is much different from Japanese education system. An interesting point is that we discussed a topic in a group, and then we wrote an essay as an assignment based on the ideas talked in the group discussion. As for the speaking and listening classes, there were two classes taught by two different teachers. In one class, we trained practical communication skills through the studies of idioms, listening comprehensions, and asking questions and answering to them in pairs with other classmates. We also gave a short presentation in class, and we

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sometimes debated topics (for example, college education, getting tenure, becoming a vegetarian) and saw video clips. The desks in a class room were different, compared with those in a Japanese class room, and thereby we could have a discussion easily as shown in Figure 2. We spent a lot of time discussing many topics, and as a result we were able to interact with students and teachers.

We found ELI teachers taught students English in a very interactive way. For instance, they looked carefully at students to catch students' understanding and feeling while teaching. Of course, KOSEN teachers look at students during class too, but the ELI teachers looked at even students' facial expressions. For example, they sometimes asked questions like, "Tom, you have a question, don't you? Your face is saying," and "You know the answer. Your face is telling me." Sometimes it was correct and sometimes not, but their teaching style was worth being impressed. Looking toward international students, students at the time came from different countries such as China, Korea, Taiwan, Iran, Turkey, Colombia, Venezuela and Cuba. Most of them had a clear purpose. In addition to that, their English skills, especially speaking skills, were pretty good. They discussed questions and topics with us without any hesitation in class. Because of the ELI teachers, our classmates and English-language environments, we felt our English skills improved.



Figure 2. Discussion in ELI class.

Research with mentor professors

Before arriving at QC, mentor professors were assigned to each of us. However, QC did not focus on engineering although our specially was based on engineering, as mentioned previously. Some QC professors and some of us collaborated effectively on a research project and they still have kept working on some research and might see another future collaboration. On the other hand, research fields of some mentor professors were quite different from our speciality. In those cases, it was difficult to collaborate with the professors and that was treated as an issue of our program for the next year program.

QC regular courses

We took at least two regular courses. One was a course for earning grades and the other was an auditing course. Taking regular courses allowed us to learn about an American lecture style and tips and points of how to teach in English. As mentioned previously, our speciality was different each other; we took different courses. We were accordingly able to experience various size of class from 15 to 150 students and teaching style such as a basic lecture style and discussion style, or using active learning and PBL methods.

One of us, for instance, took "Principles of Cell Biology," which was a subject for students learning general biology and the main target grade was sophomores. The textbook used in the course was "Essential Cell Biology, 4th Edition," which was very famous in the world in this field. The number of students taking the course was about 150. The teacher used PowerPoint during his lecture and the lecture style in the course was characterized as being typical or conventional. In another large class, however, a lecturer used an additional electric educational tool, a "clicker," which elicited a response from students. The clicker was a powerful encouraging tool for the students, who were shy or hesitant to express their opinion and feeling. It should be noted, however, that students here looked much more active than those in Japan. Most of students did not hesitate to ask teachers questions during class. There were always some students waiting in line to ask teachers questions after every class. In the light of globalization of education in Japan, it seems not enough just to change the language used in class into English.

In terms of ICT application, Blackboard, which was a web-based learning management system (LMS), had been introduced as a principal educational tool in the City University of New York. The Blackboard is an educational platform service software and embeds an attendance book, exam making system, self-study system, grade management system, discussion board, and so on. KOSEN is also considering to introduce the Blackboard.

TiE and ALS

Teaching in English (TiE) and Academic Language Support Course (ALS) were specially designed for the program aiming at improving our skills of teaching in English. Since those courses were the first attempt not only for us but also for the teachers of QC, the contents and effects of the courses were unpredictable at the beginning. Both courses were conducted once a week. Since all the teachers in the courses knew that we would give our lecture in Penang after the QC program and in Japan after the entire program, they took that situation into account in designing the courses.

TiE was conducted by five teachers. Some of them belonged to Center for Teaching & Learning of QC, and their specialized fields covered a broad area such as psychology, linguistics, biology, instruction technology and physics. All information concerning this course including syllabus, assignments, opinion exchange using discussion board, etc., was integrated on its web site created using Google Sites. Before starting this course a survey on our interests was performed. The course proceeded with discussion, and we were a little bit confused because we were not used to the style and we thought that it would be a lecture style class. However, as the course went on, we got used to the

style. Figure 3 shows a picture during the class. We learned and practiced in-class technology using the Internet such as Google Apps, the Blackboard in TiE. Those tools allowed us to share students' and teachers' data, ideas and opinions.

TiE teachers sometimes invited guests and they shared their experiences in the class. One of the guests, for example, was a drama advisor of Department of Drama, Theatre & Dance at QC. She asked us to give our short presentation, which was recorded on video, and she thoroughly checked our behaviours during presentation. After checking the important points for in-class presence such as voice projection, eye contact and avoiding distractive gestures through video clips, she gave us very critical and useful comments.

We also learned how to improve students' learning efficiency with specific examples. For instance, the TiE teachers introduced us examples of flip teaching and active learning based on video clips on the internet and their experiences. An interesting point for us was that teachers in QC (in the U.S.) were also concerned about students' motivation for learning. Some of us thought teachers in the U.S. generally did not much care about their motivation because of individualism or self-reliance. In any case, we understood the motivation was the key to improve students' learning efficiency. Lastly, we learned about grading such as formative assessment and summative assessment. The topic of grading extended to Rubrics.

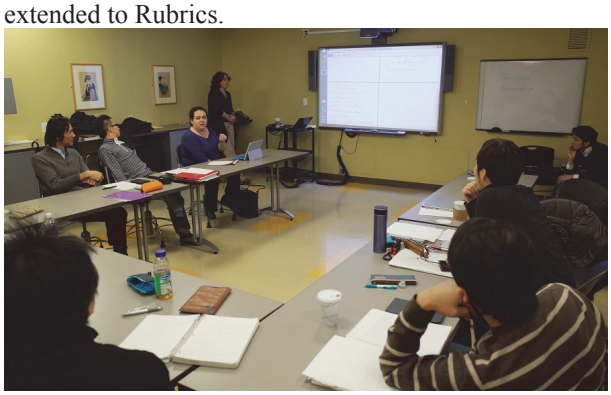


Figure 3. During Teaching in English.

ALS consisted of Communication Workshop and Reading/Writing Workshop. In the Communication Workshop, we practiced the basics of pronunciation such as distinguishing R and L sounds and schwa sounds. Also, we gave 15-minute presentations about our specialized fields, and then the teacher of the Communication Workshop corrected our pronunciations of technical terms and grammatical errors. In addition, we learned idioms and basics of prepositions. In the Reading/Writing Workshop, we mainly practiced reading and summarizing some articles, finding grammatical errors from some sentences, and training vocabularies. We found many vocabularies in the articles that we didn't know although the teacher of the workshop told us that those were at a high school level. We not only learned a lot of things but also saw the depth of the difficulty of English through ALS.

QC treated us as a kind of a faculty member not as a student, but we could take ELI and regular courses because of the program. Our accommodation was a dormitory named the Summit. The Summit provided us with four-bedroom apartments, each of which included a common space and two bathrooms. There were four electric stoves, an oven, a microwave oven, a sink, a fridge, and a table in each apartment. There were 11 RAs (Residence Assistants) in the Summit and they offered many planning activities for the dormitory students. Some of us participated in some activities, and also planned an activity in the Summit.

Program at Penang

We stayed in Penang, Malaysia during two months for lecturing in a local university and some other schools. In addition, we made an online educational tool that teachers (in KOSEN, TUT and NUT) could learn how to teach their subjects in English.

Lecture

We all gave lectures, which we taught specific and academic engineering study on each, in USM, Universiti Sains Malaysia, and PSP, Politeknik Seberang Perai. Some of us gave their lectures in PSDC, Penang Skills Development Center, where young students were learning how to operate machines that were installed in factories in Penang, and DISTED College where students were learning advanced scientific knowledge due to enter the university, which was in Malaysia or outside. We prepared two contents of lectures, the first was basic knowledge of engineering and the second was advanced knowledge in each specific field. We gave advanced lectures only in USM Engineering Campus because only the students studying at this campus have had the higher level of science and academic knowledge. The number of students varied depending on the lecture place and schedule (from less than 10 to over 60 students). Students' existing knowledge about the lecture content also depended on the student because some of the participating students' majors were different from the lecture content. In addition, we had not been able to know about those until we met the students. This was also challenging for us. We used some teaching methods, which we learned from the lecture, Teaching in English, at QC, especially active-learning methods and ICT tools. It seemed that these methods attracted the students to the lectures, and most of them were satisfied with the contents we taught according to surveys taken after each lecture.

Educational Tool for Teaching in English

We made an educational tool, which contains basic phrases, scientific phrases and advanced teaching methods used in a classroom for teaching engineering subjects in English. Targeted users of the tool are mainly KOSEN, TUT and NUT teachers. Table 1 shows the content names and details of the contents. In basic phrase section, the tool provides phrases used in earlier, middle and latter in lecture. In addition, we took videos that were based on the classroom situation and showed

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some phrases which were used in the basic phrase section, so the video could enable learners to know how and when to use the phases. In the scientific phrase section, we also selected technical phrases, how to explain graphs, tables, and equations, which were used in an engineering class frequently. Also, this section has the videos as same as the basic section. It is noted that our recorded voice was used for all the phrases. We think it is interesting and unique.

Finally, in the advanced methods section, the tool provides the lecture videos recorded at QC where teachers used phrases in their classes. The phrases were also selected from the basic and science sections. Additionally, the tool introduces the active-learning examples and teaching tools that we learned while staying in the U.S. The tool shows how to study English in our cases (during the program) for giving our lectures, and also provides our messages and advice, and our comments as a column to learners.

Future Development

The first year program already finished and we are working at each KOSEN college and TUT again. Some of us are in charge of an international committee. Some are trying to give their lecture in English. Some are considering how to conduct active learning in English. Some are planning to give special lecture in English for elementary school or junior high school students. In addition to that, we can share together what we perform. It should be useful information for us, and then we can improve our educational activities each other. That's because we already have a strong network. This is a great advantage for us. In addition to that, the second year program has already started and the program will last several years. We could see a lot of educational activities not only by us but also the second year and future participants. Our further activities and educational researches should be published in the future.

Summary

This paper described the first year faculty development program for nurturing global education and research abilities in detail and what we, the first year participants, had done in the program. The program was divided into three parts: TUT for three months, QC for six months and Penang for two months. We focused on improving our English skills at TUT and QC. Also, we learned and thought about teaching in English to give our lecture not only in Penang but also in Japan in the future. Subsequently, we gave our lectures in English to Malaysian students in Penang, making use of what we studied at TUT and QC. In addition to that, we made an educational tool, which contains basic phrases, scientific phrases and advanced teaching methods used in a classroom for teaching engineering subjects in English. Finally, the paper described our future development and possibility.

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Table 1. Contents of the tool how to teach engineering subjects in English.

Section Name	Content Name		Number of Phrases or Contents	Content Detail
Basic Phrases	Earlier in Lecture		33	Greeting, Self-introducing, Hook etc.
	Middle in Lecture		252	Signposting, Emphasizing, Responding etc.
	Latter in Lecture		41	Summarizing, Handing assessments, Greeting etc.
	Video		14	Combining above phrases
Scientific Phrases	Equations		51	Mathematical phrases, Chemical equation
	Figures and Tables		26	Bar/circle/line Graphs, Functions in Graph
	Video		12	Combining above phrases
Advanced Methods	Lecture in QC	Middle in Lecture	82	Signposting, Emphasizing, Responding etc.
		Latter in Lecture	3	Summarizing, Handing assessments, Greeting etc.
	Active-Learning Example		2	Lecture of QC, Olin College
	Teaching Tools		4	Blackboard, Google docs, TED Ed, web sites
	Learning Methods		5	Listening, Writing, Speaking and Reading
	Column		2	Advices for teaching in English, columns

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Organized Session

Topic 1

Education Research & Practice

（教育研究・工学教育）

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AUTOMOTIVE COMPONENT STAMPING SIMULATION

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Abstract

One of the tendencies in the automotive industry is the efficient use of energy; to reach this goal, obtaining better relationship between the weight and power of the vehicle is advantageous. Using steels with strength higher than conventional steels in the manufacturing of the frame of the vehicle, besides lighten the frame, provides passive safety on the vehicles.
The stamping of an automotive crossmember done with conventional CMn steel was replaced by one made with dual-phase 590 steel, which is an Advanced High Strength Steel (AHSS). The particular focus for this purpose is to determine the best conditions for the stamping of the proposed steel component without changing the dies.
In this work, the mechanical characterization, experimental spherical stamping and their FEM simulation were used to obtain elasticity modulus E, yield strength σ_y, hardening exponent n, coefficient K and the average Lankford coefficient or average plastic strain ratio r_{prom}.
The full manufacturing process of this component are comprised of three main operations; i.e., pre-drawing, drawing and final trimming. Each one of these operations and calculus of springback after pre-drawing and drawing operations were set up in a Finite Element Model by means of LS-Dyna using Hill48 plasticity as yield criteria, Hollomon law as hardening rule and Forming Limit Diagram (FLD) as failure criteria. From the second to the final step the states of stresses and strains of the previous one were considered as initial conditions in actual step
To use values on the computational analysis, a security factor based on the forming limit diagram (FLD) was proposed.
A Design of Experiments to obtain the better material conditions for stamping considering 6 parameters is shown; 64 simulations were carried out using the maximum and minimum values from standard deviations of samples of DP 590 steel.
It can be concluded that for this stamping operation is better using the 590 dual-phase steel with elasticity modulus E and yield strength σ_y in their low values but with n, K and r_{prom} in their high values.

Keywords: *AHSS, stamping, FEM, springback, wrinkle, thinning, stress, FLC, FLD*

Introduction

The automotive industry is doing a great effort to use more efficiently the energy, this is done by two approaches, the one is treat to do more efficient motors, and the second is lighten the structure of the car body also providing passengers passive safety to passengers.
In the case of lightening the body, one of the methods is diminishing the weight-strength rate on the used materials, and this is possible with the usage of the Advanced High Strength Steel (AHSS).
The conventional CMn steel has been used to stamping chassis elements, however, with the AHSS materials development, it is possible diminish the weight of some parts and increase or maintain the passive safety
In this work, a FEM simulation was done to evaluate the possibility of stamping an automotive crossmember with dual-phase 590 steel and the dies geometry used right now with CMn steel, the particular focus for this purpose is to determine the best material parameters for the stamping.

Materials and Methods

Stamping process

In the industry, the crossmember CMn steel stamping is done following the process: blanking and make a pre-drawing this to avoid high thickness-reduction, when this deformation is reached, punches are separated and a first springback takes place, in a second step, the pre-stamped sheet is setting up in other dies to stamp a better shape and when the dies open, a new springback occurs to reach the final shape, now, trimming operation is done to obtain the final crossmember.

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Finite element simulation

To develop the FEM simulation, the characterization of dual-phase 590 steel was done, the ASTM E517-00, ASTM E646-00 and ASTM E8M standards were followed, using tension testing samples at 0^0, 45^0 and 90^0 from the rolling direction and using longitudinal and transversal extensometers. The values of Young´s modulus E, Lankford coefficient r, tensile hardening exponent n, strength coefficient K and yield strength σ_y, were obtained.

Using symmetry conditions, only half of the crossbar was simulated as is shown in Figure 1.



Figure 1. Half Crossbar

The software used to simulate the stamping process was LS-PrePost 4.0 from LsDyna® including the sheet metal forming module.

The material model was HILL48 by their good results working with steels and also for its computational advantages.

Simulation of Pre-stamping

The first stage was a gravity simulation, the adequate metal sheet placement over the die including simulate the gravity effect. In Figure 2 the sheet weight effect is shown

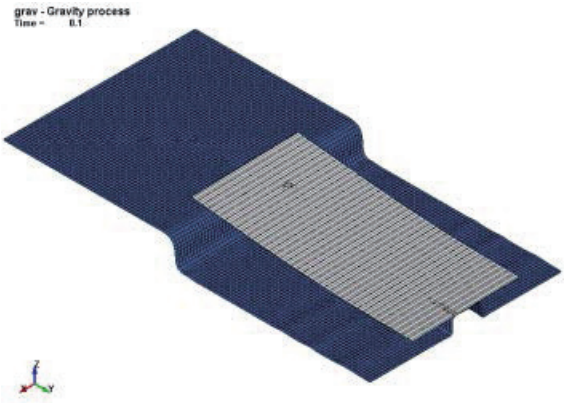


Figure 2. Gravity effect on the sheet steel

Next step in the simulation is the placement of the blank holder on the sheet metal pressing it against the die.

There are two punches that stamp the sheet, both punches move going down in a 45^0 angle and simultaneously they press the sheet against the die.

The movement of the punches is in the X-Z plane

In the Figure 3, the punches are green.

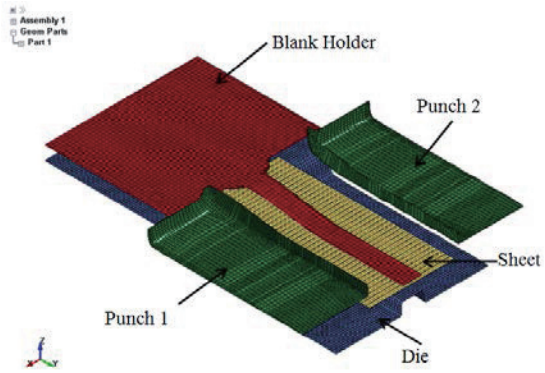


Figure 3. Pre-stamp begins

Data of this step on the solution like residual stress, strain, and thickness reduction, are stored to simulate the next process step.

When the pressure of both punches finishes, the movement of the punches are get out again at 45^0 in the X-Z plane, now, the sheet steel is free and it is convenient simulate their springback, from the data stored, the result of the pre-stamp is shown in Figure 4.

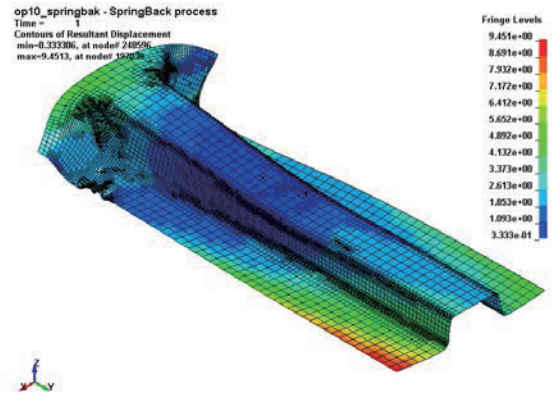


Fig 4. Pre-stamping finished after sheet spring back

Data of the solution of pre-stamping are stored again to simulate the next process step.

Simulation of Stamping

Now, the pre-stamped sheet steel is carried to other dies with the final shape.

The next step is simulate the stamping in the final dies, to do this, all data of the previous step are imported and stamping in the new dies is simulated

It is no necessary the gravity load because that the alignment of the pre-stamped shape on the die is by geometry and the effect of the gravity is negligible compared with the load of the punches. The punches movement is again 45^0 slow down, and the stamped piece is shown in the Figure 5.

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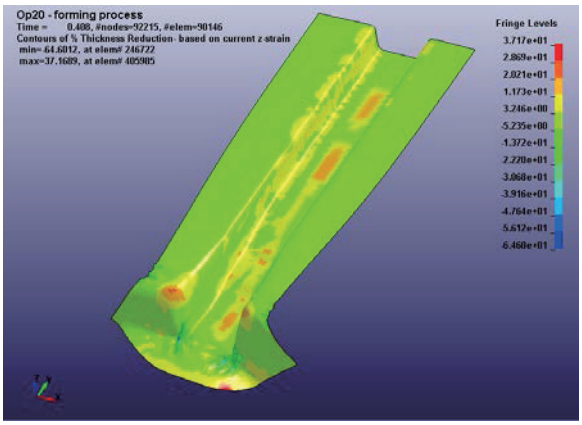


Figure 5. Final stamping.

Again, when the punches are out, all data are stored and in the next step the springback effect is simulated. The crossbar in this stage is shown in the Figure 6.

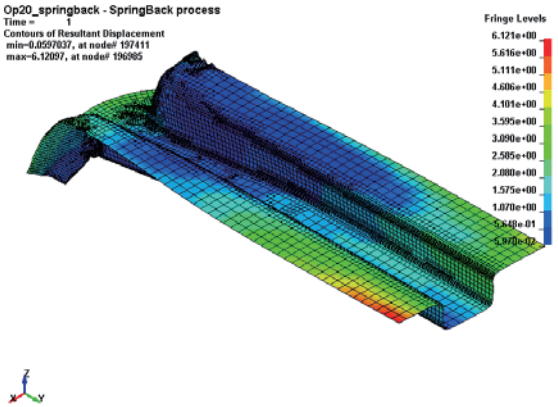


Figure 6. Cross member after sheet spring back

Finally, the material surplus is trimmed to obtain the crossbeam as is shown in the Figure 7.



Figure 7. Final cross beam from simulation

Design of Experiments (DOE)

When the process simulation was finished, the next step was a search to obtain how the influence of some material parameters in the stamping process is. The approach is to evaluate the parameters that have more influence in the *security factor* and *thickness reduction* on the crossbar stamping process.
The considerate input parameters are: elasticity modulus (E), yield strength (σ_y), tensile hardening exponent (n), strength coefficient (K), average anisotropy r_{prom} and friction coefficient (f_s).
A Design of Experiments with model 2^6 was used because it is considered a stable model and is required to analyze the effects of interaction between variables. 64 simulations were performed, the array of the cases was generated by the Minitab® software by varying the input parameters; the maximum and minimum values of these variables were obtained from standard deviations from samples of dual-phase 590 steel.
Each simulation case comprising the steps of Pre-drawing, springback, drawing, springback, and final trimming.
One of the output variables of experimental design is the safety factor with respect to the Forming Limit Curve (FLC), because this factor is not found in publications, it was decided that to assess this parameter is necessary to calculate the vertical distance from the point Critical (farthest to the points that are on the FLC or the closest to the points that are under the curve) to the FLC
To develop the above, the following procedure was performed:
From the graph of formability into the LS PREPOST (Figure 8), the program gives a mapping of all states of strains, corresponding to elements in model, over a FLD where all points are classified according to a quality of forming criteria; i.e., rupture risk, rupture, excessive thinning, wrinkling and safe area.

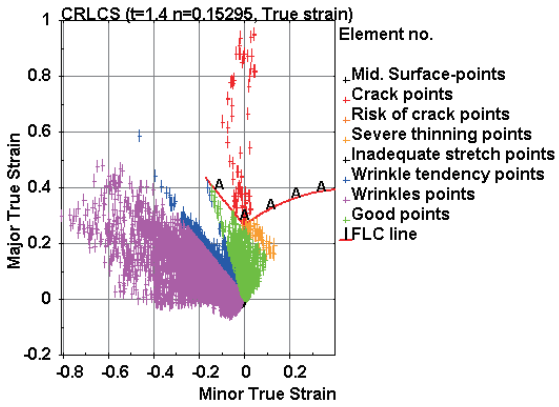


Figure 8. Formability graph

The results filtered only with critical points, the FLD curve is as shown in Figure 9. "Subtract" the curves in the graphic editor of the program and the greatest distance is the safety factor

(considered negative). If critics were under the curve points the shortest distance (considered positive) is taken.

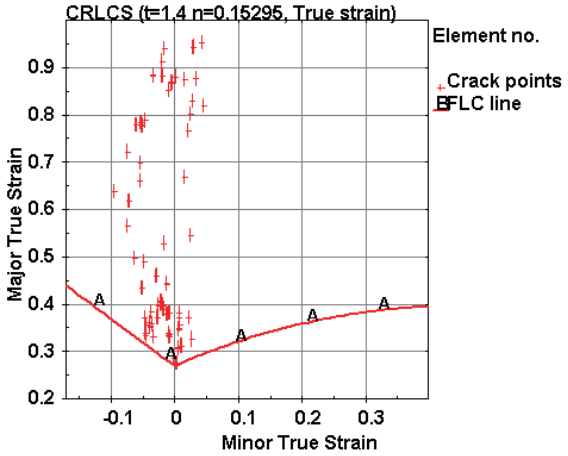


Figure 9. FLD curve and critical points

If the position of the most critical point is known and its distance to the curve, it is possible to find the point on the curve that corresponds to the limit value and then calculate the safety factor by calculating the ratio between the limit value and the critical value. According to the above, if the safety factor is greater than 1, the point would be in safe zone; if it is less than 1 there are rupture of the sheet.

Simulation results of the cases considered for the design of experiments were obtained and data were entered into Minitab® software to get the graphs of main effects and interactions of variables.

In the Figure 10, the resulting graphs for thickness reduction are shown.

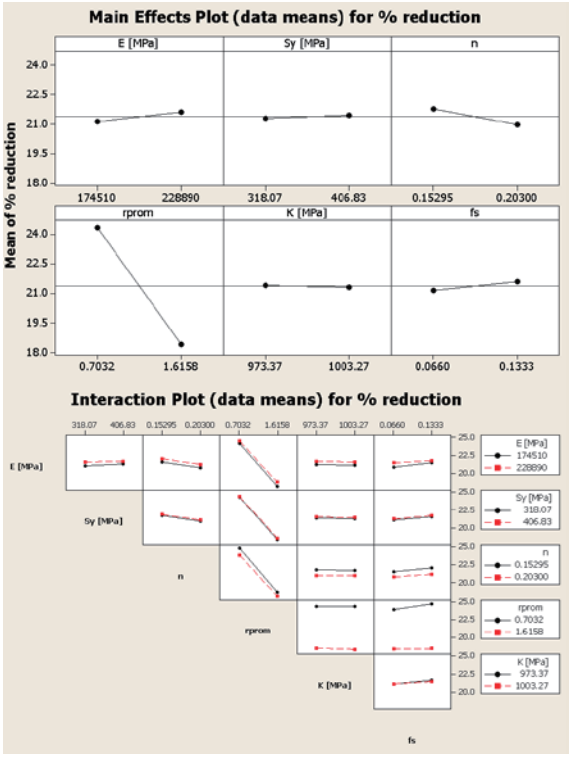


Figure 10. Influence on Thickness Reduction

The resulting graphs for the safety factor are shown in Figure 11.

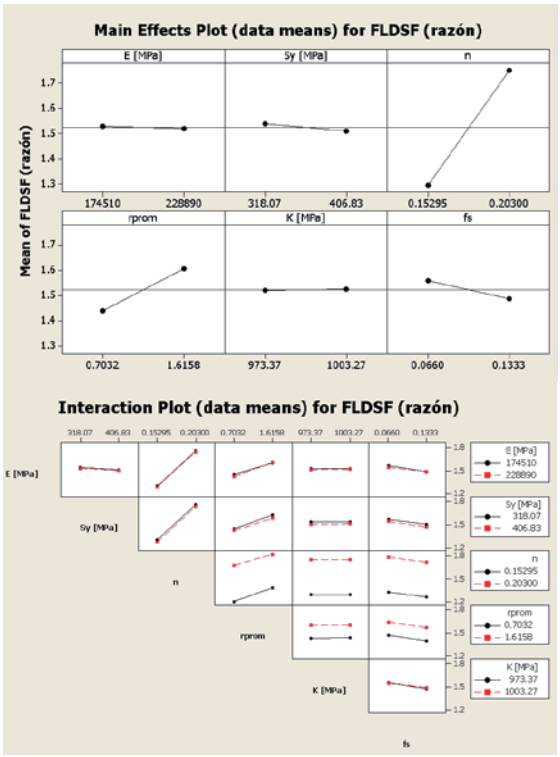


Figure 11. Influence on Safety Factor.

Results and Discussion

According to the results shown in Figure 10, it can be concluded that the parameter that most influence on the thickness reduction in the sheet is the average anisotropy (r_{prom}) followed lesser extent by the exponent of strain hardening (n) , modulus of elasticity (E) and coefficient of friction (f_s). For all other parameters we can conclude that its influence is negligible. As for the interaction of variables it can be considered that there are no interactions that influence the process.

With Figure 11 we can conclude that the changes in the value of n, have great influence on the safety factor (FLDSF (ratio)), this is because the height of the FLC depends on this value, when n is reduced, the safety factor average is reduced.

Average anisotropy (r_{prom}) is also a parameter to be considered to increase the safety factor, as we know of Figure 10 if r_{prom} is high, decreases the mean of the percentage reduction in thickness and therefore the mean value of the safety factor increases. The third factor to consider is the coefficient of friction, as is logical, the greater this is, the safety factor decreases.

All this is consistent with what is stated in the literature. The following conclusions were obtained agree with ASM Handbook Volume 02, ASM Handbook Volume 08, ASM Handbook Volume 09, ASM Handbook Volume 14, Groover Mikell 2000, and James A. Szumera 2003.

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To depth drawing, should use a high value of n because endures large deformations, but requires more force and is subjected to greater stress. When the material has a large value of n, meaning that it hardens due to cold working or plastic deformation.
For shallow stamping pattern, should use a low value of n and low strength yield, since if a metal can be formed with a low stress (as in super-plastic deformation) then, levels of stress to throughout the deformation of the workpiece will be low, and the fracture is less likely.
With high values r_{prom}, the average thickness reduction decreases.
r_{prom} is a reliable indicator of drawability of a material. Deep-drawing capacity increases with a high value of r_{prom}.
The FLD adequately simulates actual conditions of sheet metal forming operations.
The higher is the FLC in the diagram, the formability is made larger. The thicker is the sheet, the curve is higher, but the required forces and stresses increase.
A material with low yield stress, high elastic modulus and low tangent modulus allows severe forming using little force and presenting little "springback".

Conclusions

It can conclude that for a sheet metal stamping operation, should use materials with low elastic modulus (E) and yield stress (σy), but with high values of n, K and r_{prom} besides promote a low coefficient of friction to carry out the operation.

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INCORPORATING FLIPPED LEARNING INTO THE SUBJECT OF AIRCRAFT ELECTRICAL SYSTEM

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Abstract

This paper reports our experience in using flipped learning to deliver three lessons in the subject of Aircraft Electrical Systems. A total of one-hundred and nine third-year students from an aviation course at Republic Polytechnic participated in the study. Fifty-seven of these participants went through the subject without using flipped learning. The remaining fifty-two students used flipped learning for three lessons in the subject. This study compared the test results of these two batches of students. Results of *t*-tests showed that students who experienced flipped learning performed significantly better in the final test. Students' reflections after the flipped learning lessons were also analysed. Majority of the feedback from students were positive.

Keywords: *Flipped Learning Model, Aircraft Electrical Systems subject, paper quiz assessment.*

Introduction

With Singapore being developed into a regional aerospace hub for both commercial and general aviation, the Singapore government is providing strong support and incentives to encourage more aerospace companies to strengthen their presence in Singapore.

Aircraft Electrical Systems is a subject in one of the aviation programmes in Republic Polytechnic. The curriculum of this subject is closely-aligned with the Singapore Airworthiness Requirements 66 (SAR 66) curriculum so that graduates of the program would be better prepared for the Civil Aviation Authority of Singapore (CAAS) examinations that they would need to take if they aspire to be Licensed Aircraft Engineers.

FLIPPED LEARNING MODEL

Bergmann and Sams (2012) were among the first to introduce Flipped Learning. The idea of Flipped Learning is to make students more independent, flexible and well-prepared in their learning before coming into the class. Students can watch the videos and read other materials prepared by their lecturer prior to the lesson. Time in class is used for discussion of concepts and for clearing up misconceptions with the lecturer so that the students can explore the topic in greater depth and create richer learning opportunities (Hamdan et al, 2013). The lecturer can also focus on students who need additional guidance and support.

The subject chosen for this study is Aircraft Electrical Systems, a subject taken by final year students in the course. It consists of fifteen lessons and the three topics chosen for flipped learning to be used are aircraft lighting system, anti-icing system and fire detection system.

Reading materials, videos and a worksheet for each topic were uploaded at least one week prior to the lesson. Students were supposed to watch the videos and read the materials given to them prior to each lesson. Students were given a quiz right at the start of the lesson. After that the lecturer gave a brief lecture on the topic of the day. After a short break, students attempted the questions in the worksheet together with supporting laboratory experiments. In the third part of the lesson, students explained the results of their experiments using what they have understood. Finally the day is concluded with another quiz to examine the students' overall understanding of the lesson.

Method

Fifty-seven third-year students in Semester 1 and fifty-two third-years students in Semester 2 participated in this study. Only the students in Semester 2 went through the three flipped learning lessons. A *t*-test was used to compare the final test scores of students in Semester 1 and Semester 2. The objective of the test is to see if students who learned the three topics through flipped learning performed significantly better than their counterparts who did not. Students' feedback on the three flipped learning lessons was also gathered and analysed.

Results and Discussion

Table 1 shows the average scores that the students obtained in the final test for the three topics under study. The mean scores that were

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obtained with flipped learning were all higher than the scores obtained by students in the previous semester when flipped learning was not used for the same lessons. Table 2 shows the comparison of the test scores for the two semesters. Results indicated that students performed significantly better for all the three topics when flipped learning was used.

Table 1 Mean percentage score of students for topics conducted using Flipped learning

	n	Lighting	Anti-icing	Fire protection
No flipped learning	57	66.0%	67.1%	52.3%
With flipped learning	52	75.0%	97.3%	75.8%

Table 2 Results of *t*-tests for topics whereby flipped learning was conducted in Semester 2

Topic	*t*	*df*	*p*
Lighting	2.00	98.8	.05
Anti-icing	7.18	91.9	.00
Fire protection	4.43	107	.00

Table 3 shows a comparison of the results for the remaining topics whereby no flipped learning used at all for both semesters. In this case, the differences were mostly insignificant except for two of the topics (transformer and split-parallel) where performance actually deteriorated in Semester 2. This result further strengthens our conviction that flipped learning had helped students learn better.

Table 3 Results of *t*-tests for remaining topics in the subject

Topic	*t*	*df*	*p*
Battery	–.57	104	.57
Generator	.34	107	.73
Motor	–1.62	104	.11
Transformer	–6.21	107	.00
Ignition	.33	107	.75
Split-parallel	–2.02	107	.05

Students were also asked to reflect on their experience of the flipped learning lessons. Majority of the students commented that they are better prepared for the class when reading materials are given to them beforehand. Three samples of students' reflections are given below.

Student A: "I went thru it yesterday and also this morning when I got to class. Honestly I find that this strategy is good because it gets you involved early and also triggers a lot of ideas and questions before class starts and then going thru it during 1st and 2nd break helps you understand it more."

Student B: "The resources that were given to me were very useful with good quality. I studied it during weekends and on that same day; I knew almost everything about Aircraft Lighting Systems. However, I still have to do some research on the internet as I need to clarify certain things which I hardly understand. I believe that this process is quite effective as it can tell whether the students have the capability to study by themselves independently or they need some proper guidance or even they seem clueless due to their laziness for not doing their given tasks. I have gained some great self-learning as this would definitely help me in my future whereby I will be on my own once I've started my new career."

Student C: "I did try to read through the resources in the morning when I am travelling in the bus to the school. I tried to read up all the resources that were given so that I would be clearer of what is going on later for the lesson. I did get quite a lot of information and the overview of today problem. The process was thumbs up as it did benefits me and put me ahead of what is going through in the class. The resources given were relevant. I am sure if I am going to do this every day, I would know better off today problem. "

Based on the above feedback, we concluded that students were more motivated during the flipped learning lessons and also experienced a sense of accomplishment at the end of the lessons. However students will only reap the benefits of flipped learning if the difficulty level of the reading materials matches the ability level of students. Otherwise students might not be able to understand

what they are reading when they are left to do the reading on their own. This observation is expressed by the following student's feedback.

Student D: "I have spent time during weekends to read through the resources and problem statement. It was quite hard for me to learn as some of the information was quite difficult for me to understand it. It would be good if sir could summarize the important point and briefly explain the topic."

Student would also not benefit from flipped learning if they are not motivated to do their own pre-reading before class. In this study, we also saw examples of such students.

Student E: "I did not study the resources provided before the start of the class. However, I did take the time to read them after the quiz before you began with the problem. That counts too right? I think what helped me through was the prior knowledge that most of us already had with regards to the aircraft lighting. I think that this method is great and it's better, it helps us see onto what we will understand for today. Or maybe just because today's lesson seems easier. "

Conclusion

Semester 2 in 2014 was the first time we tried using flipped learning to teach three topics in the subject of Aircraft Electrical System. The analysis of students' test results suggested that flipped learning had a positive effect on students' learning. The feedback from students regarding flipped learning was also generally positive. This experience gave us more confidence in using an alternative pedagogy to deliver the subject content, and we will continue to explore the feasibility of using flipped learning in other subjects.

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PHYSICS EDUCATION THAT ADOPTED GROUP WORK -PHYSICS HANDICRAFTS 2008~2014-

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Abstract

In National Institute of Technology, Kagawa College, the author practiced the action of Physics Handicrafts since 2008. The aims of this action are to rise of motivation to study physics and to make students feel physics interesting, further to make students associate the laws and principles in physics with physical phenomena in their daily life.

In the concrete procedure, the students make the handicraft taken the laws and principles in physics into consideration, by group work. They have to make not only the handicraft but also the presentation materials about their handicraft. Many interesting handicrafts were submitted, the author utilized good ones in physics class and exhibited them in their campus festival and experimental workshops.

In the result of student's questionnaire, its effects are indistinct. However, some students enjoyed Physics Handicrafts and understood physics more deeply. Further a few students joined the activities making handicrafts in workshops for children. Though this action has a little effect for all students, it is better action that adopted group work, active learning and presentation. Hereafter the author will continue its action, as characteristic one in KOSEN.

Keywords: *Physics Education, Engineering Education, Motivation, Active Learning, Group Work, Presentation Skill*

Introduction

Physics is indispensable for engineer and engineering education, so students to be engineers must learn basic knowledge and ideas in physics. In particular, as students in KOSEN get earlier engineering education, they need earlier physics one. However, there is a gap of the education in junior high school and that in KOSEN. On the other hand, the declining population of children has an influence on the difference of scholastic ability in enrollments of KOSEN. Some students don't feel physics interesting and exciting, and can't associate physics with engineering education and physical phenomena in their daily life. Further a few students have an awareness that they can't understand physics.

As improvement methods, the schemes in physics

Table 1.Concrete procedure for Physics Handicrafts

	2008	2009	2010	2013	2014
Submission	Handicraft Electronic file		Handicraft Electronic file Idea paper (including List of materials request)		
Materials purchase (for Applicants)	By teacher By budget for school				
Members of group	5-6 students	4-5 students			
Division into groups	By students			By teacher	
Announcement time	Before summer vacation (early in July)	Middle of December	Early in October	Early in December	Early in August
Idea paper deadline (including List of materials request)	None		middle of November	End of December (for materials purchase) Middle of January (for the others)	Early in November
Handicraft Electronic file deadline	End of September	Early in February	Middle of November	End of January	Middle of December
Submission method	USB memory Mail				
Presentation	None				3 minutes
Evaluation	By teacher				By teacher and students
Utilization of handicrafts	Educational materials in Physics classes			Educational materials in Physics classes Exhibition in Campus festival	

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classes and supplementary lessons have some effects on the rise of their scholastic ability. On the other hand, in National Institute of Technology, Kagawa College, the author (2009, 2010, 2014) practiced the action of Physics Handicrafts since 2008. The aims of this action are to rise of motivation to study physics and to make students feel physics interesting, further to make students associate the laws and principles in physics with physical phenomena in their daily life.

In the concrete procedure, after the students study basic knowledge in physics, they make the handicraft taken the laws and principles in physics into consideration, by group work. They have to make not only the handicraft but also the presentation materials about their handicraft. Many interesting handicrafts were submitted and the author evaluated them, furthermore student's evaluations were taken into account since 2014. The author utilized good ones in physics class and exhibited them in their campus festival and experimental workshops.

In this paper the concrete procedure of Physics Handicrafts and good ones are introduced. Furthermore the result of student's questionnaire are analyzed and its effectiveness is discussed.

Procedure

In National Institute of Technology, Kagawa College, the author practiced the action of Physics Handicrafts in physics classes of first grader. Since 2008 the author has done it continuously except for 2011, 2012 in the author's absence. The procedure has improved year by year and is shown in Table 1.

At first, the submissions of the action are Handicraft and Electronic file. The students have to make the Handicraft taken the laws and principles in physics into consideration and Electronic file about their Handicraft. Furthermore since 2010 they have to make Idea paper including List of materials request and the author checked the contents and the safety of it. Applicants were supplied with materials of Handicraft by the budget for school. Figure 1 is Idea paper including List of materials request.



Figure 1 Idea paper including List of materials request

The group consisted of five or six members in 2008 but some members didn't join in group work. Therefore the member of group decreased and since 2009 the group consisted of four or five members. In 2008, 2009 and 2010 the groups were made by students freely. Since 2013 the author divided students into groups by their student numbers. For example the group of No.1, No.11, No.21, No.31 and No.41 was called Group 1. The Division into groups is useful for seeing the members of groups.

The time of the action was altered with reflections of previous year. However the best time for it is indistinct. In 2008 Physics Handicraft began as the homework of summer vacation. The author announced it before summer vacation, early in July, and the deadline of submission was the end of September. As students of first grader didn't study physics so much, the action was held late in 2009. However in January students and the author were busy, so the time of it was altered in 2010, 2013 and 2014.

In 2014 the presentations about their handicraft were held for the first time. For three minutes every group explained their handicraft in short. Figure 2 shows the picture of their presentation. The evaluations of the handicrafts were adopted the mutual evaluations of students in 2014, in addition to those of the author.

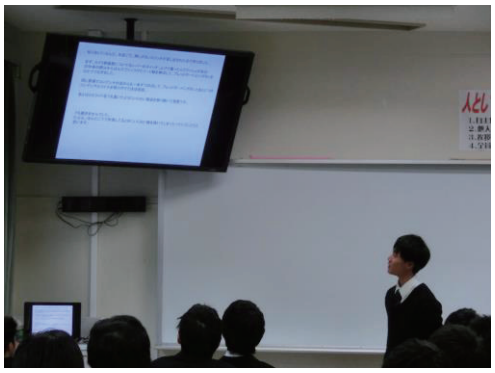


Figure 2 Picture of presentation about their handicraft

Physics handicrafts were utilized as educational materials in physics classes. Furthermore the handicrafts in 2013 were exhibited in Campus festival as works of first grader. Figure 3 shows the picture of exhibition in campus festival.



Figure 3 Picture of exhibition in campus festival

Results

For five years many handicrafts and electronic files were submitted. There were interesting ones, highly complete ones, low complete ones that adopted interesting principle and so on. In this section good ones are introduced.

In 2008 there were many same handicrafts as though the water rocket and the collision pendulum. Figure 4 shows the collision pendulum using momentum conservation and the robot made of paper cup using moment of force. In 2009 though there were many same handicrafts, many groups devised and many good ones were submitted. A group made Yagi antenna using knowledge of electromagnetic wave. Figure 5 shows Yagi antenna and Magnet pendulum that explains Kepler's laws. In 2010 some group made highly complete ones and Figure 6 shows the low power coil gun using electromagnetic induction and the robot made of wood using moment of force. In 2013 there were many interesting ones and some low complete ones that adopted interesting principle. Figure 7 shows the hand-operated electric generator, so-called Erekiteru, and the toy of linear motor car. Especially Erekiteru was excellent one in completeness and principle. In 2014 there were interesting handicrafts but few highly complete ones. For the first time the presentations about their handicraft were held and mutual evaluation of students. Figure 8 shows the toy of space elevator and picture of group work. Figure 9 shows the parts of Electronic file about the low power coil gun.

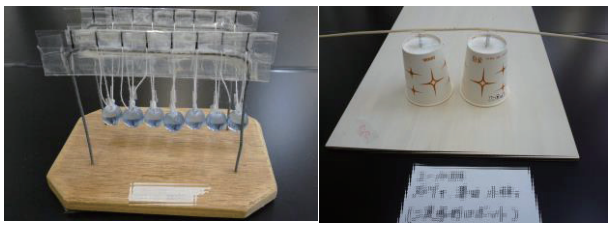


Figure 4 Collision pendulum and Robot made of paper cup(2008)

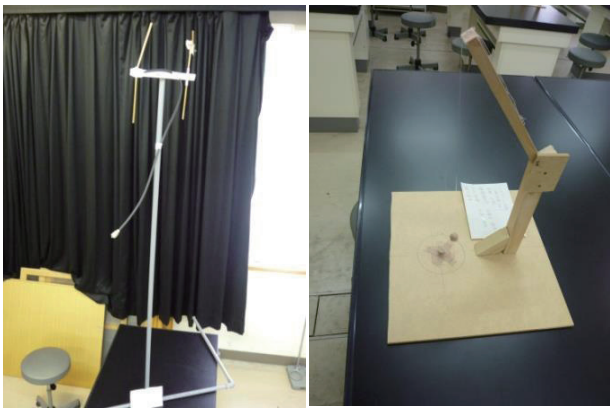


Figure 5 Yagi antenna and Magnet pendulum(2009)

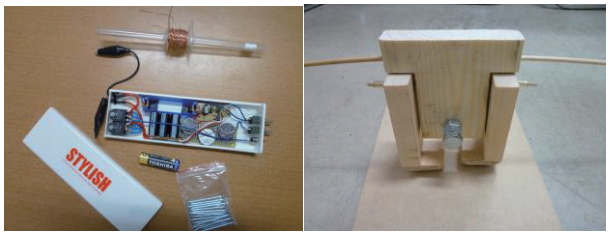


Figure 6 Low power coil gun and the robot made of wood(2010)

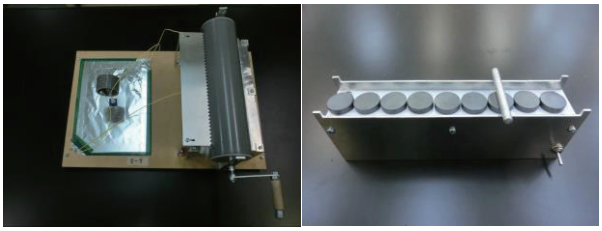


Figure 7 Erekiteru and the toy of linear motor car(2013)

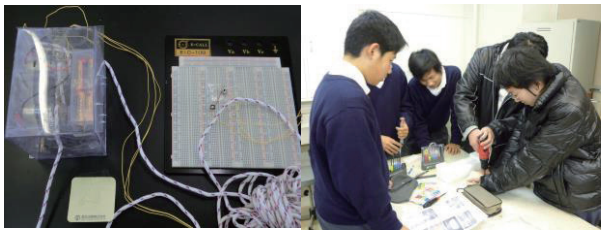


Figure 8 Toy of space elevator(2014) and picture of group work(2009)

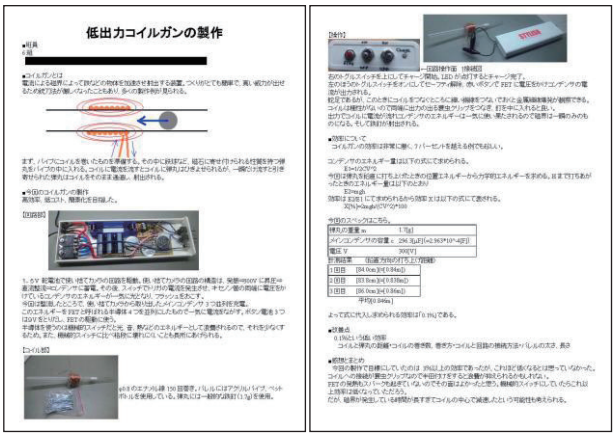


Figure 9 Parts of electronic file about the low power coil gun(2010)

Questionnaires and Discussion

In the end of first grader, after the action, questionnaires for the students were held in 2009, 2010, 2013 and 2014 except for 2008. As the question items are not same in all years, the results of five common ones are analyzed and discussed below.

Figure 10 shows the result of Q1 "Did you enjoy Physics Handicraft?". Though the percentage of answer "Neither" is larger, "Very enjoyable" and "Enjoyable"

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come to about 40% altogether. All students didn't enjoy but some of them wanted to make other handicrafts and join the club that hold the experimental workshops and develop the educational materials.

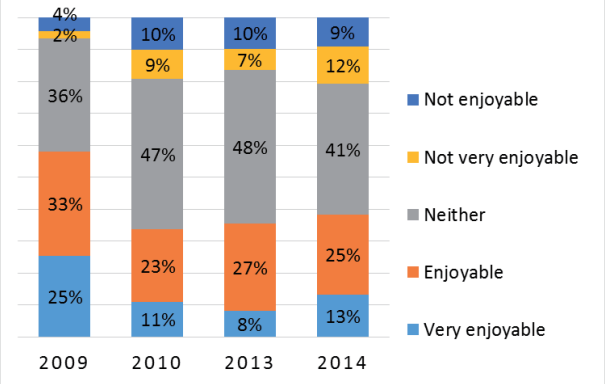


Figure 10, Q1.Did you enjoy Physics Handicraft?

Figure 11 shows the result of Q2 "Did you join in actively?". The answer that they joined in actively increases in 2014. However these data aren't reliable so much and as the action is group work, some of members don't join in. As the measures, in 2014 the mention of member's roles was demanded in Electronic file. The effect is indistinct.

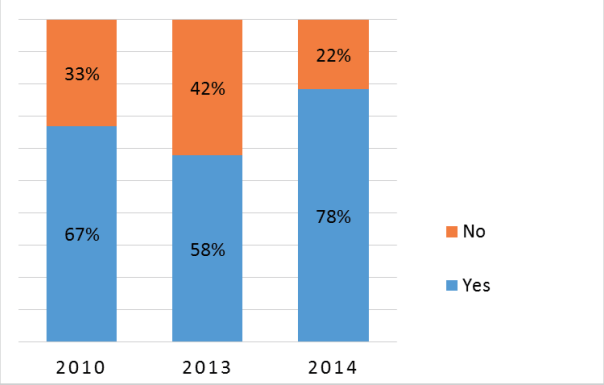


Figure 11, Q2. Did you join in actively?

Figure 12 shows the result of Q3 "Did the action change your study in Physics?". Most of the students felt a little change and not a few students felt change for the laws and the principle in physics. Especially in 2014 the ones increased.

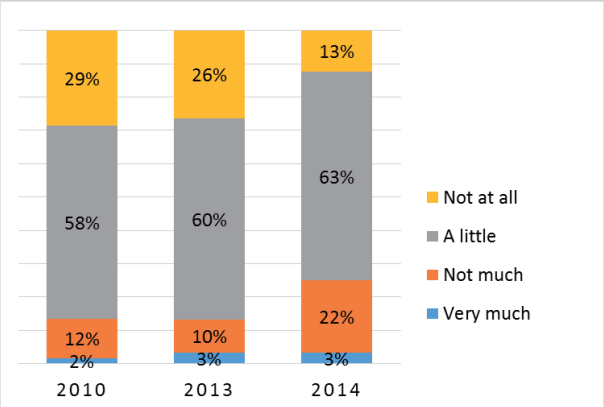


Figure 12, Q3. Did the action change your study in Physics?

Figure 13 shows the result of Q4 "Do you think that the action is effective for study in Physics?". The percentage of the students that think the action effective was increasing year by year and in 2014 it was higher than 70%. The students felt effectivity but couldn't change their study in Physics.

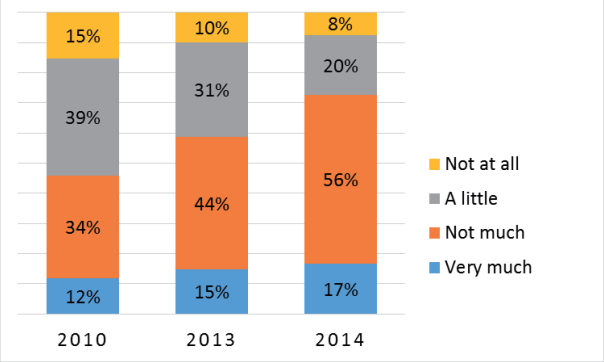


Figure 13, Q4. Do you think that the action is effective for study in Physics?

Figure 14 shows the result of Q5 "What is source of the Handicraft?". As everyone can see, most of them looked into Handicraft on Web. Comparing 2010 with 2013, the students looking into it by textbook and book decreased.

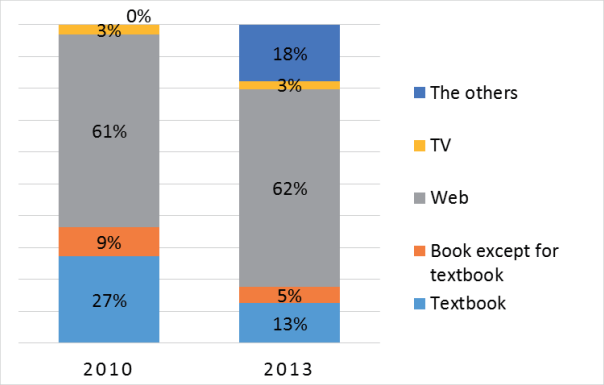


Figure 14, Q5. What is source of the Handicraft?

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In these questionnaires, though the student subjects of the survey are replaced every year, in 2014 the students that felt the change of study and effectiveness of the action increased. In 2014 presentations about their handicraft were held and the students evaluated the others handicraft each other for the first time. The presentations and the mutual evaluations are one of the reasons for increase of students that felt the change of study and effectiveness of the action.

Conclusions

For five years many interesting Physics Handicraft were submitted. In the result of student's questionnaire, distinct opinions about Physics Handicrafts don't appear and its effect is indistinct. However, some students enjoyed Physics Handicrafts and understood physics more deeply. Further a few students joined the activities making handicrafts in workshops for children. Though this action has a little effect for all students, it is better action that adopted group work, active learning and presentation. Hereafter the author will continue its action, as characteristic one in KOSEN.

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TRIAL FOR ACTIVE LEARNING OF INDUSTRIAL ENGLISH CLASS IN NIT SUZUKA COLLEGE USING BLACKBOARD

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Abstract

Recently, the requirement and need for active learning and student-centered classes have been intensified, since the outcome and the improvement of classes quality are very important in popularized higher education system all over the world. From the background, we focused on an industrial English class in Dept. Materials Science and Engineering in this study. The class was originally composed of 40 something students in the Dept. Materials Science and Engineering. However, the number decreased to several ones drastically, after they had the first lesson. Even the reason might be attributed to that the class was elective to some extent, the main one should have been considered that it was pretty inactive, bored and passive. Their original dislike for English might have reinforced the tendency. Then we decided to introduce active learning style where students could tackle with the problems. Then a powerful learning management system (LMS), Blackboard, was introduced to Kosen colleges (NIT). Therefore, we utilized it for the elective class. Teachers uploaded problems or files for each lesson at the bulletin board of LMS in advance. Students could solve them while they were staying at home or somewhere out of class. Even if they could not learn it at home, they could make progress for their reports and answers. Such a flexible manner could help them to continue their motivation. Their reports were evaluated by a simple and tentative Rubric. However, it was still fundamental and should be improved further in the future. Holistically, their learning style could be activated. Even though this was just an overall impression at this point, their whole attendance supported our impression. After all of the lessons, we gave students questionnaires and tried to evaluate the outcomes quantitatively.

Keywords: Active learning, learning management system, LMS, industrial engineering, Rubric

Introduction

The importance of English learning is becoming important more and more in the world. Our Kosen[(1)] has the mission to produce lots of industrial engineers for the future. Since the future engineers would be expected to be very active in the world, they should have opportunities to learn English as much as possible. And at the same time, they should learn English from the viewpoint of industrial engineering. From the background, we faculties in the departments of materials science and engineering have set the class for industrial English in these many years. However, we have had the problem that students learning activities have been not so positive and that the outcomes have been problematic. One of the authors (Kanematsu) took the charge of the class 2014. As well as his past experiences in the class, students activity did not satisfied him. However, he realized that the number of refusers for the English class reached the maximum this time. Concretely speaking, the situation could be described as follows.

The class was originally composed of 40 something students in the Dept. Materials Science and Engineering. However, the number decreased to several ones drastically, after they had the first lesson. Many reasons could be mentioned. However the main one should have been considered that it was pretty inactive, bored and passive. Their original dislike for English might have reinforced the tendency. Then we decided to introduce active learning style[(4)] where students could tackle with the problems. As an educational tool, Blackboard[(2),(3)], one of the learning management system, was introduced. The LMS was introduced formally by Kosen recently. In this educationa traial and experiment, we carried out the industrial English class with Blackboard, discussed/evaluated the results.

Materials and Methods or pedagogy

We decided to use a text book like the usual class. The text book was not oriented specially to industrial English class, but an usual and practical one. In the text book, students could concretely learn practical examples

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of English sentences students might encounter in engineering or industrial world with the high probabilities. The academic level was pretty fundamental. Students had to prepare the textbook for each in advance. As already described, the text book would have been originally used for usual fact-to-face "inactive" learning. However, it was also kept as text book after changing the classroom type.

Problems were provided to students in advance. One week before the next time, just after the previous lessons, they appeared on the LMS. Students had to prepare the answers for proposed questions. Then they particpated to each lesson in the real classrooms. They struggled with solving problems in the classroom. In a meaning, we could say it would be a sort of flipped classrooms. Students attendance rate were almost 100%. It means they almost join the classroom activities.

They uploaded their answers to the LMS each time and the answers were evaluated online. Rubric systems attached to the blackboard was introduced. However, it was restricted to a trial usage this time. Students could not see their evaluation by teachers immediately and they could know their judges a couple of weeks later.

After all of their classes ended, a questionnaire composed of some questions were required for students to answer. And the results were discussed at the end of the term.

Results and Discussion

Students were forced to join the classroom online in the class and also outside classroom, when they tackled with the course, Industrial Engineering. First of all they had to selected the course from many ones the teacher provided. (Fig.1)

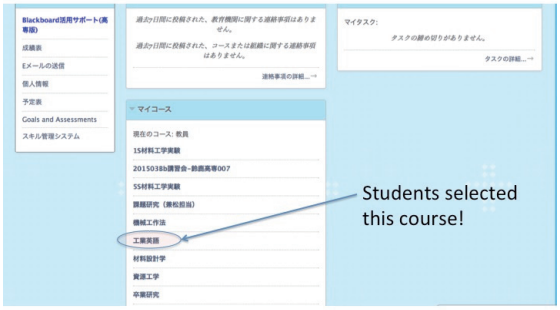


Fig.1 The display appearance when students entered first of all.

Then the students entered the next screen as shown in Fig.2. They clicked the discussion menu to see the question view. In the discussion section, students could see the problems for each session and wrote down their answers.



Fig2. Students should have clicked "discussion" to questions and answers.

After they uploaded, teachers judged their answers online. One of the question view is shown in Fig.3. Usually, each session was composed of several questions.



Fig.3 A question view.

And the trial Rubic function was shown in Fig.4.

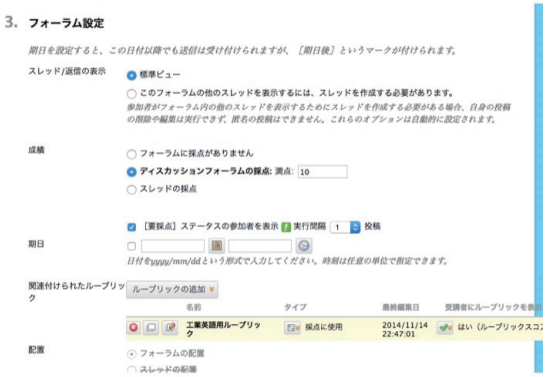


Fig.4 A rubric view.

Teacher could reach the rubric view and edition function through the edition function of discussion menu. The results were shown not only to teachers, but

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also to students participating the class. As already described, they should have been in that way. However, the usage of the function did not work this time, since the evaluation was delayed several weeks this time.

In this educational experiment, the rubric was composed of the following matrix (Fig.5)



2. ルーブリックの詳細

ルーブリックグリッドは、［成績のレベル］（列）を測定するための［基準］（行）をリスト表示します。
このルーブリックは採点に使用されたことがあるため、変更できません。

	成績のレベル			
基準	S: Super（期待する思考活動以上に、何かプラスαが見られる。）	A: 十分満足できる（期待する思考活動が十分見られる）	B:概ね満足できる（期待する思考活動は見られるが、未到達な部分もある）	C:努力を要する（期待する思考活動が見られない。）
的確に問題点を把握しているか？ 加重 33.00%	100 %	80 %	70 %	50 %
よく考えられているか？ 加重 34.00%	100 %	80 %	70 %	50 %
正しく回答しているか？ 加重 33.00%	100 %	80 %	70 %	50 %

Fig.5 Rubric used in this experiment.

The standard was composed of three points as follows.
#1: Did students understand the problem (33%).
#2: Did they think over the problem and prepared to answer?
#3: Their answers were appropriate and correct?

On the other hand, grading (academic levels or outcomes evaluation) was carried out according to the following points.
S (Super): There are some great performances beyond expected thinking activities.
A: Satisfied fully.
B: Satisfied pretty well.
C: More efforts should be done.

According to the rubric, grading was carried out. However, the result could not be evaluated properly. That would be the future mission for us.

After the final class at the end of the term, a questionnaire was given to the students online. They were as follows.
Q1. Your motivation was enhanced by the usage of blackboard.

(a) Very much (b) Pretty much (c) neutral (d) not so much (e) not at all

Q2: The class with PC was more fun.
(a) Very much (b) Pretty much (c) neutral (d) not so much (e) not at all

Q3: Was your teacher friendly?
(a) Very much (b) Pretty much (c) neutral (d) not so much (e) not at all

Q4: The class with the usage of blackboard prolonged my preparation time.

a) Very much (b) Pretty much (c) neutral (d) not so much (e) not at all

Q5: The class with the usage of blackboard made me concentrate in the classroom.
a) Very much (b) Pretty much (c) neutral (d) not so much (e) not at all

Q6: The classroom with the usage of blackboard prolonged my review time.
a) Very much (b) Pretty much (c) neutral (d) not so much (e) not at all

Q7: I feel such a type of class should increase in the future.
a) Very much (b) Pretty much (c) neutral (d) not so much (e) not at all

Q8: My interest about English became stronger.
a) Very much (b) Pretty much (c) neutral (d) not so much (e) not at all

Q9: Please mention the merits for such a type of class.

Q10: Please mention the demerits for such a type of class.

Q11: Please indicate the area of improvement.

Q12: Please give us your feedback, if any.

The remarkable accordance could be observed at questionnaire 3. It indicates all of the students felt their teacher very friendly. It suggests that they enjoyed the class very much. However, the analyses for their answers should be discussed more in detail, since their answers were pretty complicate.
The positive answers were observed at Questionnaire 2, 5, and 7. It means that they enjoyed the class with higher concentration and also that they wished such a type of class in the future. The result for questionnaire 8 indicates all of the students showed pretty positive feeling. It suggests that some of the students had the interest for English itself through the class. The rate of positive students for the question was 40%. That was not so bad news for teachers.

On the other hand, the results of questionnaires 1, 4 and 6 were scattered. The results suggest that students were not confident with the outcomes of the class. As for the education and academic outcomes, the results should be analyzed in different ways.

As for the free feedback, they gave us many kinds of useful suggestions and tips, fortunately.
According to their feedback, all of the students agreed that they could tackle with the class very freely and more concentration. However, the time required to solve the problems differed from student to student. many students insisted that the number of the problems should be increased more. A students felt that this type

of class would be appropriate for small groups. However, the student presumed that the class would not be so good for large groups. And other student felt that the group work should be introduced for such a class.
Any feedbacks were appreciated and they will be the references for the improvement for the future.

Conclusions

We carried out an active learning by introducing Blackboard as learning management system for industrial English in the department of Materials Science and Engineering of NIT, Suzuka College.
The results showed that the active learning made the students active and concentrate. However, the outcomes and its precise evaluation should be our future topic.

Acknowledgements

We express deep gratitude our college President, Prof. Nitta for his continuing support and understanding. We also thank the students participating to our educational trial with their challenging spirits.

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https://en.wikipedia.org/wiki/Blackboard_Learn
(4) Active learning:
https://en.wikipedia.org/wiki/Active_learning

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USE OF 3D SIMULATION OF PICK-AND-PLACE ROBOTIC ARM FOR TEACHING CONTROLLER DESIGN

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Abstract

This study explores the use of the 3D simulation courseware to teach controller design to third year students of the diploma in electrical engineering students. Students struggle with the theoretical subject content and are unable to translate the output waveforms into physical outcomes.

The use of 3D simulation of a pick-and-place robotic arm in a printed circuit board (PCB) assembly line will enable students to visualize the link between the design parameters and system performance in a real-life application. Students have to design a controller based on requirements given to them. The simulated robotic arm moves according to the given inputs. The output waveform is drawn in sync with the real-time movement of the robotic arm so as to allow students to make the association between the control parameters and system performance. The courseware also compels the students to take on the role of assessors to compare the system's performance with the design specifications and decide how to tweak their design to better it.

Students will be involved in the design-visualize-evaluate-improve cycle and this enables them the engage in higher-order thinking.
Students will then extrapolate their design to a real hardware setup in the laboratory to view the differences in the system performance in a real practical world due to non-linear hardware effects such as hysteresis and lag. This structured form of pedagogical guidance ensures that students are not overwhelmed and at the same time reinforces the concepts in a systematic manner.

Keywords : *3D simulation, controller design, Applied Learning, higher-order thinking*.

Introduction

A polytechnic education seeks to train students with relevant and specific skills for the workplace. Due to the general downward trend in interest in engineering education, students enrolled in our Electrical Engineering course are not enthused about the nature of the course and lack the strong mathematical foundation that is required of them. Control and Automation module is a third year core module taken by students in the Electrical Engineering Diploma course at Ngee Ann Polytechnic. Students are introduced to the characteristics of first and second order control systems and are required to analyse the systems in time and frequency domain. They need to understand the natures of proportional, integral, derivative (PID) controllers and phase compensators. By garnering the abovementioned knowledge, the students will eventually be able to design controllers as per the system requirements. Design is a key higher order skill that would be expected of a third year student as well as in degree-awarding tertiary education institutes. Design procedure comprises of understanding the design requirements, making valid assumptions and calculating design parameters using the appropriate mathematical techniques.

Challenges faced by Students

Currently the students learn the theory of Control and Automation module during lecture sessions and they have tutorial sessions to discuss about the theory learn in lecture and solve problems based on the theory. The laboratory sessions have simulation software and hardware set-ups to let students experiment and cement the knowledge learnt in lecture. Many students find this module on Controller Design very challenging due to its emphasis on mathematical steps. As students do not have strong grasp of the mathematical knowledge learnt in their secondary school and general feel of numbers, they grapple with understanding of the design procedure. During a focus group discussion with students who have completed the module, it had come to light that some of the students who scored well for this module

did not have a good grasp of the knowledge. This sharing by the students led to some concerns about the transfer of learning as "Being able to reproduce knowledge in a de-contextualized examination does not guarantee that knowledge can be used in a real-life setting" (Bloxham, S., & Boyd, P. (2007) [1]. In other words, the students were just exam-smart and the results were not a good indication of their real understanding of this module. This is an example of the "negative backwash" [2]. Even the academically better students resort to strategies that will guarantee higher grades in the examinations rather than understanding the module content which is the result of "surface learning"[2]. As a result, when the question is varied (albeit slightly), they get easily confused and are not able to answer it. They get frustrated and feel that they are being tested on something that has not been taught. Moreover, theoretical subject content and lack of simple real life applications make it difficult for the students to get engaged in subject matter.

Another challenge for students is that they are unable to visualize and make sense of what they have learnt and are unable to apply the design technique learnt from the content topic to another. Referring to Solo Taxonomy by Biggs [4], students know and are able to remember the design steps, at the multi-structural stage. This level of learning will not be enough for graduating students. Without understanding the underlying principle behind the mathematical calculations, the design process boils down mere execution of a series of steps without thinking. They have to move to the next level of the Solo Taxonomy, i.e relational where they will form relationships between the design steps and actual execution of the control system. They will better appreciate the relationship between the control parameters, output waveforms and physical outcomes of the system. Appreciation is the foundation upon which higher-order cognitive skills such as analysis and design are built.

While there are the physical hardware sets made available to the students to practise what they have learnt in class during the laboratory sessions, direct relationship between the control parameters and system performance and the output waveforms and physical outcomes might not be obvious in a hardware setup as the response would be cluttered with effects due to hysteresis or inherent lag/delay in any of the hardware components. So in such a case, students get overwhelmed with the numerous variables that could alter the system performance during their practical sessions which can result in more confusion.

Courseware: Interactive 3D simulation for enhanced learning & understanding

A 3D simulation courseware was proposed to aid the students in the visualization of the control design parameters to the physical outcomes. This courseware will also allow students to make changes to design parameters and for them to see how the changes they make would affect the system performance. By allowing students to see the impact of the changes in parameters, they are able to explore and make suitable changes.

The courseware is designed with deeper learning in mind as depicted by the Bloom's taxonomy pyramid shown in Figure 1.

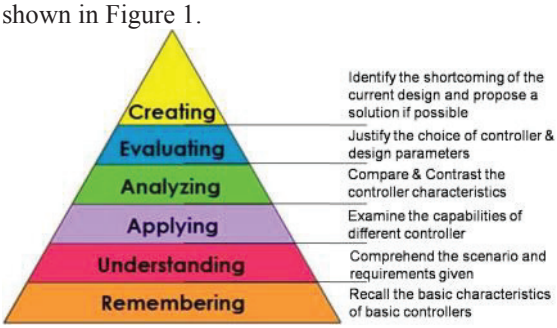


Figure 1

The students will acquire different levels of knowledge during their experience with the courseware. As a result, the students develop higher-order thinking skills by engaging in the design-visualize-evaluate-improve cycle to further reinforce theoretical concepts.

Authentic learning experiences

One of the ways to help students relate the theory they learnt in class to practice is to show them how this knowledge can be applied in the industry.

As part of the courseware, real life workplace scenarios are designed to provide the authentic context for students. One such scenario would be in the industrial context of a pick and place robot in the printed circuit board PCB assembly line will be given to students. This industrial context will engage the students more actively in the design of the controllers as they will have an actual, active role to play rather than just have another assignment to hand in to the lecturer.

The students are required to design the controller based on the design requirements as shown in Figures 2 and 3. The courseware is equipped with general

tools such as Bode plots and step response to aid students in the analysis and understanding of the given plant. The open-ended nature of the question forces students to explore characteristics of the various controllers, namely, proportional, proportional-integral, proportional-derivative, proportional-integral-derivative, velocity feedback and phase compensator, and be open to the possibility of having more than one type of controller as the solution to the given problem.

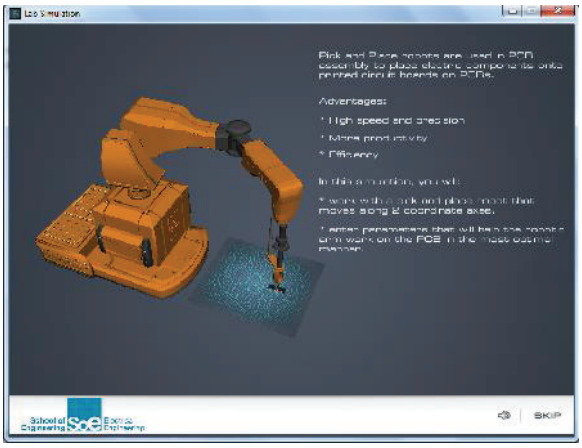


Figure 2

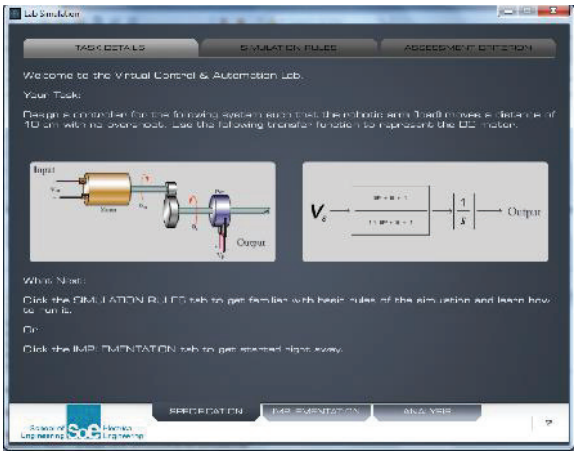


Figure 3

The graphics and the 3D animation will allow the students to view the implication of their design choice on the real-life scenario given to them as shown in Figure 4.

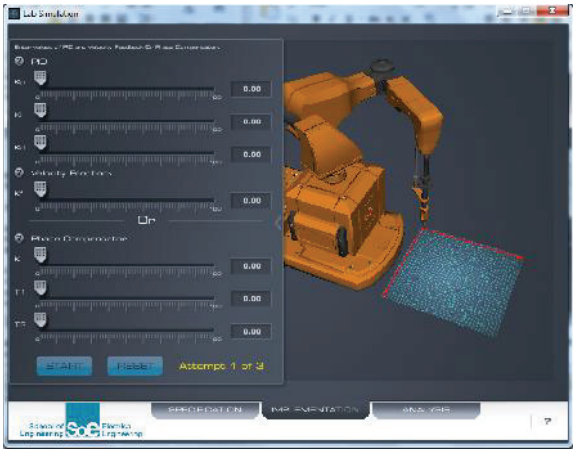


Figure 4

The real-time plotting of the waveforms in sync with the motions of the animated graphics (shown in figure 5) will show the correlation between graphical waveforms and physical outcomes of the system. Students are allowed to revise their design with justification for up to 3 times. This allows students to take on the role of assessors and to make decisions based on their own understanding of what would be the best design for that parameters.[3]"Students themselves need to develop the capacity to make judgements about both their own work and that of others in order to become effective continuing learners and practitioners."

As the students need to provide justification for their decision, students would have to take this practice seriously and not engage in a guessing game to come up with a good design.

The progression to assess one's own design is an intended one so that students are better acquainted with the assessment criteria and gives them the confidence when they come for a discussion in the class and are better able to defend their choice of the controller.

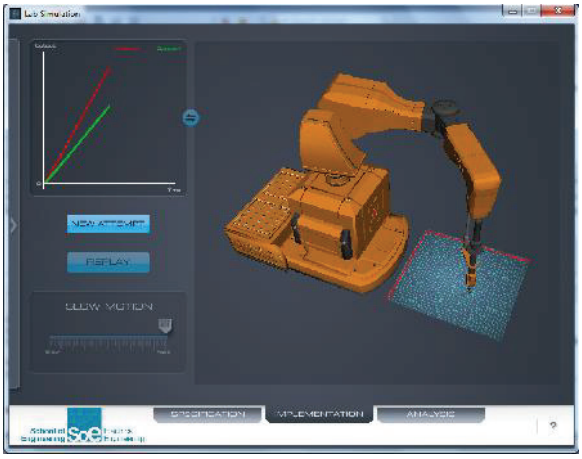
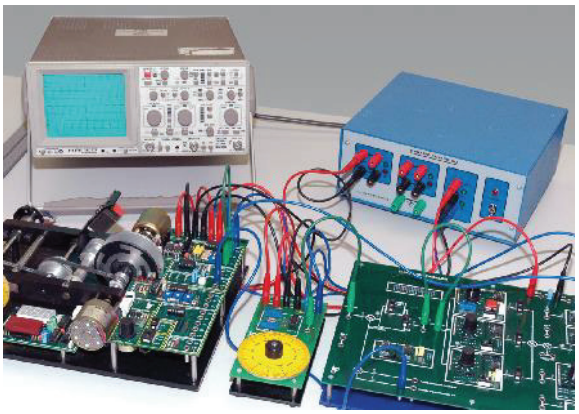


Figure 5

In order to complement the simulation based activity with some real-life elements, the students would then implement their design on a hardware set-up of a servo control motor set as shown in Figure 6. When they implement their design in the hardware setup, they anticipate a certain system performance based on the simulation. However, when the system behaves in a manner that is different, they are compelled to draw reasoning from the concepts learnt about non-linear hardware effects such as hysteresis and lag. This structured form of pedagogical guidance ensures that students are not overwhelmed and at the same time reinforces the concepts in a systematic manner. It is essential that the students are aware of these inherent hardware effects as they will encounter them in the industry.


Figure 6

Results of Beta Implementation

A small sample group of seven students who are currently studying Control and Automation module were asked to use the beta version of the courseware. The students generally commented that the movement of the robotic arm, especially as shown in Figure 5 was "an eye-opener as they can now see what the output graphs mean in physical movement of system". As a result of this, the students can understand the control terms such as stability, overshoot and speed qualitatively rather than just knowing them quantitatively. Another student commented that "easy comparison of the time responses of three attempts under the Analysis tab helps to understand the controllers' effect on the assessment criteria". Member from the teaching team also commented that the courseware would be a value-added addition to our teaching material. There are plans to gauge the understanding of large group of students in the design process by having pre and post-trial quizzes once the full working web version is ready.

Conclusion

By having 3D simulation software, the students are not bound by the time, space and location of the hardware sets available in the lab sessions to enjoy a learning experience via exploration. Simultaneously, a simulation would isolate key design components for learning so that students will not be overwhelmed and confused by factors like delay affecting the performance of a hardware set. Students will also have a feel of personalized learning where they are able to customize the learning process according to their current levels of understanding and set personalized targets to motivate or challenge themselves.

While this courseware is still in the beta testing stage, the positive feedback from the beta test group has given the teaching team confidence that the students' learning experience in this challenging area of controller design would be enhanced using this 3D simulation.

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DEVELOPING AN ONLINE CORPUS AND TEACHING MATERIALS FOR WRITING TECHNICAL PAPERS IN ENGLISH

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Abstract

In order to nourish engineers who can work internationally, what kinds of competences are required? From my experiences in engineering fields, they would be skills to read and write technical papers in English and to present their researches in international conferences. Then, I wonder if our curriculum is enough to let our students acquire such skills. Perhaps, some extra support would be necessary for them. As the first reason for that, our school is a college of technology and cannot provide more English classes than usual high schools. Second, there are differences in vocabulary, expressions and constructions between general English and English for Science and Technology (EST). Even the seventh graders in our school have difficulties writing the abstract section in a technical paper. Furthermore, in ordinary dictionaries, we hardly find example sentences for scientific verbs such as "converge" and "quantify." For technical writing, we need to learn the differences mentioned above and to get used to many expressions in science. In particular, beginners should write English sentences by replacing some parts in them with words they want to use. In this study, we attempt to develop an online system to support beginners' technical writing based on an EST corpus. Users of our system can find example sentences by choosing verbs in Japanese. This means that Japanese translation must be added to each of the example sentences. We are currently collecting more English sentences from scientific journals and translating them into Japanese. In the translation process, we have introduced the methodology called "Semantic Order Filing System (SOFS)." The SOFS classifies words/phrases in a sentence into seven categories called "Semantic Order Folder." For example, the first and second folders correspond to the subject and predicate verb of a sentence. That is, each folder represents a semantic function. The SOFS would help beginners understand the word order specific for English sentences.

Keywords: *technical writing, corpus, English for science and technology, semantic order filing system, college of technology*

Introduction

Recent years Japanese students at colleges of technology have had more opportunities to make a presentation in international conferences. This means that they are required to write an English abstract in 2-3 pages. However, it is truly a troublesome job for teachers to correct their abstracts. English sentences they write often do not have any subject. For example, if they translate a Japanese sentence "測定システムを図 *X* に示す。", their English translation may be "Show the measurement system in Fig. *X*." A correct translation is "Figure *X* shows the measurement system." The error may be the influence of their mother tongue. In Japanese language, subjects tend to be omitted in the case where they are obvious. Not only native English teachers but also Japanese teachers have difficulties in correcting their erroneous sentences. In this work, we attempt to develop a corpus-based support system for technical English writing, which makes it easier for native English teachers to correct English sentences Japanese students wrote.

Materials and Methods

The most important thing to construct a corpus-based system is to collect quality English sentences. For this purpose, we made use of a corpus of English for Science and Technology, the PERC Corpus (PERC, 2008). We can access the Web site for free. All the sentences in the PERC Corpus were collected from academic journals in 22 scientific fields. Because our system targets students at colleges of technology, we selected as a sub-corpus six fields: civil engineering, computer science, construction and building technology,

Table 1 An Example of Japanese Translation Given in Our Corpus-based System

Semantic function	who	does/is	whom/what	where	when	how	why
English sentence	We	propose	a new method	in this paper.	—	—	—
Japanese translation	我々は	提案する	新しい手法	本論文で	—	—	—

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electrical and electronic engineering, engineering and telecommunications. The English sentences we obtained are used for the purpose of academic research only.

The process of collecting English sentences consists of three steps. First, we extracted 105 Japanese verbs from Japanese abstracts, which the seventh graders in our school had written for their dissertation. Second, we translated the Japanese verbs into English ones. After that, other teachers in our school examined both the Japanese and English verbs, and added more verbs that were considered indispensable for writing technical papers. As a result, we obtained 200 English verbs with no duplication. These verbs are used as base form in collecting English sentences by the POS search in the PERC Corpus, which enables us to specify the "part of speech" of a searched word.

Our corpus-based system allows the users to search English sentences by choosing Japanese verbs. Also, they can see Japanese translation attached to English sentences obtained. In other words, our system is a parallel corpus between Japanese and English.

However, the Japanese translation is shown in a different manner from ordinary Japanese sentences. It is actually shown in a semantic order. Table 1 (see the previous page) shows an example of Japanese translation given in our system. Tajino (2011) named such a way to show an English sentence and its Japanese translation "Semantic Order Filing System (SOFS)." The SOFS would implicitly make the users aware of the word order specific for English sentences. In Japan, most of English teachers teach their students the constructions of English sentences by means of five elements: subject (S), verb (V), object (O), complement (C) and modifier (M). But this way of teaching seems not to be effective for those who are really poor at English. Therefore, we have introduced the SOFS as an alternative way.

We intend the system to be used online. Thus, it has been programmed with "Ruby on Rails." The programming language, Ruby is an object-oriented language developed by Yukihiro Matsumoto and is suitable for making Web applications. Figure 1 shows a snapshot of our system. It was named "the Corpus-based support System for Technical Writing (C-STEW)."

The users first choose a Japanese verb from the upper pull-down menu. Next, they choose an agent for the verb in the lower pull-down menu. After a pair of verb and agent was chosen, an English sentence including those words is shown in the field below. Predicate verb is in red both in English and Japanese sentences. The future version of the system will show a section tag indicating which section of an article the sentence appeared in. Furthermore, a supplementary explanation on the verb usage might be added to each sentence. Note that a series of procedures shows only one English sentence. This is not preferable for learning how to write technical English. Therefore, if the users do not choose any agent, they can see all the sentences with the verb they chose.

Results and Discussion

We tried to use the system by ourselves and it works well as a prototype of support system for technical writing. But we have found two problems. One is that there are too many verbs and agents in each pull-down menu. In the present version, each verb has only five example sentences. However, as the number of sentences increases, it becomes more difficult to find the usage of a verb which the users want to know. The other is that one Japanese verb does not always

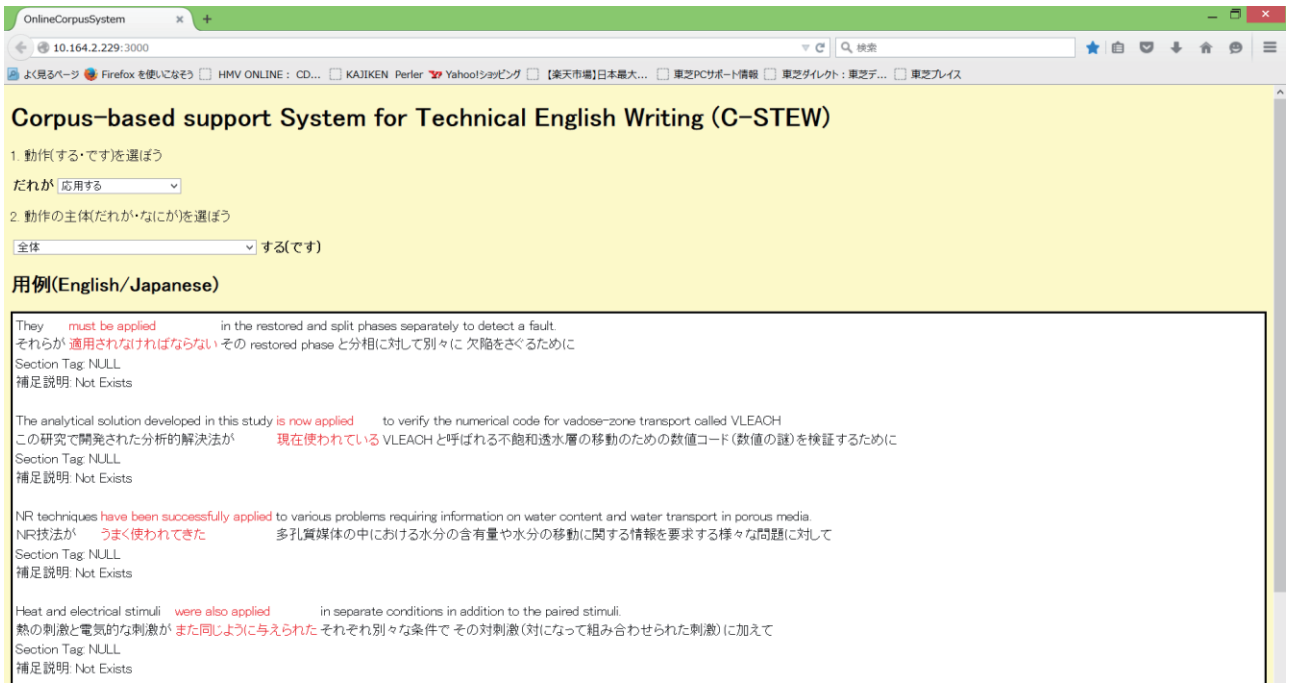


Fig. 1 A snapshot of our corpus-based system.

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correspond to one English verb. That is, the relationship between Japanese and English verbs is not one-to-one correspondence. In order to solve the two problems, some method for grouping the verbs and agents would be required.

As a first step for grouping, we attempted to analyze the collocational relationship between words in the Japanese verbs and agents. For this analysis, we employed free software for text mining, "KH Coder" (Higuchi, 2014). This is because the software includes a morphological analyzer for Japanese language, "ChaSen," which was developed by Nara Institute of Science and Technology. In addition, KH Coder provides us with a large variety of statistical tools. Co-occurrence network is one of such tools and enables us to know which word pair frequently occurs in the same sentence.

Figure 2 shows a co-occurrence network of words in the verbs and agents. Each node represents a word and an edge is drawn between two words if they co-occur frequently. We evaluated the co-occurrence frequency by Jaccard coefficient. This is defined as follows:

$$J(A,B)=\frac{P(A\cap B)}{P(A\cup B)}, \tag{1}$$

where $P(A\cap B)$ is the co-occurrence probability of words A and B in the same sentence. $P(A\cup B)$ is the occurrence probability of word A or B. The value of the coefficient ranges from 0 to 1. As the value increases, the intensity of co-occurrence becomes larger. Actually, the thickness of each edge corresponds to this intensity. For all the edges in Fig. 2, Jaccard coefficient is greater than 0.2.

The color of each node represents the betweenness centrality. The degree of the centrality is determined by whether a node is located in the shortest path between two nodes except that node. Pink color indicates the highest centrality. White and aqua follow the pink in this order.

In the upper right of Fig. 2, we can see a bright pink node surrounded by eight nodes. The node corresponds to a Japanese verb, 行う (conduct). In Japanese language, this verb is often combined with a noun implying some behavior. For instance, four nodes around the pink one show 分解 (decomposition), 実験 (experiment), 測定 (measurement) and 抽出 (extraction), respectively and they mean actions taken in a laboratory.

A hub node like 行う (conduct) seems to give a key for grouping the verbs and the agents in each pull-down menu. Namely, the users first choose an action from categories such as (a) do it inside a laboratory and (b) do it outside a laboratory. Then, they choose an agent of

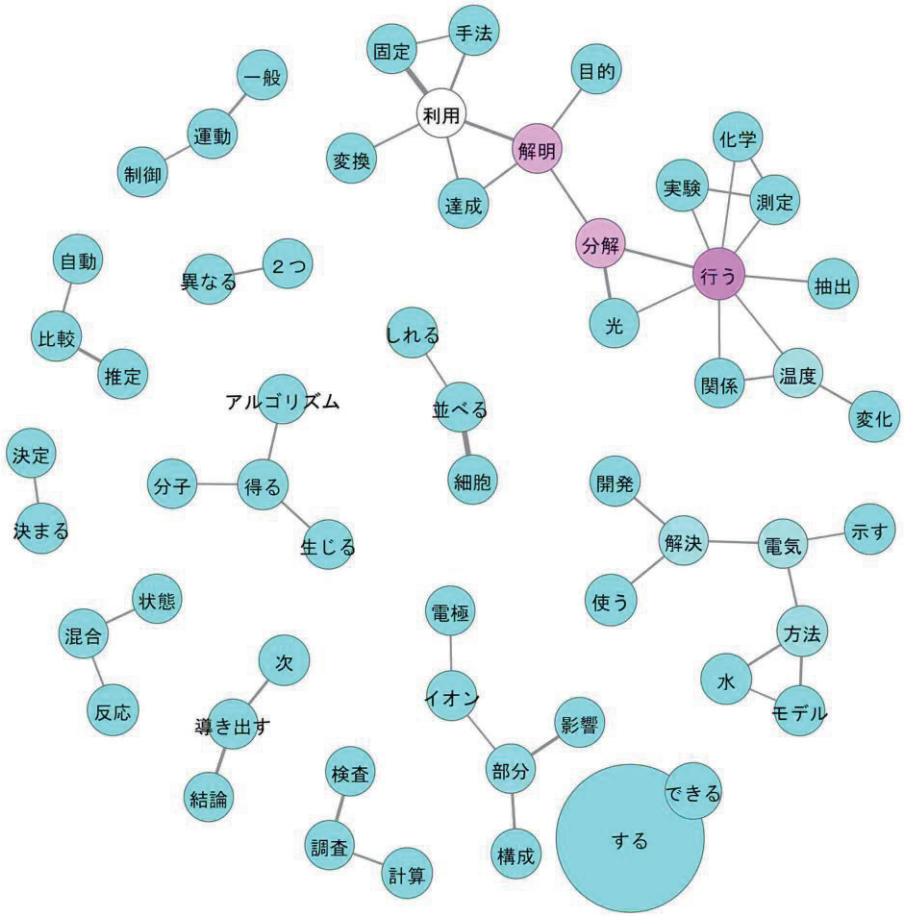


Fig. 2 A co-occurrence network of words in the Japanese verbs and agents.

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the action from categories such as (c) human and (d) machine. However, there is a problem in making such categories. We cannot know which part of speech, verb or noun, each word in the network is attributed to. For example, 測定(measurement) is definitely a noun but this could be separated from a verb, 測定する(measure) by the Japanese morphological analyzer. In other words, lots of Japanese nouns can be verbified by being followed by a verb, する(do).

Considering the above findings, co-occurrence network should be analyzed for English words, not Japanese words. Then, we should try to categorize the words and give each category a title in Japanese. This would make it easier for the users to choose a pair of verb and agent suitable for what they want to express.

Conclusions

We have developed a prototype of support system for technical English writing. Throughout the development, it was clarified that categorizing the verbs and the agents of example sentences was necessary and this could be attained by analyzing the co-occurrence network of English words in our corpus. At the same time, we need to translate more English sentences into Japanese using the SOFS. Furthermore, we are going to have the sixth graders use our corpus-based system to write the summary of their research plans in English.

Acknowledgements

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Development of Visualization of Learning Outcomes with Competence

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Abstract

The National Institute of Technology, Anan College (NIT, Anan College) was inaugurated in 2014, after the Ministry of Education University reform promotion subsidies （University reform promotion project）had begun. Many Institutions of Higher Education in this country applied for this project, and after harsh evaluation, the effort of the NIT, Anan College was highly evaluated. Especially, in Theme Ⅱ(Visualization of Learning Outcome), NIT, Anan College was the unique College of Technology designated. This shows that the plan based on FD activities in our college was continuous enough to win the admiration. By improving the management of teaching and learning which focuses on opportunities for student learning, we attempt to visualize the Learning Outcome and provide an environment in which students can be taught thoroughly and autonomously. That provides an environment where students can study unsupervised with thoroughness, and build a system that students mature comprehensively as a human beings. 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 capacity for the Career Design.

In concrete terms, by using cloud-based LMS and with faculty cooperation, our college will achieve educational improvement. Four programs will be the core of the approach: (1) Ensure the learning time by accumulating the Learning Portfolio. (2) Evaluate competence. (3) Implement Student Surveys to know the actual learning situation. (4) Make an Academic Portfolio leading to improving education and developing skills of teachers.

In this paper, we describe observations about the achievements and the results addressed up to now, and report the future plan of competence development within the visualization of learning outcomes. As a result, we especially report the result of company survey regarding required competence.

Keywords: *Outcomes, Competence, Portfolio, Learning management system, Institutional research*

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 basic the 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 Ⅱ which is aimed at visualizing learning outcomes and is characterised by focusing on competence. So we could gain insight into educational improvement system based on the activities proven worth.

Background

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 half years. More than 80% of NIT, Anan College faculty members created portfolios.

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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 accumulate the survey targeted at first grade students, student survey and graduation survey which were newly-introduced, and share the importance and the method of using IR in the professional development workshop for faculty which almost all faculties 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 are shown in Figure 1.

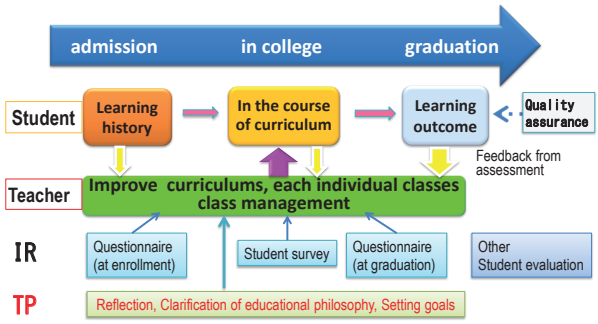


Figure 1 Quality assurance and teaching improvement using IR and TP at NIT, Anan College.

Program of visualization of learning outcomes

The overview of AP program at NIT, Anan College is shown in Figure 2. Our aim is to prepare educational circumstances that the students can actively 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

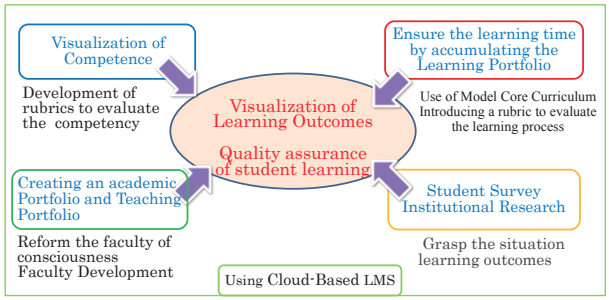


Figure 2 Overview of AP program at NIT, Anan College. There are four important approaches.

have a tie between individuals 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 the student can get through their student life in our college and support their career formation.

On-going activities

Our program started from the second semester in 2014. Office for Excellence in Teaching and Learning is newly-organized to carry out our program. At first, we prepared the LMS as educational infrastructure and carried out a questionnaire survey to understand the trend of competence for all current students using LMS. Actually 97% of current students responded. Homeroom instructor returned the result report sheet to each student at a meeting and the student received the same result of PDF file on LMS. After that students recognized their own competence and they set specific goals for achievement with in the year on learning portfolio on LMS. We expect the students to get a goal reflecting by themselves. Homeroom instructor has a regular meeting to help them to achieve success. Outline using learning portfolio is shown in Figure 3.

We investigate the relationship between the competence and each subject in the academic curriculum. Active learning is getting increasing in the classroom and also developing competence is increasing in the classroom. Then the competence should be embedded in an academic program. We recognize that co-curricular activities facilitate the development of various competency and want to evaluate the competence to experience through co-curricular. In order to evaluate the competence, we are discussing adapting the rubric reputation.

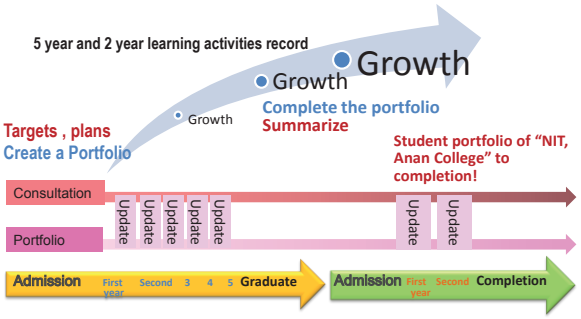


Figure 3 Outline using learning portfolio.

Results and Discussion

Here, we report the results of the company survey. We carried out a questionnaire survey to identify the most in demand competence by the company. The survey periods are two weeks in July, 2015. The target is the companies that have hired our students, have attended a job matching fair in Anan College to recruit on campus and have visited our campus to see a person

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in charge as recruiting activity. We issued a questionnaire on our website for 235 target companies and 145 companies responded.

There are three questionnaires. The first is to lank six out of twelve skills in order of most desired. The second is to ask questions regarding satisfaction with each selected competence in the first question. The third is to rank six out of twelve skills in order of the competency which a person can develop having practical experience in a company after graduating. Here, the twelve skills we used in the survey are as follows: "Communication skills", "Consensus Building", "Information literacy", "Problem-Solving Skills", "Logical Thinking Skills", "Independence", "Self-Managing Skills", "Responsibility Skills", "Teamwork Skills", " Leadership", "Ethical Outlook", "Career Design".

Figure 4 shows the result of the first question. The skills are arranged by order of importance that the company selected. They are shown as follows:
(1) "Communication skills"
(2) "Teamwork Skills"
(3) "Independence"
(4) "Responsibility Skills"
(5) "Problem-Solving Skills"
(6) "Logical Thinking Skills"

From Figure 4, it is clear that the most expected competency is "Communication skills". Approximately 90 % of responders selected "Communication skills".

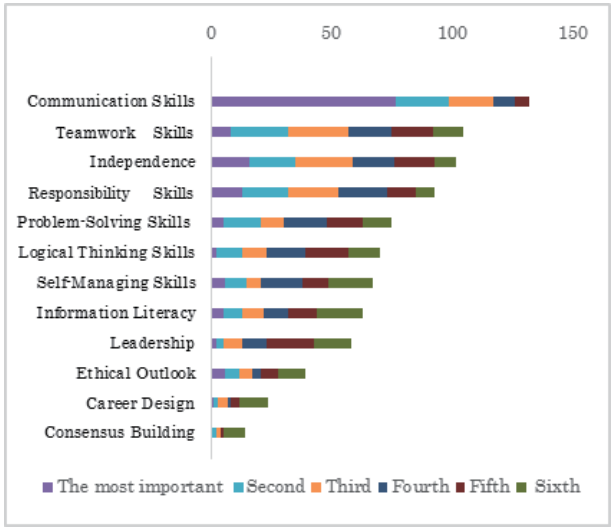


Figure 4 Skills that the company demands.

Figure 5 shows the result of questions regarding satisfaction with the selected six skills in the first question. 77 % of the responders are satisfied with the ability of Kosen students. Here, "Satisfied" indicates the numbers of "strongly agree" and "agree". "Unsatisfied" indicates the numbers of "strongly disagree" and "disagree". Especially, "Responsibility Skills" and "Teamwork Skills" have a high rating in the satisfied group. On the other hand, "Responsibility Skills", "Career Design", "Leadership" have a low rating in the unsatisfied group.

Figure 6 shows the result of the third question. The skills are arranged in a high potential order of competence which a person can develop having practical experience in a company after graduating. They are shown as follows:
(1) "Information literacy"
(2) "Problem-Solving Skills"
(3) "Communication skills"
(4) "Teamwork Skills"
(5) "Logical Thinking Skills"
(6) "Leadership"

From these points of view, the skills which the company requires Kosen students to have before joining a company are "Independence" and "Responsibility Skills". In other words, we might be aware of the importance of developing these skills through the curriculum.

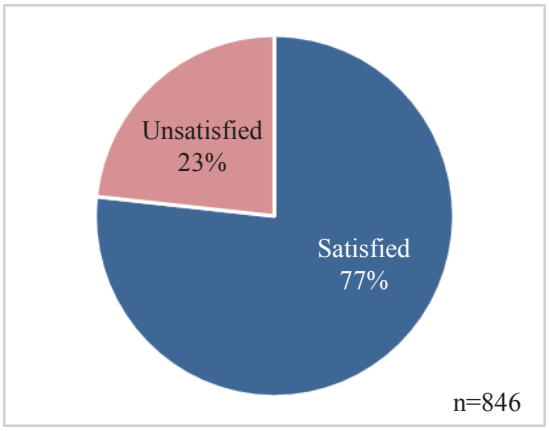


Figure 5 Satisfaction ratios for upper six skills.

Figure 6 shows the result of the third question. The skills are arranged in a high potential order of competence which a person can develop having practical experience in a company after graduating.

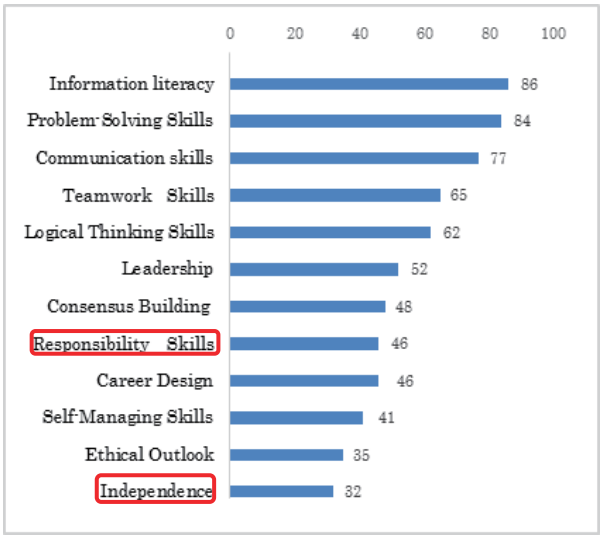


Figure 6 Competence ranking which a person can develop having practical experience in a company after graduating.

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Conclusions

In conclusion, we could specify the six important skills from the company survey so far. Then we try to evaluate the competence in some courses of the academic curriculum for the second semester in 2015. As a future goal, we would like to show the visualization of the competence which the students obtain through both the academic curriculum and co-curricular activities in their college life to utilize getting their desired career.

We will also analyze the relationship between the competence and the academic results.

Acknowledgements

This work was supported by MEXT 2014 Acceleration Program for University Education Rebuilding.

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Development and Practice of a Solar Cells Fabrication Experiment

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Abstract

A new engineering experiment related to the fabrication of organic solar cells was introduced for students in advanced courses of National Institute of Technology, Akita College ('NIT, Akita College'). It has been difficult to choose the experiment theme of the engineering experiment ('Exercise of Creative Engineering') on Environment Systems Engineering Course because of the course was established with the combines and integrates of different department: Department of Applied Chemistry and Department of Civil and Environmental Engineering. In that situation, it was chosen to focus on the organic solar cell for following reasons, the device is familiar for students and is easy to fabricate and evaluate. The students learn about various elemental technology through the introduction experiment for several weeks. Then, students parted into groups of two or three and the group propose to improve the conversion efficiency or to improve an attractive product idea to take advantage of low cost. The students conduct experiments on the basis of the proposal and give a presentation based on knowledge acquired from the experiment in the end of experiment.

Keywords: *Engineering Education, Problem based learning, Enhancement of learning motivation, Presentation skills*

Introduction

As one of the major challenges to be solved in order to achieve sustainable growth, it is necessary to recognize the limits of self-cleaning function of Earth and consumption of the fossil fuel. On that basis, development and introduction of a renewable energy sources which are represented by solar energy is required for the purpose of sustainable growth. We have performed engineering experiments about the dye-sensitized solar cells ('DSSC') which are expected as a clean energy source for the students in advanced course.

In this paper, I describe the engineering education in Environment Systems Engineering Course and then explain how to introduce about fabrication of solar cells. I also report responses from students after doing the experiment.

Experimental subjects of chemistry course

National Institute of Technology, Akita College consists of four departments, Mechanical Engineering, Electrical and Computer Engineering, Applied Chemistry, and Civil and Environmental Engineering. In the Department of Applied Chemistry author belong to, Introduction to Industrial Chemistry, Manufacturing Technology Workshop Practice, Experiments in Analytical Chemistry, Experiments in Organic Chemistry, Experiments in Inorganic Chemistry, Experiments in Biotechnology, Experiments in Physical Chemistry, Experiments in Instrumental Analysis, Experiments in Chemical Engineering are held as experimental subject. Although we provide a technical program which puts emphasis on experimentation and practical training while maintaining a high standard of education, there are no subject corresponding to the design subjects in the regular course. Therefore, engineering designs subject has been introduced from 2017 in order to correspond to the model core curriculum of National Institute of Technology. In addition, Production Systems Engineering Course and the Environment Systems Engineering Course have been installed in Advanced Engineering Faculty. Advanced Experiments and Exercise of Creative Engineering have been performed for the student in advanced Engineering Faculty and Exercise of Creative Engineering has become a subject that corresponds to engineering design education in JABEE (Japan Accreditation Board for Engineering Education).

The contents of the experiment

At the beginning, it was a problem to determine the experiment content that can respect the independence of the student and enhance the creativity. Students who attend the experiments is the first year grade students in advanced course and graduated from Applied Chemistry or Civil and Environmental Engineering. Experiment content was determined to fabrication of electronic devices such as solar cells in consideration of their interest. Seto reports educational effects on the device

fabrication experiment (Seto *et al*., 2014). Furthermore, it was decided to learn about various elemental technology through the introduction experiment for several weeks to make up for the differences in abilities of the experiment.

Flow of exercises

At first, students performed basic experiments for each elemental technology for the purpose of better understanding of the chemical reaction process, analysis, and evaluation methods. Specific contents are as follows: Preparation of TiO_2 film and evaluating performance of the film as photo catalyst, fabrication of solar cells and impact assessment of sensitizing dye using in the solar cells, fabrication of 2-cell solar cell and performance evaluation. A schematic device structure is shown in Fig.1 and a picture of DSSC is shown in Fig.2. Then, student performs the research proposal for the problem to be solved, differentiating itself from basic solar cells, improving the power generation efficiency of the dye-sensitized solar cell. Students submit an experiment proposal. And then, based on the experiment proposal, students evaluate and discuss with creating the original solar cells. Proposed issue of students is like the following: to optimize the film shape of the titanium oxide and to clarify the influence of the surface area, to promote the effective use of light by consider the dye. Some contents of the proposal were also taken up as a research theme of the graduation research (Kosaka and Nishino, 2009, Ishiyama and Nishino, 2008).

Students will conduct a presentation on the obtained results and knowledge. In addition, after the presentation, we conduct a power generation efficiency contest. Students create open cells using their technique, compete the average value of the conversion efficiency.

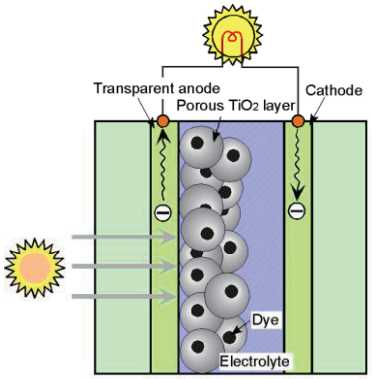


Figure 1. A schematic device structure of DSC.

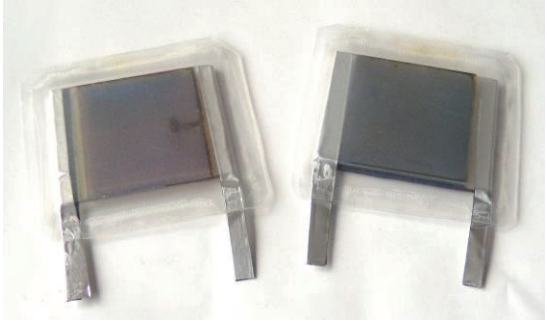


Figure 2. A picture of closed solar cells fabricated by students.

Evaluation

Evaluation of this experiment is carried out as well as other experiment in the following. “Conception ability · program design · realization” is 30 points, “Tackling situation” is 20 points, “Report” is 50 points. In particular, “Conception ability · program design · realization” consists of the following items, students can propose a creative idea, students can apply plural knowledge to experiments, design or solution in consideration of the constraints and the problems was obtained. “Tackling situation” consists of the following items, communication skills and/or teamwork, activeness and ability to execute premeditatedly. “Report” consists of the following items, Students can discuss the improvement and development of the problems to solve, the impact on the natural and social. Students can explain in an easy-to-understand manner about the results of design, conception, solution using the figure, table, and sentences.

Most students were surprised to find that it was easier to fabricate a solar cells than they had thought and students feel happy to look at the running motor by applying light to the solar cells.

Conclusions

A new engineering experiment related to the fabrication of organic solar cells was reported. While students with different background of knowledge and technology has attended, we have taught first element technology of the experiment. In addition, we have made the group consist of student who graduate from applied chemistry and civil and environmental engineering. Then, student propose an experiment proposal and conduct a presentation on the obtained results and knowledge.

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EDUCATING A 21ST CENTURY WORKFORCE: TEACHING EMPLOYABILITY SKILLS TO ENGINEERING STUDENTS

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Abstract

"The driving force behind the 21st Century economy is knowledge, and developing human capital is the best way to ensure prosperity" (National Governors Association, 2001).

Today's 21st century knowledge-based economy has created unprecedented challenges for employers and workers alike. This means that it is no longer sufficient for a new graduate to simply have theoretical knowledge, but it is also increasingly important that they are equipped with a broad range of skills, expertise and competencies that will enhance their employability prospects. The question is what are these skills and competencies that are required in order to produce employable graduates?

Drawing on the latest research in the field of teaching employability skills and recommendations by the Singapore ASPIRE committee, the presenter together with her subject team has responded to these questions by revising the curriculum of the subject, Career Communication, offered to third-year School of Engineering students so as to prepare and empower them to thrive in the economy of the future. A needs analysis was carried out with graduating students using a survey and interviews. The purpose was to examine the gap in the subject curriculum in preparing them for the workforce and to determine which employability skills and competency knowledge are needed to incorporate into the revised curriculum. Employability skills were defined as "skills required to not only gain employment, but also to create value and effectively contribute to organizational needs". The eight identified employability skills are „communication skills", „interpersonal and teamwork skills", „problem-solving skills", „technology skills", „future-orientation", „transnational mindset" and „self-management skills". The presenter will discuss how the team used the results of the research to determine the criteria for selecting the materials and methods to revise the subject's curriculum. She will also give examples of activities and authentic sources for teaching employability skills from a polytechnic's perspective and discuss implications of this revised curriculum for developing a systematic approach in teaching employability skills.

Keywords: engineering, teaching and learning in the 21st century, employability skills, life-long learning

Introduction

As a small country with no natural resources, Singapore depends heavily on her human capital. In fact, she has been described as a modern miracle because her success has been built on only one resource – her people. One of the key enablers to Singapore's success is the government's investment in the education sector. With this in mind, Singapore's Ministry of Education commissioned "The Applied Study in Polytechnics and ITE Review" (ASPIRE) committee to look into further strengthening applied education at polytechnics and Institutes of Technical Education (ITEs). The committee led by Senior Minister of State for Education, Indranee Rajah, made ten recommendations which can be categorised under three broad themes: *1. Better choices:* Helping students make better education and career choices *2. Deeper skills:* Helping polytechnic and ITE students grow the skills they need *3. More pathways:* Building more paths that will allow polytechnic and ITE graduates to progress in their careers ("Aspire committee report: 6 ways to improve polytechnic and ITE education", 2014).

The ASPIRE committee's recommendations aim to create "a strong skills system and industry linkages that support the alignment of the skills individuals have with what the job market needs" (Ministry of Education [MOE], 2014). It also aspires to equip Singapore's polytechnic and ITE graduates to not only be work- ready but world-ready to meet future global challenges.

Singapore's polytechnic and ITE system has been successful in enabling students to develop themselves and realise their potential with nearly nine in ten graduates finding employment within six months of

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graduation (MOE, 2014). However, with a dynamic environment and globalisation, the education system needs to innovate in order to better meet the industry and employers‟ future needs.

In order to identify the skills that are required by the workforce, it would be useful to first define employability. „Employability skills‟ is defined as "those basic skills necessary for getting, keeping, and doing well on a job" (Robinson, 2000). In fact, in March 2005, Singapore‟s Workforce Development Agency (WDA) introduced the Singapore Employability Skills System (ESS). Under ESS, WDA identified ten employability skills which will help workers become more effective at work as the skills are transferable and thus can be applied across different industries. Table 1 shows the employability skills identified by WDA.

Table 1: Ten employability skills identified by WDA

No.	Employability Skills
1	Workplace literacy & numeracy
2	Information & communications technology
3	Problem solving & decision making
4	Initiative & enterprise
5	Communication & relationship management
6	Lifelong learning
7	Global Mindset
8	Self-management
9	Workplace-related life skills
10	Health & workplace safety

The employability skills developed by WDA were designed to equip the workforce with skills that are transferable and enable continuous and lifelong learning. Not only are these skills recognised by the industries and employers, they also form the critical skills in which the workers could further build on to acquire broad based and specific skills in their respective industries (WDA, 2007).

Engineering graduates need a range of employability skills in order to maintain relevance with an ever-changing economy. Nowadays, it is no longer sufficient for a graduate to only have the technical skills to succeed at the workplace but one also need be able to effectively contribute to the organisation‟s needs. Illing (2001) found that employers placed importance on graduates acquiring a diverse set of skills in differing work environments. This was also highlighted by Beder (2000):

"Skills such as problem solving, communications, interpersonal skills and critical and independent thinking should be fostered in engineering education, not just because they are qualities that employers look for but because they should be part of any tertiary education."

The objective of this paper is to examine the current gaps in the curriculum of Career Communication, a subject offered to third-year School of Engineering students in Temasek Polytechnic and to determine which employability skills and knowledge are needed to incorporate into the revised curriculum. The revised curriculum with a proposed model of desired employability skills was then piloted. The aim is to highlight the factors which had an impact on teaching these employability skills to students and in light of the findings, find ways on how to improve teaching and students‟ mastery of these skills. The aims will be addressed using data from a quantitative survey of 476 Engineering students from different diplomas who have completed about four months of internship in external companies. Implications on and recommended practices for polytechnic educators on how to enhance the teaching of employability skills and how to better meet industry needs are then discussed.

Method

470 third year Engineering students were surveyed for this research. The 470 students were randomly selected from more than 1300 students across fourteen different engineering diplomas who had completed about four months of internship in different external companies. No distinction was made regarding the gender or age of the respondents.

The students completed a hard-copy survey of ten MCQ questions (see Appendix, Table 3) and two open-ended questions (see Table 4) which was administered by their subject tutors at the end of the subject tutorial. The survey focused on questions regarding the application and relevance of communication skills subjects they had taken at Temasek Polytechnic prior to their internship. Students were first asked to state whether they were equipped with adequate communication skills in order to be effective communicators prior to starting their internship. To measure the students‟ perceptions on the importance of employability skills in their workplace, students were asked to rate – based on three statements - the use of the defined employability skills. The three statements were as follows:

Table 4: Three statements regarding employability skills in students‟ survey

A.	I observed my colleagues use these skills at the workplace.
B.	I used these skills at the workplace.
C.	The Communication Skills modules in TP prepared me well to perform this task.

For the two open-ended questions, the students were asked to 1. Suggest areas that they needed help in order to become more effective communicators as well as 2. Provide examples of situations during their internship in which they encountered any forms of miscommunication.

A total score was then tabulated for each question in performing each of the behaviours in the workplace for each diploma. A shortlist of the top eight most common responses for the two open-ended questions was then collated.

Limitations of study

Firstly, the survey uses the student‟s self-assessed definitions and ratings to measure the level of competency in their employability skills. This may not be accurate due to issues of bias and disparity in students‟ perceptions. There are also limitations posed by the sample of respondents as it comprised only about 36% of the total number of students.

Results and Discussion

447 students out of 470 (95%) responded that they were equipped with adequate communication skills in order to be effective communicators prior to starting their internship. This showed that the communication skills subjects the students took during the first two years in the School of Engineering in Temasek Polytechnic had prepared them well for the workplace. These subjects were *Effective Communication Skills* and *Writing and Oral Presentation Skills* in Year 1 and *Organisational Communication* in Year 2. The results also showed that students from the Diploma in Aviation & Management Services (102 students), Diploma in Business Process & Systems Engineering (91 students) and Diploma in Integrated Facility Management (91 students) were the most confident in performing well in the workplace.

The results suggest that a range of factors influenced the students‟ perceived competence in their employability skills. This in turn has multiple implications for educators. Firstly, although 95% of students responded that they were equipped with adequate communication skills to be effective communicators prior to starting their internship (which can be attributed to the preparation they had received in their two years prior), the results showed that a high percentage (see Appendix, Table 5) felt that the Communication Skills modules in TP did not prepare them as well to perform this task compared to their other responses according to Table 4. Thus urging further exploration into why the disparity in results.

Based on the results for the two open-ended questions, the following eight employability skills were identified as being the most desirable in order to succeed in the workplace.

Table 6: Eight employability skills identified by Year 3 TP Engineering students in ascending order

No.	Employability Skills
1	Communication skills
2 & 3	Interpersonal & teamwork skills
4	Problem solving skills
5	Technology skills
6	Future orientation
7	Transnational mindset
8	Self-management skills

The students‟ responses in Table 6 seem to suggest that students were able to identify the missing components or the “desired to have” components in order to perform well at the workplace, specifically the identification of communication skills as being the most important in order to succeed at the workplace. This point is supported by Jensen (2000) who stated that employers want:

“…a number of new competencies, with an emphasis on an increased ability to communicate…”

The next two most important employability skills are having “interpersonal & teamwork skills”.

The results (see Table 5) suggest that whilst students were able to apply or observe the use of employability skills during their internships (refer to Table 4), they were unable to relate their successful application as a result of the communication skills subjects they took prior to their internships. Further investigation into the students‟ responses may be necessary before a conclusion can be made.

The results also reaffirm the importance of working in teams and the ability to have good interpersonal relations in the workplace. This is supported by Harvey et al. (1997) which showed that British employers tend to value generic skills (such as communication, teamwork skills) more highly than disciplinary based understanding and skills. As there are no similar studies done on tertiary students in Singapore, more research is needed before a definite conclusion can be reached.

As a result of the above results and discussion, the revised curriculum for Career Communication took into account the identified eight employability skills and used them as the main themes. The subject is organised into two parts/module: *Part One* focuses on Workplace Communication, preparing students to communicate well in terms of presentation skills and working in teams (including interpersonal skills) as well as their transnational mindset (in working with peers from different nationalities, races and cultural background). *Part Two* focuses on Enhancing students‟ Employability, preparing them to work not only on their communication and interpersonal skills, but also on their problem solving and self-management skills. The revised syllabus also incorporate technology skills and future orientation with the use of online resources (Blackboard, search engines, library databases, research techniques) and critical analysis so as to be prepared for future challenges.

This revised curriculum enables engineering students to develop their learning holistically as it also simulates real-life workplace scenarios via the use of research skills techniques as one of the assessments for Part One: Workplace Communication. This is also seen in Part Two: Enhancing their Employability whereby students have to demonstrate their communication skills by writing a resume and cover letter and their presentation and interpersonal skills in an interview skill assessment.

The main focus of revision, however, was on the Workplace Communication module which replaced the previous Major Report writing component. The revision was done so as to better integrate the recommendations from the ASPIRE Committee‟s report

as well as to better equip the engineering students to be 21st century learners and future workforce. While the previous Major Report writing component only focused on the student's writing skills, the revised Workplace Communication focuses on an integration of the desired employability skills based on the survey conducted (see Table 3). This includes the critical and highly desired communication skills, interpersonal and teamwork skills, problem solving skills, technology skills and future orientation. Thus the students are able to learn in a more sequential and coordinated manner, guided by the employability skills framework.

Conclusion

The revised curriculum for the subject, Career Communication aims to provide engineering students with a broad range of industry-relevant skills which are critical for employability and to meet the future workforce challenges. In fact, its significance is even more important as employability skills have been shown to aid academic development (Baker and Henson, 2000). Thus, this helps to prepare the graduates for their future, equipping them with the right skills and mindset to be continuous and lifelong learners. This in turn supports the ASPIRE Committee's aim to "set out key strategies and recommendations to secure a better future for our young people" (MOE, 2014).

However, it is also important to note that employability skills is only one aspect (although very significant) aspect of an engineering graduate employability. Technical knowledge, economic and job market conditions, and an ever-changing world landscape also influence employability. Therefore, this revised curriculum serves only as a stepping stone or rather as the first step in understanding of what it takes to make a polytechnic graduate work and world-ready. Thus, these findings serve only as just the beginning in teaching employability skills to engineering graduates.

Other areas that would be valuable to explore would include "How can employers and the industry and the education system best support new graduates to realize their full potential, and progress in life," and "How can the education system and the tertiary institutions better respond to the challenges, opportunities and ever-changing world landscape." Thus, leading to the question on how these can be best translated to educating the 21st century learners, specifically in the polytechnic classroom.

In conclusion, what is most critical in teaching employability skills in the tertiary context is to make students realise that the only constant in their lives would be developing their capacity for change at any points in their careers as well as the passion for life-long learning. As Toffler (1970) aptly said, "The illiterate of the 21st century will not be those who cannot read and write, but those who cannot learn, unlearn, and relearn".

Acknowledgements

The author would like to thank the Communication Skills team in the School of Engineering, Temasek Polytechnic for their support.

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Appendix

Table 3: Student Survey

Workplace Communication Survey				
Diploma: AMS / AEG / BIE / BZE / CEN / CER / ELN / FDM / GBS / IMT / INE / MET / MIE / MTN		**Gender: F / M**		
Company Name: _____				
Brief Description of Job Responsibilities (eg. project planning, supervise staff; perform stock checks etc):				
(I)	During the internship, did you have adequate communication skills to be effective communicators.	**Yes / No**		
(II)	Instructions: Please read the following statements and tick all relevant anwers.			
A. I observed my colleagues use these skills at the workplace.				
B. I used these skills at the workplace.				
C. The Communication Skills modules in TP prepared me well to perform this task.				
#	**Statement**	**A**	**B**	**C**
1	Communicate ideas and information, concerns and issues using appropriate communication skills.			
2	Use appropriate questioning and active listening techniques (e.g. when obtaining information).			
3	Follow spoken workplace instructions.			
4	Communicate effectively to request advice, to receive feedback and to work with a team.			
5	Convey meaning clearly, concisely and coherently (e.g. when responding to requests and inquiries), using an appropriate communication style.			
6	Participate in workplace meetings and discussions.			
7	Participate actively in conversations about appropriate workplace topics.			
8	Complete written records and reports applicable to the job.			
9	Use instant messaging tools like SMS text messaging, WhatsApp, Twitter etc. for work purposes.			
10	Demonstrate clear and precise non-verbal communication (e.g.good use of body language).			
(III)	**Open-ended Questions**			
D.	Suggest areas of help that you require to make yourself more effective communicators.			
E.	Describe a situation in the company where you encountered miscommunication.			
Thank you for completing this survey.				

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Table 5: Results from survey

	Respondent's Option	**C. The Communication Skills modules in TP prepared me well to perform this task.**													
#	**Statement**	**GBS**	**MTN**	**BIE**	**IFM**	**AMS**	**INE**	**BZE**	**CER**	**MET**	**AEG**	**AEL**	**ELN**	**IMT**	**MIE**
1	Communicate ideas and information, concerns and issues using appropriate communication skills.	16	29	2	43	38	5	43	7	2	1	0	8	2	1
2	Use appropriate questioning and active listening techniques (e.g. when obtaining information).	7	26	2	29	41	4	38	5	2	1	0	5	1	0
3	Follow spoken workplace instructions.	9	11	0	18	32	1	30	3	0	0	0	3	0	1
4	Communicate effectively to request advice, to receive feedback and to work with a team.	15	25	3	36	40	4	51	6	1	0	0	7	3	2
5	Convey meaning clearly, concisely and coherently (e.g. when responding to requests and inquiries), using an appropriate communication style.	12	21	1	42	35	7	38	8	1	0	0	9	1	0
6	Participate in workplace meetings and discussions.	18	27	0	46	42	8	49	7	1	1	0	5	1	1
7	Participate actively in conversations about appropriate workplace topics.	7	8	0	27	29	3	30	4	1	0	0	5	0	2
8	Complete written records and reports applicable to the job.	16	27	0	50	47	7	55	9	1	0	1	10	5	1
9	Use instant messaging tools like SMS text messaging, WhatsApp, Twitter etc. for work purposes.	5	4	0	14	18	1	21	2	1	1	0	4	0	0
10	Demonstrate clear and precise non-verbal communication (e.g. good use of body language).	9	16	0	42	35	4	46	1	0	1	0	12	0	1

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Mutual Evaluation System Using Video and Web for Making Circuit Experiment

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Abstract

After students conduct the engineering experiments or learn programming, generally they have to submit reports to organize experimental results or deepen the understanding. This method is only submitted from a student to a teacher, and it is rare that students inspect the reports or programs of other students. Since a few years ago, we are keeping building the web system that students can mutually refer to the reports of the experiments or the program of the exercises in. Simultaneously, we are researching how long it is effective as to improvement of the interest and learning effects by using this system. The former system is not able to treat only the characters like program lists or the graphical output results which were obtained by programming. This work is to improve this mutual evaluation system that we developed so far, so that they can record the electronic circuits using the microcomputer which they made in their experiments and they can upload them to this system in order to comment later each other. We adopted following factors to use this system in an experiment this time. A) Students refer to the operation of the production circuit of a past student by recorded videos in the Web. B) Students upload the videos of the handiwork which students made by themselves to the Web, and evaluate them among the students. In A, we expected that it was helpful for the students to produce their own ideas of new circuits in reference to various videos of past produced examples. In B, effect of the collaborative learning among students was expected. Recently, education of physical computing with a microcomputer Arduino, sensors and actuators is focused on in engineering education. When the students created their circuits using a microcomputer in this lesson, we made them upload their works to this mutual evaluation system. We carried out a questionnaire to the students who worked on the experiment and inspected it about effects using this system afterwards. As the results obtained from this questionnaire, it became clear that there were improvement of the interest and learning effects to this experiment.

Keywords: Mutual evaluations, Improvement of learning effect, Effect of video data, Physical computing, Engineering experiments

Introduction

After students conduct engineering experiments or learn programming language in a class, generally they have to submit reports, which deepen the understanding of contents of the class to organize experimental results or to make their program. In such a way, report is one directionally submitted from a student to a teacher, and it is rare that students inspect the reports or programs of other students' individual. Since a few years ago, we are keeping building the web system that students can mutually refer to the reports of the experiments or the

programs of the exercises[1)2)]. We realize that there is improvement of the interest and learning effects by using this system. In this study, we applied this system to an engineering experiment of the circuit production, so that the students can improve the gallery of their circuits. In late years, with the spread of smart devices, and the recording of videos became easy. Therefore, we decided to let students record video of their circuit production and report it. We report improvements of learning effect by using the video for the exercise. Also, we report influences of students' learning will by mutual evaluation in students about their handiworks.

Summary of the system

Summary of the system is shown in Figure 1. Each student's pages are made for mutual evaluation in the system. The pages are embedded videos of student's handiworks that is recorded by them. And the pages are described illustration of the video.
The mutual evaluation system, which includes them, is achieved on the web page in the local network environment. Other students refer to it and feedback an impression and suggestion to student as comments afterwards.

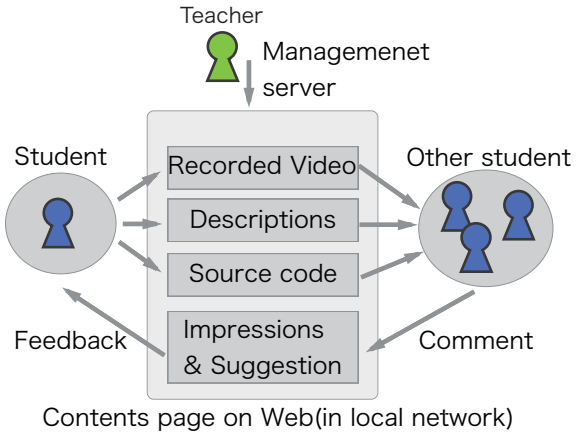


Figure 1 Summary of this system

Flow of the system

The flow of this system is shown in Figure 2. the following flows were set by this system.

1) Giving the student's exercise to them
2) Producing of a circuit using the kit of Arduino
3) Recording a video of the operation of a circuit
4) Uploading the video to Google Drive
5) Generating pages of the contents on Web
6) Mutual watching the pages of handiwork
7) Comment on the other student's handiwork
8) Feedback to each student

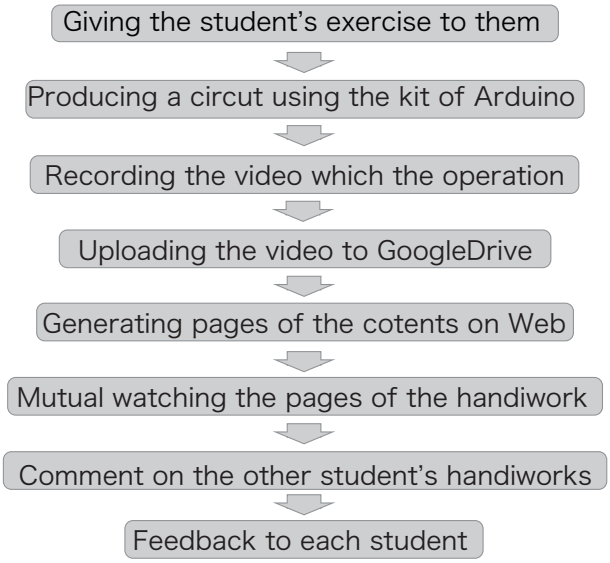


Figure 2 Flowchart

About Experiments

The kit with put various kind of sensors and actuators, were prepared, and the students performed exercises for the purpose of the microcomputer using the learning kit. Sensors such as a Cds sensor and an infrared distance sensor, a triaxiality acceleration sensor and actuators such as a LED and a motor those are prepared in the kit of Arduino. After having performed the fundamental exercises to learn how to use about each sensor and each actuator, the students produce the circuit which students considered themselves as application of basic exercises.

Introduction of Arduino[1)]

Arduino is an open source platform for physical computing, and a development environment with simple input/output interface is implemented based on Processing language. It is open source hardware comprised of the board, which implemented a microcomputer chip, and the development system.

Recording the video

With the smart devices such as a smartphone, students record videos of the operation of their handiworks. Since most students possess various smartphones recently, they can create freely video data. If students don't possess such devices, they can rent the devices such as iPad. For watching many videos mutually, we advised student to record the video time from 10 to 30 second.

Uploading the video & its description

The service of the Google drive is used for uploading the videos. The reason is that, all students are given Google accounts in our

college, and they are usually utilizing Gmail and any other Google services.
Furthermore, their video data are shared easily among students and them are able to embed in the web page using their file sharing service of Google Drive.
We let students add the description of their handiwork circuits their video data and submit it. The contents of the description are as follows, title of the handiwork, kind of the sensor and the actuator that are used, the description about the operation, and the points that students arrange their handiwork themselves, whether or not the operation of the circuit is according to one's plan, and a student's impression of the exercise.
Furthermore, we let students submit it to the source code that they made.
The submitting method used input form of the original uploading in 2014 instead of email (Gmail) in 2013.

Generation pages of the contents on Web

The page as to the handiwork of the student are generated by submitting videos and texts
A sample of the pages is shown in Figure 3.
The pages are generated when students input sharing links of the videos and texts that are about the videos of descriptions from the web form by the script of a server side in 2014.
Thus, students become able to start mutual evaluation immediately. In 2013, the pages of students were generated manually by script using data of emails that were send from students. Therefore, Students were not able to start mutual evaluation immediately.
The pages were built to be easy to watch the videos and a text of the description. And video player is embedded in the pages for easy to watch the videos. As as a result, students are able to carry out mutual evaluation efficiently.
In 2013, it is necessary to open a link of the video for to play in the pages. Since it is inconvenient, we improved the point.

Mutual watching the videos in class

After the upload of the videos were completed, and pages for reference are generated. Mutual watching the videos of each handiworks and comment were carried out in the class which students exercise in.



Figure 3 Example of Student's page (2014)

Watching the videos which were recorded last year

The exercise was performed for different classes in 2013 and 2014. We tried that we let the students refer to the videos of their handworks.

About comments

About the production circuit of the students, the system was built so that the other students comment.
Two types of comment questionnaire for were carried out. One is the question-style in 2013 and the other is free-description-style in 2014.

Application of the system

This system was utilized in 4th year class of electric and electronic department of our college.

Evaluation of the system

The evaluation of this system was performed by some items. The items are as follows, the impression of that the teacher and staff used the system, the questionnaire result from the students and an analysis of the result. Also the analysis of the comments of the mutual evaluation was used for the evaluation of this system.

Questionnaire contents

We performed a questionnaire to students using the system. After having completed all exercises, we inspected the effects of it. Answers were obtained each class of 2013 and 2014.

Questionnaire contents

The questionnaire contents are as follows.
Ⅰ. Referring the videos of the production circuit mutually.
Ⅱ. The reason of the answer Ⅰ.
These items were carried out for the purpose of getting the evaluation about the act to refer to become the basis of the system.
Ⅲ. Recoding of the video, and a way of the upload of the video.
Ⅳ. The reason of the answer Ⅲ.
These items were established to guess an impression about the labor to affect presentation
Ⅴ. Recording the video of the circuit which myself made.
Ⅵ. The reason of the answer Ⅴ.
This item was established for the purpose of evaluating the effect of using video. It is an important element of the system developed at this time.
Ⅶ. Referring the videos of the produced circuits in last year.
Ⅷ. The reason of answer Ⅶ.
These items were established to judge whether referring to past handiworks affect the students who make new circuit from now on. This question reached for the student who worked on exercises in 2014.
Ⅸ. Free description of impressive things through recording of the video, submitting, and referring it.

Results and Discussion

Review of teachers

At first, we report feelings of using the system from the teacher and staff side. Review 1: “It is easy to grasp what kind of operating circuit students produced in comparison with normal reports.”
Review 2: “The point that can examine the operation of the students’ handiworks in out of the time is good. In addition, the point that can perform a comparison evaluation to the handiworks without a limit of the time is good”.
These show that this system includes useful point of the merit for the teacher and the staff side.

Questionnaire result from users

Questionnaire result was shown in Figure 3 to 6.
Answers about question Ⅰ. are as follows.
Almost favorable answers were obtained in both years. It becomes 97% when the answers of good and the answer of good and the answers of very good are added.
Answers about question Ⅱ. are as follows.
We classified it about the answer to this questionnaire item when we greatly had a tendency towards two. As for the classification, as for the first, the item about reference

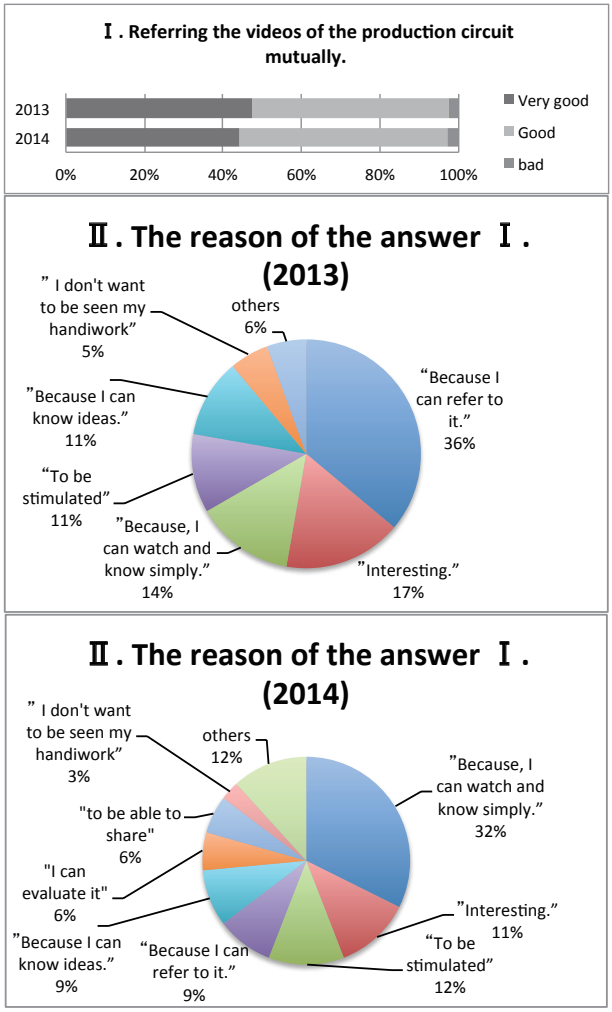


Figure. 3 Result of Ⅰ and Ⅱ of the Questionnaire

characteristics, the second are items about the interest. The answers about reference characteristics consists of “Because I can refer to it.”, “Because I can know ideas.” and ” Because, I can watch and know simply.”. It become over 50% when these answers are added in both years. Then, the answers about the interest consists of ” Interesting.”, “To be stimulated". It become over 20% when these answers are added in both years. We were able to achieve a purpose that is the improvement of the learning effect from Questionnaire result. Additionally, since the system is made improvement for useful, it is thought that student became easy to understand to various merits in 2014.
As for both years, there was a few following answers,” I don't want to be seen my handiwork” and ” I am ashamed that I show it”.
A few students have negative impression that is showing their handiworks.
Answers about question Ⅲ. are as follow.
Answer that “easy” and “difficult” are about the same values.

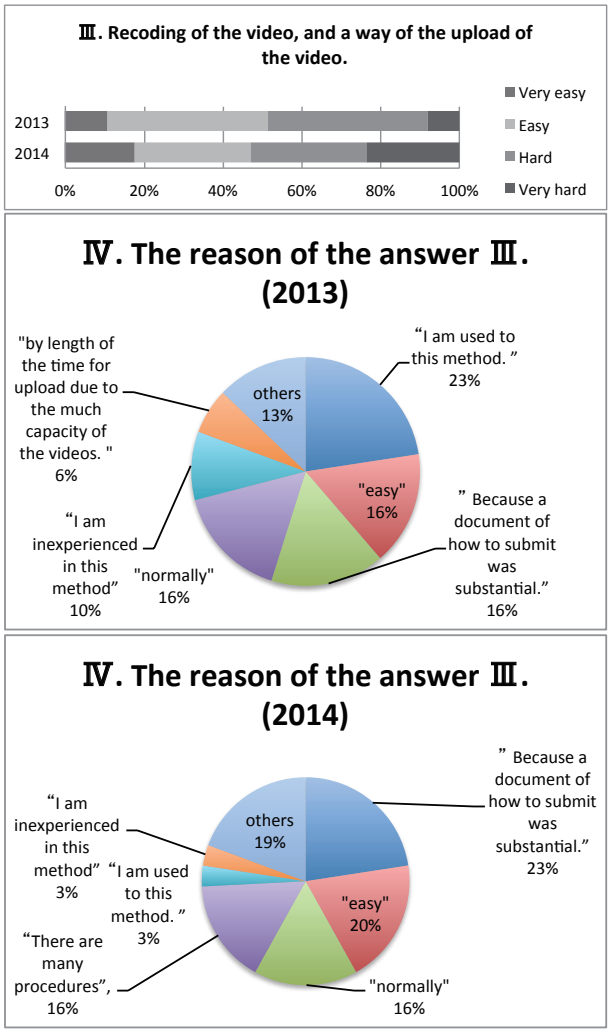


Figure. 4 Result of Ⅲ and Ⅳ of Questionnaire

Answers about question Ⅳ. are as follows when students answered “easy”, the reasons were “I am used to this method. ” and ” Because a document of how to submit was substantial.” in 2013.On other hands, when students answered “difficult”, the reasons were “I am inexperienced in this method”. In addition, it was one of the reasons by length of the time for upload due to the much capacity of the videos. When students answered “easy”, the reasons that there was the most was “Because a document was substantial” in 2014. In contrast, when students answered “difficult”, the reasons were “There are many procedures”, and “A procedure is complicated”.
It is thought that the difference of submitting method between 2013 and 2014 is caused by the fact that we changed it. The submitting method was relatively easy in 2013.the method was to send the email that attached video data. However, it became redundant in 2014. It was necessary to insert it in a form after having acquired the joint ownership link of the video. It is thought that it was reflected by an answer result that procedures increased by having changed the submitting method.
Answers about question Ⅴ. are as follow the answers were an approximately favorable opinion.
Answers about question Ⅵ. are as follow. This result provided answers characterized by ease of understanding and ease of illustration. The answers about the interest consist of "It’s comprehendible” and ” This method can explain that it is hard to illustrate by a sentence”. It become over 45% when these answers are added in both years. As for this, it is thought that the characteristic of the report using the videos strongly appeared when students use the videos for the reports. It is thought that students felt that they can illustrate production contents effectively.
Answers about question Ⅶ is most students showed affirmative answers.
Answers about question Ⅷ. are the reason were shown such that “Because I can refer to it.” and ”I thought that those handiworks were good.” There were many reasons that were objective than mutual evaluation.
Answers about question Ⅸ. are as follows. A lot of interest for the point that could refer the individual work of other students was shown. It is thought that this shows that a good theme of exercise of the affinity for this system reflects personality.

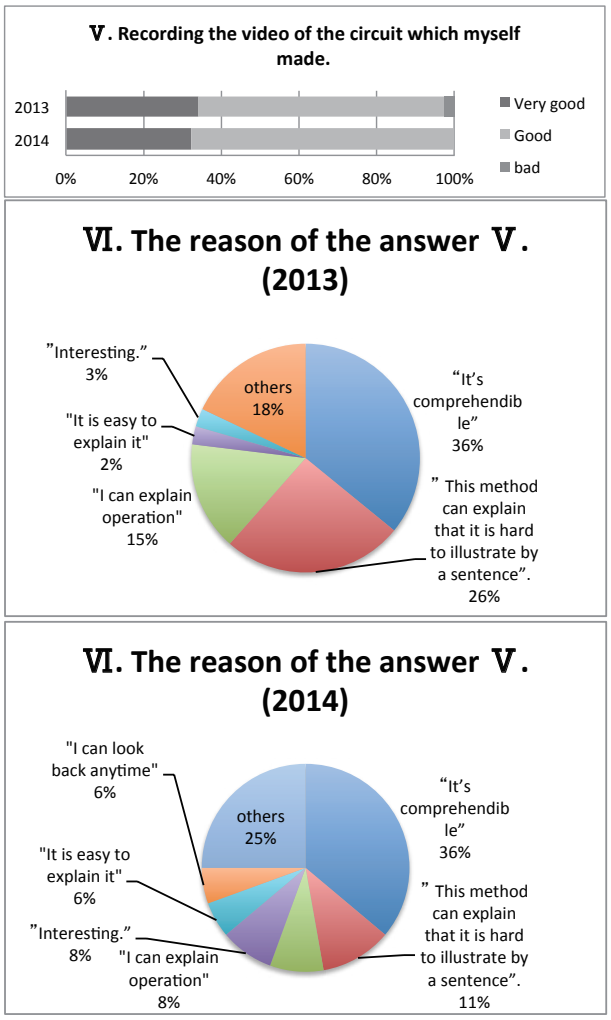


Figure. 5 Result of Ⅴ and Ⅵ of Questionnaire

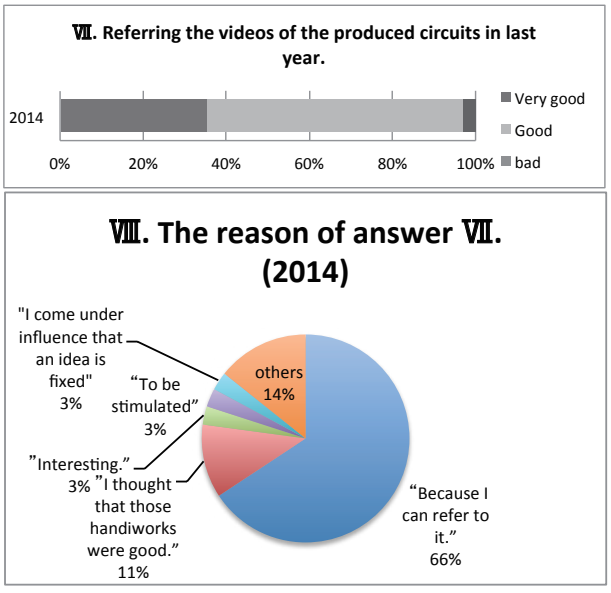


Figure. 6 Result of Ⅶ and Ⅷ of Questionnaire

Tendency of the comment

From the contents that a student commented on other students, we show it about the tendency. At both years, there are many impressions about the handiwork. In addition, there was less advice than an impression. And, there was the comment "I did not think of by myself". It is thought that it was possible for the confirmation of the objective achievement degree by comparing one's works with the others.

Conclusions

During a class of experiments, there are few opportunities that students watch the results of other students. We performed a trial to give the opportunity to students by using this system. It was recognized it was the almost good from the questionnaire result of students using this system. And we confirmed the usefulness of using of the videos, referring and evaluating mutually.

Acknowledgements

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ATTEMPTING TO TRAIN ENGINEERS IN MONGOLIA

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Abstract

There is a serious shortage of engineers in Mongolia. It is said construction, mechanical and electrical engineers will be in high demand over the next 10 years.

A group of people, most of whom studied in Japan have wanted to implement a "kosen" which means college of technology into Mongolia. 3 kosens have been established in Mongolia with the support of Japan since September 2014. We are belongs to one of them called "Mongol Koosen".

A kosen is a system designed to provide professional education in stages starting at 15 years old after accomplishing compulsory education. In the junior high school stage, 3rd year Mongolian students don't know sufficiently about what mechanical engineers, electrical and electronic engineers and construction engineers do. In Mongol Koosen, the first year students are taught the basic manufacturing (Monozukuri) practice of aforementioned 3 departments as a general class, which is to make them understand the basics of engineering. After that, when students are sophomores they choose their profession.

This paper describes how the student consciousness is changing from the time of admission, through a comprehensive Monozukuri practice and tries to explore ways of appropriate profession selection.

We are discussing about the reason for choosing this kosen and situation before and after the implementation of the Monozukuri practice based on questionnaires and reports of students.

According to the questionnaire, more than half of our students want to be construction engineers. The reason is Ulaanbaatar is constructing buildings very fast and It is visible before our eyes. Surely, we need more construction engineers. But, for our country's future development, we also need engineers who can innovate new technology, new equipment, new manufacturing and operate what others have made. We can see that Monozukuri practice is changing some student decisions for the better from the questionnaire.

We are trying to make students and their parents understand the demands of every engineering field and instruct students to become humane, creative and skillful engineers.

Keywords: *shortage of engineers, kosen, Monozukuri, professional education*

Present of Mongolian higher education

Since the beginning of the 21st century there has been a shift in how students are trained. Previously there was very much a teacher centered method, but the main emphasis is much more on student or learner centered training. The student should be the main focus in the study and there needs to be a balance between learning the theory as well as gaining practical experience.

On the web site of the Ministry of Education, Culture and Science, it is clear that the training results in higher education are not meeting the required standards. For instance: there are almost 20 thousand unemployed people with a bachelor degree, almost 5 hundred unemployed people with a master"s degree as well as almost 9 thousand unemployed people with a secondary education. The reason that so many people can"t find work in their profession is due to their skills not meeting market requirements. It has become very obvious that we need to revisit the higher education system.

On the other hand higher education in Mongolia has become a business. There are many state and private universities which are based on common interests of people. This means that the quality of training specialists is not good enough. The specialist the education system produces does not match what private industry needs. Far too many lawyers and economists are graduating. What Mongolia needs is more specialist in mining, construction, transportation, information technology, agriculture and engineering field. These are industries that are growing in Mongolia and in those industries we need new and more specialists.

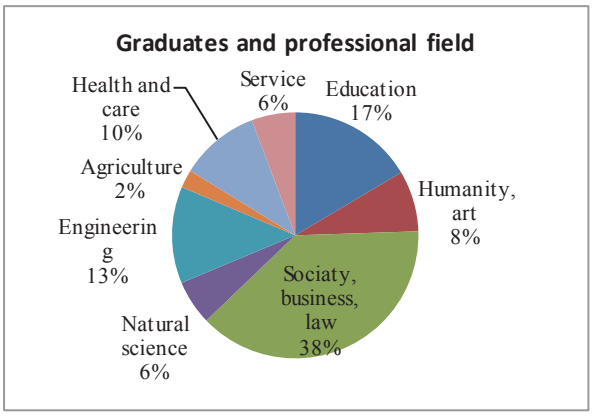
Most university curriculums are based on theory. It does not give students enough practical experience that is so vital for any successful study. Now, most graduates have to be trained on the job after they have been employed. Theory has its place, but there must be

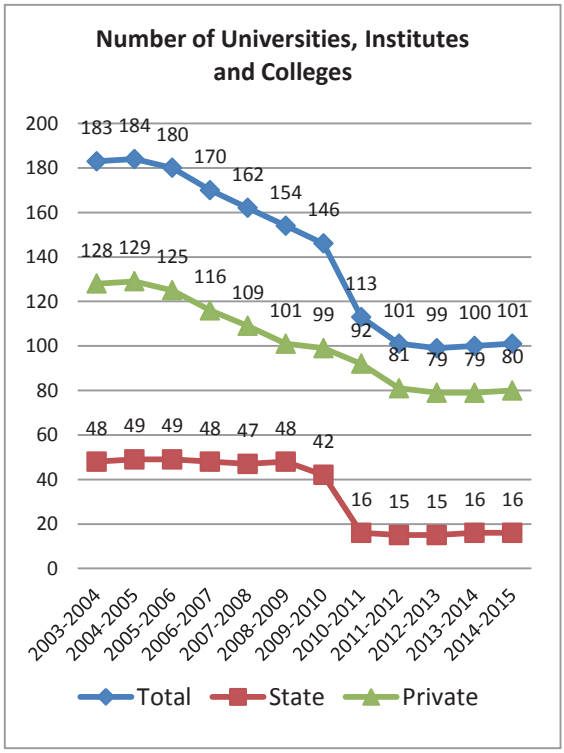
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a practical learning process that goes with the theory. It is becoming more and more obvious that the educational institutions need to work in cooperation with private industry so that they can produce specialist that the private sector is looking for. Now students have too much idle time and all along the teaching experience should be the coming together of teachers, students and industry.

Research has found that about 30000 students graduate from Universities, Institutes and colleges (Universities) each year and that most high school students enter university. It shows that 25000 new work places must be created each year to absorb all the graduates. 150000 students are studying at university of which about 50000 students are from the countryside.

For instance: A total of 37243 (23949 or 64.3% are women) students graduated from state and private universities in 2013. Following graph shows its professional field.





There were 184 state and private universities at national level in 2004-2005. 142 of them were located in Ulaanbaatar city. But in 2014-2015 there were 101 universities, 92 of them are located in Ulaanbaatar city.

About 140 thousand students study in Universities. That is equal to 15 percent of the Mongolian total working force. 41.8% of the graduate students from 2013 had found employment. The other 58.2% of graduates joined the unemployed and had to find work in doing some business, drive taxis or maintenance work. Most new vacancies are in mining, infrastructure and factories.

According to the survey the main reason why our young people joined the ranks of the unemployed was their lack of knowledge of the labor market. The skills they had required where not the ones that the labor market was looking for.

From a survey of the Department of Labor and Social Welfare, 78 percent of companies which were asked said that it"s very difficult to find people who meet the requirements. 80 percent of applicants don"t meet the requirements and 67 percent have no practical skills. 70 percent of companies arrange training for new workers. So again it is apparent that practical training as part of your study is a vital pre-requisite for success in the labor market.

Choosing the right profession is not easy. Many high school students think that "what profession should I choose?" when they finish high school. Some students study a profession not of their liking, but the one their parents advised them to study while others choose a common profession. It means they don"t do some research to see what study will have the best chance of employment after graduation. Making a bad choice leads students to join the unemployed while having a professional diploma.

Mongol Koosen and Monozukuri class

Most primary, secondary and high schools of Mongolia are just in one place. They give lessons by turns due to the lack of classrooms. Primary school has 5 years and secondary school has 4 year schooling. And then 3 years schooling depends on students interests.

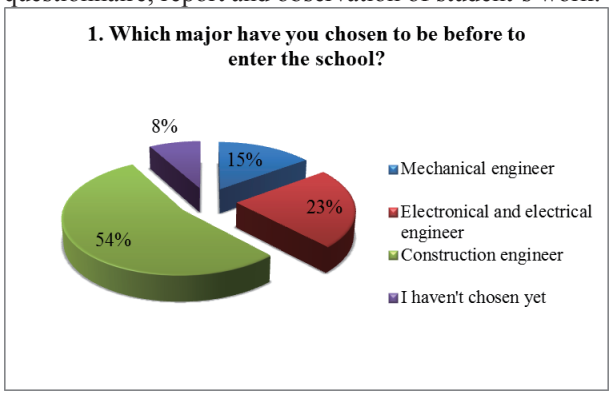
Kosen is a higher education organization which students are able to enter after they finish secondary school.

The model class of Japanese style kosen started giving lessons in December, 2013 and "Mongol Koosen" kosen was established in September, 2014. Students study same lessons without choosing profession in the first grade. They had Monozukuri class which is a base of engineering lesson, and when students are sophomore they are divided into 3 professional classes namely civil engineering, mechanical engineering and electrical and electronic engineering based upon their interests and lesson marks. So Monozukuri must have topics and contents which helps students to understand these professions.

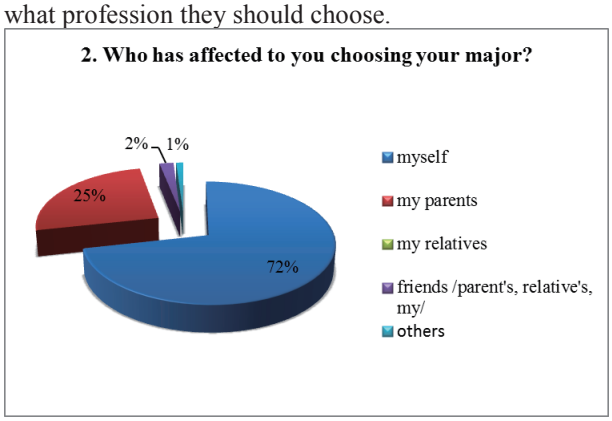
We will report the result of making observation to Monozukuri class in order to see how student"s interests are changed since they enter our school and test that looking for the best way to choose a good profession.

We have produced a summary as to why students choose kosen and conduct a survey about impression

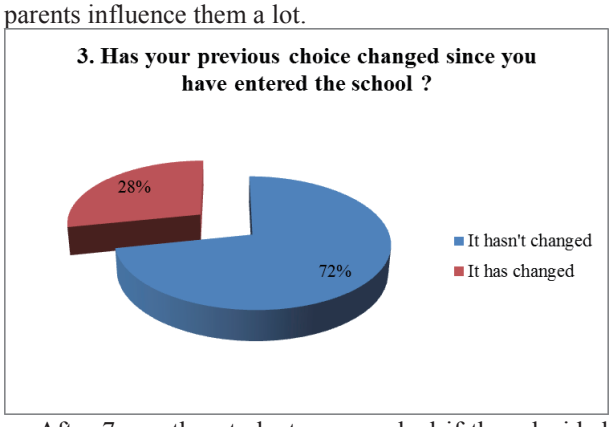
before and after the Monozukuri class using questionnaire, report and observation of student‟s work.



The graph-1 shows the result of student‟s survey that asked „what type of engineer do you want to be?” 94 students got involved and results are shown by percentage. Most students chose civil engineering, followed by electrical engineering and mechanical engineering. There were 8 students who did not know what profession they should choose.

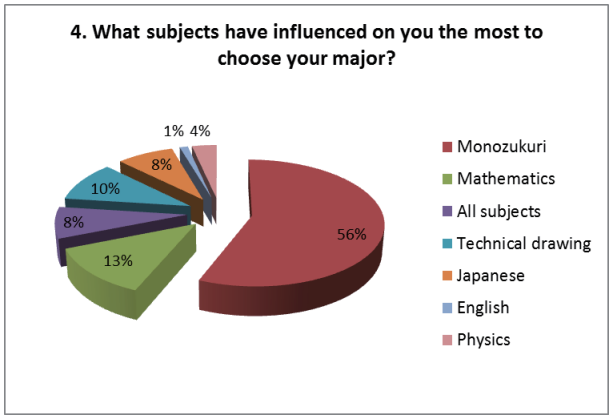


72 percent of students answered “my own decision” and 25 percent of them answered “parents decided” for the question on who decided to choose this profession. It shows that when students choose their profession their parents influence them a lot.



After 7 months, students were asked if they decided to change their profession. In March, 2015. 28 percent of students answered that their choice has changed. We studied what influenced them to change their choice.

Graph-4 shows the result of which class influenced them to change their choice. The class most influenced was Monozukuri and it takes 56 percent. I heard that there are not enough materials and devices in secondary school and the students of Mongol Koosen are very active for this class.



Mongol Koosen has 35 weeks a year and 50 minutes per class. 1 credit means the class once a week is studied for 35 weeks. Monozukuri has 4 credits, 4 times a week, total 140 times.

In the first semester (Sep to Jan) and second semester (Feb to Jun) all engineering classes are studied 2 by 2. It means all students do 3 professional practice. 30 students are included in one standard classroom and divided into 2 groups when having Monozukuri. The welding practice is done in short time using the appliances of the Institute of Engineering and Technology (IET) and taught by a Japanese specialist.

Engineering	1st semester	2nd semester
Practice base	Safety training, report writing, 5S rule	
Mechanical	Hand processing-Making scriber and center punch	Screw types, their names and measuring
	Measuring practice using callipers	Screw threading, Making Dudu car
Mechanical and Civil	Arc welding	
Electrical and electronic	Soldering practice, Solder art	Making tester and its usage
		Makin IchigoJam and its usage
Civil	Surveying base, Making 3D map	Reading technical drawing, making declivous road
		Usage of tools for wood
United practice		Connecting declivous road, Dudu car race

Table 1. Monozukuri topics

Let us explain about practice of every profession.

1. Mechanical practice

The base of mechanical engineering is to learn and understand to measure length correctly and hand processing. In the first semester, teach how to work with callipers and use 3 different callipers which are made in Russia, Japan and China and measure car parts and give understanding of measurement mistake. Students made scriber and center punch using iron saw and file.



Pic 1. Mechanical practice



Pic 2. Center punch and scriber

In the second semester, we had a practice to measure outer diameter of screw using callipers and learned how to call them. There is no factory that produces screws in Mongolia. Necessary things are come from foreign countries. So students will learn to name screws correctly.



Pic 3. Students at the car design exhibition



Pic 4. Making Dudu car body by wood

The last practice was to make a Dudu car. We had a car design exhibition at IET in order to let students interest in cars. The picture-7 shows the engine design, car control system and the arrangement of pedal and brake. The body of Dudu car was made with junk woods using saw, file, chisel and plane. We learned to name screws and did practice to thread using tap and die.

2. The united practice of mechanical and civil engineering or welding practice

In Mongolia, the welders are very demanding. There‟s professional welder‟s class in IET. Equipment and devices are enough. So we added the welding class to the first grade. First of all welding practice is required safety. So we invite Japanese specialist and were taught well.



Pic 5. Japanese specialist and safety training

The students of model class are taught welding and participated in welding skill competition which is held in Saitama, Japan for the second year and become confident in themselves.



Pic 6. Welding practice

3. Electrical and electronic practice

The base of this field is soldering. When you create electrical circuit, it is very important to connect parts perfectly using solder. If not the circuit doesn‟t work, explode or make trouble. To make soldering practice interesting, we put solder art in class. First, a group has to discuss about title and then they create.

In the 2nd semester we had a practice to make tester and then learn how to use that. Also taught to build a microcomputer named IchigoJam, then to understand its usage students made stopwatch by themselves and used that in Dudu car race. In the 8th picture we can see how students showed time on screen.

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Pic 7. Soldering practice



Pic 8. Stopwatch made by students on screen

4. Civil engineer practice

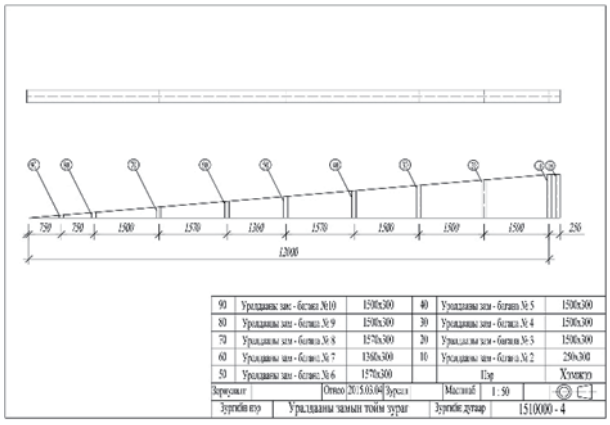
In the first semester students took understanding about surveying and created 3D map. The map was painted to differentiate contours and heights and stick on styreneboard, cut with hot wire cutter and stick up in layers. Most materials are from Japan this time. Tomakomoi kosen"s graduate student came and taught how to make it.



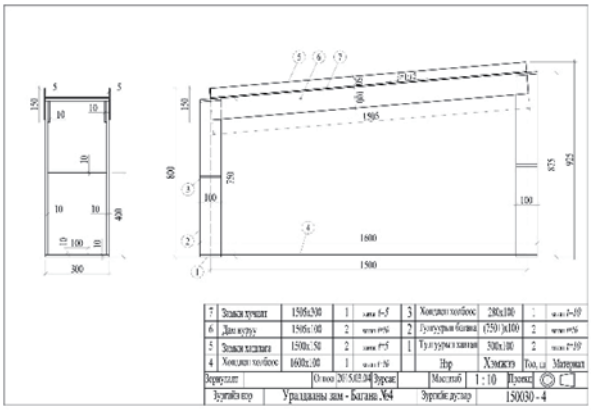
Pic 9. 3D map

In the second semester, we build declivous road. The height is a meter, length is 12 meters and have 9 column. Picture 10 shows the united drawing and picture-11 shows the divided parts.

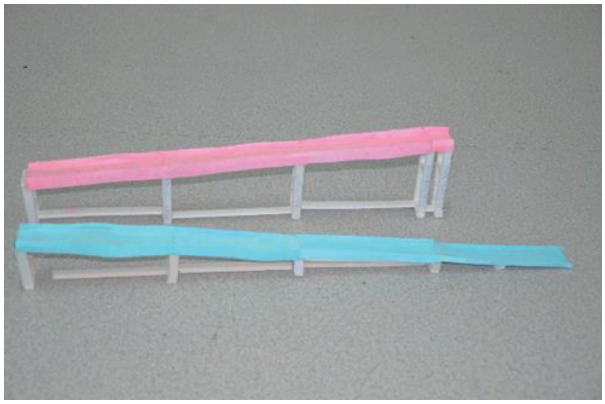
When making divided parts, there should be 3 or 4 students in one team and make model on a scale of 1 to 10. Check well and draw the picture of parts. The materials are 10 mm and 5 mm thick board. The board is sawed and attached with wood screws.



Pic 10. United drawing



Pic 11. Divided part"s drawing



Pic 12. Model of declivous road

5. United practice

It"s mentioned that every single Monozukuri course has certain topic. The declivous road was built in civil engineering practice, dudu car which races on declivous road was made in mechanical practice, and the stopwatch which measures time from start to end in electrical practice.

It"s forbidden to use actual car tire. Tire and spindle must be made by hand. Race car should be made with wood. Students learned to use wood tools from Japan. Cars can be made by team and a team can make several.

DuDu car race organized on 12th of June as the closure of Monozukuri class. Every car were different. Total 28 cars joined the competition and 8 of them

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completed their action successfully. The car which took first place sped up 7.29 seconds

Size	Length	Until 150 mm
	Width	Until 130 mm
	Height	unlimited
Weight		Until 1 kg
Tires		Not on sale, make by yourself

Table 2. The requirements for race car.



Pic 13. Opening of car care



Pic 14. Fastest car is in the middle

50mm bracket was made the 2 sides. It was very important that front and back tires connection should be straight, size of tires should be the same, bumper should be attached, to be stable when hit bracket, diminish the friction around spin part and adjust the weight. The teacher did not explain about these. After the race, three cars were chosen for speed, also best technology, best design, best idea, best performance, special place were selected and awarded appreciation.

Results and Discussion

There are a lot of difficulties implementing kosen education system, such as,

- There is no kosen law in Mongolia
- Students are poor in math, physics and language.
- Students lack verbal skills and find it hard to do assignments in a timely manner.
- Some students may have come from dysfunctional families.
- Training facilities, equipment are insufficient.

We took survey of satisfaction and summarized that this is the best time to get the kosen education system into Mongolia and highlighted the following advantages.

- Students have a solid base established for their studies in 1st year.
- Students use modern equipment and devices and do all things authentically.
- Universities and employers connect easily and students don"t need to be trained after employment.
- Have repetition if some students left behind.
- Students will be able to make new creations, innovations and share them with others…

As we get kosen we will be able to make following reform in engineering education

- Implementing curriculum of technology and new education method
- Intensify the teachers education potential and work of specialize
- Improve the service to students
- Improve the quality of students training and assist in any language difficulty
- Bring together universities, graduated students and employers

Conclusions

Table 1 shows how Monozukuri was conducted. Students wrote comments that they found difficulties first in Monozukuri class. But after they have done it was cheerful and interesting. The research result shows Monozukuri influenced students to choose their professions. We had a result through practicing with possible equipment and devices. Therefore we would like to choose the topic that is expressive, effective and useful for students.

Acknowledgements

We are truly appreciate Dr.Nakanishi Yuji, Dr.Nishiyama Haruhiko for advising on Monozukuri practice.

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ACADEMIC ACTIVITIES AND TEACHING METHODS IN UNIVERSITY CLASSROOM IN THE UNITED STATES

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Abstract

Recently, the Japanese government has been strongly promoting the globalization in the educational field, and they demand a drastic reform in the educational system. 'English education' is one of the keywords. Therefore, KOSEN has firstly started it at Akashi and Ibaraki Colleges. These colleges were awarded Grant-in-Aid for 'KOSEN Global Model Project'. Furthermore, the 'Top Global University Project' and 'Tri-Institutional Collaborative/Cooperative Educational Reform Project', represented by Nagaoka University of Technology and Toyohashi University of Technology, were adopted as a relevant project. Special subjects in English have been gradually introduced to KOSEN and both universities. Also, KOSEN has been interested in Active Learning because more effective educational methods are sought. Under these circumstances, we participated in the 'Long-term Faculty Development Program for nurturing global education and research abilities' to learn about teaching skills to conduct lectures in English as a second language.

In this report, Queens College of the City University of New York (QC), a famous college for English education, and Franklin W. Olin College of Engineering, a well-known college for active learning, are introduced. In addition, this report discusses a way for improving KOSEN education.

A lot of educational tools are used at QC. The Clicker, an audience response system, seems to be one of the most effective tools for active learning because almost all Japanese students would be nervous when they speak or listen to English. Some lecture rooms of Olin College were equipped with white boards on every wall and many sticky papers were prepared at these rooms. These teaching tools are so effective to make discussion. We need to improve the environment of educational place to attract our students for participating in discussions.

Keywords: *Globalization, English teaching, Teaching Methods, American University's education, Active learning*

Introduction

The Japanese government has been strongly promoting the globalism in the field of education. There are some reasons; one reason is Japan's policy of accepting international students, and another is acceleration of overseas transfer of Japanese factories. Also, Tokyo 2020 Olympic games may have given some influences to the globalization policy. Therefore, the Ministry of Education, Culture, Sports, Science and Technology developed some projects to accomplish this ambitious objective. The 'English Education Reform Plan Corresponding to Globalization' targets elementary and lower/upper secondary schools, while the 'National University Reform Plan' targets institutions of higher education: Japanese colleges and universities. The 'Top Global University Project' and 'Tri-Institutional Collaborative/Cooperative Educational Reform Project', represented by Nagaoka University of Technology and Toyohashi University of Technology, were adopted as a relevant project. Under these circumstances, we participated in the 'Long-term Faculty Development Program for nurturing global education and research abilities' to learn about teaching skills to conduct lectures in English as a second language (Iwashita, T). One of our purposes is to provide a lot of knowledge that we learned in the United States, such as the educational system of some universities, to KOSEN (Akazawa, S).

We collaborated with Queens College of the City University of New York (QC). This college has an English courses for foreign students who want to learn English as a second language. Since the courses were a good reference for planning our specialized course in English, these courses are firstly introduced. Secondly, specialized courses for us at QC are explained. Thirdly, education system of Olin College is describe. The last section, a way for improving KOSEN education is discussed.

The English Language Institute at Queens College of the City University of New York

Queens College of the City University of New York (QC) is located in Queens, New York City. The English Language Institute (ELI) at QC is an institute that provides a comprehensive academic program for people who want to learn English as a second language. The institute was established in 1945 and was the second oldest in the entire United States (Queens College, QC). The tuition of Full-time Day Program, Summer Two, which we participated in (about six weeks) is about $1,600 and the fall is about $2,700 (about 4 months).

We participated in the ELI's program. Before starting the courses, we took a placement test to assess our English levels. There are seven levels from Beginning (1st level) to High Advanced (7th level) classes. The number of students is about 10 to 20 per class and the course schedule is 4 days a week, 24 hours a week, and Monday through Thursday, 8:30-11:30 and 12:30-15:30. There were 4 categorized courses, which were Grammar, Writing, Listening/Speaking, and Reading in each class. Also, these subjects were slightly overlapped each other. Other students at the time came from different countries such as China, Korea, Taiwan, Iran, Turkey, Colombia, Venezuela, Cuba, and Japan. There were students from nine countries in one class, for example. Of course, some students had already started their life in New York.

In terms of ELI's lectures, essay writing was the first concern for the ELI students because it was one of the most important skills at the higher education institutions in the United States. It was much different from Japan education system. If you are not able to write five paragraph's essay within 30 min, you can never enter the high-level class.

The desk of the class rooms was different from Japanese class rooms. The desktop was combined with a chair. Therefore, we were able to move the chairs for discussion quite easily as shown in Figure 1.

The teaching methods in ELI courses were unique comparing with the courses in Japan. Teachers often used movies, which were uploaded on YouTube or New York Times, to practice the listening ability. It was easy for students to obtain the outline of the story because they can get information not only from the auditory sense but the visual sense. This method seemed to encourage students to keep a concentration listening to English in class. Another teaching methods were to have an opportunity to discuss with a group or pair. Students had lots of occasions to speak their opinions in English in the discussion training. Actually, we felt we had to show our opinion with listening carefully to other opinions. This discussion style required deep concentration on thinking in English through the whole conversation.

Almost all foreign students in high-intermediate level were able to express their opinions and feelings in English even if their English grammar skills were lower



Figure 1. The ELI class's discussion style.

than ours. We felt a difference of educational system in Japan from that in foreign countries.

One thing we would like to say is that Japanese teachers do not have to follow all the education systems; however, understanding the methods itself should help us.

QC regular courses and educational tools

Specialized courses of QC

We took some regular courses in Fall Semester according to our speciality. One, for example was a "Principles of cell biology" which was a subject for general biology, and the main target grade was a sophomore. A title of the textbook in the course was "Essential Cell Biology, 4th edition" which was very famous in the world in this field, and there were about 150 students taking the course. The lecture style was very basic because the lecture was a lecturer centred style and the lecturer used only PowerPoint all the time during his lecture (Figure 2). In another large class, however, a lecturer used an electric educational tool named "Clicker" which elicited a response from students. The Clicker was a powerful tool for making most of the students participate. The lecturer was also able to add the voted results to student's grade. We were surprised at an exam style of the course because some of exams were a multiple choice type (answer sheet exam) and using mark sheet. Actually, almost all large classes had introduced this exam style. Also, the "BLACKBOARD", which was education support system, had been introduced as the principal educational tool in the QC. The BLACKBOARD is an educational platform service software and embeds an attendance book, exam making system, self-study system, grade management system, discussion board, and so on.

This university was equipped with convenient systems for lecturers. If our KOSEN introduce these systems, our educational strain may be reduced.

Active learning of QC -Introduction of geology and Science and technology in New York City-

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Introduction of geology offered students a field trip activity. This was an integral part of this course. The participants visited the site of the field trip of New York City (NYC) by bus (a two-hour ride) for learning the geologic history of their city on a weekend.



Figure 2. A large class at QC.

Before the trip, we signed a letter of safety commitment. We spent a whole day and visited two places, one was a mountain side, and the other was a seaside. We studied geological history of NYC based on handouts and learned knowledge so far. Students had to study by themselves by handouts, which the teacher gave them in class before they had a survey trip. Most of the students listened carefully to what the teacher said in the field, and some of them asked questions during the survey. We supposed that students learned this subject spontaneously when they were having experiences on the study trip. In addition, they had precious experiences to obtain the geological knowledge that they're not able to have in class. Since this subject's target was a freshman whose speciality was no limited, this event was more effective for improving motivation of students.

Science and technology in New York City was the course to learn about biological basis of human health conditions, urban health issues, and so on (Holtzman, N). This course had an interesting event which was "Health Fare". The event was one of the mandatory tasks. The students were separated into some small groups and set up booths dealing with the health issues



Figure 3. "Health Fare" at QC.

provided as the themes of the day. NYC Health Center joined the event and carried out AIDS inspection at that place free of charge. Since the AIDS test was a quite popular service in the United States, many students utilized the inspection service. Some booths dealt with alcoholic and drug poisoning problems (Figure 3). We would never be able to see the situation in our College.

These cultural or liberal arts topics are one of the good themes of active learning. Surprisingly, the grading ratio of this activity was only 15%. However, if the related plan added to the grading, the total grading ratio reached 30% (included such a website making). Since this subject caught up various evaluation points, even if there were some nervous students in the class, the lecturer would be able to evaluate the students correctly. It also will be an important viewpoint in our lecture.

Visitation at Franklin W. Olin College of Engineering

Franklin W. Olin College of Engineering is a famous college for active learning and Project-Based Learning (PBL), and the National Institute of Technology, Japan (NIT), which is upper organization of KOSEN, is focusing on the college education systems.

The Olin College was founded in 1997 as a private institution. The College is located at Needham in Massachusetts, and the annual tuition fee is about $44,000 (2014-15). Also, the College is ranked at third of the "Best Undergraduate Engineering Programs in the United States" (U.S.News & World report, Education). In this section, educational environment and content of lecture are introduced. As for the lecture, "Six microbes that changed the world" is introduced as an example.

We visited the Olin College, a famous college for active learning and PBL, for learning education style. The education style was very unique: for example, students must live in the dormitory, and they can take any subjects from any department regardless their major. This college adopts multidisciplinary education style. The admission policy of the college is "Innovative thinking in a creative environment creates a revolutionary education". The college does not have graduate program because of its policy of focusing on undergraduate education. The education system integrates with active learning and PBL of many subjects. At the first grade, the rate of these subjects to the whole subjects is about 20%, but the senior class achieves over 60% (Kobayashi, S). The Olin College will be attempting to develop their students' thinking mind through the specialized curriculum.

One subject, which was a "Six microbes that changed the world," in a course is explained here as a good example of the Olin College education. According to the syllabus, this subject is an interdisciplinary course and they will use six influential microbes as a window into a rich study of the interactions between science and societal context. This course will connect biological and historical knowledge through discussions, integrated assignments, presentations, and hands-on

laboratory activities (Huang, J). The main target grade was a junior. The course had 39 lectures (3 classes/week) including laboratory work in half a year. The course integrated with lecture and the laboratory experiment. Furthermore, poster presentation was prepared at the last class. Some of poster themes were provided by the lecturer, and the students were able to choose these themes according to their own interest. However, the themes were not novel topics. It seemed important for the students to construct their own strategy and process for their poster presentation.

Our Mission to Activate Global Education in Japan

Nowadays, the introduction of active learning and lectures in English is demanded at many universities in Japan, and acclimation of the situation is required. Almost all Japanese students are nervous when they speak or listen to English. In fact, according to the study of how to incorporate English into engineering undergraduate education (Wijeyewickrema, A), many students rarely speak English, and they will be nervous if they present their study in English. Therefore, improvement of the educational environment is necessary so that our students can confidently participate in the class activities in English utilizing the information acquired from these examples. Also, we should adjust our teaching method.

However, the most important thing is to improve our specialized skills or knowledge for research. If we don't have those skills, even if we can speak English fluently, nobody will have anything to do with us. We must make an effort to develop our specialized skills and improve our students' specialty.

Conclusions

The education style of Olin College is totally different from that of Japanese colleges and KOSEN. On the other hand, QC education system has some similarity to KOSEN, but learning tools were newer than those in KOSEN. Those styles have been introduced to some of our colleges, and will be spread out all over our colleges within 10 years. The purpose of these educational tools and techniques is to generate students' motivation for study, eventually.

We will need to develop and introduce various educational techniques to encourage students, continuously.

Acknowledgements

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Graduation Research Based on Social Implementation Education

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Abstract

In the present higher engineering education, advanced inter-personal communication skills, doing creative thinking and working on complicated problems proactively must be strongly developed. However, such abilities are not developed sufficiently by studying knowledge in scientific and technological contexts and performing experiments and exercises only inside the world of the school. In order to develop such abilities, going through the process of facing real world problems outside the world of the school is necessary. Engineering education introducing this process is called social implementation education in this paper. In colleges of technology (KOSEN), on the other hand, fifth-year or final-year students of the regular course work on graduation research for one year. Therefore, graduation research can be seen as a good opportunity to perform social implementation education. This paper introduces three examples of graduation research based on social implementation education (GRBoSIE), compares GRBoSIE with conventional graduation research and examines the differences between them, and reviews the educational effects of GRBoSIE. In addition, we mention some important points to consider for the future development of GRBoSIE. There seem to be two important things which have to be done as prior education for GRBoSIE. One is that students need to get used to finding problems by themselves and learning willingly and actively. The other one is students must have strong motivation toward social implementation. In order to have motivation, the theory of pedagogy shows that cultivating students' confidence is necessary. Therefore, our department is trying to do special hands on exercises applying microcomputers and electrical circuits. In the hands on exercises, each student has a different goal, that means each student works on designing and making a various small-sized microcomputer system based on his/her interests and ideas. We have seen that having experience of completing their projects through hands on exercises leads to cultivating their confidence.

Keywords: *graduation research, social implementation, motivation, confidence, real world, hands on exercises*

Introduction

We have entered an era where a fundamental change in higher engineering education is required. In this era, advanced inter-personal communication skills, doing creative thinking and working on complicated problems proactively must be strongly developed through engineering education. However, such abilities are not developed sufficiently by studying knowledge in scientific and technological contexts and performing experiments and exercises only inside the world of the school. Going through the process of facing real world problems and trying to solve them is necessary. Engineering education introducing this process is called social implementation education in this paper (e.g. Asano (2014)).

Social implementation education is composed of four steps as follows; firstly, discovering problems in the real world and proposing new devices and services to improve or solve them, secondly designing and making them, thirdly operating them in the real world, and finally getting 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 many times (NIT, Tokyo College (2015)).

In colleges of technology (KOSEN), fifth-year or final-year students of the regular course do one year of graduation research under the guidance of a supervisor in their engineering. Therefore, this graduation research can be seen as a good opportunity to perform social implementation education. This paper, firstly, introduces three examples of graduation research based on social implementation education (GRBoSIE), secondly, compares GRBoSIE with conventional graduation research and examines the difference between them on how to implement this graduation research, thirdly, review the educational effects of GRBoSIE. Finally, we mention some important points to consider for the future development of GRBoSIE.

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Examples of Graduation Research Based on Social Implementation Education

Graduation research based on social implementation education (GRBoSIE) has been performed in our laboratory since 2012, and some examples are introduced here.

Development of a daily activity monitoring system for elderly people living alone:

This theme was set in response to the following suggestion by the supervisors to the students: "Let's work on a problem in the real world, and propose something that will solve the problem and be of use to someone. You can design and make anything you want, but under the condition that you must operate it in the real world. I want you to think about any theme that satisfies this condition."

The students proceeded by setting themes based on that suggestion. They thought long and hard, and decided on the problems of an aging population, which is a huge issue for Japanese society at present. Finally, they focused on the development of a "senior watch system"—a daily activity monitoring system for elderly people living alone. The students tried to develop a system that does not make elderly people feel as if they are under surveillance but also give a sense of security to the family who are watching over the elderly people.

As shown in Fig. 1, a motion-detecting sensor module has been developed by combining a microcomputer, an acceleration sensor, a wireless communication module, and dry batteries in a small box-shaped case. The sensor module can be attached to a living room door (as shown in Fig. 2), toilet door, living room chair, chest of drawers and so forth. The sensor module responds to the movements of the doors, chairs, or drawers during the daily life of the elderly people living alone. The information on what moved at what time is transmitted to a small computer installed simultaneously with the sensor modules within the home. Analysis of that information can reveal the living patterns of the elderly, and if unusual living patterns are detected, family members can be notified by email.

This monitoring system has been developed over a three-year period with improvements added every year. The social implementation of this monitoring system has been carried out in the homes of elderly people in the local community. The students need to build a good relationship with the elderly to install the system and to obtain evaluation of the system at the end of the social implementation. The period of social implementation started at around 2 weeks at first, and was extended to 3 months, and currently has been extended up to 6 months.

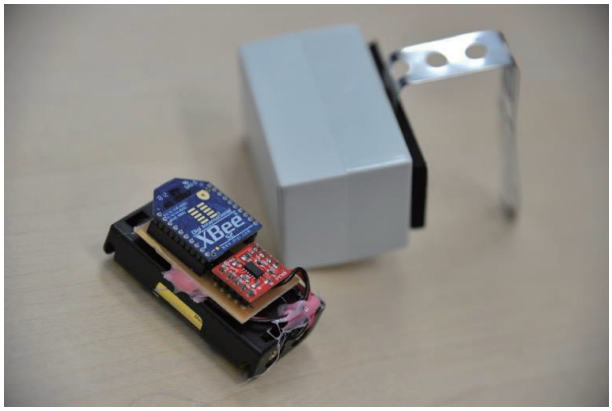


Figure 1 : A motion-detecting sensor module combining a microcomputer, an acceleration sensor, a wireless communication module, and dry batteries, and a box-shaped case to store it



Figure 2 : A motion-detecting sensor module attached to a living room door.

Development of Man–Machine Interface for Severely Handicapped People:

This theme was set as a result of a visit to a care facility for children with severe mental and/or physical disabilities near our school. When several students in our laboratory took a tour of the facility, a therapist working in the facility explained the role of the facility and the services it provides. During the explanation, some of the problems faced by the facility were mentioned. After the tour, several proposals to solve the problems were made through the discussion between the students and the therapist. In the end, one proposal to focus on a patient with a disability of the limbs was picked up. He has a daily routine of watching TV, but has to rely on others to turn the TV's power on/off, or change the TV's channel. Therefore, the development of a switch to turn the TV's power on/off according to the patient's necessity was set as the theme.

Fig. 3 is an example of a switch that has been developed after repeated trial and error. The switch works as follows. Pushing an empty mayonnaise container with a body part causes a change in the air pressure inside the left-side container. If a

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microcomputer in the left-side container detects the change in the air pressure, then it sends a signal to TV using a wireless communication module to switch the TV's power on/off. Currently, improvement is in progress to add a channel-switching function.



Figure 3 : An example of a switch developed for severely handicapped people

Study of a Rehabilitation Effect Measurement Device Using Surface Electromyogram:

This theme was set as a result of our tour of a hospital with a rehabilitation department near our school. Our laboratory has conducted research related to electromyogram (EMG) measurement, and the tour was intended to allow students to observe the actual use of an EMG measurement device in the rehabilitation department, as well as the use of the device by doctors. In the department, rehabilitation was being conducted by a physical therapist; however, an EMG measurement device was not being used, and rehabilitation was being conducted based on the experience and intuition of the physical therapist. When a student in our laboratory asked, "Why isn't an EMG measurement device being used?" the physical therapist replied that the device is expensive, and that the department had a lack of experience looking at EMG or using the device. This student exchanged some opinions with the physical therapist and decided on the theme of developing a cheap and easy-to-operate EMG measurement device specialized for rehabilitation.

Fig. 4 shows a device designed to measure myoelctricity. The number of myoelctricity measurement locations is minimized to keep the cost low, and the measured wave data are recorded and displayed on a laptop. This device was actually tested by the physical therapist in order to gain opinions on its usefulness: opinions gathered included that the laptop was too complex to control, making it difficult to use, and that it might be useful for videotaping the process of measuring EMG.

Further improvements were made in response to the above opinions. The number of buttons on the laptop screen was reduced, and a function to record a webcam videotape was added. The function enables the device to display both the EMG waveform and the process of measuring the EMG simultaneously as shown in Fig. 5.

A device equipped with this function was tested by the physical therapist again, and then applied to a patient during actual rehabilitation. As a result of its use, the patient can monitor the rehabilitation process through the videotape and confirm which part of rehabilitation is insufficient by consulting with the physical therapist. Thus, a cheap device to measure the effect of rehabilitation was realized. Students could also observe this process and thereby identify points how the device could be improved.

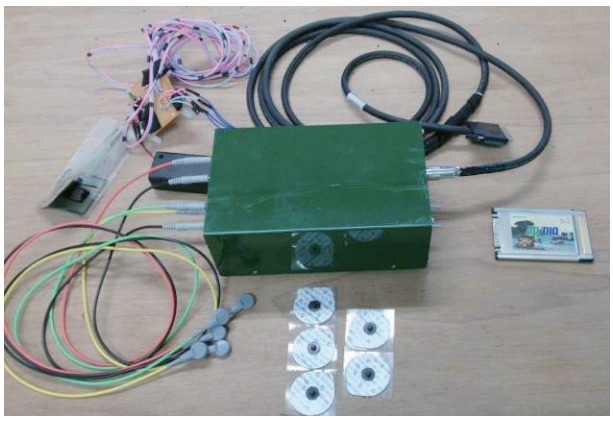


Figure 4 : A Device to measure myoelectricity

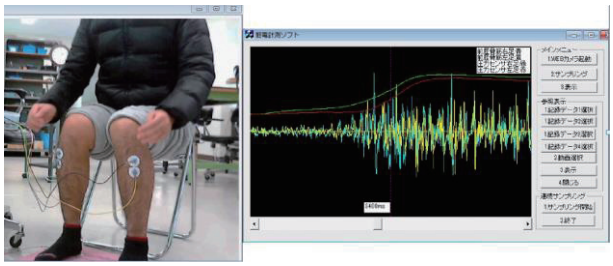


Figure 5 : Simultaneous display of both EMG waveforms and a captured video of rehabilitation.

Difference Between Conventional Graduation Research and That Based on Social Implementation Education

Table 1 presents a summary of the differences between conventional graduation research and that based on social implementation education on how to conduct graduation research; broadly speaking, in the latter, students are required to work proactively from the stage of theme making, because they need to gather information by talking with users, and learn a wide range of knowldge to solve the real world complicated problems. And the responces obtained from users spur the students to work harder.

Table 1 Difference Between Conventional Graduation Research and That Based on Social Implementation Education

	Conventional Graduation Research	Graduation Research Based on Social Implementation Education
How to decide the theme	The supervisor prepares several research themes from his/her specific research field, from which the students make a selection	The students need to have some connections with society, discover problems in the real world, and decide the theme through discussions with the supervisor
Scope of special knowledge to solve the problems	Almost entirely covered by the special knowledge of the supervisor	As two or more fields of special knowledge are needed to solve problems in the real world, the supervisor's specialty alone is therefore insufficient
What to do at the beginning	The course of research activity is mostly guided by the supervisor	The course of research activity is vague
Prior information or investigation relating to the problem	Normally, materials and information relating to the problems are provided by the supervisor at the beginning of the research	The students themselves need to gather information by talking with users to investigate their problems in the real world
Attitude of the students for the graduation research	The students tend to become passive, waiting for instructions from the supervisor	The responses obtained from users in the real world spur the students to work on the graduation research proactively

Effect of Graduation Research Based on Social Implementation Education

Now we would like to look at the educational effects of GRBoSIE from the perspectives of both the students and the supervisors.

What have the students learned from their GRBoSIE? The four students who experienced GRBoSIE were asked the question; "What have you learned from the GRBoSIE?" The following replies were obtained: (1) I have learned the importance of finding out the real needs of the user, and also that what the user says is not always what the user really wants, and the difficulty of knowing what the user really wants. (2) I have learned the importance of processes, such as, actually operating the developed device and system in the real world, obtaining the user's evaluation, and making further improvements. (3) I have experienced the necessity of having a wide range of knowledge without adhering to my own special field.

On the other hand, we supervisors consider GRBoSIE as follows. Its' themes are decided through students' proactive thinking, and there always exist target users in the real world. Therefore, students can always get feedback from the users about the device and/or system designed by themselves. Through this process, students can really feel the relationship between their work and society, and gain an awareness of how they could be useful to others. In consequence, students can maintain high motivation for the graduation research, working on it proactively.

Considering the circumstances mentioned above, it seems that GRBoSIE is a suitable method for developing advanced inter-personal communication skills, doing creative thinking and working on complicated problems proactively.

Discussion: Future Development of Graduation Research Based on Social Implementation Education

From the Perspective of Students:

In GRBoSIE, students are required to work on thinking about the theme proactively. This may seem like a big hurdle for students who are used to being given problems or tasks by supervisors and just solving or completing them. Furthermore, the process of gathering a wide range of information by talking directly with the target users, discovering the problems, proposing new services and devices to solve problems, designing and making them, operating them in the real world, and finally getting feedback from the users, requires strong motivation.

Therefore, there seems to be two important things which should have to be done as prior education for GRBoSIE. One is that students need to get used to finding problems by themselves and learning willingly and actively. The other one is that students must have strong motivation toward social implementation education. According to the theory of pedagogy, the following factors are required for motivation before learning. (1) Attracting students' attention, (2) having them understand the relevance to the learning, and (3) cultivating their confidence that they can accomplish the task if they try. And (4) giving them satisfaction after learning maintains the learning effect. This theory is called the ARCS theory (e.g. Matsuda (2013)).

Applying the theory, the following educational activities, for example, are considered as prior education linking to GRBoSIE. That is, talking about the necessity or significance of social implementation education during daily lectures and experiments/exercises, and explaining how the materials being studied now are related to the social implementation education to be conducted during the final year. Moreover, having students who have already finished GRBoSIE talk to junior students about their experence seems to be effective. The opportunity for junior students to participate in Q&As with students

who have experienced social implementation education should allow the junior students to familiarize themselves with the social implementation education.

In addition, in order to cultivate students' confidence, our department is trying to do special hands on exercises applying electrical and electronic engineering subjects such as microcomputer engineering and electronic circuits. The hands on exercises are performed by making use of experiments or exercises in a schedule of classes. The key point of the hands on exercises is that each student has a different goal, that means each student works on designing and making something based on his/her interests and ideas. An example to practice this kind of hands on exercise is to provide students with the rough instruction to design and make something that entertains people or improves your daily life. In this case, students need to think what to make, and students can decide what to make by themselves. It is not easy for each student to complete his/her project. However, we have seen that having this experience of completing and operating their work based on their interest and idea leads to cultivating their confidence (Aoki (2015), Koike (2011)).



Figure 6 : Hands on exercises using microcomputer and electronic circuits, students design and make something based on their interests and ideas.

From the Perspective of Supervisors:

In contrast to conventional graduation research, the distinctive feature of GRBoSIE is to deal with problems in the real world, where real users always exist. The examples described in this paper were performed in cooperation with the senior's club and rehabilitation facility/hospitals for people with severe mental and physical disabilities near our school. A great amount of cooperation between our laboratory and each institution was required for things like talking to or exchanging opinions with the students from an early stage, or evaluating the developed device/system during the social implementation stage. For the above reasons, supervisors need to build a network to be able to cooperate with local communities, various kinds of institutions outside the world of the school and specialists in other fields.

Furthermore, how to guide students in GRBoSIE differs from the conventional graduation research. Rather than teaching something within the laboratory, as is usually done, it would be more important to have students broaden their outlook, and thus to provide a place or environment where students can face the problems in the real world and put social implementation into practice.

Summary

In this paper, we introduced three examples of GRBoSIE, and compared it with conventional graduation research on how to conduct the research. Then, we mentioned the educational effects obtained through the examples. Consequently, GRBoSIE is a suitable method to develop advanced inter-personal communication skills, doing creative thinking and working on complicated problems proactively. In addition, we consider some key points of the future development of GRBoSIE from the perspectives of both the students and the supervisors. With regard to the former perspective, to provide students with motivation is important in prior education linking to GRBoSIE. As for the latter, each supervisor needs to build a network to be able to cooperate widely with local communities, various kinds of institutions outside the school and specialists in other field.

Acknowledgements

We would like to send our sincere appreciation to all of the people, doctors and therapists in the hospitals and care facilities who have cooperated for our GRBoSIE in the local comunity from the bottom of our hearts.

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HOW MUCH DO JAPANESE CHEMISTRY STUDENTS STUDY?

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Abstract

Organic chemistry is one of core areas of chemistry and also a challenging course for many chemistry major students. We surveyed how Japanese undergraduate students study organic chemistry and what obstacles and requests they have in studying and understanding the subjects. Responses were collected from 807 students at 4 Universities and 4 Colleges of National Institute of Technology (KOSEN). We also conducted the same survey at the University of Memphis to compare with the U.S. students. Japanese undergraduate students spend an average of 0.6 hours per week for 2 hour-lecture class which is far less than expected for a college education standard, whereas the U.S. students spend 7 hours per week for 3 hour-lecture class. In the class at the Univ. of Memphis, they've just started the "flipped classroom method" and this teaching style demands students prepared. This result vouches the report by the Central Council for Education at the Ministry of Education, Culture, Sports, Science and Technology (MEXT). In Japanese Universities, undergraduate students are expected to finish most of their course work by 3rd year and to involve intensively in research at their senior year with their advisors. In curriculum of many universities, the course work is so dense especially for the first and second years that it might take away study time from students. Many Japanese students study organic chemistry by reading textbooks and reviewing their lecture notes rather than solving problems. Grading is mainly based on the mid-term and final exam, and some assignments. The teachers don't give students many quizzes so that they are not urged to study and focus on the materials. Moreover the graded exams and the answer keys are seldom given back to students. So they cannot know what their problems are. Despite their lack of study hours and passive style of studying, many Japanese students made comments that they want to learn the subjects and need the feedback and the answer keys of exams and homework assignments.

Keywords: *organic chemistry, undergraduate students, study hours, student engagement, understanding level*

Introduction

According to the Japanese University Establishment Standards, one Academic credit hour represents 45 hours of studying the subject including direct faculty instruction in class and student preparation time. Although the institutions can determine the amount of students' work per credit hour, most universities adopt the composition of 15 hours of lecture and 30 hours of student preparation. At the Colleges of National Institute of Technology (KOSEN), the lecture time may account for more than half in 45 hours.

The Central Council for Education of MEXT reported the Japanese college students need to increase their study hours up to the international level (2013). Many believe that science major students study relatively harder than non-science major students in Japan. We have conducted the survey of chemistry major students at 4 (2 National and 2 private) universities and 4 KOSEN colleges about how they study organic chemistry from 2010 to 2014. Responses were collected from 807 students. We also conducted the same survey of 91 students at the University of Memphis, Tennessee.

Study Survey

The survey is paper-based and has 8 questions which enable the students finish within 10 min so that it can minimize interference of the lecture time. At the University of Memphis, the instructor gave the students who answered the survey extra points to their final exam. The questionnaire is as follows:

Q1. Please rate your level of understanding of the Organic Chemistry course content? Circle the number of scale 1 to 6.

Q2. On average, how many hours per week do you spend studying for this course?

Q3. How much do you use your textbook including solution manuals to study Organic Chemistry? Circle the number of scale 1 to 6.

Q4. When you have questions during studying Organic Chemistry, you usually

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☐ Do nothing. ☐ Read textbook or other books.
☐ Ask friends. ☐ Go website.
☐ Ask instructors. ☐ Ask TAs.
☐ Others ( )

Q5. Do you think quizzes during the course are helpful for your understanding Organic Chemistry?
☐ Yes ☐ No ☐ Not sure

Q6. How do you allocate your study hours for Organic Chemistry? Please specify some of them.

Q7. What difficulties do you think there are when you study Organic Chemistry?

Q8. Please identify any helpful features of the Organic Chemistry course to improve your understanding.

Results and Discussion

Study Hours

All the Japanese universities and colleges at which we conducted the survey have a 2-hour organic chemistry lecture per week. The actual lecture time varies from 90 to 100 minutes. At the University of Memphis, they have 85-minute lecture twice a week which is equivalent to 3 hour lectures per week. The study hours mean how many hours the student spends for studying for organic chemistry lecture every week. That doesn't include the lecture time itself nor the study time in the summer vacation and spring break.

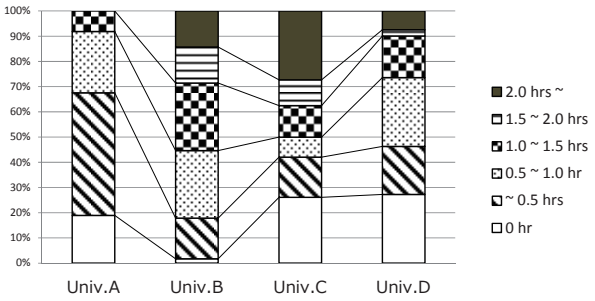


Figure 1. Study Hours of Japnaese University Students

Fifty percent of Japanese university students spend less than 1 hour to study organic chemistry for 2-hour lecture. These are so-called reputable, high ranked universities in Japan. Another aspect which we cannot ignore is the portion of students who don't study at all. On the other hand, the average of study hours of American students at the Univ. of Memphis was 7.1 hours per week and there was no student who doesn't study at all for the lecture. Seven point one hour is more than twice as long as the lecture time and this meets the University standards.

The KOSEN students spend even less hours than the university students. Majority of KOSEN students spend less than 30 minutes for 2-hour lecture and about 30 % of students don't study at all. At KOSEN colleges, their academic curriculum challenge to finish the 3 year high school and 4 year college education in 5 years. They have about 40 hour lectures per week (8 hour lectures every day) which is similar to high school. They study the same advanced science materials as the universities, but physically they don't have enough time to prepare for all the courses. While the university students cooperated in this survey are sophomores and they are around 20 years old, KOSEN students are in the third year and most of them are 18 years old.

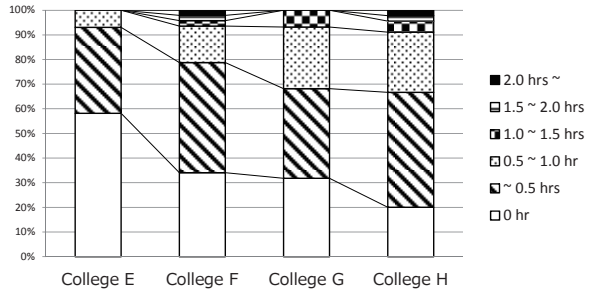


Figure 2. Study Hours of College (KOSEN) Students

Understanding Level

The survey asked the students to rate their own understanding level of the course content ranging 1 to 6. The number 1 means he or she doesn't understand at all and the number 6 means he or she understands very well. Figure 3 shows the ratio of students who marked 1 to 3, which means they don't understand well and who marked 4 to 6, which we categorize that they understand relatively well. The many students of University B spend the longer hours among four universities and show the highest portion of saying they understand course content well.

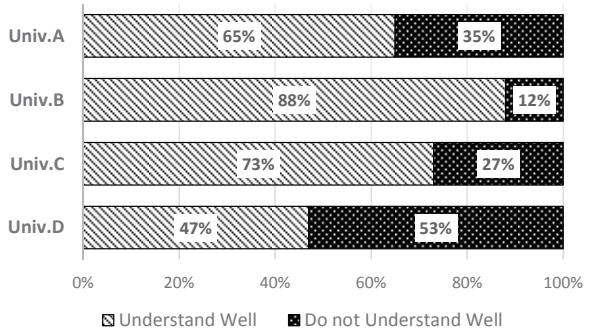


Figure 3. Understanding level of University Students

In the case of the KOSEN colleges, there was not obvious correlation between the study hours and their understanding level. One possible reason might be the difference of their scholastic ability and spending more time in studying doesn't necessary result in better understanding the materials.

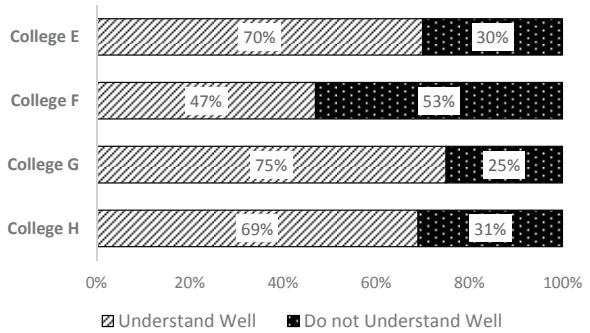


Figure 4. Understanding level of College Students

Textbooks

The designated textbooks were used at Organic Chemistry classes of the Universities and Colleges surveyed (Table 1). At three KOSEN colleges, they use less paged, short course textbooks.

Table 1. Organic Textbooks

Institutions	Textbook
University A	McMurry
University B	Clayden, Greeves, and Warren
University C	Vollhardt and Schore
University D	Vollhardt and Schore
College E	McMurry*
College F	Hart*
College G	McMurry
College H	Bruice*

*short course textbook

Many students cannot understand the lecture by just attending the class. They need to read the textbook carefully in order to complement their understanding the materials. Figure 4 shows the correlation between the usage of textbook and the understanding level. The more students read textbook, the more they understand the lecture.

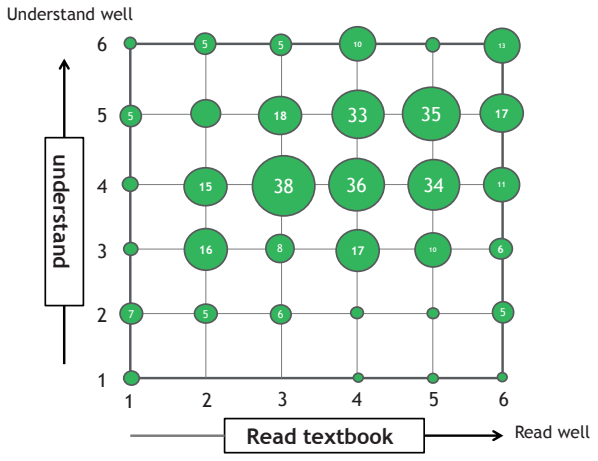


Figure 5. Reading textbook helps understanding the lecture

Study Style

How do students usually study organic chemistry? Most Japanese students reported that they study organic chemistry by reading textbooks, reviewing notebooks, and trying to solve some problems in textbooks. On the other hand, the students at the Univ. of Memphis reported doing homework and assignments are the main part of their study. It seems that Japanese students spend the most of time in digesting the lecture materials and the American students spend more time in solving the problems. The class of the Univ. of Memphis has just started the flipped classroom. In the flipped class, the students are required to see the short lecture video in advance to grasp the concept of the next lecture. In the classroom, the instructor don't spend much time to explain the content but rather focus on making students think about the approaches to solve the problems. Does the difference of study hours come mainly from the flipped class method? It is true that active learning such as flipped classroom demands dedication and more hours of studying. According to Smith and Jacobs (2003), however, the organic chemistry students reported that spending an average of 5.8 hours per week for 3-hour lecture. They spend 3.3 hours for reading textbooks, 2.1 hours for solving problems and 0.4 hours for web site and it is before the trend toward flipped classroom.

Organic chemistry is a dense, content-filled subject and the many students are easily drowned in the sea of information and try to memorize them at random. Reading textbook and reviewing notebooks are passive ways of studying. Shifting to solving problems is necessary for Japanese students to learn more actively. In the United States, the instructor provide the plenty of assignments and quizzes during the semester to make students study. Teaching assistants (TAs) always help the instructor to reduce the teaching heavy load. In Japan, we have rarely see the TAs working at colleges and universities because of the limited budget in education.

Comments and Requests

Students' comments and requests on the lectures were also collected in the survey. There are little difference of teaching styles in Japanese colleges and universities. Some instructors use PowerPoint but most of them prefer the classical style using chalk and blackboard. Surprisingly there are no negative comments from the students on their teaching styles. Many university students complain there are not enough practices during the lectures and no answers of problems provided. This is a typical situation seen at universities in Japan for many years that the graded assignments or exams are not returned to the students. The students cannot verify their answers right or not. One reason is a concern that everybody would make photocopies of problems and solutions. The instructors are afraid of being unable to use the problems in the next year.

The textbooks they use are originally written in English and translated to Japanese. The study guide and solution manuals are available in bookstores but they are not written in Japanese and the prices are as high as the textbooks. The university students also made comments of teaching assistants. They want to have TAs to ask questions without reserve. The professors are not accessible for many students.

On the other hand, at the KOSEN colleges, the physical and psychological distance between the professors and students are much less than universities. That might be resulting in no request of TAs appeared on the survey. The instructors at KOSEN try to give more practices and quizzes to students to improve their understanding. Some of them answered that they review the quizzes before exams.

In the details of organic chemistry, the many students of both the universities and the KOSEN colleges feel the difficulty of understanding reaction mechanisms. Memorising thousands of pieces of information doesn't help much to understand the mechanisms of organic chemistry. They cannot get used to draw the curved arrows describing the movement of electrons which is a key tool to rationalize the each reaction.

Conclusions

The students survey revealed the fact that Japanese chemistry students spend hours far less than expected by the University Establishment Standards. On the other hand, we found American students study the same subject several times longer than Japanese students. There are several possible factors and reasons why Japanese students don't study. The biggest one is that universities haven't provided the good study environments which force them to study. Proper amount of homework and quizzes, the feedback of exams and assignments are essential to encourage students to study materials.

While Japanese university forget making students busy, the KOSEN colleges may need to explore the different approaches. They are already busy working on reports and assignments. The students need to use their limited time effectively and focus on the essential topics rather than cover all the details.

The survey also told us that the students have eagerness to learn organic chemistry in their mind although they don't spend enough time to study for now. It is time to think the environments of higher education more seriously in order to keep proud of being one of the greatest countries in science and technology.

Acknowledgements

We thank all the students and professors to cooperate with our survey.

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SOME ARRANGEMENTS FOR INCREASING ADVANCED COURSE STUDENT'S MOTIVATION AT THEIR RESEARCH

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Abstract

KOSEN (Colleges of Technology) is one of the higher education facilities in Japan. KOSEN has Advanced Course and the students can earn bachelor's degree from the National Institution for Academic Degrees and University Evaluation (NIAD-UE). But KOSEN does not have a graduate school. The advanced students go to graduate schools of other universities if their will to learn and to research more is there. We dedicate an engineering education via "Research Projects" at the advanced course. The advanced students make their research by themselves, get a lot of knowledge that is needed for their research and learn how to think at a research. Their engineering senses are built in the process. We arrange some works for increasing the student's motivation at their research. The arrangements are an extracurricular activities "Mecafe (Mech. Cafe)" for 1st-4th year regular course, "Oral presentation at KANSAI branch conference for students of the Japan Society of Mechanical Engineers (JSME)" for 5th year regular course, "Member of steering committee for the JSME KANSAI branch Student Association", "Project assistant of a short term exchange student", "Oral presentation at international conference" and "Explainer at exhibitions" for the advanced students. The all arrangements aim to give the students opportunity to communicate with a lot of people through making presentation about their research results and mechanical engineering topics which they found out by themselves. If they could translate their thought to other people in this opportunity, the experience leads to increasing their motivation for research. A total of 29 mechanical engineering students of Nara College made presentation at KANSAI branch conference for students of the JSME during the past 5 years. Three students got "Best Presentation Award (BPA)" at the conference. All of them entered the 3rd year regular course of universities and went on to graduate schools. KANSAI branch conference for students of the JSME is conducted by the JSME KANSAI branch Student Association. A total of 18 mechanical engineering students of Nara College sat the steering committee during the past 5 years. Percentage of who went on to graduate schools of its students increase every year.

Keywords: *Student motivation, Advanced student, Presentation, Research Projects, Graduate school*

Introduction

KOSEN (Colleges of Technology) is one of the higher education facilities in Japan. KOSEN has Advanced Course and the students can earn bachelor's degree from the National Institution for Academic Degrees and University Evaluation (NIAD-UE). But KOSEN does not have a graduate school. The advanced students go to graduate schools of other universities if their will to learn and to research more is there. The feature of KOSEN is "early engineering education". The students are from 15 years old to 20 years old in the regular course and from 21 years old to 22 years old in the advanced course. The curriculum of the regular course is almost same to that of the universities. We dedicate an engineering education via "Research Projects" at the advanced course. Because graduation research increase student's motivation (S.Kono, H.Hamada, K.Oowada, R.Saeki and J.Yoshino, 2012). The advanced students make their research by themselves, get a lot of knowledge that is needed for their research and learn how to think at a research. Furthermore their engineering senses are built in the process. It will lead to their jobs as engineers in future. Therefore, we arrange some works for increasing the student's motivation at their research. The all arrangements aim to give the students opportunity to communicate with a lot of people through making presentation about their research results and mechanical engineering topics which they found out by themselves. In this paper, we thought about the effects of the arrangements.

Arrangements for increasing the student's motivation

Numbers of students who go to advanced course is not many. We have arranged some works depending on each year student as shown in Table 1. Because we think that a lot of times need for increasing the student's

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motivation. We mainly discussed the arrangements for the advanced students and the effect in this paper.

Table 1 Arrangements for increasing student's motivation

School year	Arrangements
1st-4th year regular course	Mecafe (Mech. Cafe)
5th year regular course	Oral presentation at KANSAI branch conference for students of the Japan Society of Mechanical Engineers (JSME)
Advanced course students	Member of steering committee for the JSME KANSAI branch Student Association
	Project assistant of a short term exchange student
	Oral presentation at domestic conference and international conference
	Explainer at exhibitions

Mecafe (Mech. Cafe): This arrangement is an extracurricular activity for 1st-4th year students. In the activities, the students can realize their will for manufacturing something (Y.Taniguchi, M.Ozaki, T.Sasayama, H.Shimada, T.Inoue, K.Kodama and H.Fukuoka, 2014). Motivation which grew in the wake of the activities has led to research activities of the students. Some students became to have will for studying mechanical engineering more. Some of them went to universities or the advanced course.

Oral presentation at KANSAI branch conference for students of the Japan Society of Mechanical Engineers (JSME): This conference is the first chance for the students of KOSEN to make a presentation at a domestic conference of a society. The presentation topic must be their graduation research. Therefore almost presenters are 4th year student of universities in KANSAI area of Japan. In case of KOSEN, 5th year student and 2nd year of advanced course students can submit to the conference. It is basically for 5th year student in department of mechanical engineering, Nara College.

A total of 29 mechanical engineering students of Nara College made presentation at the conference during the past 5 years. Three students got "Best Presentation Award (BPA)" at the conference. Figure 1 shows a scene that one of them made a presentation. All of them entered the 3rd year of universities and went on to graduate schools. BPA seems to be one of the motivations for the graduation research.

Member of steering committee for the JSME KANSAI branch Student Association: KANSAI branch conference for students of JSME is conducted by the JSME KANSAI branch Student Association. The association consists of graduate students of universities in KANSAI area of Japan and students of KOSEN. In Nara College, some of the advanced students become the members of the steering committee. A total of 18 mechanical engineering students of Nara College sat the steering committee during the past 5 years. Numbers of the steering committee members of Nara College are shown in Figure 2.



Figure 1 A scene that a recipient of BPA made a presentation at KANSAI branch conference for students of the JSME.

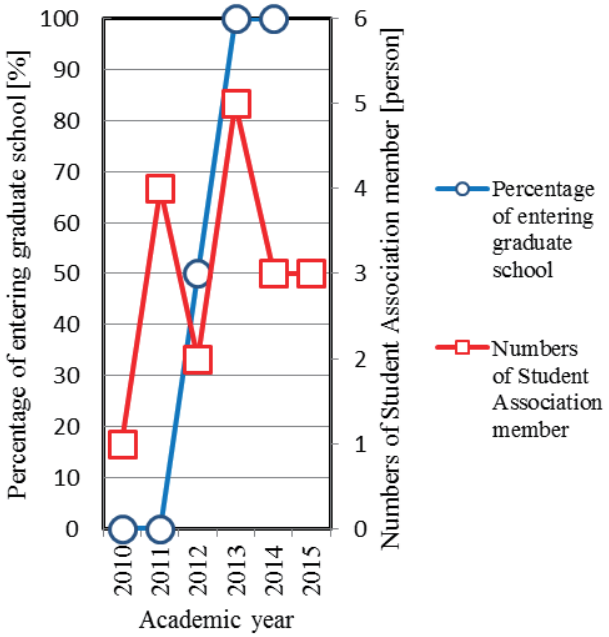


Figure 2 Numbers of JSME KANSAI branch Student Association and the percentage of entering graduate school in case of Nara College.

Exhibition of "MechaLife World" is managed by the Student Association too. The exhibition is held in Kobe every year. A lot of children come to the exhibition every time and they enjoyed to touch and watch some machine elements and to make some toys concerned with mechanical engineering. The steering committee members made a presentation about the topics and helped the children to make the toys. The steering committee members seem to have a fun through these experiences. Their interesting for mechanical engineering become strong and the motivation to their research activities seem to grow up.

The meetings of the steering committee were held about 8 times a year. The advanced students talked with a lot of graduate students in the meetings. So the

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advanced students had a wide perspective and their will to learn and to research more. As shown in Figure 2, percentage of who went on to graduate schools of its students increase every year.

All the members of Nara College got the contribution award from the JSME during past 5 years. The members of two academic years are as shown in Figure 3.



(a) Academic year 2013



(b) Academic year 2014

Figure 3 Advanced students who were the members of steering committee of the JSME KANSAI branch Student Association got the contribution award.

Project assistant of a short term exchange student: Nara College accepted two short term exchange students last year for the first time. One of them made a research about a manufacturing design with CAE. Some advanced students assisted him as shown in Figure 4.

The short term exchange students cannot speak Japanese. So the language of their communication is English. Some international students come to 3rd year of Nara College every year even until now. The international students can speak Japanese. So the language of their communication is Japanese. The situation that there were short term exchange students needs to speak English. It was better for the students of Nara College.



(a) Exchange student and advanced students.

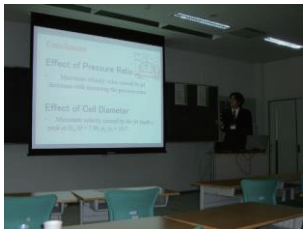


(b) Exchange students in The Exhibition of "MechaLife World"

Figure 4 Short term exchange students and the students of Nara College.

Oral presentation at domestic conference and international conference: Total numbers of oral presentations at domestic conferences are 10 during past 2 years. Total numbers of oral/poster presentations at international conferences are 16 during past 5 years. Four cases are shown in Figure 5. An advanced student who made a presentation at an international conference in Okinawa in 2011 got "Young Scientist Award". An advanced student who made a presentation at a domestic conference in 2014 got "Student Best Presentation Award". Such awards contribute to the improvement of the student's motivation for their research activities.

Explainer at exhibitions: We participate in the exhibition about once a year. Students create a panel of their own research and explain it at the exhibition. The scene that an advanced student explained her research and her experience at an international conference is shown in Figure 6.



(a) 1st year advanced course student had an oral presentation in Oki-nawa, 2011.



(b) 1st year advanced course student had an oral presentation in Spain, 2013.



(c) 2nd year advanced course student had an oral presentation in Nara, 2014.



(d) 2nd year advanced course student had an oral presentation in Thai-land, 2014.

Figure 5 Oral presentations at international conferences.



Figure 6 1st year advanced course student explained her research and her experience at an international conference in KOSEN girls forum.

Conclusion

We think that continual arrangements has improved student motivation.

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EXAMINING LEARNING APPROACHES AND SELF-DIRECTION IN LEARNING: THE CASE OF FIRST-YEAR ENGINEERING STUDENTS IN A PROBLEM-BASED LEARNING CONTEXT

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Abstract

This study aims to examine students' approaches to learning and self-direction in learning as they transition to a Problem-based Learning (PBL) environment. A total of 122 first-year engineering polytechnic students on completion of one semester of study participated in a survey. Overall, the students rated their use of the deep approach lower than the surface approach to learning. The deep approach to learning was found to be positively and significantly correlated with self-direction in learning. The deep approach to learning was also found to be a significant predictor that discriminated students with high and low self-direction in learning. The study findings shed light for educators that while the PBL could potentially promote deep approach to learning and high self-direction in learning among students, it takes time and students need to be well supported to develop these learning characteristics when making the transition to the PBL environment. Implications for practice, along with future research directions are discussed in the paper.

Keywords: *Learning approaches, self-direction in learning, problem-based learning, engineering, polytechnics*

Introduction

Recent reports on engineering education are recommending teaching and learning approaches that equip engineering graduates with the desired competencies to meet the challenges of the 21st century (Jamieson & Lohmann, 2009; Sheppard, Macatangay, Colby, & Sullivan, 2009). Engineering graduates today must be self-directed, flexible and life-long learners to avoid having obsolete technical skills and knowledge. Faced with complex, multifaceted problems in the world, engineering graduates also need to be effective problem solvers with deep and long lasting conceptual understanding, skilled communicators and team players.

Towards this end of producing engineering graduates with the desired competencies, it is worth examining the learning characteristics among engineering students in a polytechnic that employs problem-based learning as its main pedagogical approach, which is believed to promote the deep approach to learning and high self-direction in learning (Dolmans, Wolfhagen, & Ginns, 2010; Schmidt, 2000).

Literature Review

Deep and surface approach to learning

Approaches to learning refer to what students do when they go about learning and why they do it. Marton and Säljö (1976) were one of the first to introduce the distinction between the deep and surface approach to learning. In the deep approach, the learner intends to understand, relates new ideas to previous knowledge, supports conclusions with evidence and examines the logic of arguments. The learner has an intrinsic motivation to learn, with intellectual curiosity rather than external reward driving the efforts. In the surface approach, the learner intends to complete task requirements and memorises information needed for assessments. The learner exhibits an extrinsic motivation to learn, such as learning in order to pass a test, to graduate or get a good job (Entwistle & Peterson, 2004).

A number of studies (Meyer, Parsons, & Dunne, 1990; Prosser & Millar, 1989; Ramsden, 2003) showed that the deep approach to learning contributed to the desired learning outcomes. Ramsden (2003) found longer information retention in tertiary students who took the deep approach to learning, as the information was learnt in context rather than by rote memorisation. Prosser and Millar (1989) found that first-year physics students who adopted the deep approach showed significant progress in the conceptual understanding of force compared to those using the surface approach, while Meyer, Parsons, and Dunne (1990) reported that engineering students who adopted a deep approach were more likely to pass the course compared to those using the surface approach.

Self-direction in Learning

Self-direction in learning had been widely researched in adult education (Candy, 1991; Knowles, 1975; Long & Agyekum, 1983). A recent conceptualisation of self-direction in learning by Brockett and Hiemstra (1991) proposed that both the characteristics of the teaching-learning transaction (self-directed learning) and the characteristics of the learner (learner self-direction) function together within the learner's social context, and contribute to the outcome

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of self-direction in learning (SDL). The Personal Responsibility Orientation (PRO) model was later operationalised in an empirical study by Stockdale and Brockett (2011) to develop a validated 4–factor scale to measure self-direction in learning. Stockdale and Brockett (2011) identified the SDL factors as control, initiative, motivation and self-efficacy. In the PBL literature, Schmidt (2000) described SDL as the "preparedness of a student to engage in learning activities defined by him- or herself, rather than by a teacher" (p.243). Clearly, the current ideas of self-direction in learning are important and play a crucial role in the PBL process.

Linking self-direction in learning and learning approaches in PBL

While there are numerous studies on learning approaches of students in the PBL context (e.g. Dolmans et al., 2010; Groves, 2005; Tiwari et al., 2006) and self-direction in learning in PBL (e.g. Blumberg, 2000; Loyens, Magda, & Rikers, 2008; Sungur & Tekkaya, 2006), few studies examined the link between learning approaches and self-direction in PBL environment, particularly in the engineering discipline. Studies of PBL with medical undergraduates (Kek & Huijser, 2011) and nursing students (Ali & El Sebai, 2010) reported that learners with the deep approach to learning also exhibited higher self-direction in learning.

Learning approaches of first year students in PBL environment

PBL is a departure from previous educational contexts for many first-year polytechnic students in Singapore. Other studies (e.g. Vardi & Ciccarelli, 2008) highlighted hurdles for students new to PBL to change previous habits of learning and to cope with the demands of greater ownership of learning. In studying the transition of first-year students to higher education, Donnison and Penn-Edwards (2012) found stronger tendencies for the surface approach, where assessment is a strong motivator for learning, and students' learning strategies shaped by their previous schooling experience.

Besides the learning context and students' characteristics, it was found that students' perceptions of excessive workload, unclear course goals and relevance of assessments that focused on reproducing information drove students towards surface approach to learning (Baeten, Kyndt, Struyven, & Dochy, 2010). While deep approach to learning is valued, Gijbels, Segers and Struyf (2008) cautioned that any interventions to promote deep learning takes time, especially if the initial approach to learning adopted by students is strongly surface. In a study of polytechnic students, Choy and Lim (2012) found that a notable increase in adopting the deep approach to learning occurred only after two or more semesters of study.

There is currently a lack of studies on the learning characteristics of engineering students as they transition to polytechnic education in Singapore. Thus, this study aims to fill a gap in the literature by examining the learning approaches of first-year engineering students and investigating any relationships with self-direction in learning.

Research Questions

Based on the literature review, the following research questions were formulated and guided the data analysis in the study:

(a) What are the reported deep and surface approaches to learning among first-year engineering students?
(b) Are there relationships between deep and surface approaches to learning and self-direction in learning?
(c) Can first-year engineering students with low and high self-direction in learning be distinguishable by their deep and surface approaches to learning?

Methods

Sample

The sample for this study consisted of 122 first-year engineering students from three aviation engineering diplomas who had completed a semester of study in a polytechnic. Among them, 101(82.8%) were males and 21 (17.2%) females, with a median age of 18.5 years.

Instruments

The questionnaire comprises a 20-item Revised Two-Factor Study Process Questionnaire (R-SPQ-2F) developed by Biggs, Kember, and Leung (2001) with items scored on a 5-point Likert scale, ranging from 1 (never or rarely true of me) to 5 (always or almost always true) and the 25-item Personal Responsibility Orientation to Self-Direction in Learning Scale (PRO-SDLS) developed by Stockdale and Brockett (2011) with items scored on a 5-point Likert scale, 1 (strongly disagree) to 5 (strongly agree). Demographic data such as gender, age and types of diploma were also collected in the questionnaire.

Data Collection

The data were collected using an online questionnaire, administered by the lecturers in class. All participants were informed of the purpose of the study, that their participation is strictly voluntary and they have the right not to participate in the study. Respondents took about 20 minutes to complete the questionnaire.

Ethics

Ethics approval for the study was obtained from the Institutional Ethics Review Committee. The approved research protocol included informed consent by the participants and de-identified data for analysis.

Results and Discussion

Data from the questionnaires were analysed using SPSS 18.0 and AMOS 18.0. The R-SPQ-2F data were subjected to an exploratory factor analysis, with principal components factor analysis of the 20 items using varimax rotation. Results from the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.80,

above the recommended value of 0.6, and the Barlett's test of sphericity was significant ($\chi^2(120) = 661.46$, $p < 0.01$), providing support for the factorability of the data. To select and retain items in the scale, we removed items of factor loading less than 0.5, and those on cross-loadings with other items on the factor. This resulted in a 2–factorial structure comprising 16 items for measuring deep and surface learning approaches, accounting for 46% of the total variance. A confirmatory factor analysis was conducted to validate the factorial structure of the scale for measuring learning approaches. The model fit indices (χ^2/df = 1.29, CFI = 0.95, TLI = 0.94, GFI = 0.90, RMSEA = 0.049) indicated the 2–factor model was empirically sound.

Our initial analysis of all 25 items' scores in the PRO-SDLS found that many students misinterpreted the 11 negatively worded items. Thus, these negatively worded items were excluded from further analysis, and the remaining items analysed using corrected inter-total correlations. An overall score of self-direction in learning (SDL), comprising selected items from the four SDL factors of control, initiative, motivation and self-efficacy, was computed for each student.

Descriptive statistics consisting of the mean and standard deviation, reliabilities and correlations among the study constructs are shown in Table 1. Cronbach's alphas (α) of the surface approach, deep approach and self-direction in learning constructs ranges from 0.79 to 0.83, above the acceptance level of 0.70 (Nunnally, 1978), indicating high internal consistency reliabilities.

The surface approach to learning items had mean scores ranging between 2.87 and 3.83. On examining the individual items, high scores greater than the mid-point of 3.00 on the 5-point Likert scale were found in items on surface motive, such as "I see no point in learning material not likely to be in the test" (M = 3.83, SD = 0.80) and surface strategy items, such as "I learn some things by rote, going over and over until I know them by heart even if I do not understand" (M = 3.52, SD = 0.81). The scores suggested that the majority of first-year students' learning was driven by assessment. It is possible that these students employ learning strategies acquired in their previous education before enrolling in the polytechnic. This finding is consistent with other studies on first-year students' transitioning to higher education (Donnison & Penn-Edwards, 2012; Wingate, 2007).

The deep approach to learning items had mean scores ranging between 2.17 and 3.06. A closer examination revealed that scores for items on deep strategy for learning were low, for examples, "I make a point of looking at most of the suggested readings that go with the lessons" (M = 2.17, SD = 1.04) and "I find most new topics interesting and often spend extra time trying to obtain more information about them" (M = 2.51, SD = 1.05). This suggested that first-year students did not carry out or follow through their deep learning strategies by spending time on suggested pre-readings and researching for more information. A study by Case and Marshall (2004) supported such possibility, where first-year students were found to be limited by their inexperience and inability to show all characteristics associated with taking the deep learning approach (McCune & Entwistle, 2000).

Table 1 shows the correlations among constructs. The surface approach to learning was found to be negatively correlated with deep approach to learning (r = – 0.17) and self-direction in learning (r = – 0.09), and not significant. Deep approach to learning was however, positively and significantly correlated with self-direction in learning (r = 0.61, $p < 0.01$). One plausible reason is that PBL uses authentic problems as contexts for learning, where engineering students are motivated not only to seek the knowledge that is needed to respond to the problem, but also spending time to understand the information well enough before applying it. This finding on the positive relationship between deep learning and self-direction in learning is consistent with other studies in the nursing and medical disciplines (Ali & El Sebai, 2010; Kek & Huijser, 2011).

Table 1 Descriptive statistics, reliabilities and correlations among constructs (N = 122)

	Variables	Descriptive Statistics		Reliabilities	Correlations		
		M	SD	A	(1)	(2)	(3)
(1)	Surface Learning Approach	3.43	0.56	0.83	–	- 0.17	- 0.09
(2)	Deep Learning Approach	2.72	0.74	0.81		–	0.61**
(3)	Self-Direction in Learning	2.77	0.66	0.79			–

Note: **$p < 0.01$

To determine if first-year engineering students with low and high self-direction in learning were distinguishable by their deep and surface approaches to learning, the students were categorised into low and high self-direction in learning (SDL) groups based on their overall mean scores in the sample. Students with low SDL were those with scores less than and equal to 2.77, and students with high SDL had scores more than 2.78. The two SDL groups were then plotted on a scatterplot with the surface approach to learning scores on the vertical y-axis and the deep approach to learning scores on the horizontal x-axis as shown in Figure 1. One pattern that emerged from the scatterplot was that students with high SDL tended to be high in deep approach in learning (right half of the scatterplot). Hence, this pattern needed to be examined closely by performing a discriminant analysis.

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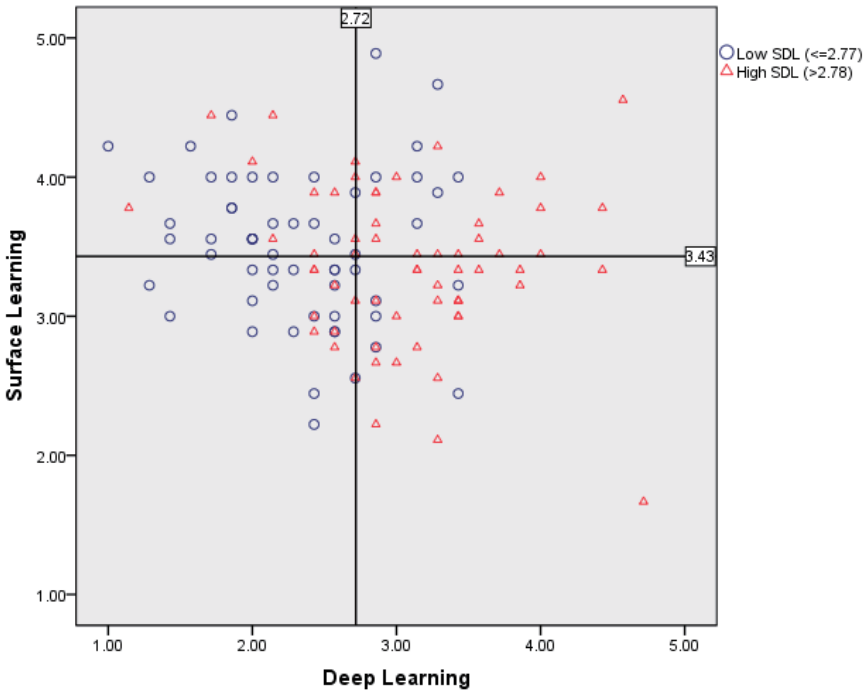


Figure 1. Scatterplot of SDL groups and learning approaches

The mean and standard deviation of the surface and deep approach to learning scores in each SDL group are shown in Table 2. The difference for the mean surface approach to learning scores for the 2 SDL groups was found to be small (0.14) and not significant. However, the difference for the mean deep approach to learning scores between the 2 SDL groups was relatively large (0.76) and significant (Wilks' $\lambda = 0.732$, $p < 0.01$), as shown in Table 3.

These findings allowed us to proceed with the discriminant analysis by determining how well we could predict the group membership (high versus low SDL groups) based on the predictor variables of surface and deep approach to learning. The resulting discriminant function showed differentiation between students in the high and low SDL groups (Eigenvalue = 0.370, Wilks' $\lambda = 0.730$, $\chi^2(2) = 37.42$, $p < 0.01$) with the deep approach to learning as a strong and significant predictor (standardised coefficient = 0.986) as shown in Table 3).

Table 2. Means and standard deviations of predictor variables in the low and high SDL groups

Groups	Predictor variables	M	SD	N
Low SDL (≤ 2.77)	Surface Learning Approach	3.50	0.54	59
	Deep Learning Approach	2.32	0.59	
High SDL (> 2.78)	Surface Learning Approach	3.36	0.56	63
	Deep Learning Approach	3.08	0.61	

Table 3. Significance of predictor variables and discriminant function coefficients

Predictor variables	Wilks' λ	Standardised canonical discriminant function coefficients
Surface Learning Approach	0.984	–0.085
Deep Learning Approach	0.732*	0.986

*$p < 0.01$

The accuracy of the discriminant function's prediction was tested, and the results in Table 4 showed that 73% of the original cases were correctly classified as low or high SDL based on their learning approaches scores. This was very close to the acceptable predictive accuracy level of 75% or better for a discriminant function, and much higher than the 50% chance prediction with two predictor variables (Burns & Burns, 2008).

This result is significant as it can predict whether a student is likely to have high or low self-direction in

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learning based on his or her reported score on learning approaches. Where students are found to be low in deep learning approach and low in self-direction in learning, appropriate intervention can be devised to assist these students in their learning.

Table 4. Classification results using the discriminant function

Levels of performance		**Predicted group membership**		
		low SDL	**high SDL**	**Total**
Original Count	low SDL	43	16	59
	high SDL	17	46	63
%	low SDL	72.9	27.1	100.0
	high SDL	27.0	73.0	100.0

Note: 73.0% of original grouped cases correctly classified.

Implications for Practice

Based on the findings discussed above, the following are some key instructional strategies that can be adopted by lecturers to develop deep approach and higher self-direction in learning among students during PBL lessons:

(a) *Support students to construct their understanding and changing their conceptions of learning.* Lecturers could focus on how students arrive at their answers by asking them to articulate their understandings, and giving feedback on the progress of students' learning.

(b) *Evaluate the amount of students' workload, clarity of learning goals and how students are assessed.* Feedback can be sought from students by the lecturer during the course on whether students' workload is perceived as excessive, learning goals are unclear, and assessments are perceived to focus on reproducing information rather than understanding and application.

(c) *Develop learning support strategies that focus on building students' self-efficacy.* Learning activities and questions to scaffold understanding of concepts can be employed by lecturers to help students build self-confidence. Flipped learning approach can be integrated with the PBL process, where students acquire some prior knowledge through pre-readings before attending the class to discuss and apply their knowledge, and thus building self-efficacy that they can successfully learn on their own.

Limitations and Future Research

This study has a few limitations which should be highlighted. First, the study involves a particular cohort of first-year aviation engineering students' self-reported learning approaches and self-direction in learning. Thus, the findings might not be generalisable to other first-year engineering students. Future research could include a larger sample of first-year students in other engineering diplomas. Second, the current study provides a snapshot of the students' approaches to learning and self-direction in learning in a PBL environment. A longitudinal study to examine changes in these learning characteristics over the academic years with the same cohort of engineering students is another worthwhile area for further study. Third, since students' perceptions of academic quality on workload and assessment could influence how students choose to study based on previous study (Baeten et al., 2010) a qualitative study employing focus group interviews to gain more insights into the reasons and motivations for first-year students adopting particular learning approach is worth undertaking.

Conclusion

This study is an attempt to examine the learning approaches and self-direction in learning of first year engineering students. The findings suggested that after one semester of study in a PBL environment, students still rated their use of the deep approach to learning lower than the surface approach to learning. The self-direction in learning was positively and significantly correlated to deep approach to learning but not to surface approach to learning, and high self-direction in learning tendencies could be predicted in students who predominantly adopted the deep approach to learning.

Overall, the findings show that immersing first-year students in a learner-centred environment such as PBL might not quickly result in the students adopting deep learning approaches and becoming self-directed in their learning. Deliberate instructional strategies and time are needed to support students in making the transition to the PBL environment.

Acknowledgment

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INTELLIGENT TUTORING SYSTEM WITH AFFECT CAPABILITY

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Abstract

The paper presents the design and development of an intelligent tutoring system to help students in learning computer programming. Effective tutoring by human is a guided and interactive process where students' engagement is constantly monitored to provide remedial feedback and to maximize the motivation to learn. Learners exhibit a multitude of emotions which are integral to human learning, creativity and flexible problem solving. By responding appropriately to detected emotions, we will be able to sustain the students' interest and optimize their learning.

Hence, this research aims to design and develop an intelligent tutoring system that will provide adaptive hints to the students when they show signs of frustration. The intelligent tutor is able to assess the emotions of the student using unobtrusive techniques through facial expressions and keystrokes analysis in a naturalistic learning environment. By responding to the student's emotions expressed during the interaction with the intelligent tutoring system, it can prevent the potentially negative motivational state in which the student gives up working on the problem totally.

Experimental and machine learning methodologies were used in creating the backend algorithms of the intelligent tutoring system. Results from a random sample of 60 students show that the increase in interest of learning computer programming using the intelligent tutoring system is statistically significant. This preliminary analysis suggests that the intelligent tutoring system is an effective tool in engaging students in their learning.

The recommendation is to deploy the system for lecturers to use as an e-learning tool. The targeted students are the first year students taking programming modules in the School of Information Technology, Nanyang Polytechnic. The student's inferred emotions and scores obtained for each topic will be collected and stored in the database, which can also potentially be mined to help instructors understand the topics which students are weak in and for further refinement of the tutoring system.

Keywords: *Intelligent Tutoring System, affective tutoring system, scaffolding, facial expression*

Introduction

One-on-one human tutoring is highly effective for student learning (Bloom 1984). However, it is often difficult to achieve such a tutor-student ratio due to resource constraints. This motivates the creation of an intelligent tutoring system (ITS), which embodies the intelligence of a human tutor and provides immediate and intelligent instruction or feedback to learners, usually without intervention from a human teacher to optimize the learning of the learner.

Recent advances in intelligent tutoring system (ITS) research such as examining learner emotions during tutoring continue to enhance the effectiveness of ITSs (Kort 2001, D'Mello et al. 2010, Arroyo et al. 2009). Pekrun (2002) reported that emotions which occurred during learning are largely neglected and he conducted a series of qualitative case studies to investigate further into this. He concluded that learners experience an assortment of positive and negative emotions and positive activating emotions such as enjoyment of learning generally enhance academic motivation whereas negative deactivating emotions (e.g. boredom) have a negative effect on the motivation to learn. This finding highlights the importance of incorporating models of learner emotions into ITSs to provide students with more effective learning experiences.

Predicting student affect thus becomes an essential step towards developing an intelligent tutoring system with affect capability. A promising means for predicting student affect is by analyzing student's facial expressions. Recent investigations have also identified facial expression configurations that relate to students' emotions (D'Mello et. al. 2010, Craig et al. 2004, McDaniel et al. 2007). Although there is no comprehensive catalogue of students' emotions to date, the occurrences of confusion or frustration are highly relevant during learning (Graesser et. al. 2003).

Specifically in the study of Information Technology, attracting and retaining students has been an ongoing concern and keeping the students engaged through the learning process is an important endeavor for our school. Students experience frustration in the learning of computer programming

and prolonged frustration will lead to loss of confidence and eventual disinterest in the learning itself (Hansen & Eddy 2007). The modeling of frustration is thus important as it informs on the appropriate time to intervene so as to achieve effective learning for the student. Thus, in this paper, we present our methodology and results on the modeling of students' frustration.

From our literature survey, most of the studies on the investigation of emotions during learning are conducted using obtrusive sensors which are strapped on the participants to observe their emotions. The complexity and hassle involved in setting up these ITSs limits their usability. Hence, we propose using unobtrusive sensors in which a simple webcam would suffice for our ITS.

To model frustration, we use the following features in our predictive model: 1) facial expressions, 2) keystroke logs and 3) contextual information of the question which the student is working on. Although there are a number of studies on affect detection, to the best of our knowledge, none of the studies utilizes a combination of contextual information, keystroke analysis and facial feature recognition for the detection of frustration.

We present in this paper the modeling approach based on the experiment data which we collected during the tutoring session. Each tutoring session captures facial expressions and latency between keystrokes for each question as a sequential set of observations. The goal is to predict unseen observations based on prior observations. A number of modeling techniques may be appropriate for this task and our findings show that the logistic regression model is promising in predicting student's frustration.

The rest of the paper is structured as follows: The next section describes the system design of our ITS, followed by the methodology section that describes the modeling approach which utilizes the contextual and keystroke features that are logged during the student's interaction within the ITS. Subsequently, the results and the evaluation of the results are discussed and the final section concludes this work.

Overview of System Design

The system design of our ITS is as shown in Figure 1. As the student works through a problem, his or her facial emotions, keystroke and contextual logs will be collected by our system and stored in a centralized database. This raw data about student interactions with the system feed all our intelligent modules to prompt hints that will be helpful for the student and the tutoring system in general.

Before the system can provide adaptive hints to the learner based on the automatic elicitation of the learner's emotions from the facial and keystroke sensors, we will first need to collect data to build the adaptive tutoring response. Figure 2 shows the user interface of the tutoring system which was used in collecting the training data.

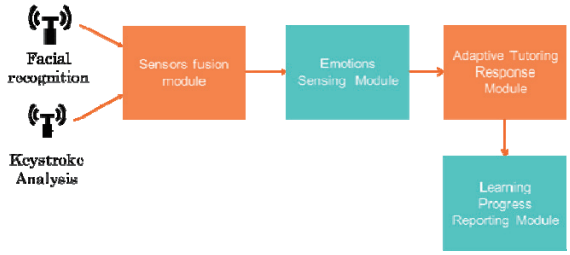


Figure 1: System Design

The tutoring software contains instructional pages and exercises grouped by topics. Students can choose to read the conceptual instructional pages first, possibly to refresh their memory on the various programming syntaxes before attempting the exercises. The student's actions, keystrokes and the respective time stamps in which each action or keystrokes occur within the tutoring software will be logged in the database. The adaptive tutoring response module will then provide prompts when frustration is detected. The details of the modeling techniques used in predicting frustration will be elaborated in the next section.

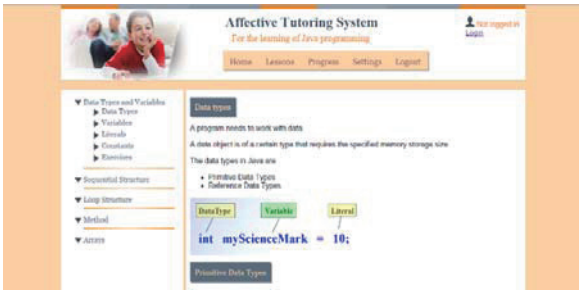


Figure 2: User Interface

Finally, the learning progress reporting module model the student's knowledge on an ongoing basis to provide effective help, there have been only preliminary attempts to incorporate knowledge of student group characteristics (e.g., profile of cognitive skills, gender) into the tutor and to use this profile information to guide instruction (Shute, 1995; Arroyo et al., 1999). Hence, this learning progress module will help lecturers to have a better understanding on the topics which students are weak in and the profile of students for topics which requires more help.

To verify if this system would be helpful to students in their learning of computer programming, we conducted a random survey of 60 students from the School of Information Technology at Nanyang Polytechnic. The students were first asked to indicate if they like to learn computer programming, using a Likert scale of 1 to 10, with 1 being Strongly Disagree and 10 being Strongly Agree. Subsequently, the students were informed of this intelligent tutoring system and were asked again if it would help to increase their interest or liking in learning computer programming. The Paired T-Test result shows that the increase in interest of learning computer programming using the intelligent tutoring system is statistically

significant (p-value<0.0001). This preliminary analysis suggests that the intelligent tutoring system is an effective tool in engaging students in their learning of computer programming.

Methodology

Data

The data collected from the students in the School of Information Technology at Nanyang Polytechnic were used in this work. The study was conducted in computer labs where students were enrolled to work on programming exercises in a Java programming tutoring software. The tutoring software was developed by the first author. It consists of 6 topics and a set of 2 programming exercises per topic, giving a total of 12 exercises to be completed. The topics cover the basics of Java programming and include the use of variables, loops, conditional statements and arrays. Most of the students who participated in this study have undergone a foundational Java programming course in their first year of study. Conceptual instructional pages are also provided per topic and students can choose to read the conceptual instructional pages to refresh their memory on the various programming syntaxes before attempting the exercises.

Each exercise is preloaded with a set of Java code with gaps in between (denoted with a comment stating that code to be inserted) and students will have to fill in the missing lines of code to complete the exercise. Within each exercise page, students can click on a "Submit code" button to submit the code for compilation. They can then check the output window for the compilation output or errors. The compilation output will be verified against the required output when the student clicks on the "Check answer" button and will be marked as completed if the correct output is obtained. The students are free to choose the sequence of working on the exercises and topics and they are also allowed to switch from one exercise to the next even if they have not completed the current exercise.

The student's actions, keystrokes and the respective time stamps in which each action or keystrokes occur within the tutoring software are logged in the database. Some examples of the actions that are logged include the start and end time of each exercise, the time stamp of each "Submit code" action and the time when the exercise was completed. Copying and pasting of code from other sources is a common behavior among the students and that is captured in the keystroke logs as well.

Contextual features

The contextual features used are the completion status of the exercise, the number of submissions for compilation of the exercise, the number of switches between the exercise and other exercises, the difficulty level of the exercise and the self- perceived effort. The completion status is a categorical variable that denotes whether the exercise attempt was completed. A completed exercise attempt is one that produces the correct program output. The number of submissions for compilation is a discrete variable that denotes the number of times the student has submitted the code for compilation for the designated exercise. An observed behavior is that students click on the submit for compilation button a number of times within a span of two seconds, thinking that clicking more will help to speed up the compilation time. To prevent duplicate counting, all submissions for compilation logs (by the same student for the same exercise) time-stamped within duration of two seconds are only counted as one submission for compilation.

Students are allowed to switch between exercises to recap even if they have not yet completed the current exercise. The number of switches is a discrete variable that tracks the number of switches to other exercises from the designated exercise.

Keystrokes

Keystrokes are captured only when the students are working on the exercises. The raw keystroke files are processed to derive details such as the keystroke, timestamp, duration of the key and whether modifier keys such as shift or control keys are depressed. The duration of the key is the duration from the time a key is depressed to the time when the next key is depressed. The duration between keys refers to the flight time (the duration from the time one key is depressed to the time the next key is depressed) and the wait duration refers to the duration in which no key was depressed.

Video annotation

The study included 14 students with a gender breakdown of 7 males and 7 females. They are students currently undertaking a diploma course in information technology and have an average of about 1 year of programming experience between them. Both their screens and their facial expressions were recorded using web camera and each session lasted for an average of 81.3 minutes. The recordings were used for a retrospective annotation of frustration by an observer. This retrospective observation technique was employed by a number of prior studies (Cetintas et al. 2010; Graesser et al. 2006; Rodrigo & Baker 2009). Some examples of the frustration behaviors noted in the session includes the use of expletives, long sighing, excessive gesturing and roughly ruffling through hair while visibly distressed. The observations were recorded with a time stamp and this time stamp is used for synchronizing with the captured contextual and keystroke logs. In this study, the granularity of the detection of frustration is on a per exercise level (N=56).

Modelling Technique

Logistic regression is used as the mathematical model to detect the occurrence of frustration in this study. It is used here as it is generally well-suited for describing and testing hypotheses about relationships between a categorical outcome variable with one or more categorical or continuous predictor variables. The data set is divided into a training set (80% of the data set) and a test set (20% of the data set).

Results and Discussion

With the Logistic regression model, we obtained an overall accuracy of 66.7% for the test set. For precision and recall, the results were 0.625 and 0.833 respectively. F1 measure is 0.714 while AUC is 0.722. The high recall performance measure indicates that our model is able to identify accurately the incidences of frustration. The F1 and AUC figures further confirm the adequacy of the performance of our model.

There are however two primary limitations that should be noted. First, as the manual annotation of facial expressions is very labor intensive, automated techniques are actively being investigated. Second, the predictive models require large amounts of data to produce better accuracy which can be deployed to a larger population. Further experiments and validations are necessary to evaluate the accuracy of predictive models on students' frustration and their use in the ITS in naturalistic environments e.g. library or public study area.

The overall performance of our model looks promising. As more training data are gathered, the overall accuracy will increase further. Hence, the plan is to deploy the system for lecturers to use as an e-learning tool. The targeted students are the first year students taking programming modules in the School of Information Technology, Nanyang Polytechnic. The student's inferred emotions and scores obtained for each topic will be collected and stored in the database, which can also be mined for further refinement of the tutoring system.

Conclusions

In this paper, we presented the system design nad development of our ITS with affect capability. The analytical techniques to predict the occurence of frustration will help us determine the time for the ITS to intervene and provide prompts to the students. A number of possibilities exist to extend this study. A higher granularity or time resolution of detection will be useful for scaffolding the student in his or her learning. To achieve this, we may need to incorporate other input modes such as mouse clicks and explore the use of other machine learning algorithms. Future research will be undertaken to investigate this possibility.

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INTRODUCTION OF COMPUTATIONAL THINKING IN HIGH SCHOOL STUDENTS BY DESIGNING MATHEMATICAL GAMES

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Abstract

The PISA test revealed that Mexican students had a low performance in logic and mathematical thinking. There must be some explanations: the excess of themes that inhibit the students to learn the mathematical basic concepts, and the myths about the difficulty of learning mathematics and its application in the real world. At the University of Guanajuato High School programs, all the students must take four mandatory courses: Algebra I and II, Geometry and Trigonometry, and Analytical Geometry. The students enrolled in Engineering and Sciences must take Differential Calculus and Integral Calculus. However, there are no specific courses for developing the computational thinking in students. The acquired skills help the students to understand how to solve problems through reduction, integration, transformation, decomposition, and simulation. Also, it helps to improve planning, searching, programming and logical thinking which are all related to computational thinking. The PISA tests revealed that students need additional support to learn mathematics. It utilized a non-traditional methodology to develop computational thinking in High School Students by creating mathematical games. The freeware Scratch from Massachusetts Institute of Technology was employed. The Algebra II students created interactive games to understand and practice basic mathematical operations such as solving quadratic equations. These games familiarized the students with the computational thinking, and the pleasure of learning. The games and student performance were assessed by using the Google forms tool. Before this project, the polls showed that 31.4% of students believed that mathematics was boring, and there was no interaction with other disciplines such as Natural or Social Sciences. After using Scratch, 85.6% of students mention that mathematics is useful and interactive, and 76.6% of them were considered skilled in the use of computers. Before the activity, 74.2% of students preferred to work individually and 66.8% considered themselves with moderate computer abilities. After using Scratch, 77.2% of them preferred teamwork and 78.1% thought that the computers are important tools to learn and to practice mathematics. Finally, we can conclude that computational thinking helped the students to improve the performance in mathematics and promote skills such as teamwork, organization and activity planning.

Keywords: *Computational Thinking, mathematics learning, logical thinking, teaching learning process, programming*

Introduction

The results of standardized tests such as PISA or EXCALE have identified problem in the Mexican educational system. The main objective of these tests is to provide information in order to compare educational levels in different countries. The test of quality and educational attainment (EXCALE), developed by the National Institute for Educational Evaluation (INEE) and the test of the Programme for International Student Assessment (PISA) of the Organization for Economic Co-operation and Development (OECD), are examples of these standardized assessment tools.

In the National context, the test EXCALE establishes that students with a grade of "insufficient" have important deficiencies in the domain of knowledge and academic skills, which result in a limitation to keep progressing satisfactorily in the subjects evaluated. The results of this test in 2008-2009 showed that 14.7% of students at the elementary school level did not have the necessary knowledge to continue studying mathematics. Moreover, 52% of students at the junior high school level were located in the insufficient level.

In the PISA test, different levels of student performance are established. Level 2 means that the students have the minimum knowledge to continue studying at higher educational levels or to integrate into the labor market successfully. Students who are not at this level will have serious problems to keep learning. The results of this test in 2012 showed that 23% of students were below level 1 and 32% of students were located at Level 1. Thus, 55% of students in High School were below level 2 and they did not show the minimum knowledge to continue studying. The results obtained in 2012 are very similar to the results recorded in 2009.

Bagur (2011) makes this distinction, “Although PISA test and EXCALE test are not related, both tests show similar results in the context of our country. Over 50% of our students are in the later levels of the scales of assessment. We are below the levels that our students can achieve.”

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Bagur (2011) established that this problem is multifactorial. Besides, we cannot reduce the problem to a single cause and we should not treat it in a dispersed manner attacking separately possible causes. We need to find solutions that target all causes of these levels of mathematical incompetence. Possible causes of these math deficiencies are: we have saturated the contents of the curriculum with knowledge that prevent students learn the basics, there is a deficit of mathematical knowledge at all levels of study, better preparation of teachers in the area of mathematics is necessary, students do not find use for all subjects of mathematics and so they forget them easily and the mathematics are surrounded by myths and it has become difficult to teach. All these causes are related to the curriculum, the training of teachers, lack of freedom for teachers to teach their students using different strategies, the use of mathematics in everyday life and the mathematical culture of our nation. The impossibility of not being able to get children and young people to learn mathematics means depriving them of basic skills such as reflection for decision-making, the ability to anticipate what might happen, the ability to say with certainty, learning to learn and to understand other disciplines.

Bagur (2011) considers that at present the teaching of mathematics is complicated; despite the wealth of information and tools that are available to almost everyone on the Internet. Use of these resources would make it easier and fun to understand the concepts and solving exercises. Besides, many proposals maintain that the teaching of mathematics should not be so complex and it must take into consideration the characteristics of the age of the students. We must remember that children learn through play, the youth through group participation and challenges and adults through the application of knowledge to generate new ones. Finally, Bagur proposes that our country needs children and youth with reflective thinking and ability to use mathematics and to make decisions in their daily lives.

Nowadays, there are freewares available on the Internet developed with the aim of making the teaching-learning process more dynamic, fun and efficient. Some of the tools are Scratch, Educaplay and Googleforms. Scratch is a project of the Lifelong Kindergarten Group at the MIT Media Lab. It is provided free of charge. Scratch helps young people learn to think creatively, reason systematically, and work collaboratively — essential skills for life in the 21st century. When people learn to code in Scratch, they learn important strategies for solving problems, designing projects, and communicating ideas. Scratch is designed especially for ages 8 to 16, but it is also used by people of all ages. Nowadays, students are learning with Scratch at all levels (from elementary school to college) and across disciplines (such as math, computer science, language arts, social studies). Millions of people are creating Scratch projects in a wide variety of settings, including homes, schools, museums, libraries, and community centers. On the other hand, Educaplay is a platform to create multimedia teaching activities. It is provided free of charge, too. In order to create these activities, you do not need any kind of software, besides, the activities generated by Educaplay can be integrated on e-learning platforms. In Educaplay you can create interactive maps, riddles, crosswords, wordsearch puzzles, Quizzes, jumbled words, etc. Educaplay is a contribution of adrformaciom.com to the education community. Finally, googleforms is an app of google drive with which we can make questionnaires and surveys to gather information on the opinion of a group of people. This tool can be used in all areas of our life. We can use it in areas such as: education, employment, social, business or just leisure. The tools mentioned can make the teaching-learning process easier and fun, besides they can help students to understand the concepts and solve exercises more efficiently.

At the University of Guanajuato High School programs, all the students must take four mandatory courses in the area of mathematics: Algebra I and II, Geometry and Trigonometry, and Analytical Geometry. The students enrolled in Engineering and Sciences must take Differential Calculus and Integral Calculus. However, there are no specific courses for developing the computational thinking in students.The introduction of computational thinking in the curriculum is important because the skills developed through it helps students to work on mathematical thinking, improving their mathematical skills. Besides, the computational thinking helps the students to understand how to solve problems through the reduction, integration, transformation, decomposition, and simulation (mathematical logical processes). Also, it helps to improve planning, searching, programming and logical thinking, all related to computational thinking.

There is no doubt that educational programs should be adjusted to a new reality in order to obtain better results in the teaching-learning process. The use of innovative tools, based on computational thinking and playful aspects, represents an attractive alternative for solving the existing problems in the area of mathematics.

Materials and Methods

Basogain (2014) established that in solving problems associated with the natural sciences and mathematics, the traditional methodology proposes to find the solution we must analyze the information and environment, to think over about the situation and to make appropriate actions. Thus the problem structure is summarized in Figure 1.



Figure 1. Elements of the traditional approach to problem solving.

The results of standardized tests show that there are deficiencies in students associated with the skills to problem solving, (EXCALE 2008-2009 and PISA, 2012) so the traditional approach to solving problems need to be modified. Basogain (2014) establishes that a new methodology known as problems based on multiple processes suggests that the solution to a problem must have an open approach. Examples of these problems are: to design a car driving along on a track, to build a prototype, to implement a game or to create an animated story. These problems are closer to the problems of everyday life and are more relevant for students. Thus the problem structure based on multiple processes is summarized in Figure 2.

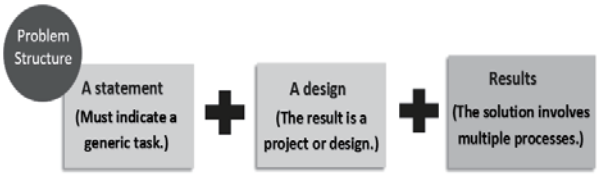


Figure 2. Elements of the approach based on multiple processes to problem solving.

Basogain (2014) recognizes that computational thinking is applied appropriately in problem solving based on multiple processes. This kind of thinking is defined as the recognition of aspects of computing in the world around us and the application of tools and techniques of computations to understand and to reason about natural and artificial systems, Figure 3. Besides, we must use computational thinking in order to solve problems based on multiple processes because this approach promotes creativity, logical thinking and collaborative work. We mustn't forget students learn better through games, challenges and teamwork.

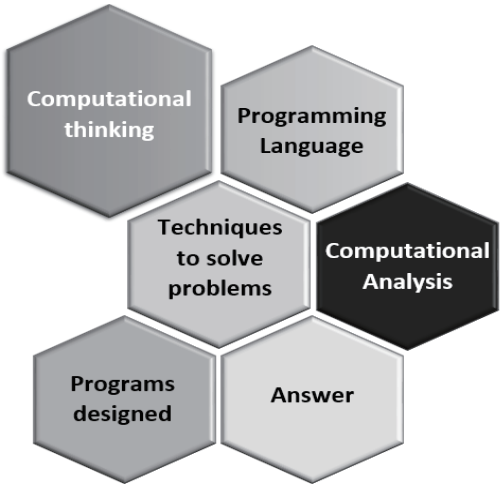


Figure 3. Elements of the Computational thinking used in solving problems.

According to Bagur (2011), the construction of knowledge in people is given by one of the following reasons:

a) Because they need to solve an important problem in order to subsist or to achieve a goal. Necessity is the mother of science.
b) Because they can't explain an interesting or amazing fact.
c) Because someone tells them what they can learn.
d) Because they don't know something and they need to learn to be like everyone else (social learning).
e) For the pleasure of learning.

Furthermore, the natural learning requires the convergence of the five above causes. It is important to note that the third cause is not sufficient for learning a topic despite being used by the traditional methods. The problems based on multiple processes and computational thinking combines two of the best strategies of learning, learning based on projects and solving problem, Figure 4. In this way, when we design a project to solve a problem in our environment, we give importance to knowledge and we achieve the skills, knowledge, attitudes and values to converge and to solve the problem.

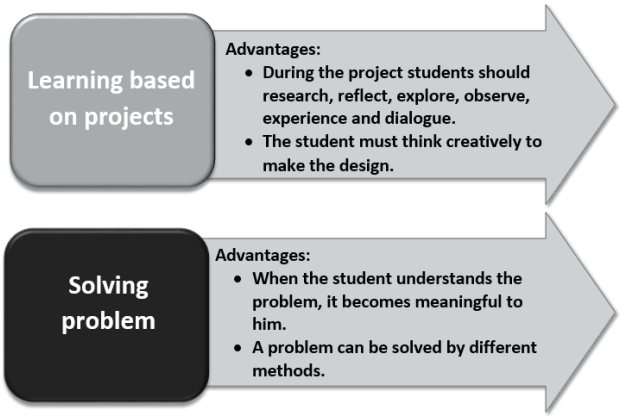


Figure 4. Advantages of different strategies of learning,

The results of standardized tests, mentioned in the introduction, revealed that students need additional support to learn mathematics. In this project, it utilized a non-traditional methodology to develop computational thinking in High School Students by creating mathematical games. Tools such as Scratch, and Googleforms were employed. The Algebra II students developed projects aimed at creating interactive games to understand and practice basic mathematical operations such as solving quadratic equations. These games familiarize the students with the computational thinking, and the pleasure of learning. For the realization of the projects the students had to develop the following stages:

a) Integration teams composed of 4 people.
b) Selecting a topic included in the curriculum and research and reflection on the subject.
c) Generation of ideas and development of a flow chart for the selected idea, Figure 5.
d) Writing the code and initial testing, Figure 6.
e) Presentation of the project and writing the final report.

f) Evaluation and feedback of the projects. This stage development through oral presentations of the project and through polls of 30 questions developed in Googleforms.

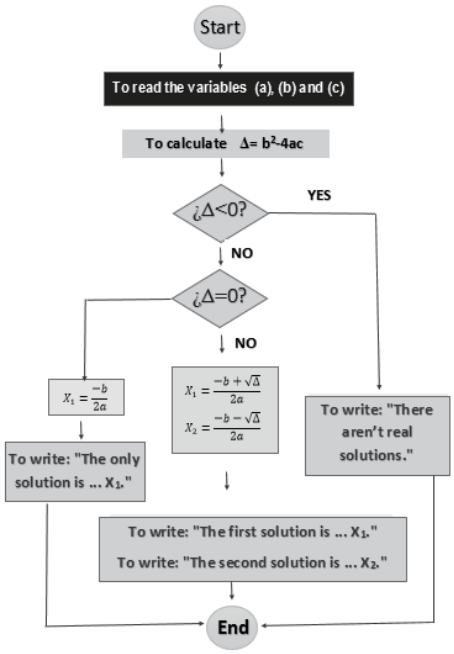


Figure 5. Flowchart for the process of solving quadratic equations.

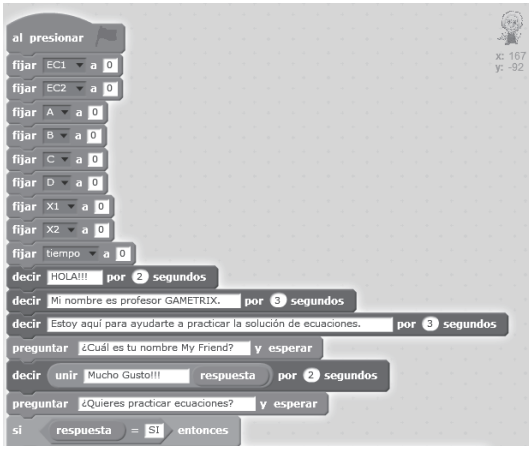


Figure 6. Modular structure of the code developed from scratch for the process of solving quadratic equations.

Results and Discussion

Table 1 provides a description of the sample of students participating in the project. Characteristics such as age, gender, education level, ability to use computers and Internet access are included. Furthermore, Table 1 and Table 2 show important aspects associated with the vision that students had about math before developing this project. Before this project, the results showed that 68.9% of the students were unsure of the benefits of using technology in learning. Besides, the polls showed that 38.6 % of students believed that mathematics was boring.

In addition, 42% of students are unsure of their usefulness for success in their life or for understanding other subjects. About 30% and 52.5% of students believe that mathematics is not useful in the exact sciences and the social sciences respectively.

Table 1. Description of the sample of students participating in the project.

Total Students	**Male**	**Female**
120	47 %	53 %
Average Age	15 years old	
Level of education	High School (Grade 10)	
Tech gadgets at home		
Device	**Yes/(% Students)**	**No/(% Students)**
Desktop	79.5	20.5
Lap top	82.1	17.9
Tablet or Ipad	53.8	46.2
Smartphone	66.7	33.3
Internet access at home (% students)	**Yes/(% Students)** 84.6	**No/(% Students)** 15.4
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**
	7.1	21.2	66.8	4.9

What do you prefer?	**Teamwork** 25.8 %	**work individually** 74. 2 %

Initial Questionnaire/ (% Students)	**I agree**	**Undecided**	**I disagree**
Do you consider the use of technology in education has benefits?	26.7	68.9	4.4
Do you think math is boring?	31.4	30.0	38.6
The mathematics are useful for success in your life	17.5	40.0	42.5
The mathematics are useful for understanding other subjects	19.8	38.0	42.2
Mathematics are easy to learn	35.9	10.3	53.8
To learn mathematics you need to work hard	70.0	15.0	15.0
The mathematics are incompatible with the use of technology	80.0	7.5	12.5
The Mathematics are useful in the exact sciences	35.0	32.5	32.5
The Mathematics are useful in the social sciences	20.0	27.5	52.5

Table 2. Vision of students about math before making the project.

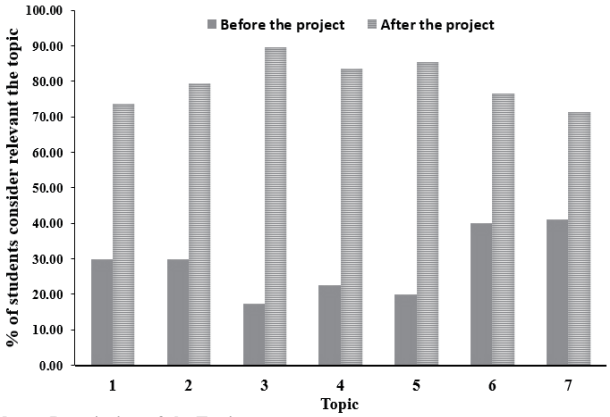
Question What does it mean "to learn mathematics"?	*Scale of degrees of Certainty/ (% students) 1	2	3	4	5
To know many definitions, formulas and theorems.	10.0	7.5	12.5	17.5	52.5
To Know many procedures in order to solve exercises.	10.0	15.0	10.0	37.5	27.5
To decide the importance of a mathematical concept.	7.5	7.5	7.5	42.5	35.0
To apply creative processes to different situations.	25.6	38.4	23.1	5.2	7.7
To get good grades on tests	5.0	7.5	5.0	30.0	52.5
To solve the exercises quickly	7.5	7.5	7.5	37.5	40.0
To demonstrate and manipulate formulas	7.5	5.0	5.0	40.0	42.5
Question **What is a mathematical problem?**	***Scale of degrees of Certainty/ (%students)** **1**	**2**	**3**	**4**	**5**
An exercise which the teacher propose in order to know if the student has learned a definition, a formula or procedure.	7.5	7.5	15.0	42.5	27.5
An exercise in which we can apply a mathematical procedure to a real situation	17.5	20.0	32.5	20.0	10.0
A situation that motivates students to learn new definitions, formulas or procedures.	10.0	27.5	32.5	20.0	10.0
A situation that allows students to develop new skills.	2.5	35.0	30.0	15.0	17.5
A situation that motivates students to learn new concepts, plan activities, develop strategies and propose solutions to real situations.	25.0	27.5	30	10.0	7.5
A situation which connects knowledge from different areas	20.0	35.0	22.5	10.0	12.5
A situation that involves the development of competencies (knowledge, skills and attitudes)	2.5	27.5	20.0	37.5	12.5
Question **Which are the main features of a mathematical problem?**	***Scale of degrees of Certainty/ (% students)** **1**	**2**	**3**	**4**	**5**
There is only one correct answer	0.0	23.1	17.9	20.5	38.5
There is only one correct procedure	12.5	20.0	10.0	22.5	35.0
The solution of a problem requires creativity	17.5	22.5	40.0	10.0	10.0
The solution of a problem does not depend on the procedure used	0.0	2.6	44.6	12.8	40.0
The problems must solve useful and practical situation	0.0	15.0	25.0	30.0	30.0
A problem can be solved more quickly with the use of computers	5.0	10.0	25.0	40.0	20.0
The solution of a problem is specified	15.0	25.0	20.0	17.5	22.5
Question **If you want to solve a mathematical problem which aspects need to consider?**	***Scale of degrees of Certainty/ (% students)** **1**	**2**	**3**	**4**	**5**
You must be able to recognize the relevant data contained in the statements	0.0	10.3	12.8	51.3	25.6
You need to make the mathematical operations required by the method of solution	0.0	25.0	15.0	30.0	30.0
The most important element to solve a math problem is to discover that operation must calculate	0.0	12.5	30.0	37.5	20.0
The solution involves the relationship of concepts previously studied and understood	0.0	25.2	33.7	21.1	20.0

The results in table 2 show that most of the students believed that "know math" means knowing many definitions, formulas, theorems and mathematical processes, get good grades on tests, to know how to resolve exercises and demonstrate and manipulate formulas. In addition, students thought that a mathematical 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.

Before the project, 74% of students preferred to work individually and 66.8% considered themselves with moderate computer abilities. After using Scratch in order to create mathematical games, 77.2% of students preferred the teamwork and 76.6% considered themselves skilled in the use of computers.

Besides, 82.8% considered that mathematics is useless in the real world and 78.1% that the computers are important tools to learn and to practice mathematics. Around 90% of students mentioned that mathematics is useful for understanding other subjects and it is related closely with other areas of knowledge such as the natural sciences. Student motivation for learning mathematics was increased. Hence 85.6% of students mentioned that mathematics is funny and interactive.

After this project, the students keep considering that "know math" means knowing many definitions, formulas, theorems, mathematical processes, to know how to resolve exercises and demonstrate and manipulate formulas. However, students changed the concept of what should be a mathematical problem. They think that a mathematical problem must be an exercise based on a real situation and it must involve learning new knowledge, skills and attitudes. Besides it must promote planning activities, strategy development and connection of knowledge from different areas, figure 7.



No.	Description of the Topics
1	It must be associated a real situation.
2	It must motive students to learn new knowledge
3	It must motive students to learn new concepts, plan activities, develop strategies and propose solutions.
4	It must connects knowledge from different areas.
5	The solution of a problem requires creativity.
6	The solution of a problem may be general or particular.
7	The solution involves the relationship of concepts previously studied

Figure 7. Evolution of the concept of what should be a mathematical problem.

Back

Finally, we identify benefits about the development of projects associated with computational thinking from surveys and evaluation reports. These benefits are included in table 3.

Table 3. Benefits about the development of projects associated computational thinking.

Feature/ % of students	I agree	I disagree
They provide meaningful learning	86.7	13.3
They develop communication and values	76.7	23.3
They promote teamwork	82.2	17.8
They promote creativity	88.6	11.4
They motivate to learn new concepts, plan activities, develop strategies and propose solutions	83.3	16.7
They promote learning of new knowledge and develop new skills	78.3	21.7
They connect knowledge from different areas	90.0	10.0
They promote the generation of multiple solutions	88.4	11.6
They involve real problems	70.8	29.2
The solution takes time and often is of a general nature	91.2	8.8

Conclusions

The inclusion of the computational thinking in developing projects helps the students to improve their performance in mathematics and promote skills such as teamwork, organization, planning activities, strategy development and connection of knowledge from different areas. Besides, when we design a project focused on solving a problem, we indirectly attach importance to knowledge and we converge knowledge, skills, attitudes and values in the same activity. Furthermore, solving a math 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. The development projects associated with computational thinking requires that students think and propose solutions. Students will learn more if they are able to offer a greater number of attempts to solve the problem because every time they propose an alternative they reflect on what works and what does not. Finally, taking a mathematical challenge and finding a solution implies satisfaction, which makes us look for new challenges and with each challenge more experience is gained.

Acknowledgements

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Learning from the Community
—Introduction of a new CLL (Community Language Learning) Practice in the Class—

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Abstract

Originally, Community Language Learning (CLL), developed by Charles Curran, is a Language-teaching method, based on the Counselling-approach, where students work together to develop skills of their target language. Getting hints from this learning style from the community, I revised and developed it into a totally different method of learning.

This study attempts to provide evidence that there is a distinctive effect of my "new", "different", "unique" and "challenging" CLL method in the students' learning acquisition process.

The outline procedure of this method was as follows:

1. Students close the textbook and listen to the text on CD.

2. The teacher reads one full sentence or a part of the sentence according to the length of it, ONLY ONCE.

3. One student repeats the sentence after the teacher.

4. If the repetition is correct, the students continue repeating it until the fourth student repeats it correctly. After 4 correct repetitions, all the students in the class repeat it in unison.

What effects does this CLL practice bring to the learners? First, taking advantage of the community-like environment, they can memorize the sentences correctly. This leads them to nurture a sense of solidarity. A student who succeeds in repeating can be a role model and even educate the whole class.

Secondly, even after one student succeeds in repeating, he or she might have to say the sentence again, which makes a rousing atmosphere in the class. He or she cannot relax nor lose concentration because they might be given the task to repeat it again. Students' attention is held and there is a good kind of tension maintained in class.

Thirdly, by repeating and listening to the same sentence, the students can enhance "retainability" naturally. It is a quite natural process for them not only to acquire grammar and word order but also to brush up pronunciation, intonation and fluency.

In order to prove how effective this CLL practice is, I'll present the results of mini tests and questionnaires from the students as sources for analysis, introducing some real case study. I'll analyse the effects of this CLL practice both from quantitative and qualitative points of view.

Keywords: *CLL, community, retainability, acquisition process, repetitions, concentration, spontaneous memorization*

1. Introduction

Putting aside the CLL method developed by Curran, this study attempts to provide evidence to show how effective this "new" CLL is in the students' learning acquisition process. This original CLL method was conducted in 4 English Communication Ⅱ classes for the 1st year students in National Institute of Technology, Kure College. The total number of the students was 172 in 2015.

As sources for analysis, I'll present the results of mini tests data and their questionnaires on CLL in order to prove how effective this CLL practice is. Surprisingly some students have started filling in the blanks with their retained phrases right after CLL practice. This is evidence to show the possibilities of the natural and spontaneous acquisition with the use of this method. To be more persuasive, I'll analyse the effects of this CLL practice both from quantitative and qualitative points of view in this presentation.

2. What is the "new" CLL method?

The procedure of this method is as follows:

1. Students close the textbook and listen to the text on CD.

2. The teacher reads one full sentence or a part of the sentence according to the length of it, ONLY ONCE.

3. One student repeats the sentence after the teacher.

4. If the repetition is correct in terms of grammatical accuracy, intonation and pronunciation, the students continue repeating it until the fourth student repeats it correctly. After 4 correct repetitions, the teacher says, 'everyone', and all the students in the class repeat it in unison.

The goal is to follow this procedure without any incorrect repetitions. However, there were occasions where students could not repeat after the teacher correctly or could not repeat it at all.

Some possible cases were as follows:

Case 1: When students cannot repeat correctly or cannot repeat at all, each student is asked to repeat again until the correct repetition ensures. When the correct repetition is attained, we go back to the students who couldn't repeat it accurately. This 'coming-back-situation' makes for a stimulating class.

Case 2: Even while we are going back to the students quickly, some of them might forget the sentence or make mistakes with the original sentence. In those cases, we go on until we get the right sentence again.

Case 3: When all the students repeat the sentence incorrectly or forget the sentence, the teacher has to read the same sentence again. This 'around-the-class' situation happens occasionally.

3. What are the merits of the "new" CLL method?

What effects does this CLL practice bring to the learners? There are 4 points of merit to be pointed out.

1. To nurture natural 'retainability'

By listening to the same phrases or sentences many times repetitiously in a community, the students can enhance 'retainability'. It is a quite natural process for them not only to acquire grammar and word order but also to brush up pronunciation, intonation and fluency. The students will memorize them quite naturally. Taking advantage of the community-like environment, they can simultaneously acquire not only the expressions themselves but also the intonation and pronunciation correctly with their ears.

2. To nurture grammatical skills through the ears

When the word order was incorrect or hard-getting subtle sounds such as "a", "the" or "ed" were dropped, the students were asked to repeat correctly. While skipping incorrect repetitions and going on to reach a student who could utter correct phrases, they themselves started to assume which part was wrong and what words or sounds were missing. This attitude of self-assumption can develop a good grammatical sense through the ears. Eventually they came to perceive a difference between a correct phrase and an incorrect one by listening only with some short hints, without any grammatical explanation from the teacher.

3. To maintain both tension and concentration

Even after one student succeeds in repeating, he or she might have to say the sentence again, which makes a rousing atmosphere in the class. He or she cannot relax or lose concentration because they might be given the task to repeat it again. When some successful students might forget the sentence or change it into an incorrect one, the turn of the repetition task might come back all the way to the very first student. Under this 'coming-back-situation,' they have to concentrate on listening to their classmates' repetitions carefully and retain the sentence. Students' attention is held and there is a good kind of tension maintained in class.

4. Encouraging community warmness

They even start checking if the classmates' sentence is correct or not and if it is not correct, some students cannot help saying 'Almost!' or 'Close!' The students even applaud when their classmate gets over difficulty in repeating it and manages to succeed in repeating it after many hard trials. These attitudes nurture cooperative and encouraging community warmness in class. The students who succeed in repeating act like teachers, and this leads to develop their confidence more. The cooperative atmosphere among the students can eventually build autonomy.

4. Analysis on the effects of the "new" CLL

Two sources to analyze the effects of this "new" CLL method are as follows:

Source 1. Mini Tests of filling in the blanks on checking their memorization immediately after CLL practice

Source 2. Questionnaires on CLL from the students

The students: 1st year 4-different-course students in 2015

Majors: 39 students major in Mechanical Engineering (M); 46 major in Electrical Engineering and Information Science (E); 45 major in Architecture and Structural Engineering (A); 42 major in Civil and Environmental Engineering (C)

The total number of the students: 172

Concerning the Source 1, every mini test is designed with a maximum 10 points in order to check how well they retain English phrases after CLL practice. The average scores in 4 different courses are as follows:

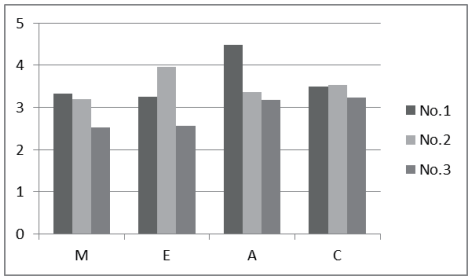


Figure1: The Transitional Scores of Mini Tests on checking memorization right after CLL practice

As the English levels of text goes up, scores in M course goes down, while scores in C and A courses remain steady during these three tests. Scores in E course goes up at the 2nd test but fall by 1.4 points at the 3rd test. E course shows 3.9 points at the 2nd test, falling to 2.5 as the same scores as M.

However, a difference between tests right after CLL practice and ones a few days afterward is distinctive. E course shows 0.6 points difference between 3.8 points right after CLL practice and 3.2 points a few days afterward. C course shows 0.5 points difference between 3.2 points right after CLL practice and 2.7 points a few days afterward. It can be said that

'retainability' was higher right after CLL practice than that that was shown a few days after CLL practice.

Questionnaires as Source 2 were conducted when they had completed a 3-month-practice of CLL in July 2015.

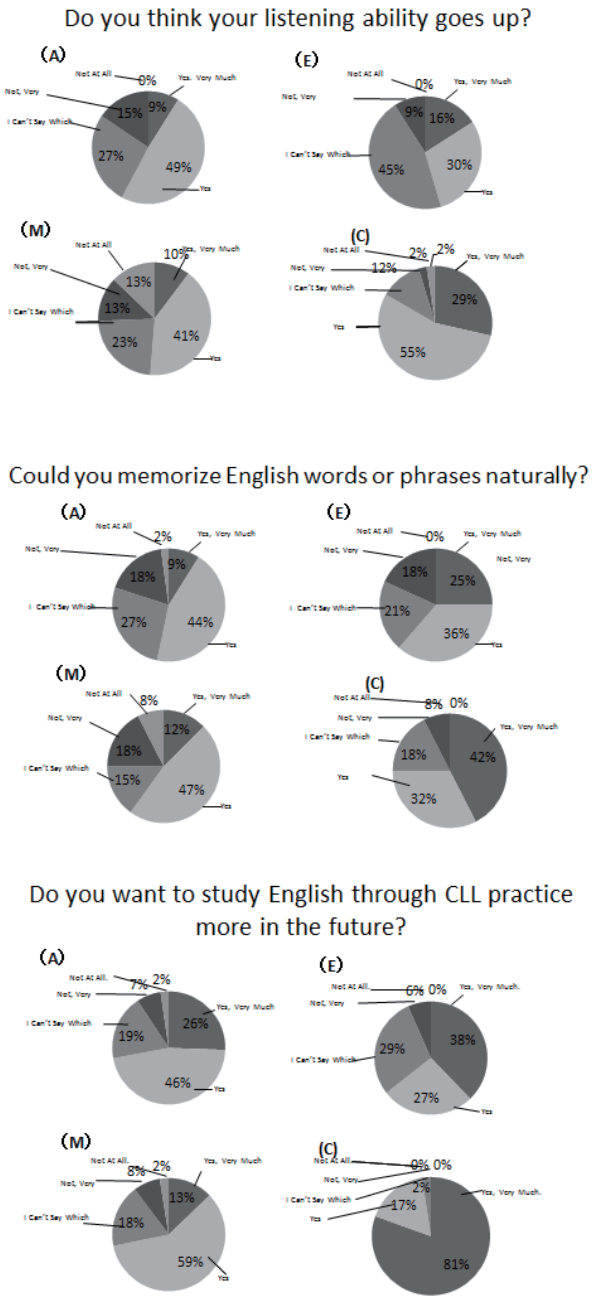


Figure 2: Questionnaires on CLL from the students

For each question, the students answered in the style of 5 multiple choices such as 'Yes, very much,' 'Yes,' 'I can't say which,' 'Not, very,' and 'Not at all.' In the question 'Do you think your listening ability goes up?' more than half of the students in 3 courses (A (58%), M (51%), and C (84)) answered 'Yes (very much).' In the question 'Could you memorize English words or phrases naturally?' more than half of the students of all courses answered 'Yes (very much).' In the question 'Do you want to study English through CLL practice more in the future?' the high rate of the students in all courses (E (65%), A (72%), M (72%), C (92%)) answered 'Yes (very much),' which shows the students' high expectation on CLL practice.

In their free writing, many answered 'I enjoy the practice,' 'I'm happy to memorize English naturally,' 'I want to continue,' 'It can be an effective practice by listening to the same sentence many times,' 'I can concentrate on listening to English and acquire the correct pronunciation with rhythm,' 'Thanks to this CLL practice, the class atmosphere got warmer and better,' 'It was helpful to study for the term test,' 'I can check the spelling and sound in the mini test right after the CLL,' and so on.

The results from these questionnaires describe how the students are enjoying the practice and beginning to feel certain and natural development on their English ability.

Conclusions

Through this new CLL method, the students can naturally acquire English phrases by listening to repetitious phrases in their community many times. They can retain a certain tension and concentration in class, helping, supporting, encouraging their classmates who cannot repeat correctly. A student who can get over his or her difficulty in repeating are admired with applause. A student who can repeat correctly can lead the class as a role of a teacher. This nurtures autonomy in class as a merit of this practice.

Many students hope to continue to learn English through this new CLL practice. I hope to be able to broaden the horizons in the search of more effective ways to utilize this CLL practice in the future.

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CONTINUOUS ASSESSMENT AND COLLABORATIVE PEDAGOGY AS TOOLS TO IMPROVE THE LEARNING OUTCOMES IN THE DEGREE PROGRAMMES IN ELECTRONICS AND ELECTRICAL ENGINEERING OF HELSINKI METROPOLIA UAS

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Abstract

In 2014 all the degree programmes in the Helsinki Metropolia University of Applied Sciences went through a fundamental change. All the curricula were totally renovated and many degree programmes were merged based on the new national outlines. For example the degree programmes in Automation Technology and Electrical Engineering (tuition in Finnish) were merged and the curriculum of the degree programme in Electronics (in English) was heavily integrated to the contents of the new Finnish programme. The student progression results of the old programmes had not been very good and since the funding of the Finnish UAS's is now based on the student progression as well as the number of graduates, it was decided that a pedagogical reform is needed as well to improve these results. Traditionally the curricula have been based on a large number of small courses taught by individual members of staff without much integration between the different courses. Even though continuous assessment has been emphasized in many courses, still a large number of courses were assessed by end exams only. In the new curricula the pedagogy is based on collaborative teaching and learning where all the old contents are integrated to larger courses and each course is taught by a larger number of professors. All the topics within the courses are thus integrated and only one single grade is given of the whole course. The professors involved have to agree on the grade and the assessment has to be continuous students receiving feedback of their behavior throughout the whole course. The student intake in September 2014 to these renovated degree programmes was 160 students. The student progression has been analyzed in detail after the first two semesters and the results show significant improvement in the student progression. Almost 90% of the students have completed all the courses of the first semester compared to a very low value of only 60% in 2013 and 2012. Thus the improvement in student progression has been significantly improved. The new pedagogical approach has been improving the learning outcomes as well through the means of continuous assessment.

Keywords: *Continuous assessment, collaborative teaching and learning, modular curriculum, integration of studies, improved student progression, student tutoring*

Introduction

The curricula of all the degree programmes in Helsinki Metropolia University of Applied Sciences went through a total reform in 2014. The most profound change took place in the engineering degree programmes, since the Finnish ministry of education made a new degree programme structure to be followed by each university. Many old programmes were merged and therefore the contents of old programmes had to be integrated. For example the old programmes of Electrical Engineering and Automation Technology were merged. In the new programme structure the studies of the first two semesters were integrated and Electrical Power Engineering, Automation Technology and Electronics are from now on only majors in the new combined programme. The language of tuition in that programme is Finnish. The same department organizes as well an English degree programme in Electronics and its contents were as well integrated to the Finnish programme since the study paths of the Finnish and English Electronics students are connected after the first year of study.

It was as well decided by the university board that the new curricula will be based on collaborative pedagogy (Barkley, Miles and Peters, 2006) and integration of studies at least in some level. Some engineering programmes decided to go all the way and organize the studies in large periodical entities in which all the studies are integrated. That was done in the degree programmes related in Electrical Engineering, IT and HVAC Engineering. After the first two semester the student progression analysis shows clearly that the results in these programmes is significantly better compared to the engineering programmes that followed the instructions only in the minimum level.

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The basic reason for such a huge pedagogical change is the new funding principles of the Finnish ministry of education. From 2014 on the funding of the Finnish UASs is based on the number of graduates as well as the number of students completing more than 55 ECTS credits a year (out of yearly offered 60 ECTS). Previously the results in the engineering programmes have been very poor, since the courses have been organized as 3 credit blocks and if the student fails two courses (that he/she may retake later), the yearly credits fall below 55 and that has a direct negative effect on the funding. By organizing the courses as entities of 15 ECTS, it basically forces the students to complete all the topics in time. All the larger courses are based on collaborative teaching and learning as well as continuous assessment. Collaborative learning enhances cooperation between the teaching staff and the students making the assessment more transparent as well as motivates the students by making the links between different subjects more visible. The continuous assessment activates the students throughout the course instead of focusing on the end exams and as well makes it much easier to follow the learning outcome specifications by making it possible to ensure the learning of individual outcomes by simple checks during the course. The engineering degree programmes as well follow the CDIO pedagogy (Crawley, Malmqvist, Östlund and Brodeur, 2007) by incorporating the required project courses, active learning methods etc.

Modular Curriculum

The modular curriculum consists of study modules of 15 ECTS credits. In the degree programme in Electronics (in English) and the degree programme in Electrical Engineering and Automation Technology (in Finnish) all the study modules equal just one single course of 15 ECTS where all the subjects are integrated and only one single grade is given. Each year of study is divided into four consecutive study periods of 10 calendar weeks. One period then consists of 8 weeks of teaching and two self-study weeks. One course / module is organized during one single period during which the students focus on one single course only (some electives may be also taken). The student paths in different degree programmes are optimized and synchronized in a way that some professional modules are usually common to many degree programmes. The students may thus easily pick minors of two modules from other degree programmes as well (Valmu, Ikonen, Soini and Olli, 2014).

In the degree programmes in Electronics as well as Electrical Engineering and Automation Technology the modules of the first year of study are common and compulsory to all students. After the first year the students select their major (Electrical Power Engineering, Automation Technology or Electronics). The study paths of both the Finnish and English electronics students are connected after the first year and from then on all the courses are given in English. The Electronics students may later as well select a major in Healthcare Engineering which is a common major to students both in Electronics and Information Technology.

The courses (modules) of the first year of study and their contents are listed below in table 1.

Table 1. The study modules and course of the first two semesters together with their main contents.

Module #1; 15 ECTS
Orientation to Engineering Studies
1. expressions, equations and functions
2. quantities and units
3. graphical chart
4. communications skills for technology
5. oral and written reporting and communication
6. introduction to programming
7. learning and study skills
8. introduction to current topics in the field
9. key guidelines of higher education studies
10. Metropolia as a study environment
11. electrical safety at work

Module #2; 15 ECTS
Orientation to Electronics and Electrical Engineering
1. physics related to electronics and electrical engineering
2. DC circuits
3. basics of analog electronics
4. basics of digital electronics
5. vectors, matrices and complex numbers
6. introductory project

Module #3; 15 ECTS
Orientation to Electrical Power Engineering and Automation
1. elementary differential and integral calculus
2. concepts of a derivative and an integral
3. mechanics
4. introduction to automation
5. introducton to electrical power engineering
6. English language
7. AC circuits

Module #4; 15 ECTS
Project in Electrical Engineering and Automation Technology
1. applications of differential calculus
2. magnetism
3. computer aided design
4. communication and documentation in English
5. design project

Integration of Studies and Collaborative Teaching and Learning

Each of the courses is given by a larger number of professors. As shown in table 1 each course consists of traditional basic studies (maths, physics, communications skills, etc.) as well as engineering studies. In each of the first year courses 5 professors were involved including one professor teaching mathematics and one teaching physics. Due to practical reasons (at least in the first round) each professor was given timely slots in the weekly schedule to organize the teaching. However the assessment methods as well as common exercises were discussed and agreed by the group. Different assessment methods were encouraged in the

first round, but it was decided that the assessment should be continuous based on weekly tasks to students as well as smaller exams throughout the course instead of an end exam. It was decided as well that none of the subjects are assessed separately.

Also the students were encouraged to work together to solve the problems given and complete the project tasks. One of the goals was to encourage the more qualified students to help out the ones having problems in the more difficult subjects. However most of the smaller exams to define the final grades were individual ones.

The weekly schedule was designed so that the students had actual teaching (lectures, labs, etc.) in the morning and in the afternoon. Between these hours the students had always at least 2½ hours to complete their weekly exercises and work on the projects. Besides these hours all the students had one hour per week in the schedule to meet their teacher tutor who was one of the professors involved. Many teacher groups as well decided to book common hours for their smaller exams.

Continuous Assessment - Case Study

The assessment of each of the courses in the degree programme in Electronics as well as in the degree programme in Electrical Engineering and Automation Technology is continuous. The student have to complete a large number of various tasks and smaller exams and therefore they have to work actively throughout the course. No end exams on different subjects are organized. The students are divided to groups of approximately 40 students. The student intake in autumn 2014 was 120 students to the degree programme in Electrical Engineering and Automation Technology and 40 students to the degree programme in Electronics. Therefore there were altogether four parallel student groups studying the same modules simultaneously. Each group of teachers were encouraged to define their assessment procedures freely within certain limits. When the teacher teams were altered between the modules the new teams copied the best practices from the previous experiences and finally after the first year the procedures will be standardized by selecting the best procedures.

In module #3 the teacher team consisted of teachers specialized in the following subjects: a) mathematics, b) physics, c) electronics, d) circuit theory and e) project management. Most of the teams allocated to this module used the following assessment procedure. Each teacher gives the students weekly exercises/tasks related to his/her field. These tasks are usually homework exercises, CAD tasks related to electronics/circuits, project related tasks or laboratory assignments. During the eight weeks of contact teaching the students have altogether 40 weekly tasks (8 weeks * 5 teachers = 40 tasks). Each task is simply evaluated as pass/fail. In order to pass the whole course of 15 ECTS the student has to pass 34 of these weekly tasks. Besides the weekly tasks the teachers organize smaller exams throughout the course (each teacher arranges 4-6 smaller exams; some exams common to multiple teachers). These exams are evaluated (max. points 100) and the final grade is based on the exam points. This assessment procedure was just one of the many procedure experimented, but it will be most probably the standard procedure for the first and second year students in the next academic year.

Student Tutoring

Each group of students was divided to five subgroups of approximately eight students. Each member of the teacher team in that module was the student tutor of one of the subgroups and the tutor met his/her group once a week. The main purpose of such an arrangement was to follow that all the students were completing all the exercises in time, to keep track of the student progress, to receive feedback and to help out the students in the process if necessary. By this subgroup arrangement we were able to enhance the collaborative work and cooperative spirit between the students and the teachers. Such a tutoring system will continue as well in the more professional modules in the future, but more resources are allocated for the tutoring of the first year students in order to enhance the student motivation as well as to keep the drop-out rate as low as possible during the first year.

The teacher tutors of the first module will continue as the mentors of the students throughout their studies.

Student Progression Results and Discussion

The student progression results of the first semester have been analysed and reported before (Valmu, Vartia, Kupila and Heikkinen, 2015). Here we present the results of the whole first academic year. Figure 1 shows the credit distribution of the students in the degree programme in Electrical Engineering and Automation Technology after the first semester (modules #1 and #2).

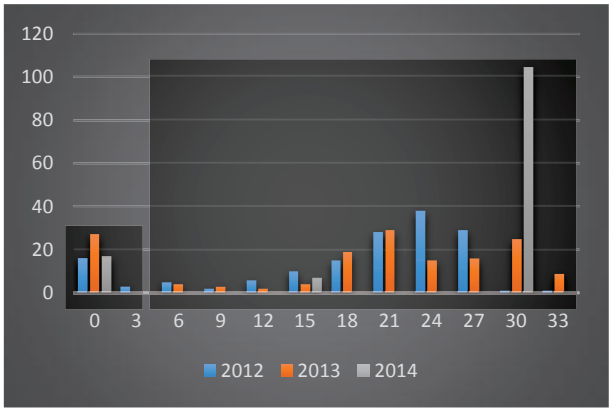


Figure 1. The credit distribution of the students of the degree programme in Electrical Engineering and Automation after the first semester in 2014 compared to two previous years (results of two old programmes combined). The number of credits in x-axis and the number of students in y-axis (Valmu, Vartia, Kupila and Heikkinen, 2015).

It may be seen that in the new curriculum (2014) the students have completed either 0 or 15 or 30 ECTS credits. Most of the students did complete all 30 credits

in autumn term of 2014, some have completed 15 ECTS and those having 0 credits are ones who either did not start their studies at all (even though they were accepted) or did drop out during the first two or three weeks. In the previous system the studies were arranged in 3 credit courses and the distribution is totally different. One must notice that the funding limit of the Finnish ministry of education is 55 ECTS/year and by failing just two courses a year has a negative effect on the funding. Therefore the students that had completed less or equal to 24 ECTS are in danger in falling below that limit, if they do not compensate the courses in the spring term

Figure 2 shows the improvement of funding criterion of students completing more than 55 ECTS / year from 2012 to 2014. This criterion was introduced in 2012 and it may be seen that just by improving the internal processes in the programmes based on the old curriculum the results were much improved from 2012 to 2013 without any pedagogical change. The results of 2013 in the programmes presented here were significantly better than the general level of other engineering programmes in our university where the corresponding percentage was below 50%. Further improvement was however still wanted and this was accomplished by introducing the pedagogical reform presented in this paper. These results have to be compared still to other programmes from which we not have yet necessary data available. Preliminary comparison shows already that the results are much better in the programmes arranging the courses in larger entities and focusing on continuous assessment (programmes presented here) or project based learning (the IT programmes).

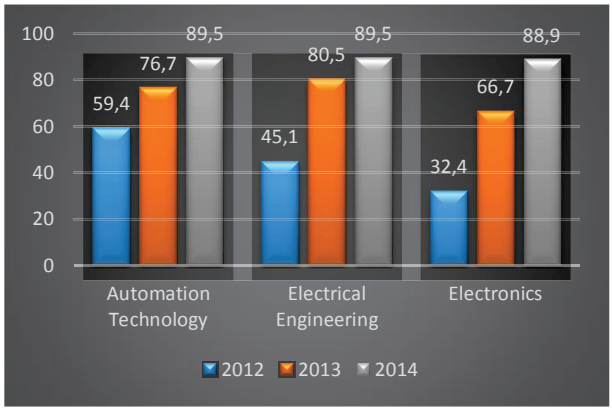


Figure 2. The percentage of students in three different degree programmes completing more than 55 credits a year in 2012, 2013 and 2014.

Figure 3 shows the percentage of all the studies offered completed in the programmes presented here in 2012 - 2014. These results are analyzed by calculating the credit point average of the students and comparing that average to the maximum of 60 ECTS / year. The drop-out students and those who studied only one semester (and left to complete theit military service etc.) were omitted from the calculations (as well as from the analysis presented in Figure 2).

When the results in Figures 2 and 3 are compared one may notice that by increasing the average credits presented in Figure 3 only slightly the percentages affecting the funding (presented in Figure 2) may be increased significantly. That is explained by the fact that just by failing two old smaller courses the students fall below the funding limit even though the credit average is still reasonably high. In the degree programme in Electronics the credit average percentage in 2014 is somewhat strangely over 100%. This is explained by the fact that already during the first two semesters many overseas students took Finnish courses as electives. Some students have completed as much as 10 ECTS of Finnish for Foreigners during the first year.

It is thus evident that the new curriculum with the larger courses improves the student progression significantly when the funding results are concerned. One must definitely still undersstand that the present funding system is not the only reason for the change. Another great benefit is that in the new system very few students have any courses pending. In the old system many students had to retake some first year courses in parallel with their second year studies. This makes the progression in the future years more difficult, prolongs the studies and makes it more difficult to achieve the specified learning outcomes.

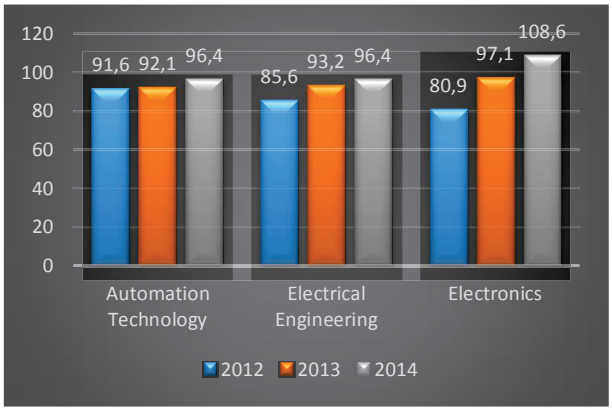


Figure 3. The percentage of studies completed in different degree programmes after the two first semesters in 2012, 2013 and 2014.

Conclusions

It is shown that the new curriculum together with a fundamental pedagogical change focusing on continuous assessment, integration of studies and collaborative teaching and learning improves the student progression significantly. It also makes the students achieve the specified learning outcomes in due time and will therefore facilitate the students study paths in the future years as well.

In the future years all the professors in the fields on electronics, electrical power engineering and automation technology will be organizing their courses based on the pedagogical approach described in this paper. Therefore after the successful first year future training and motivation of the professors have to take place. Also the

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assessment methods as well as other procedures have to be at least somewhat standardized.

After the first year only the student progression has been analyzed in detail. A major student feedback survey will take place in the third semester and its results will be compared to the results of corresponding surveys of the previous years. Also ways to analyze the actual student learning will have to be specified and such analysis performed. At the moment it seems that the student learning is at least in the same level as before, since in some cases the smaller exams have been quite equivalent to the end exams of the previous years, but that all has to be carefully analyzed in detail in the future.

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Proposal of a Method for Visualization of Skills at Experiments and Practical Training

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Abstract

The total number of graduates of all colleges of National Institute of Technology (NIT) is over 10,000 every year. The graduate students are valued from the industry for over 50 years. In order for the students to acquire high skills, the features of the curriculum in NIT are to combine lectures, and experiments and/or practical training. However the skills of experiments and practical training is implicit knowledge until now. Therefore we make the skills to be explicit knowledge for improvement of skills. Then we propose a method to visualize the skills, and we introduce an approach to decide the level of achievement of experiments and practical training skills.

Keywords: *technical experiments, visualization of experimental skills, achievement of the experimental skills, 5-level evaluation, curriculum improvement, educational improvement*

Introduction

In the National Institute of Technology that consists of 51 colleges, professional education in 7 engineering fields (mechanical, electrical and electronic, chemical, material, architecture, construction and information) has been carried out. Also, technical experiments and practical training have been carried out in the each field. It is a feature of the NIT that is focused on experiments and training. Experimental skills of graduates in society have been highly evaluated. However, it is important that the students to experience the experimental skills, it is necessary visualization of experimentation and evaluation skills of achievement.

By specifying the metrics of the experiment the contents of each college, to facilitate the evaluation of the achievement of the experimental skills, further allowing for effective technology education. It is possible to clarify the metrics, to visualize the student skills. Then, by indicating the achievement and effect of student technical education, it is possible to expect the effect of increasing. Here, we proposed by using the experimental evaluation-sheets and the experimental skill-sheets, to clarify the metrics of the experiment and to indicate the achievement level.

There are educational effects by the evaluation introduction of the experimental skills. First, the features of the educational content have been revealed. Metrics and arrival goal in the experiment of each technical college will be systematically collected. As a result, content and function of education is clear. Then, we will visualize the experimental skills of students. Here, we made the 5-level evaluation criteria for elements of experimental basis, theory, measurement, analysis and report. We experiment to evaluate the skills in using this criterion. As a result, the outcome is visualization, we can expect that the outcome and will sense of students to rise. The teacher will be able to guide more students. Finally, it is the improvement of education. It uses the skills sheet that will be linked to the review of the curriculum and educational improvement.

The features of the Model Core Curriculum

Each of colleges was independent before 2004, various problems have occurred when become one corporate organization. Several problems are indicated below.

- No unified evaluation standards
- Not enough to announce the feature of curriculum to society
- The curriculums of each colleges are independent

In order to improve those problems, the Model Core Curriculum (tentative plan) was published in 2012.

The features of the Model Core Curriculum are as follows.

- The learning level of the NIT's students is defined
- The learning item of each specialized field is shown

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The Model Core Curriculum is a common decision by all colleges. It's important for the contents of subjects and the evaluation standard to have been explicitly. It's important to have been shown the contents of subjects and the evaluation standard. However, the Model Core Curriculum includes the following problems.

- There is a few numbers of items of the experimental subjects or the training subjects.
- The evaluation standards of the experimental subjects and the training subjects have not been defined.

The above problems require careful discussion, and time is required. In order to improve the curriculum of the experimental subjects and the training subjects, the experimental skill-sheet and the evaluation-sheet that will enhance the Model Core Curriculum have been developed. Overview of the project is shown in Figure 1. In following sections, we show the reasons and the developing procedure of these sheets.

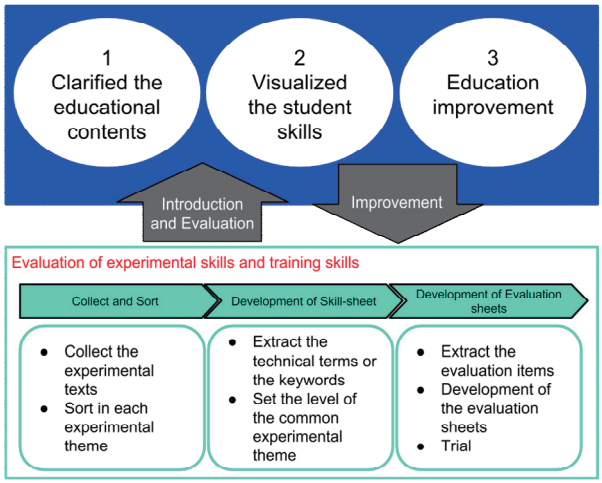


Figure 1. Overview of the project

Development of the experimental skill-sheet and the evaluation-sheet

The Model Core Curriculum has defined the contents of subjects and minimum learning level in all colleges. As stated above, there is enough description to the lecture subjects, but there is not enough to the experimental subjects or the training subjects. The reasons are as follows.

- The laboratory instruments in a department will influence on the contents of the experimental subjects or the training subjects.
- The learning items are related to the curriculum policy of each department.
- The curriculum policy will be affected in the feature of the area where the college is located.

Therefore, as the refinement of the Model Core Curriculum, the experiment skill-sheets and the evaluation-sheets have been developed. The common items of the experimental contents at several colleges are collected in the experiment skill-sheet.

Phase1: How to develop the experimental skill-sheet

It is difficult to collect the experimental manual/tutorial of all colleges. Therefore, seven colleges (8 campus) with different areas were chosen, the experimental texts of those colleges were collected to develop the experimental skill-sheets. The experimental manuals/tutorials of five specialized fields (Mechanical, Materials, Electrical and Electronic, Chemical and Architecture and Construction) were collected.

The steps to develop the experimental skill-sheet are as follows.

1. Collect the experimental manuals/tutorials
2. Sort in each experimental theme (Figure 2)
3. Extract the technical terms and the keywords (Figure 3)
4. Classify the common items to the experimental skill-sheet
5. Set the level of the common experimental theme (Figure 4)

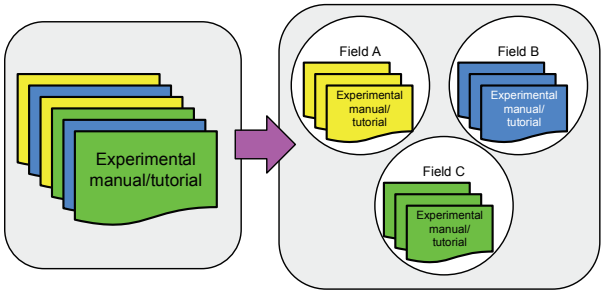


Figure 2. Collect and sort

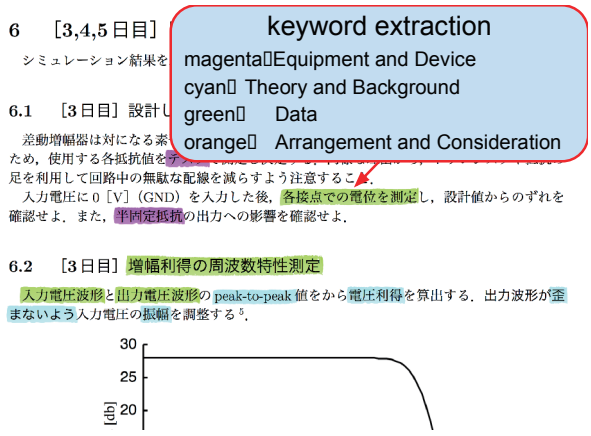


Figure 3. Extract the technical terms and the keywords

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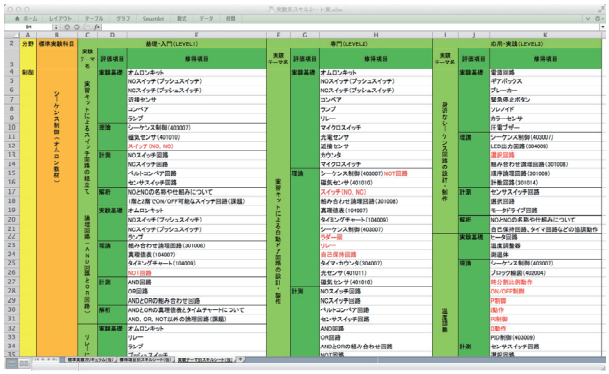


Figure 4. The common experimental skill-sheet (Japanese)

The above steps had created the experimental skill-sheets. Those sheets of each field are as follows.

Mechanical: 25
Materials: 10
Electrical and Electronic: 230
Chemical: 18
Architecture and Construction: 23

Phase2: How to develop the evaluation-sheet

The experimental skill-sheet is a framework to sort the items in the specialized field of the experimental subjects or the training subjects. However, the experimental skill-sheet does not show the evaluation standard for the students who work on the experiment theme.

To solve the problem, the evaluation-sheets that correspond to each experimental skill-sheets have been developed (Figure 5). In addition, the evaluation is set to five levels, and each level is defined as follows.

Level1 (knowledge and memory):
Teacher's guidance is needed to do an experiment.

Level2 (understanding):
An experimental text and teacher's advice are needed to do an experiment.

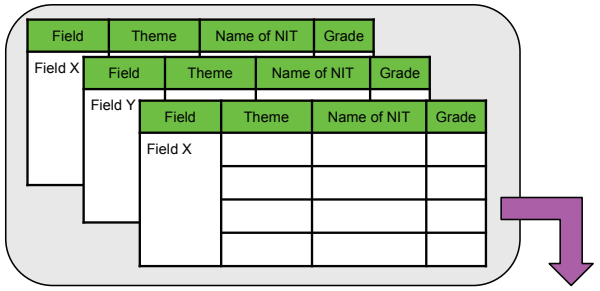
Level3 (adaptation):
An experimental text is needed to do an experiment.

Level4 (Analysis):
An experimental text is sometimes used to do an experiment.

Level5 (Evaluation):
Nothing is needed any advice to do an experiment.

The development of the evaluation-sheet make possible to show the evaluation standard for the students who work on the experiment theme. The evaluation-sheets had been created.

Mechanical: 5
Materials: 2
Electrical and Electronic: 4
Architecture and Construction: 3



Evaluation items	Evaluation standard	Self Check	Comment
Basis	Correct handling of the laboratory equipment and the elements		
Theory	Learning for the theory in the experimental contents		
Measurement	Acquisition of the measurement technology conforming to the experiment theme		
Analysis	The result of measurement can be gathered and considered in the table and the chart		
Report	Acquisition of the technical-writing skill		

Figure 5. The evaluation-sheet

Trial of the experimental skill-sheets and the evaluation-sheets

The experimental skill-sheets and the evaluation-sheets were tried out. 3 classes of Tsuruoka College and 1 class of Sendai College tried those sheets. In these trials, we evaluate the propriety of evaluation-sheet in actual, then we have several valuable knowledge as follows.

(1) It is available to visualize the skill using the evaluation-sheet, but granularity of item in the sheets is consideration.
(2) It is possible to evaluate the level of skill achievement by students themselves; here accuracy and variance are also consideration.
(3) It is very necessary to recognize the importance of experimental skill evaluation to students, staffs and lecturers.

Although there are a few trials, it was possible to indicate the utility of the experimental skill-sheets and the importance of the evaluation-sheets.

The Figure6 is an evaluation model using UML (Unified Modeling Language) that Tsuruoka College had created. From this figure, the experiment items and the skill achievement will be evaluated independently each other.

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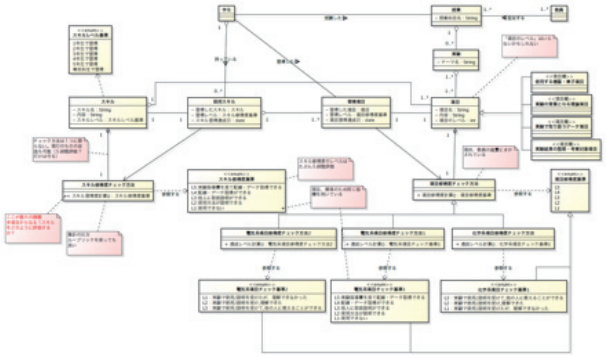


Figure 6. Evaluation model using UML

Conclusions

In the current Model Core Curriculum, the contents of subjects or the evaluation standard of the experimental subjects and the training subjects have not been well defined. Therefore, we worked on defining the contents of subjects or the evaluation standard. Thus, the educational content will become clearer, it will be possible to further reveal the feature of the NIT (Figure 7).

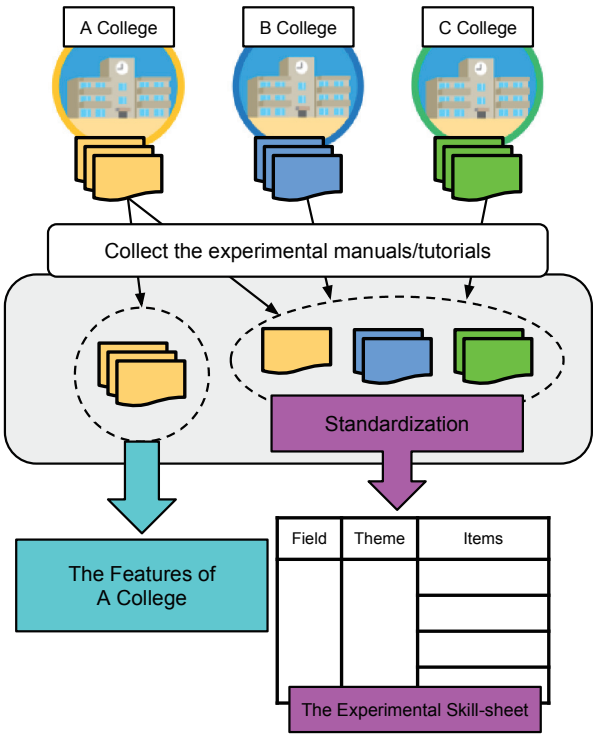


Figure 7. Collect and standardization

In this project, the number of the collected experimental texts amount to over 300. The experimental skill-sheets and the evaluation-sheets have been developed using the learning items, which sorted those texts manually. Improvement of those sheets and assessment methods will be the challenge in near future. In order to increase the working efficiency, it is necessary to develop a system for automatically creating the experimental skill-sheets.

Finally, it is possible to visualize each student's skills by defining the evaluation standard. The evaluation standard is one of tools to guide students effectively. Thus, the sense of achievement and the motivation of student will be increased in the experimental subjects and the training subjects.

Acknowledgements

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INTERNATIONALIZATION OF CURRICULUM BY TEACHING SUBJECTS IN A SECOND LANGUAGE: CHALLENGES AND LESSONS LEARNED

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Abstract

Mexico delivers education in Spanish, the country's official language. Nowadays, global industries require professionals with good English command. In 2014, our country ranked 39th out of 63 countries according to the EF English Proficiency Index (EF EPI). The University of Guanajuato (UG), located in the central region of Mexico, is committed to the internationalization of its curriculum. According to the UG Development Plan (2010-2020), it shall offer at least 2% in 2015, and 5% in 2017 of subjects in English. Nevertheless, these programs have to overcome several barriers: English is not the mother tongue of professors and students, and both live in a Spanish speaking environment; these circumstances render difficult the purpose of the Program. Furthermore, the teaching process should accomplish two learning outcomes: to teach subject content and to develop English communications skills for academic purposes. Our results show that the program is incipient, since only 82 (1.46%) of 5608 subjects at the whole university are offered in English. Furthermore, most of the professors with a good level of English are mainly concentrated in the Academic Divisions of Natural and Exact Sciences, Engineering and Economy and Administration. In addition to professors who are already teaching English, another group of 90 professors want to participate in this program. The professors manifested the need for specialized pedagogical training. Thus, specialized courses were offered to faculty where Constructivist methodologies were taught including class preparation, class development, and alternative assessment. From our practice, it was found that students taking subjects in English need at least a B1 English level, according to reference to the Common European Framework of Languages. The student-centered learning approach helped the students to become more participative in the classroom, and to utilize English for academic purposes through discussions and presentations. This experience shows that undergraduate students need to take two or more courses in English to use this language for their professional life and academic purposes.

Keywords: *Internationalization, constructivism, English for academic purposes, student-centered learning, internationalization at home.*

Introduction

At present, English is considered the *lingua franca* of the modern time, since this language is used for business, education, or science. Therefore, English is the best way to communicate with people who speak different mother tongues. Interestingly, non-native English speakers shape the language to their needs, for work, business or to study in English-speaking countries (Seidelhofer, 2005). Considering the importance of English language, many countries have adopted a national policy that emphasizes the importance of offering courses in English. This initiative aims to promote economic and social developent to connect the citizens with the world, and to offer an international educaion to their students (Dearden, 2014). Thus, France and Japan are now offering educational programs in English to provide local students an international education, and to attract students from abroad to internationalize their Higher Education Institutions (HEI) (Campus France, 2015; Japan Student Services Organization [JASSO], 2015). Mexico is not immune to these global transformations. With the arrival of foreign industries to the central region of Mexico, the socio economic scenario is in constant transformation. Moreover, overseas industries settled in Mexico require professional with good command of English (British Council, 2015). Nevertheless, despite these requirements, our country ranks 39th out of 63 countries according to the EF English Proficiency Index (2014), a comprehensive ranking of countries by English skills. Hence, the

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Mexican government is aware of the changes needed in the National Education System. Two initiatives will be mentioned. The Mexican Ministry of Education (SEP), to promote international competitiveness has implemented a program to secure the quality of higher education throughout internationalization (Secretaría de Educación, 2015). The Mexican HEI's should adopt this new dimension as a mean to reduce the gap in development with highly developed countries through the international cooperation among universities (PIFI program, Secretaría de Educación, 2015). Furthermore, the Mexican National Council for Science and Technology (CONACYT) promotes accredited graduate programs through the *National Quality Graduate Program* (PNPC, from its acronym in Spanish). One of CONACYT policies includes international cooperation and curriculum internationalization, and English proficiency as a requirement for student graduation (CONACYT, 2015). The Higher Education System in Mexico delivers education in Spanish, the country's official language. Importantly, some public and private HEI are offering courses taught in English, as well as complete undergraduate and graduate programs to internationalize their curricula and also to increase their international visibility. Implementing the use of English as a language of instruction at HEI represents a challenge since the students must master the language and then take specific subjects in English. Moreover, the faculty members should have a good command of English to use "English as a medium of Instruction" (EMI) at different education levels in non-English speaking HEI (Dearden, 2014).

The University of Guanajuato (UG) in Mexico is a public state university that offers 194 undergraduate and graduate academic programs. UG mission is to prepare professionals with an international profile to perform in the world arena. One of the ways to support internationalization is offering subjects taught in English as stated in the UG Development Plan 2010-2020. UG expects to offer by 2015 at least 5% of the total number of courses in English. To carry out this goal, several tasks have been accomplished: First, identify the professors with English skills and the willingness to teach in English. Second, determine the pedagogical training required by professors to teach in English. Third, encourage the students to use English for academic purposes. Our primary objective is for students to learn course content and use the English language for academic and professional purposes. UG has identified the faculty members with the English skills and the willingness to use English for teaching purposes. The need to provide specific training for faculty members on the use the Student-Centered approach based on Constructivism was detected (Béres. & Turcsányi-Szabó 2010; Hussain, 2012). This methodology has been developed in accordance to the Educational Model of the University of Guanajuato (Universidad de Guanajuato, 2011). Finally, the challenges that this Program embodies were identified, and the lessons learned to find the most suitable means to implement this program to succeed will be shown.

Procedures

Mexican government and university policies for foreign language acquisition. It is important to grasp the present situation of Mexico regarding the internationalization guidelines and their relation to the learning of a second language in HEI. The following documents were consulted: (1) The Development National Plan 2013-2018 (Plan Nacional de Desarrollo, 2015. (2) The Sectoral Plan of Education 2013-2018 (Secretaría de Educación, 2015). (3) The Graduate Programs policy from CONACYT (2015). (4) The UG Development Plan (2010-2020) (Universidad de Guanajuato, 2010). (5) The UG Educational Model (Universidad de Guanajuato, 2011), and (6) one report from The British Council (2015).

Survey to identify faculty to teach in English. Considering that in 2015, at least 280 out of 5600 subjects would be offered in English, it was convenient to identify the faculty members to participate that shall use English as a way of teaching. UG counts on 3,011 faculty members. The survey was launched by using the SurveyMonkey platform (www.surveymonkey.com). The professors were requested to perform a self-evaluation of their English level according to the Common European Framework of Reference of Languages (2015).

Catalog of subjects offered in English. The total number of courses offered in 2014 at the University was quantified; the information was directly retrieved from the university website (www.ugto.mx). The number of courses offered in English was quantified.

Faculty Development Workshops: Student-centered learning and constructivism. Teaching subjects in English in a Spanish-speaking environment represents several challenges: English is not the mother tongue of professors and students, and both live in a Spanish-speaking environment. The Institution provided several training workshops on student-centered learning when English was used as a teaching method. Therefore, some professors participated in specific Faculty Development Programs to teach subjects in English through student-centered learning techniques. The workshops were held in Mexico (2010) in Canada (2011 and 2013), and in the USA (2014). The faculty trained abroad in 2014 participated as facilitators in four workshops in the UG attended by 90 professors. The University of Colima and the Popular Autonomous University of the State of Puebla (UPAEP) shared their experience in setting up the courses taught in English.

Results and Discussion

Mexican National Policy. The Development National Plan (Plan Nacional de Desarrollo) 2013-2018

only mentions quality education, but no strategies are outlined related to the internationalization of the curriculum. Then, the Sectoral Plan of Education 2013-2018 (Secretaría de de Educación, 2015) only makes reference to internationalization for cooperation but no allusion to foreign languages acquisition. Importantly, for graduate programs recognized by the National Register of Quality Graduate Programs, it is mandatory for the students to sustain and approve a standardized English Test (TOEFL) to graduate (CONACYT, 2015).

Faculty survey. The objective of this survey was to detect the professors with the English skills to teach in English. A total of 254 professors responded the questionnaire. However, only 114 faculty members with an English level ranging from B1 to C3 were considered (Table 1).

Table 1. Faculty members from University Divisions with skills to teach in English.

Campus	Academic Division	Faculty for teaching in English (%)
Guanajuato	Natural and Exact Sciences	35 (30.7%)
	Economic and Administraive Sciences	29 (25.5%)
	Social Sciences and Humanities	16 (14.0%)
Irapuato-Salamanca	Engineering	34 (29.9%)
	Total	**114**

The Guanajuato Campus has 80 professors, and the Irapuato Salamanca campus relies on 34 professors with the language skills to teach in English. Regarding the experience of UG professors in the use of English for academic purposes, 35% of them reported having used it in formal courses, congresses, and conferences. Professors expressed their willingness to teach their courses in English and the need for specific training.

Course catalog. The University of Guanajuato offers 192 undergraduate and graduate programs. Only 82 (1.46%)-out 5608 of the courses are taught in English. It was found that only two campuses offer courses in English. Campus Guanajuato offers 47 (57.31%) out of 82; whereas the Campus Irapuato Salamanca imparts in English 35 (42.68%)-out of 82 courses. The distribution by Academic Divisions is shown in Figure 1.

Importantly, the Division of Humanities and Social Sciences, Campus Guanajuato offers 30 courses in English through the TESOL program, and the Master in Management offered at the Division of Economic-Administrative Sciences. At Irapuato-Salamanca Campus, the TESOL program is also and contributes with 30 subjects taught in English.

Training process: train the trainers. In 2010, nineteen professors participated in the Faculty Development Program, in Guanajuato, taught by Mount Royal University instructors. However, until 2011, two professors began to put in practice the constructivist pedagogy, but teaching in Spanish.

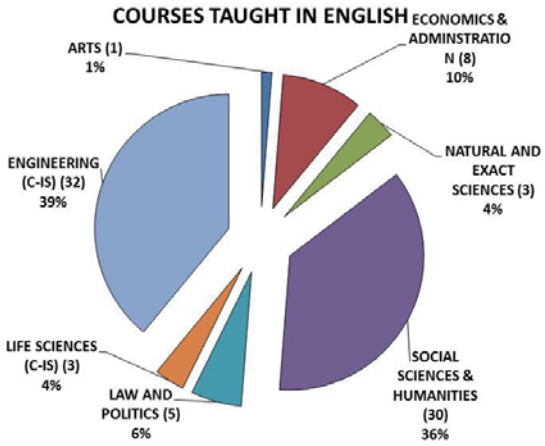


Figure 1. Courses taught in English at the academic Divisions from Guanajuato Campus and Irapuato-Salamanca (C-IS). Number of courses is shown into parenthesis.

In 2013, six professors followed the same program in Canada, but at their return little impact on teaching was noticed. In 2014, with the support of Mesa Community College Center for Teaching and Learning, five professors carried out a specific stay to learn techniques for collaborative learning and class observation. After their return, the trainees offered four workshops to share the acquired knowledge. Ninety professors attended the workshops and showed their eagerness to use English as instructional language.

Student-Centered Learning. Teaching is one of the three substantial purposes of the University, along with research and outreach activities. The professors who want to use the EMI should follow a training process to acquire and put in practice specific pedagogical strategies in the classroom. It is expected to encourage the students to use English as a communication medium of instruction in a friendly environment (Felder & Brent, 2009). According to University of Guanajuato Academic Model (2011), it is expected to change the teaching methodologies to student-centered learning.

Thus, the constructivist practices shall help the students to develop skills such as interpretations, judgments, to participate in different situations where teamwork and oral communications are acquired. The professor should play an active role by setting different pedagogical activities, as well as to encourage the students to learn in a different setting. These approaches aim to attain two main outcomes: to learn the subject content and to encourage the students to use English for academic oral communication (The University of Sydney, 2015

The involvement of students in group activities shall help them to develop an active environment in the classroom to look for information and find solutions under the guidance of their professor. Students liked the group's activities, and active participation was always present. The tri dimensional models manufactured by students allowed using them as support to explain the structure and functioning of biological molecules or systems. The oral presentations helped the students to organize logically the information and to present the subject in a coherent fashion.

Lessons learned. General recommendations.

Suggested strategies to teach in English. It is convenient to consider the following stages when teaching in English (Figure 2). Some recommendations for the class planning are shown in Table 2.

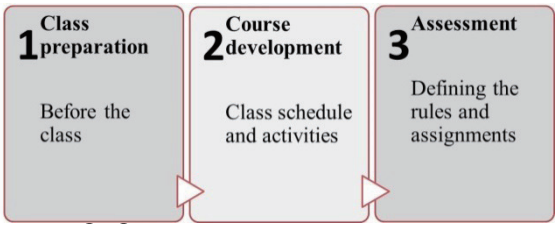


Figure 2. Stages for class development when using English for teaching.

Table 2. Suggestions for preparing each individual class.

Have ready the syllabus
Set up the dates for each theme or topic
Define the learning outcomes
Prepare each class individually
Use the most methodology for the topic
Schedule the activities to perform during the class
Let the students know the assessment methods

Communication with the students. The Use of information technologies is suggested; platforms such as Moodle or creating a "closed group" in Facebook are suitable. The materials to use in class must be upload early, 4 to 5 days previous to the session.

Defining learning outcomes. Students must know what they will learn by the end of each class, based on learning objects. Define up to five learning outcomes for each theme (Osters & Tiu, 2015).

Course development. In our experience session of 2 to 3 h is suitable to use student-centered learning. An example of 120 min class development is shown in Table 3.

Table 3. Time distribution for a 120 min class by using student-centered pedagogy.

ACTIVITIES FOR THE CLASS DEVELOPMENT	Time
Icebreaker; Both students and the professor participate	10 min
The professor provides a brief explanation about the class content	20 min
KWL exercise. It will allow the professor to assess if the students completed the assignment, work in groups is encouraged	20 min
the professor will review the responses and give feedback to students	20 min
The students will write an abstract about the class content	20 min
The abstracts will be reviewed by their classmates and graded	15 min
Debriefing or questioning	15 min

Assessment. This is the most difficult step in the courses taught in English. Since this is not a traditional course, each activity will be differentially evaluated according to the skill intended to be developed. Hence, evaluate not only knowledge but also skills. Suggested criteria are shown in the Table 3.

Table 3. Assessment criteria for student-centered teaching courses

Individual and group participation
One-to-one assessment
Oral presentations and evaluation by using rubrics
Tridimensional models elaboration
Abstracts writing
Quizzes

Professor's skills and attitudes. Professors need to develop specific skills to set up, in the classroom, an environment of confidence for students to understand, participate, practice and improve communication skills. It is important to consider that the professor cannot teach in English the same way he teaches in Spanish. Therefore, student-centered learning techniques are needed. Professors should manage the English language at least with a B2 (Common European Framework of Reference of Languages, 2015). They also should be patient; flexible, creative and innovative. Participation in specialized Faculty Development Programs should be required (Powell, 2013).

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Students. Students should have at least a B1 level of English or five courses of English learning; accept that making mistakes in English is part of the learning process and be aware that taking a subject in English requires an extra effort. Students should look for extra help in the self-access center for language learning, where English native speakers are available.

Classroom environment: The ideal size for a group to work efficiently is from 5 to 15 students. Encourage the students to work in small groups; use the traditional blackboard and in less extent a projector (Figure 3). As long as possible, do not correct student's speaking mistakes; instead, rephrase the question with the right pronunciation of phrase structure. Do not expect your students to develop all the communication skills after taking one course in English. If possible, invite an English speaking native to help both students and professor with some possible communication difficulties.



Figure 3. Classroom activities for student-centered teaching. Tridimensional models help the students to use English for description and teamwork.

Professor Testimony No. 1: Experiences and outcomes. Most graduate students in Mexico have sufficient skills to write and read in English because of the continuous years of practice. However, oral communication skills are limited, considering the students live in a Spanish-speaking environment. To improve the oral communication, in the courses the collaborative-learning techniques were incorporated. It was decided to integrate that methodology gradually in a blended fashion; the advanced courses are taught 20% in Spanish and 80% in English until the courses are offered 100% in English. For undergraduate students, the inclusion of English was more gradual.

Some of the collaborative learning techniques used are traveling file; think-pair-share and, numbered heads together. Most of the professors reported that students were excited by using new methods in the classroom. When the traveling file was employed, the professor presented the theory; the students were asked to work in groups, in a case study, to later prepare a brief report. The students learned to review, analyze, critique and evaluate someone else's work. Importantly, the students detected the main facts and also the mistakes and how to learn from them. It is important to mention that the students have learned to appreciate the work and effort of their classmates.

Thus, students are pleased to use collaborative learning techniques in the classroom. Since teamwork aims to get a common goal, it drove the participants form passive listening to active thinking and participation. Additionally, students reported no feeling stressed when answering a question incorrectly. Some professors have been using "Numbered Heads Together" to review class content before the final test; it allows students to identify the class material that was not completely clear.

Professor Testimony No. 2. Teaching Experience by using collaborative learning in the following subjects: Contemporary Biology and Immunology at bachelor's degree and Immunology at postgraduate level. Difficulties. The size of the group: a maximum of 30 students is fine, small groups (5 students or less) it could also be inappropriate. The attitude of students: if students expect a very traditional course, they may be disappointing, at least as they began to learn and take a liking to the subject. A group of many motivated students will create a better study environment; the teacher needs to set up the environment to get the students motivation and enthusiasm at the very beginning of the course. Collaborative learning is easier to develop with postgraduate students, since they are highly motivated, well-organized, and they have good study habits, and they share more interests and time with their classmates. Advantages. The most important point, in the opinion of experts (I agree), is that students truly learn. Students not only learn about the subject, but also they gain skills in finding relevant information. Students learn to share knowledge in groups by teaching and learning reciprocally with their classmates. The students develop and use proper communication skills. This methodology helps the students to develop their analytic and critical skills. Students will research more on the topics of their interest. Thus, the learning will be more meaningful. Collaborative learning is a very active, possibly funny process, and it provides a more relaxing way of learning, compared to traditional lectures or assessments.

Conclusions

The Program to use English as a way of teaching is important for internationalization since it shall attract more foreign students and increase UG international visibility. Our students will get the international profile to become more employable, or to have access to scholarships to study abroad. Moreover, UG possesses enough faculty members to support this initiative, but specific pedagogic training is needed. Therefore, this is an opportunity to create a Teaching and Learning Center also to support the Educational model for student-centered teaching and constructivism. Finally,

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there is a chance to adapt the university regulations to include instruction in English or to offer complete programs in this language, as the world-class universities do.

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The Correlation between Learning Behavior of Students and Classroom Teaching Methods of Faculty in Emilio Aguinaldo College-Cavite

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Abstract

This study aim to determine the learning behavior of Emilio Aguinaldo College students in relation to classroom methods. A total of 346 number of respondents from Engineering, Hotel and Restaurant Management, Nursing, Criminology, Education, Business Administration, Accountancy, Custom administration, computer science, Radio Technology, AB communication, Midwifery, Physical Therapy, and Vocational Technology. The frequency of use of classroom teaching methods among the faculty as follows. The faculty members always used digital light processing (DLP) and LCD projectors with the weighted mean of 2.58 and ranked first. Second, faculty members used whiteboard and marker with the weighted mean of 2.46.Third, faculty members used of handouts with the weighted mean of 2.45. Fourth, the used of group discussion were seldom used with the weighted mean of 2.20. Fifth, the assignments were seldom used with the weighted mean of 2.12. Sixth, were the used of individual presentation with the weighted mean of 2.11. Role playing and Case study were also seldom used with the weighted mean of 1.91and ranked seventh. The classroom mini seminar and workshop were also seldom used with the weighted mean of 1.71 and ranked eighth. Last in rank with the frequency of 1.53 and was rarely used, which was the return demonstration and ranked ninth.The learning behavior of the students of Emilio Aguinaldo College. Interest in the subject matter and acquired information were ranked as first with a weighted mean of 2.52. Second, was to understand important concept about the topic with a weighted mean of 2.51. Third, was to reflecting real life situation and by stimulating their imagination with a weighted mean of 2.50. Fourth, was to relate the lesson presented in the teaching strategy with another learning materials with a weighted mean of 2.49. Fifth, was to grasp the lesson easily with a weighted mean of 2.47. Sixth, was to listen attentively to the presentation of the lesson with a weighted mean of 2.46. Seventh, was to manifest official thinking skills with a weighted mean of 2.43. Eighth, was to participate well in the class discussion with a weighted mean of 2.42. Last in rank was to raise question about the content and context of the lesson with a weighted mean of 2.40. Findings revealed there was no significant relationship between learning behavior of the students and classroom teaching methods among the faculty members of Emilio Aguinaldo College.

Keywords: Education, *Learning behaviour, teaching, correlation, learners*

Introduction

Quality education was a broad avenue to obtain life betterment. School institutions were the place wherein the students acquiring more scientific knowledge, being useful in their future, and to have systematic and decent job someday. *Teaching* methods, strategies, content of the subject, and deliberation of the topics were work together to enhance the knowledge of the *learners*. How about the *learning behavior* of the students? Is it necessary to consider the students behavior in order to implant the well-equipped and useful information to their carnal mind? The students' behavior and interest these factors need an attention to inculcate their capabilities. As globalization is concern, they should focus the core competency endures to the future professionals. This study is considerable as a tool to verify the student assessments towards the teaching methods utilize by faculty members. When the researchers engaged and facilitate this study they were personally approached to the respondents. Thomas Angelo, when he said; "Teaching in the absence of learning was just talking." Doyle.T. (n.d.). A teacher's effectiveness is again about student learning. Students can answer questions about the quality of lectures, the value of readings and assignments, and the clarity of the instructor's explanations. Students were certainly qualified to express their satisfaction or dissatisfaction with the experienced. While in class, students were

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exposed to all sorts of instructional experiences (lectures, instructional materials and aids, readings, and exams). Students claimed that can judge what was taught and how it was taught. Higher education strives to become more effective teachers so that students can learn better, and many explore methods to improve their teaching practice. Depending on the nature of subject, number of students, and the availability of the facilities, there were different methods teachers are using in the classroom.

The main purposes of this study are:

- To find out the various teaching methods used by college teachers to teach students in different departments of Emilio Aguinaldo College-Cavite;
- To explore the opinion of students about the teaching methods they perceived as the most interesting and best teaching method;
- To find out the reasons for perceiving any teaching method as the interesting and best method;
- To provide suggestions for improving quality of teaching in the light of students perception and use of ratings.

Theoretical Framework

The social learning theory proposed by Albert Bandura has become most influential theory of learning and development. Bandura believed that direct reinforcement could not account for all types of learning. His theory added a social element, arguing that people can learn new information and behaviors by watching other people. Known as observational learning (or modeling), this type of learning can be used to explain a wide variety of behaviors. There are three core concepts of social learning theory. First was the idea that people can learn through observation. Next was the idea that internal mental states are an essential part of learning process. Finally, this theory recognizes that just because something has been learned, it does not mean that it will result in a change in behavior. In addition to influencing other psychologists, Bandura's social learning theory has had important implication in the field of education. Today, both teachers and parents recognized the importance of modeling appropriate behaviors. Other classroom strategies such as encouraging students and building self-efficacy are also rooted in social learning theory.

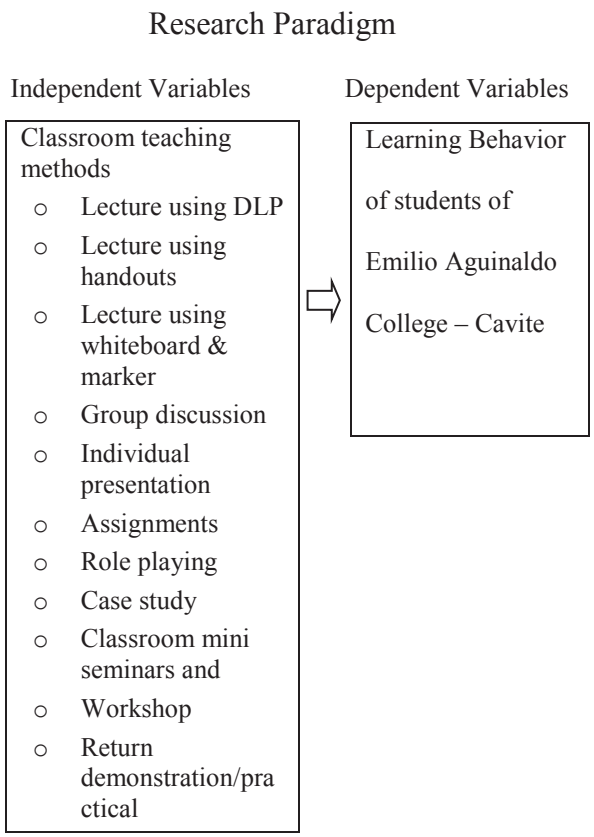


Figure 1. The Relationship of Variables

Methodology

Research Design

This study used the Descriptive – Correlational Survey type of research. The profile of the students of Emilio Aguinaldo College-Cavite was ascertained according to the variables of age, gender, course, and year level. The descriptive part dealt with the effective teaching method relation to learning behavior of Emilio Aguinaldo College students.

Respondents

A total of 346 participated in the study. The respondents are from selected students from different departments and faculty members of the Emilio Aguinaldo College.
Research Instrument

The researchers used an adapted and modified survey questionnaire with reference to the study entitled "Effectiveness of Innovative Style of Teaching as perceived by nursing students of Emilio Aguinaldo College-Cavite" by Raymart V. San Juan et., al. (2011).The questionnaire was composed of close-ended questions and included the different teaching methods commonly used in Emilio Aguinaldo College-Cavite. The questionnaire was divided into two parts: Part I included the socio-demographic data of the respondents: Age, Gender, and Year Level; Part II and III included the list of different teaching methods recently used in

Emilio Aguinaldo College. In Part II the respondents ranked how frequent it used in the classroom. Part III contained ten criteria used to evaluate the effectiveness of the teaching methods.

Results and Discussion

The *correlation* analysis of the two variables (x & y), the value of computed was -1.286 which was less than the critical value of tabulated t of -2.036 at the degrees of freedom of 8 and significance of $\alpha = 0.05$. Therefore, there was no significant relationship between learning behavior of the students and classroom teaching methods among the faculty members of Emilio Aguinaldo College. It was because the learning of the student was not depending on what teaching methods was used by the faculty and how it was deliver. The teaching methods utilized by the faculty members were nothing to do in learning behavior of the students.

Teaching Methods	T O T A L		Rank
	Mean (X)	V.I.	
Using DLP	2.58	A	1st
Using handouts	2.45	A	3rd
Using whiteboard and marker	2.46	A	2nd
Group discussion	2.20	S	4th
Individual presentation (reporting)	2.11	S	6th
Assignments	2.12	S	5th
Role playing	1.91	S	7th
Case study	1.91	S	7th
Classroom mini seminar & workshop	1.71	S	8th
Return Demonstration	1.53	N	9th
T O T A L	X_w = 2.10	S	

Table 1. Frequency of use of Classroom Teaching Methods among the Faculty Members

Learning Behaviors	T O T A L		Rank
	Mean (Y)	V.I.	
Show interest the subject matter.	2.52	A	1st
Attentively listens to the presentation of the lesson.	2.46	A	6th
Participate well in the class discussion.	2.42	A	8th
Raises questions that will improve the content and context of the lesson.	2.40	A	9th
Grasps the lesson easily.	2.47	A	5th
Manifests official thinking skills.	2.43	A	7th
Acquire more information.	2.52	A	1st
Relates the lesson presented in the teaching strategy with another learning materials.	2.49	A	4th
Understand important concepts about the topic.	2.51	A	2nd
Reflects real life situation by stimulating my imagination.	2.50	A	3rd
T O T A L	Y_w = 2.47	A	

Table 2. The Learning Behavior of the Respondents

Conclusions

Based on the findings of this study, the researchers concluded that:

- Most of the respondents ranged between 19 to 22 years old. Finding appeared that in this school year 2012-2013, female students dominated the male students in Emilio Aguinaldo College-Cavite.
- The faculty members were always using the Dim Light Projector (DLP), handouts and whiteboard marker. They sometimes used

group discussion, individual presentation, assignments, role playing, case study, classroom seminar and workshop.

- The learning behavior of the students, they showed interest in the subject matter and also acquired information by using DLP and LCD projectors which was the highest rank in classroom teaching methods.
- There was no significant relationship between learning behavior of students and classroom teaching method utilized by faculty members of Emilio Aguinaldo College-Cavite

Acknowledgements

The authors are thankful to Dr. Jose Paulo E. Campos, Mr. Arnel Pantoja, Mr. Reynaldo J. Kilala, Engr. Amelia M. Natividad, for providing the necessary facilities for the preparation of the paper. Special acknowledgments are presented to Rosettte Andrade, Claudine Kate V. Aranas, Jamielyn P. Bocateja, Armando D. Cortez, Meryl Joyce M. Cosme, and Ma. Alyzza Joy B. Cueno for their valuable contribution in this research.

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DEVELOPMENT OF ELECTRONIC BOOKS FOR THE PHYSICS LEARNING ACHIEVEMENT EXAMINATIONS: A GRADUATION RESEARCH PROJECT

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Abstract

We have assessed how third-year students who studied at the National Institute of Technology, Hiroshima College prepared for physics achievement examinations using electronic books as study aids. The ebook was created by the students of the Department of Distribution and Information Engineering who were performing graduation research. The ebook was composed of the questions and answers from the achievement examinations given in 2012.

We found that ~82% of the students questioned own a smartphone/touch device, and ~52% of them were interested in electronic books as study aids. Of the students that owned smartphones, ~37% used the ebook. For the students that used the ebook, ~72% found the book to be useful. Additionally, ~42% of students found the mathematics class in differential and integration calculus and mechanics to be useful.

Keywords: *electronic books, epub, learning achievement examinations, graduation research, smartphone/ touch device*

Introduction

Recently, many students have acquired a smartphone, such as an iPhone, or other such electronic device. To introduce a student-learning style that incorporates electronic books (ebooks), we have studied test preparation for the learning achievement physics examinations aimed at third year students in our college who utilized ebooks using information from examinations given 4 years ago.

The newly ebook was created by the students of the Department of Distribution and Information Engineering who were performing graduation research. The electronic book contains questions and answers from achievement examination given in 2012. There have been a number of improvements in the ebook compared with the previous ebook that contained questions and answers from the achievement examination in 2007-2010. The ebook was made available to students as a download from a homepage designed for that purpose.

In addition, a graduation research student played an important role as a teaching assistant in the mathematics class covering differential and integration calculus and mechanics.

Electronic books provide a novel platform when incorporated into smartphones and tablets. Using such devices, which are small and light weight, students can study at their own pace at any time and in any place. For Apple iBooks applications, pages are turned by tapping or swiping the page. To highlight, search for a specific passage, add a memo, bookmark a page, or to return to a highlighted word/section, a mouse and/or an external keyboard are not required, students need only to use their fingers.

The results of this approach are discussed herein using answers provided by the students.

Procedure for creating the ebook

The original ebook manuscript was typeset as a .docx file. To generate a .jpg file from the .docx file, the .docx file was converted into a .pdf file, which was then outputted as a .jpg file. Finally, to create an epub file from the .jpg file, which is a format used for ebooks, we used the ChainLP software, which can be downloaded free of charge from http://no722.cocolog-nifty.com/blog/, was used.

For the preparation of the question/answer format that we used for the ebooks, the question text was input by hand without using a scanner. And the answer and explanation was produced by graduation research students, which is based on their taking an examination and advice from their teachers.

They came up with various ideas to make the expression of formulas easy to see. For example, the formulas were expressed using large Meiryo fonts (22pt) and box, as shown Fig. 1.

Included in the answers are the associated formulas, and laws, and calculations highlighted by underbraces (Fig. 2), and detailed color illustrations (Fig. 3). For example, separate colors for each type of forces were used. The chapter contents are shown in Table 1.

To make the best use of the ebook platform, which allows the reader to turn a page by touching or swiping the screen, the question and its corresponding answer were placed on alternating pages.



Figure 1. The formulas were expressed using the Meiryo font and were boxed.

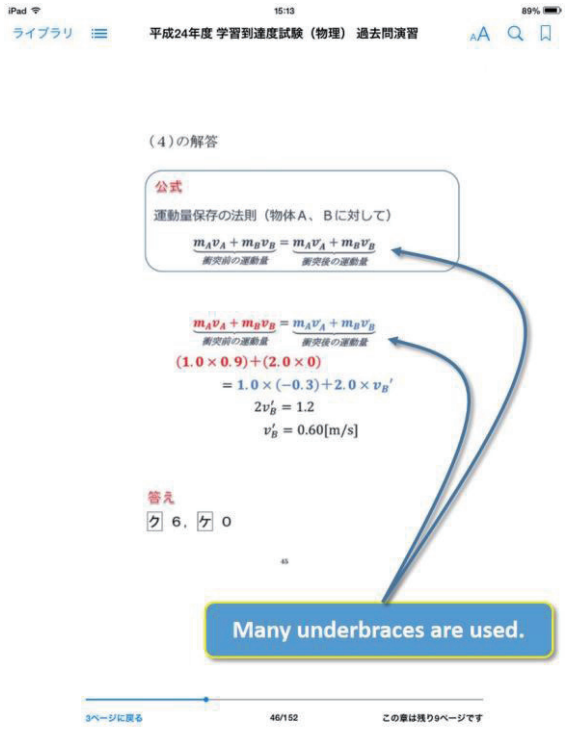


Figure 2. Helpful explanation for the transformation formula and calculation process.

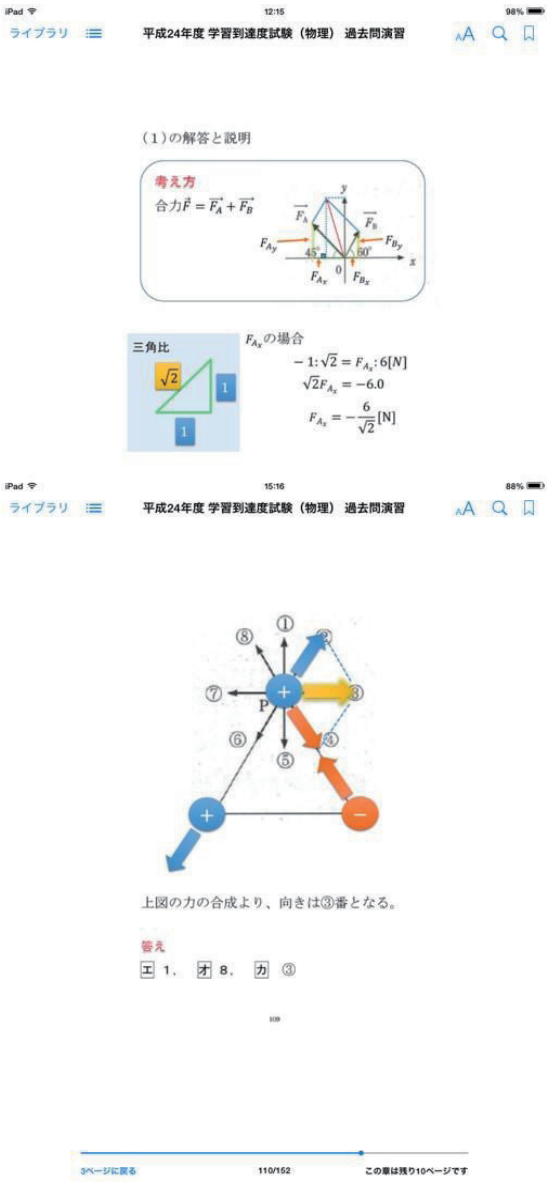


Figure 3. Separate colors used for each type of force.

Table 1. Composition of the ebook containing questions from the achievement examinations in 2012

Chapter	Contents	Page
1	Displacement・Velocity・Acceleration	3
2	Force・Equation of motion	19
3	Mechanical energy・Momentum	38
4	Rotational motion・Universal gravitation・Simple harmonic motion	56
5	Heat	73
6	Wave	92
7	Electric field	103
8	Magnetic field	121
9	Differential and integration calculus and mechanics	140

Distribution of the ebook and an explanation of how to use it

The ebook could be accessed via the homepage, http://dep.hiroshima-cmt.ac.jp/~general/staff/fujiwara1.htm, and downloaded wirelessly to an iPad or iPhone (Fig. 4).

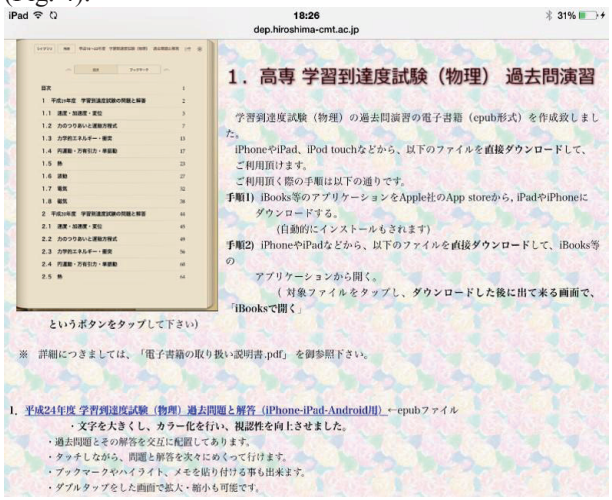


Figure 4. Website for downloading the ebook

Procedures for transferring the ebook to an iPhone, iPod touch, or iPad and its use

Step 1) The iBook application is downloaded from the iTunes store to an iPhone, iPod touch, or iPad.
Step 2) After downloading the ebook wirelessly from the homepage as shown in Figure 4, the icon "Open in iBooks" is tapped to open the iBook application.
Step 3) The ebook "*Question-and-answer of learning achievement examinations 2012*" in the iBook archive is tapped.
Step 4) The table of contents appears (Fig. 5).
Step 5) A bookmark, highlight, and memo, all of which can be added by the reader, are shown in Figure 6.

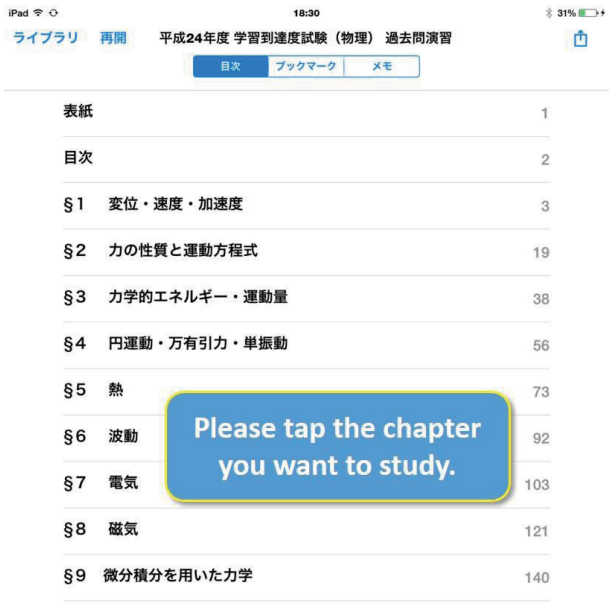


Figure 5. Table of Contents

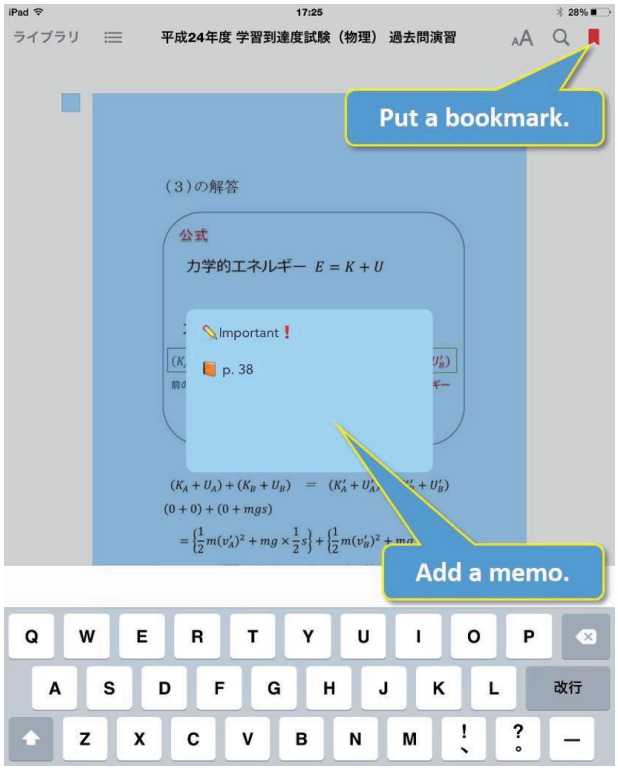


Figure 6. Place a bookmark, highlight, and memo on an ebook page

Results and Discussion

After the Achievement Examinations, questionnaires were completed by 108 students. A summary of their responses follows.

1. Do you own an iPhone, Android smartphone, iPod touch, iPad, or other similar touch device? (Question asked of all students.)
2. Would you be interested in using the teaching material presented in the ebook? (Question asked of all students.)
3. Have you used the ebook on your smartphone? (Asked of smartphone/touch device owners only.)
4. Was the ebook useful as study aid? (Answered by students who had used the ebook.)
5. Would you use ebooks as study aids in the future if a smartphone/touch device was available? (Answered by non-smartphone owners.)
6. Was the lecture of the differential and integration calculus and mechanics at mathematics class useful as a study aid?

According to the answers provided by the students, ~82% owned a smartphone, and ~52% of them were interested in ebooks as study aids (Fig. 7). Of the students that owned smartphones, ~37% use the ebook (Fig. 8). For the students that used the ebook, ~72% found the book to be useful (Fig. 9).

Among the students that did not own smartphones, ~16% were interested in using ebooks as study aids (Fig. 7). Additionally, ~26% of those students hoped to use the ebook in the future, although ~32% were undecided, and ~42% expressed no interest (Fig. 10). It appears,

therefore, given the answers to the questionnaire, that a strong demand for the ebooks exists.

Additionally, ~42% of students found the lecture of the differential and integration calculus and mechanics at mathematics class useful as a study aid (Fig. 11).

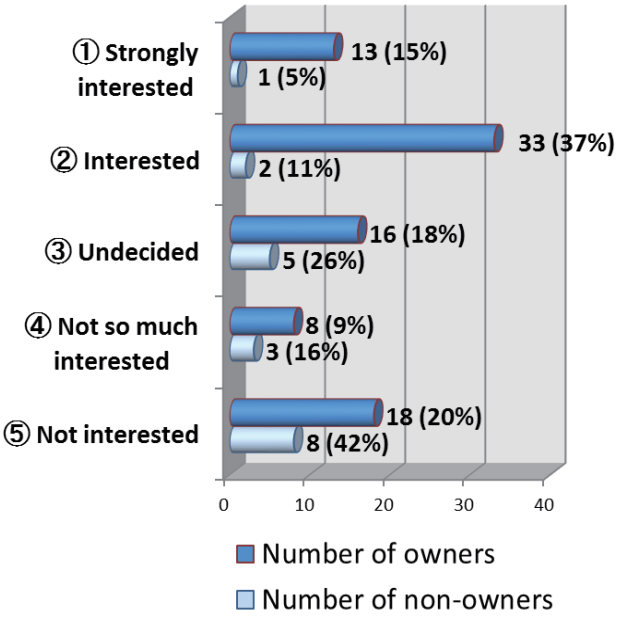


Figure 7. Student interest in using the ebooks (Percentages are given for owners and non-owners of smartphone/touch device)

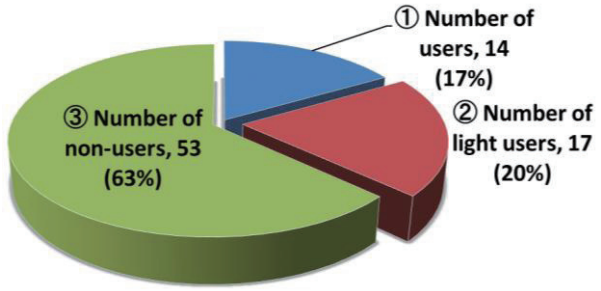


Figure 8. Use of the ebook by smartphone/touch device owners

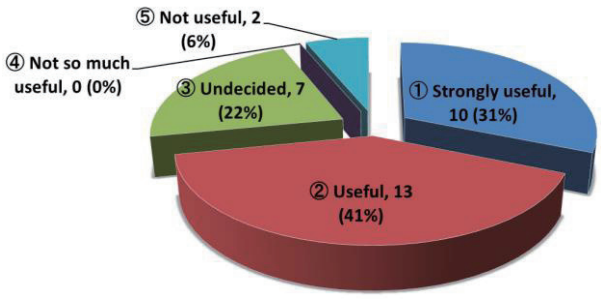


Figure 9. Usefulness of the ebook according to smartphone/touch device owners

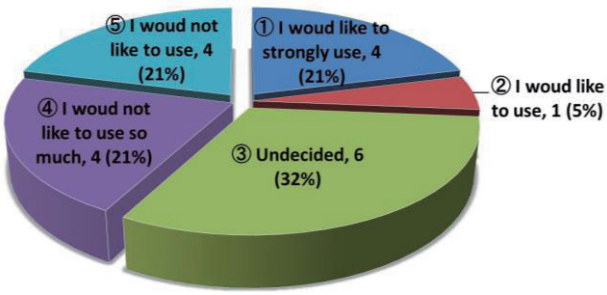


Figure 10. Desires of non-smart-phone/touch device owners to use the ebook

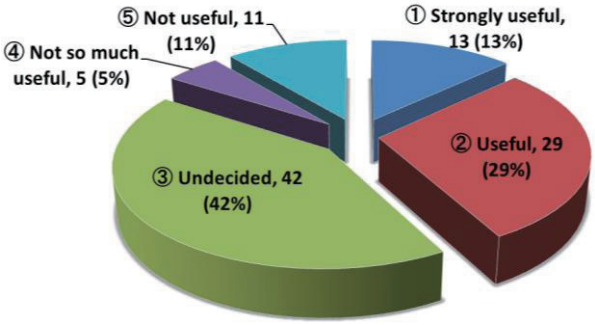


Figure 11. Usefulness of the mathematics class of the differential and integration calculus and mechanics

Impressions and evaluations from the students

Statements made by the students in the questionnaire concerning the ebooks in general are given below. (The statements are paraphrases of the original Japanese statements.)

- The ebook was fresh and had a modern feeling.
- It employed color, so it was very easy to see.
- The ebook was very useful.
- It was possible to study while moving.
- It was possible to see while lying down.
- It could be used during a wait for the train.
- Because there are few teaching materials for the exclusive use of National Institute of Technology students.
- It was easy to carry the ebook anywhere, which cannot be done with heavy paper books.
- It was easy to study in free time.
- It was easy to understand the relationship between differential and integration calculus and mechanics.
- The explanation by the graduation research students was easy to understand.
- Because I always have a smartphone with me, I could study anywhere.

Conclusions

According to the result of the questionnaire, it seems that students were interested in the electronic books. In particular, 72% of the students who had used the

electronic book found it to be useful for study. Therefore, it was clear that the student who was interested and had copied the digital book onto a smart phone was recognizing its usefulness.

The average score on the physics learning achievement examinations in 2014 was 178.6 and decreased 6.2 points compared with the previous year (2013). On the other hand the average score for our college was 66.6 and rose 28.4 compared with last year (2013).

A submitted graduation research thesis was accepted for the proceedings of the 15th IEEE Hiroshima section student symposium. A poster presentation of a graduation research student was highly regarded by a student of another university and a teacher from another college (Fig. 12). It was a great pleasure and honor for graduation research student.

In addition, graduation research students made great contributions to the class as teaching assistants. The appreciation that they received from the third year students and teachers has increased the confidence among the graduates in pursuing their graduation research.

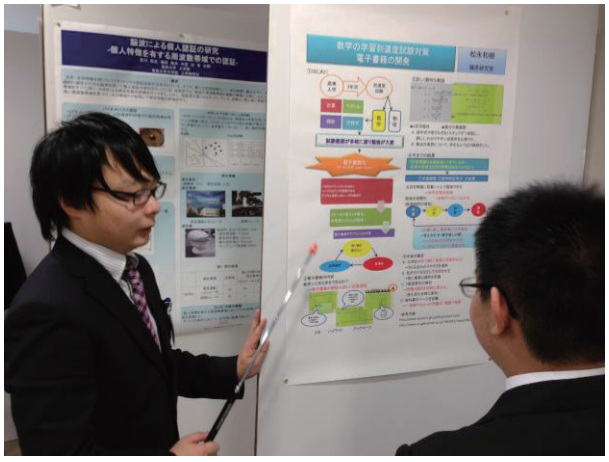


Figure 12. Graduation research student presents a poster at the 15th IEEE Hiroshima section student symposium

To advance our development of ebooks as study aids one step further, we wish to introduce a graphical method for the mechanics of a particle. For example, in graphical methods, the slope at any point on a distance-time graph gives the speed at that point in time, and the area under a speed-time graph gives the distance travelled. Such a graphical method is very useful in order to solve the problem without formulas. The development of the graphical method is now underway.

In the future, it seems likely that the provision of teaching materials in electronic book form will come to be used more widely and play an important role in ICT education.

Based on the success of this project, we intend to pursue the use of electronic books as a new educational technology in physics education.

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The ebook could be accessed via the homepage, The ebook could be accessed via the homepage, http://dep.hiroshima-cmt.ac.jp/~general/staff/fujiwara1.htm

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Blended Learning for Teaching Cloud Computing module: Benefits and pitfalls

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Abstract

Learners differ in competency levels and personality configurations, which challenges educators to use a blend of learning strategies and methods to meet individual learning needs and address specific difficulties to help, as far as is possible, all students to achieve the desired learning outcomes. This action research paper presents a student centred blended learning case study for teaching cloud computing module, which is composed of a set of learning objects with smaller, self-contained, interactive, re-usable units of learning.

It outlines a pedagogical model that can be effectively used to provide multiple differentiated learning objects to facilitate individualized learning. The approach engages the students actively in the learning process by enabling them to interact with the learning objects, facilitated by lecturers both online and in classroom.

The paper discusses the issues and challenges of constructing the learning process to addresses individual learner's needs and difficulties, and how to maintain an active and interactive group learning context throughout the module. It also details the key challenges and offers some practical approaches to facilitating the learning process along the dimension of cognition, affection and conation in blended learning. Finally, the case study shows how the learning outcomes are evaluated by the facilitator and students to continuously improve and co-construct the blended learning experience by optimizing the learning objects, reconfiguring the pool of learning objects, and enhancing the facilitation process.

Keywords: *Blended learning, pedagogic framework, cloud computing curriculum, online facilitation*

Introduction

Successful blended learning requires more than the use of technology per se, but a careful consideration of the pedagogy and instructional design that best utilizes the technology tools to facilitate student learning and attainment. The challenge is to create the optimized blended learning experience in which the benefits of both face-to-case and online contexts are maximized (Dziuban et al., 2006). Garisson and Vaughan (2008) capture the view of blended learning depicted here:

> Blended learning 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)

This paper documents a case study for teaching cloud computing module, which has systematically employed a varied and differentiated collection of learning objects, as shown in Table 1, with smaller, self-contained, interactive, re-usable units of learning as key pedagogic tools in supporting the learning process (Beck, 2010). The learning objectives are largely achieved through interactions with pools of learning objects at different levels of complexity.

Table 1: Classification of Learning Objects

Types of Learning Objects	LO Used in the case study	Interactivity	Blended Learning Support	Cloud Service
Content LO	Google Doc, Youtube, web 2.0 tools (Realboard)	Yes	Yes	SaaS
Practice LO	Google Application engine, CodePen, web sniffer, Azure, Amazon Paypal, Expedia Sandbox	Yes	Yes	PaaS, IaaS
Assessment LO	Online Quiz, Google form	Yes	Yes	SaaS
Communication LO	Forum, Facebook message, Socartive, email	Yes	Yes	SaaS

Back

Researchers have argued that learning objects offer considerable potential as effective learning tools (Kay, ,&Knaack,2009). However, careful consideration is required in the design and selection process of such tools. It is suggested that good learning objects should (a) require students to construct and manipulate, (b) provide rich feedback and interactive illustrations, (c) help students understand abstract ideas with concrete representations and (d) support key student weaknesses like limited working memory, difficulty in retrieving information from long term memory, and ineffective cognitive and metacognitive strategies. In addition, it is emphasized that instructional strategies that pedagogically support the use of specific learning objects are critical for success. A thoughtful mix of instruction, exploration, practice and reflection is needed(Kay&Knaack,2009).

Model for Blended Learning

Figure 1: Blended learning with learning objects below shows a blended learning model where students are continually interacting with the learning objects and being supported through facilitation by lecturers in both the class room and online environment.
The key is the optimized pedagogical design of the learning objects to enable the students' to maintain an active and group learning approach, supported by teaching faculty when needed, in mastering the desired learning outcomes, customized to individual cap

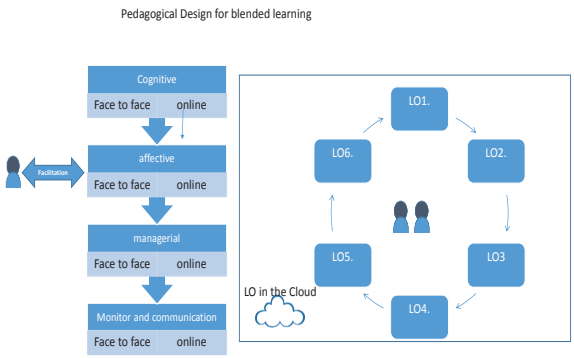


Figure 1: Blended learning with learning objects

The learning process is activated, by providing students with a challenging but achievable real life problem to solve. This is intended to evoke curiosity in students, and encourage them to explicitly frame the subject to be investigated and formulate strategies to be used for solving the problem. Typically, this involves them coming up with tentative solution through self-exploration and interaction with both peers and tutors. The students are presented with relevant learning objects to further facilitate the learning process and help them to solve the problems iteratively.

In the dynamic process of learning, reflection and sharing on learning experience, additional learning objects, from the pool of resources, are introduced when needed and facilitated according to student need.
The importance of appropriate feedback is fundamental to supporting student learning (Hattie, 2009) and is a key part of the ongoing instructional approach. For example one student commented:

"We need to get the response/comments as soon as possible; we want someone to tell us whether the suggestions are workable or whether the comments are valid". It not only enhances the students conceptual understanding but is a consistent signal to students that the instructor cares about their learning (Mizoguchi, & Dillenbourg, 2006).

Finally the learning outcomes are evaluated by facilitators to continuously identify the learners' needs, and optimize the learning experience by reconfiguring the pool of learning objects. The model provides a continuous learning process, which allows the lectures to add new learning objects, or reconfigure the sequence of the learning objects to meet the students learning needs. Figure 2: Pedagogical Design using Blended Learning depicts a detailed view for the blended learning model employed:

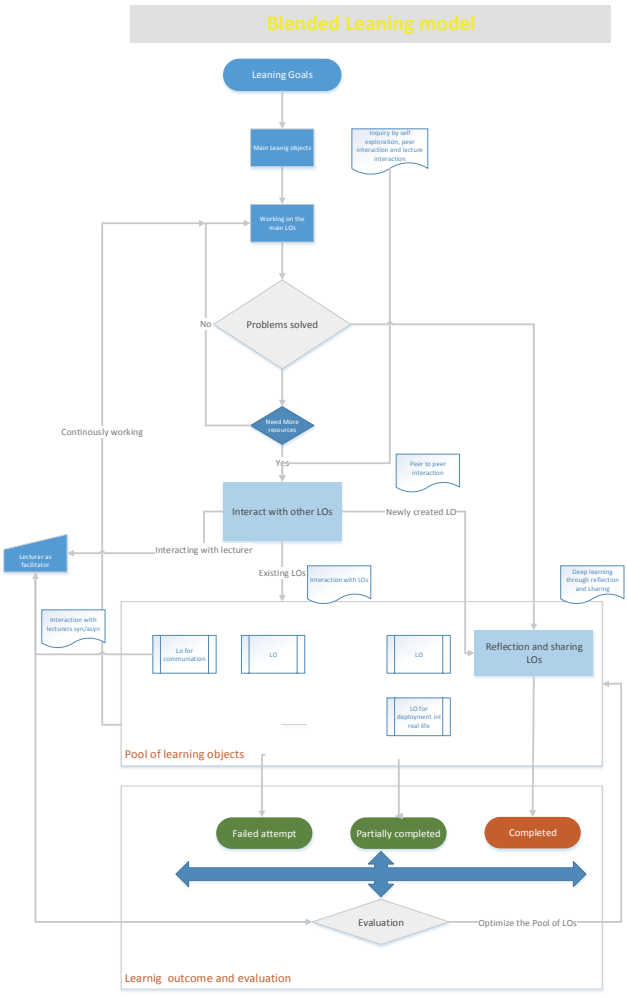


Figure 2: Pedagogical Design using Blended Learning

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It is clear that while presentation of content is clearly one important aspect of any learning encounter, without effective interactivity manifested through communication, involvement, control, and adaptation, the effectiveness of online and flexible learning will be minimized (Mizoguchi, & Zhu 2006). In this pedagogical model, ongoing activity and interaction with peers and tutors takes place synchronously or asynchronously in the blended learning experience:

***Lecturers and learning objects interaction*
Identify the students' learning difficulties in achieving the learning outcome and carefully select and evaluate an appropriate set of learning objects to address different learner's competency is critical for the model.

***Lecturer and student interaction*
Interaction is the key to facilitate the blended learning experience to know what and how the students are learning and then appropriately modify the instructional strategy if necessary

***Students and learning objects interaction*
Self-paced learning is an interactive mode of learning over the Internet that each learner does on his or her own, at his or her pace and in his or her time. It is asynchronous learning that adds significant value to the blended learning equation (Alonso, 2008).). For example, asynchronous text can provide certain significant advantages over the typical face-to-face situation. In face-to-face learning there is often too much information to absorb and too little time for reflective thought and the kind of synergetic knowledge building that comes from good collaborative learning over time. Similarly, Hamilton and Zimmerman (2002) argue that the asynchronous text medium can create an excellent forum for thoughtful, extended, reflective dialogue. They highlight that:

The medium supports iterative exchanges of information and opinions over an extended time period, so ideas are not merely "hatched" and delivered but rather allowed to evolve and be refined in a manner that makes information more convincing, narrative deliveries richer in detail, and learning more thorough. (p.265)

***Peer to peer interaction*
Peer to peer interaction allows the students to share the learning experience, such as problems encountered, possible attempts and solutions, etc. In the model, learning objects, such as supportive feedback comments, are an integral part of the blended learning model, which serves as a communication channel dedicated for the particular session. However, social media like Facebook may not be suitable for the comments as students are very sensitive to the relationship between who they are communicating with and what they are talking about with these tools (Daniel L., 2011).

Case Study: Using Blended Learning for Teaching Cloud Computing Module

While the teacher determines the learning objectives, and provides a set of learning objects for student activity through the 15 weeks using a web site (http://kindservice.net), the focus is on enabling students to be self-directed. The teacher identifies the learning difficulties and insufficiencies of the applied methods by examining the activities and establishes links between previously known concepts with the new concepts to be taught. The main purpose of the course is to teach web service and cloud concept, and programming skills to students. The teacher seeks to cultivate the students' abilities to understand the concepts and motivate them to use the learning objects by showcasing the relevance of the topics to real world application. Subsequently, students endeavour to produce solutions for programming problems.

In the lecture sessions, if the programming concepts that are to be taught are related to "HTTP request", students perform activities related to "HTTP request". Students work individually or form small groups to work collaboratively. The task of the teacher is to facilitate the learning process, identify individual learning difficulties, and direct the students to think more deeply and creatively. Learning how to program is an iterative and continuous process that lasts for 15 weeks and comprises of renewal, improvement and change. New learning objects with higher difficulty levels are introduced when appropriate and to ensure a continuous learning process. As students provide solutions and present their ideas, teachers provide the necessary feedback. Finally, teachers 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.

For practical sessions, as shown in Figure 3: Case Study for practical session, 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 Youtube videos selected for their relevance to the content and outcomes of the practical session. Students then attempt the online quiz for self-assessment. In cases where the students are in doubt, they can refer to the online tutorial.

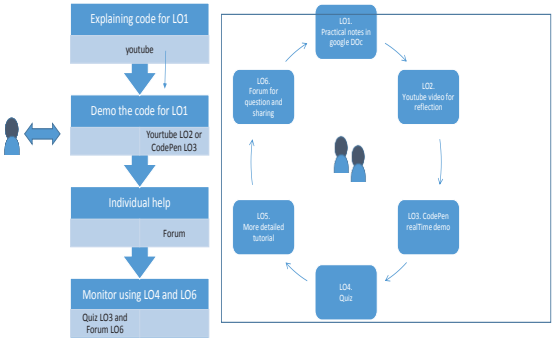


Figure 3: Case Study for practical session

Some of the key learning points are as follows:

***Consistently using the pedagogical model.*
This is also important for establishing a sense of learning community with the students (e.g., Daniel, 2011) as well as lowering the cognitive cost when switching among different learning modes.

***Detailed Documentation for the Learning Objects*
Especially for pure e-learning mode, detailed documentation for the Learning objects, such as task number, line number for the code, should be in place for the convenience of the asynchronous communication.

***Linking E-learning tasks with previous class room activity seamlessly*
When learning online mode, 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.

***Observing the partial code working to get students started*
As the nature of the module is to train students programming skills, the partially working example is provide and hosted on CodePen, which allows students to view the code, and see how the code works. The partially working code hosted on Codepen, serves as a comfortable starting place for students to work on the rest of the functions by themselves.

***Know what the students know and what they do not in real-time*
In the blended learning, interaction is the key to facilitate the learning process. Student response tools such as Socrative were used as an iterative Learning object plugged into the learning experience.
By plugging in the LO from Socrative, appropriate diagnostic interactivity with students is key to addresses different learning needs and levels of conceptual understanding.

***Mindful and continuous facilitation is a key aspect*
The use of open questions invites student to make explicit their prior knowledge as well as any misconceptions and knowledge gaps. For example, "What is the difference between HTML and HTTP?" The question can activate students to recall what they have learned as a pre-knowledge. The question is posted in the Socrative Room, where each student is given time to think individually and independently without any sharing on ground or online, which is followed by sharing the answers, brainstorming, and reviewing the answers as a whole pipeline of constructing knowledge. The following are the key learning points in the facilitation processes. Firstly an empty space is created by not sharing the answer in the first place, which allows each student to think independently based on his/her own existing knowledge and experience. Secondly detailed explanations or discussion are given as a variety of answers will be posted in the room. The focus is on what can be learned both from a correct and wrong answer given by the students, in order to enhance future learning. Lastly, the continuous presence of the facilitation process provides a consistent support for the students in the blended learning environment, which requires much effort and time.

Evaluation of Blended Learning: Benefits and Pitfalls

The evaluation for the case study for teaching cloud and service computing module using the blended 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 blended learning.
Figure 4: Leaning Objects access Data Analytics
Shows the number of visits to different learning objects by 80 students for academic year 2014/2015 semester 2:

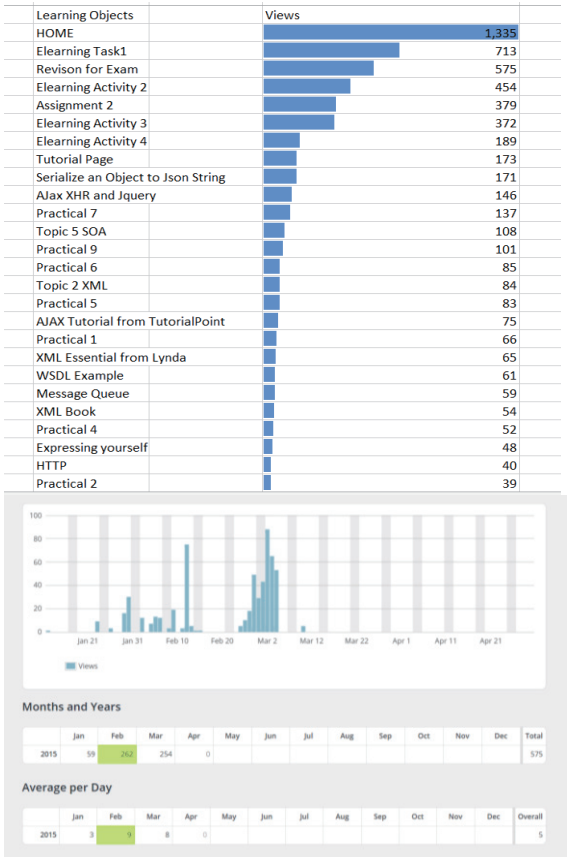


Figure 4: Leaning Objects access Data Analytics

The evaluation data to date strongly suggests that the blended learning used in teaching 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 blended learning approach. Effort has been made by the teaching faculty to add a range of learning objects to address the more advanced learning, outcomes such as security for cloud computing and Geolocation service. However, the right learning objects need to be provided at the right time, in order to meet leaning needs, and thus achieve the learning objectives. For example, learning objects for revision for exam receives total 575 hits during examination period.

Comparison of the students' performance results between traditional leaning and blended learning shows that the average marks remain similar.

Conclusions

The pedagogical design used in the case study provides a built-in mechanism for evaluation and continuous improvement for the blended learning. The key is to identify and address the students' needs both in classroom and e-learning mode, and address the needs by continuous improvement of the pool of learning objects, which could provide the differentiated learning path for each student.

Most fundamental is the focus on good pedagogic design, which has drawn much from the work of Bransford, 1999, and Hattie, 2009. The importance of activating students' prior knowledge and being able to provide appropriate learning objects tailored to their needs and competence levels are core to effective learning. Similarly, through the technology tools used and ongoing facilitation, both synchronously and asynchronously, help to motivate and encourage students to use their thinking skills (e.g. metacognitive strategies) to solve challenging learning goals. By activating prior knowledge, setting challenging goals and providing ongoing two-way feedback, the approach has been consistent with the finding of Hattie (2009) that found high effect sizes for such methods (0.67, 0.61, 0.73 respectively).

Further work includes exploring the ways to further support and encourage students to share ideas, take intellectual risks and give and receive feedback in the blended learning experience (Daniel L. 2011).

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EDUCATIONAL OUTCOMES OF ACTIVE LEARNING ON STRUCTURAL MECHANICS FOR 1ST GRADERS OF KOSEN

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Abstract

In national institute of technology, Tokuyama College (Tokuyama Kosen), the exercise class of structural mechanics based on experience named "Force and Deformation" has been practiced for 1st graders who belong to department of civil engineering and architecture, since 2009. The purpose of this introductory education is to draw out the mechanical curiosity and inquiring mind from 1st graders, who know nothing about structural mechanics, through the experience-based group learning. All themes in this exercise class are student-centered active learning. In addition, "Force and Deformation" is also utilized actively for development of new educational tools by the subject teachers. In this paper, the main educational outcomes generated from "Force and Deformation" are provided as a practical example of the active learning which is being widely recognized as the effective method for engineering education in recent years. From the results of annual student questionnaire, Good evaluation results (average point 3.4 ~ 3.7 in 1~4point scale) were obtained continuously for the past 6 years (2009-2014). The score of several evaluation items, which are related to the ingenuity about enkindling a sense of participation, was high especially, but the difficulty level and learning sheets for each themes may have a margin for improvement. For development of educational tools, the Pasta-clay tower model is introduced as an example of simple and functionable tool generated from this class. The Pasta-clay tower model will have high educational effects for learning the concept of dead load and buckling behaviour through the process of tower construction and collapse. This original tower model had been chosen as the best award in the contest of science education tool for elementary and junior high school students in colleges of technology 2012. Moreover, the proportion of 1st~3rd graders to all students, who challenged to the structure design division of design competition in college of technology, was increasing from 0 % to 60 % for recent years. In this period, our teams were awarded a prize 3 times in structure design division.

Keywords: *Structural mechanics, Active learning, Class Questionnaire, Educational tool development, Pasta-clay tower, Design competition in Kosen*

Introduction

In the field of civil engineering and architecture, it is indisputable that the structural mechanics is one of the most important core subject, because the structural mechanics is positioned as base of many mechanical subjects (reinforced concrete, steel structure, geotechnical engineering, fluid dynamics, architectural structure design etc.) which must become essential to construction engineers. However, it seems that many students have some learning concern about structural mechanics despite understanding its importance. Therefore, the educational ideas which can draw out as soon as possible the mechanical curiosity and inquiring mind from students will be required for developing the instinctive sense for mechanical problems.

From the background mentioned above, the exercise class of structural mechanics based on experience named "Force and Deformation" has been practiced for 1st graders who belong to department of civil engineering and architecture, since 2009. This class is an introductory education, which is practiced as active learning, for connecting smoothly into the subsequent mechanical subjects for 2nd graders and above. Moreover, this class will be expected to prompt participation of lower graders in the structure design division of the design competition in college of technology. These original education tools are used not only for this class but also for the visiting lecture of regional science events and the open campus of Kosen.

On the other hand, new educational tools developed by subject teachers are applied to "Force and Deformation" actively for improvement or verification of educational effects.

In this paper, the main educational outcomes, which were focused on the class questionnaire, original educational tool and leading to design competition, were provided as a practical example of the active learning. And the educational effects and active learning method were discussed for introductory education of structural mechanics through the results of some questionnaire investigations and the Pasta-clay tower construction.

Table 1. Contents of "Force and Deformation" in 2015

Weeks	Theme Number	Theme
1	(1)	Paper bridge competition
2	(2)	Kinds of force and deformation
3	(3)	Moment and equilibrium conditions
4	(4)	Structural types
5	(5)	Straw bridge competition
6~8	(6)	Pasta-clay tower competition
9~14	(7)	Bridge competition
15	—	Comment on terminal examination

Outlines of "Force and Deformation"

"Force and Deformation" is class for 1st graders who belong to department of civil engineering and architecture. This exercise class with 1 credit is conducted in first semester as introductory education of structural mechanics. This class applies the group work of 3~4 persons per 1 group to encourage voluntary learning for students. Also, this class is composed of 7 main themes in 15 weeks as shown in **Table 1**. The outlines of main theme are as follows;

(1) Paper bridge competition

Students make sensuously the paper bridges with 2 spans (22cm or 40cm) to find suitable cross-section shapes which can reduce the bending deformation through the loading test using iron miniature cars, as shown in **Photo 1** (a). The number of papers that students can use is 1 or 2.

(2) Kinds of force and deformation

At first, students investigate freely the force and deformation of interest by using the Internet or library. Then, they make a presentation using familiar objects or bodies about the learning results to other students.

(3) Moment and equilibrium conditions

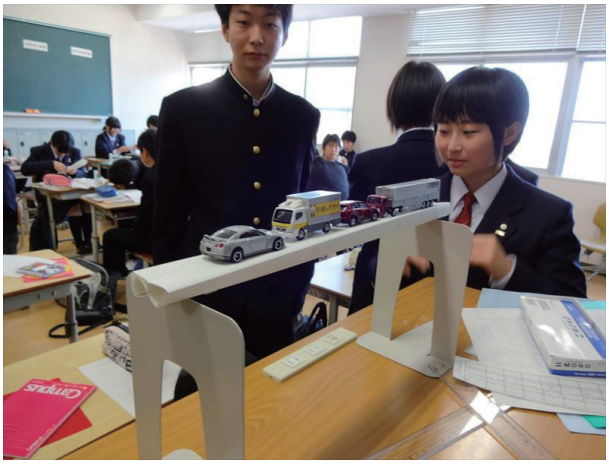
Students sensuously understand the definition of moment, equilibrium conditions and the action-reaction law through some simple experimental trials (seesaw, pulley, industrial tools, muscle training, tug of war etc.)

(4) Structural types

Students investigate structural types of interest (arch, truss, rigid frame, or shell) by using the Internet or library. Then, they make a presentation to other students by using simple models made by considering the learning results.

(5) Straw bridge competition (B. Zubrowski, 1982)

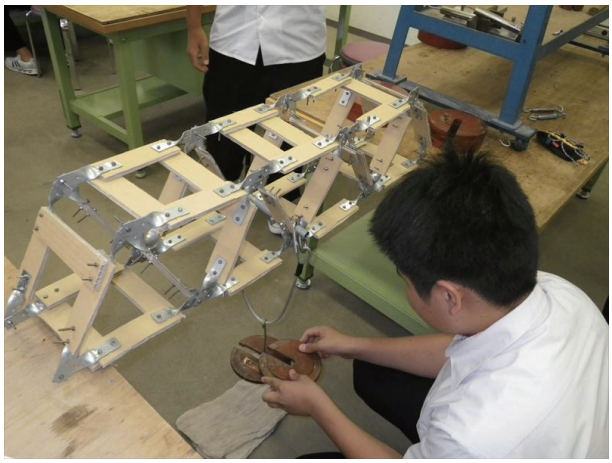
Students construct the truss bridge by using the rainbow straws with 10 colors. The loading test shown in Photo 1(b) are carried out to contest the specific strength. Also, the designing beauty of each bridge is evaluated by mutual balloting among students.



(a) Paper bridge



(b) Straw bridge



(c) Cardboard bridge

Photo 1. Examples of loading test in each theme

(6) Pasta-clay tower competition

Students construct the higher truss tower by using only oil clay and dry pastas. Details of this theme will be described later in this paper. Students will experimentally learn the dead load and various failures appearing by the axial forces.

(7) Bridge competition

This theme is the most important in this class. Based on knowledge obtained by each above theme, a bridge

Table 2. The results of the class questionnaire

Year	Question Number									Average
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
2009	4.0	3.0	3.5	3.5	4.0	4.0	3.5	4.0	4.0	3.7
2010	3.7	3.6	3.5	3.5	3.7	3.6	3.5	3.6	3.6	3.6
2011	3.4	3.4	3.4	3.2	3.2	3.6	3.4	3.5	3.6	3.4
2012	3.6	3.6	3.6	3.7	3.6	3.7	3.6	3.8	3.5	3.6
2013	3.5	3.5	3.5	3.4	3.5	3.6	3.5	3.5	3.4	3.5
2014	3.6	3.6	3.5	3.6	3.5	3.8	3.6	3.7	3.4	3.6
Average	3.6	3.5	3.5	3.5	3.6	3.7	3.5	3.7	3.6	3.6

model, which is not limited in structural types, is made by cardboards or balsa wood. Students must design under the given conditions, which are the width, height, and bridge length and span, to construct a bridge model. The bridge competition is carried out to contest the specific strength after constructing a bridge. The loading test in this theme is shown in **Photo 1** (c).

The class of "Force and Deformation" is composed of investigations, presentations, model constructions, and loading tests, as mentioned above. For achievement evaluation, students must complete and submit all learning sheets for each themes. The achievement of students in this class is evaluated by contents of learning sheet, results of each competition and presentation, and terminal examination.

Class Questionnaire of "Force and Deformation"

In Tokuyama Kosen, students must evaluate all classes per half year or full year. This evaluation is called the class questionnaire, and all students mark by 1~4 point scale (1: very poor 2: poor 3: good 4: very good) in each question. This class questionnaire includes 9 evaluation items concretely as follows;

(1) Teacher's voice was clear during the lecture.
(2) Explanation of teacher was comprehensible.
(3) Attainment goals and explanation were set to the appropriate level every time.
(4) Blackboard writing and slide shows of teacher were comprehensible.
(5) Contents of actual class corresponded to that of published syllabus.
(6) The teacher tried to heighten student's sense of participation in the class.
(7) Supplementary material such as learning sheet were utilized effectively.
(8) Composition of class was ingenious to achieve attainment goals.
(9) You have achieved attainment goals of this class.

All results of the class questionnaire by students of "Force and Deformation" since 2009 are shown in **Table 2**. Each question numbers (1) ~ (9) in this table corresponds with 9 evaluation items mentioned above, respectively.

From these results, yearly overall assessments were very high as 3.4 ~ 3.7 in average values. In each question number, the evaluation results of (6) and (8) were the highest in comparison with other question numbers as 3.7 in average values for past 6 years. Therefore, it will be thought that the mechanical curiosity and inquiring mind could be drawn out successfully from 1st graders, who know nothing about structural mechanics, through the experience-based group learning, because the high score of question number (6) means that a sense of participation for students were improved. In addition, the high score of question number (8) will mean that composition of class was suitable to keep the highly-motivated state for active learning.

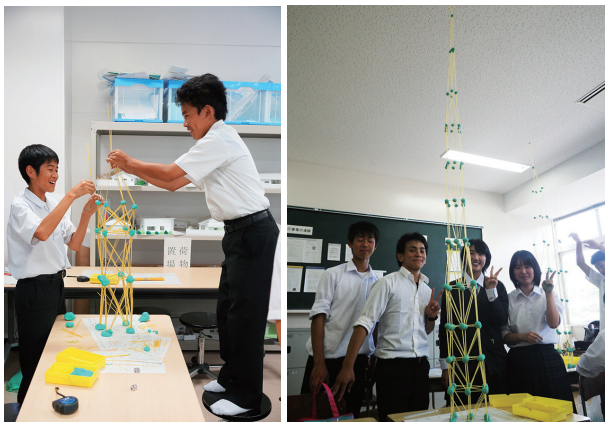
However, it was clarified that the explanation method, difficulty level and learning sheets for each themes have a margin for more improvement, because the average values of question number (2), (3), and (7) were lower (3.5) than that of other items.

Pasta-clay Tower & Discussion for Active Learning

In this section, Pasta-clay tower model, which is original tools developing through the educational experience of "Force and Deformation" since 2012, is introduced as an example of simple and functionable education model for structural mechanics. And, this model was proposed by the collaboration between subject teachers and some senior students with experience in teaching assistant of "Force and Deformation".

Photo 2 shows Pasta-clay tower in "Force and Deformation". The materials required for this tower construction are only commercially available dry pasta and oil clay. And the construction method is very simple, because student only has to insert dry pasta into clay ball. Students can justify the length of dry pasta by snapping off by own fingertips. Here, using of dry pasta with 1.8 mm diameter is recommended by considering of adherability and material properties (G.V. Guinea, 2004). By this construction method, Pasta-clay tower will be not needed to have any industrial tools and edged tools. Therefore, higher safety of students while at working will be realized. Since the especial loading test also is not needed, all efforts including preparation and clearance may greatly reduce for busy teachers. In

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(a) Under construction (b) King of towers (H=226cm)

Photo 2. Pasta-clay tower in "Force and Deformation"

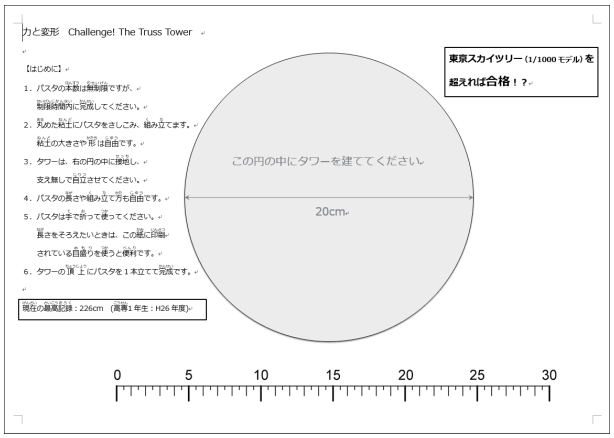


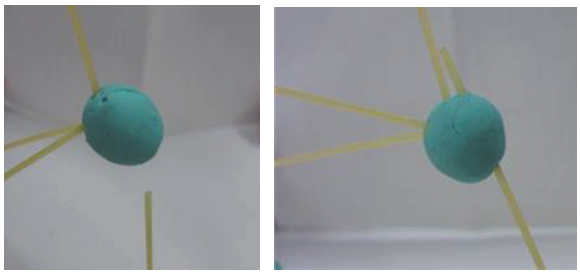
Figure 1. Mounting paper for Pasta-clay tower

passing, the cost of Pasta-clay tower will be less than 60 yen per 1 tower at most, because oil clay can repeat use.

In "Force and Deformation", students construct a Pasta-clay tower by a group of 3~4 people within the time limit (75 minutes). This time limit includes meeting and discussion time (15 minutes) before the tower construction (T. Wujec, 2010). All towers must be constructed on the inner side of a circle in 20cm diameter printed to distributed mounting paper shown in **Figure 1**. Number of pastas and amount of clay are not limited currently in competition rules. It is indisputable that the team, which could construct the highest tower within the time limit, becomes champion.

In Pasta-clay tower, one of the most important educational features is that students are able to learn easily the concept of dead load, which is unavoidable load in all structures, with enjoyment through the process of tower construction and collapse.

For constructing of higher tower, students has need to learn the basic theory of truss structure from the past themes shown in **Table 1**. In addition, observing the behaviors of own tower during construction is very important, because various local failures will be due to appear with the increase in height of tower. **Photo 3** shows the example of mechanical failures at node due to axial forces. All nodes have some pulling and punching strength by viscosity of oil clay. But, if the axial force exceeds each critical strength, local failures of node will appear as shown in **Photo 3** (a) and (b). And, students



(a) Pulling failure (b) Punching failure

Photo 3. Failures at node due to axial force

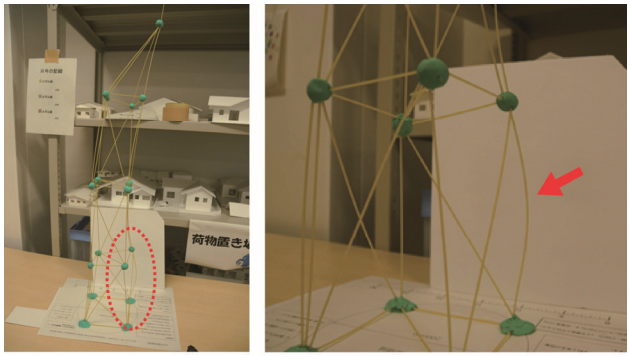
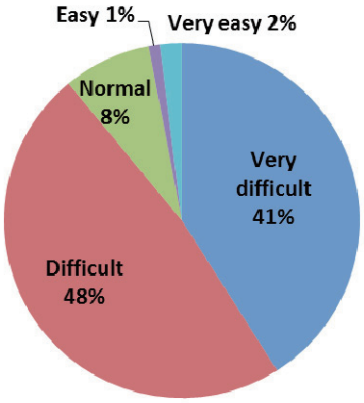


Photo 4. Global collapse due to local buckling at base

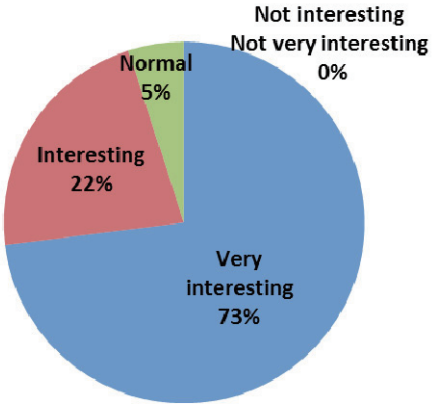
will learn the importance and measures for eccentricity, which means an axis line alignment of upper column and lower column, in compressive force. In Pasta-clay tower, pulling failure and punching failure as shown in **Photo 3** express the breaking and compression failure in actual structure members. If the local failure at each node did not appear, the buckling of column members will be certain to encounter the tower construction. **Photo 4** shows global collapse of tower caused by local buckling of column pasta near the base.

The Pasta-clay tower never collapses instantly, even if the tower has any damages in some place, because node has some viscosity resistance to rotation of members. In many cases, since the global collapse of tower spends several tens of minutes, students can observe the failure carefully. Then they will start restoration or reinforcement of tower immediately after discussion for cause of failure.

From the results of terminal examination and questionnaire for this class in 2012 and 2013, it was confirmed that most students could understand about mechanical features of each failure mentioned above through the constructing Pasta-clay tower. However, it was not enough to understand applied skills and considerations for higher tower construction (F. Onishi et al., 2013 and 2014). For improving this problem, the class for Pasta-clay tower construction was conducted twice across 3 weeks since 2014 as shown in **Table 1**. And, the time of group meetings for free discussion about structural improvement were established after first tower construction (K. Shiono, 2009). In this result, the average height of towers was increased considerably from 101cm (in 2013) to 161cm (in 2014). **Photo 2** (b) shows the highest tower, which had been reached to ceiling board, in 2014. From the observation of these high towers, main structural artifices, which students learned voluntarily, are as follows;



(a) Difficulty level of Pasta-clay tower



(b) Interest in Pasta-clay tower

Figure 2. Examples of questionnaire for students

(1) The length of column pastas at the lower position are shorter from considering of buckling. And, these compressive members are composed by lapped pastas.

(2) The diameter of clay nodes at the upper position are smaller for reducing the dead load.

(3) The design of diagonal members are the shape of "M" for preventing torsional failure of the whole tower.

(4) The lateral bracing members are attached in all section for preventing the cross-sectional deformation.

Because Pasta-clay tower was developed as an educational tool to increase more children familiar with structural mechanics, it is used not only for "Force and Deformation" but also for the visiting lecture to regional science events and the open campus of Kosen.

Finally, the examples of the questionnaire results obtained from 171 elementary and junior high school students, which joined to above events and experienced Pasta-clay tower construction, are shown in **Figure 2**. From these figures, it was clarified that the percentage of students with "difficult" answer was 89 %, but that of students with "interest" answer was very high (95%), too. This feature that combines difficulty and fun will be important and basal factor as educational tool.

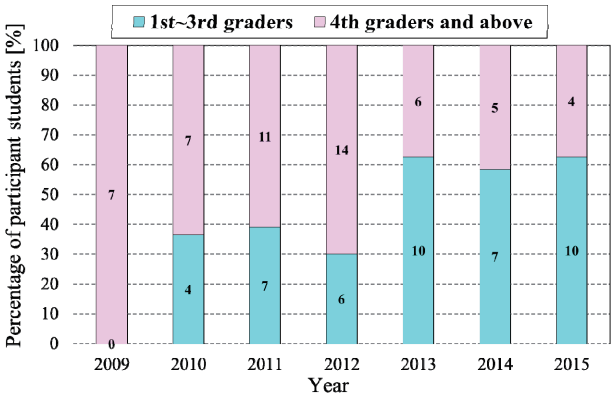


Figure 3. Yearly transition of participant students

The purpose of introductory education such as "Force and Deformation" is to draw out the mechanical curiosity and inquiring mind from children, who know nothing about structural mechanics, through the experience-based group learning. Therefore, it will be thought that the development of more functionable education tool, which is able to fill as many as possible of educational demand performance, will be essential for accomplishing this purpose. In other words, active learning and the educational tool development may be inextricably linked together in introductory education.

Leading to Design Competition

In Tokuyama Kosen, the educational effects through the student participation to the design competition in college of technology are expected greatly. However, the lower graders will have an inclination to keep a distance from active participation with concern over technical knowledge for structural mechanics. From this reason, we expected to improve this problem by "Force and Deformation".

Figure 3 shows the yearly transition of participant students to Tokuyama Kosen teams for the structure design division of design competition in college of technology. From this figure, the proportion of 1st~3rd graders to all students, who challenged to the structure design division of design competition in college of technology, was increasing considerably from 0 % to 60 % for recent years. Therefore, "Force and Deformation" enables the students of lower grades to improve the concern over technical knowledge for structural mechanics. Also, the scholastic ability of these students is not always high, but it will be definite that they like making things by own hands.

In design competition mentioned above, Tokuyama Kosen teams were awarded a prize 3 times (second place and jury's special awards in 2010, 2011 and 2014) in structure design division. Moreover, the scholastic achievement of students who challenged to the structure design division of this design competition is often improved with one's grade in school advanced. Of course, it doesn't mean that these good results was obtained by influence only of "Force and Deformation", but it cannot ignore the possibility of this experience-based class which was started from just 2009.

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Conclusions

In this study, the main educational outcomes, which were focused on the educational effects and active learning method, were discussed for introductory education of structural mechanics through the results of some questionnaire investigations and the Pasta-clay tower construction. The main conclusions obtained from educational discussions through the experience-based group learning for "Force and Deformation" are as follows;

(1) From the results of the class questionnaire for "Force and Deformation", the mechanical curiosity and inquiring mind could be drawn out successfully from 1st graders, who know nothing about structural mechanics, through the experience-based group learning. However, the explanation method, difficulty level and learning sheets for each themes have a margin for more improvement.

(2) The Pasta-clay tower model will have high educational effects for learning the concept of dead load and some local failures such as buckling behaviour through the process of tower construction and collapse.

(3) From the questionnaire results for Pasta-clay tower, the percentage of students with "difficult" answer was 89 %, but that of students with "interest" answer was very high (95%), too. This feature that combines difficulty and fun will be important and basal factor as effective educational tool.

(4) It will be thought that the active learning and the effective educational tool development must be inextricably linked together in introductory education from the experience of Pasta-clay tower construction.

(5) In Tokuyama Kosen, the proportion of 1st~3rd graders to all students, who challenged to the structure design division of design competition in college of technology, was increasing from 0 % to 60 % since 2009 when the "Force and Deformation" has been started.

Acknowledgements

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COMPARISON OF WORK VALUES BETWEEN ENGINEERING STUDENTS OF JAPAN AND HONG KONG

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Abstract

As the aging population of Japan is growing rapidly, people over 65 years old occupy more than 25% of the Japanese population now. At the same time, birth rate is also decreasing. These two factors are causing a decrease of the labor force at an alarming rate. To maintain the labor population in Japan at the present level, it is very important to increase the number of women in the workforce. However, half of the women engineers retire from their jobs after getting married or having children due to the load of housework or the care of their children. According to the survey by Women on Boards Survey by GMI Ratings in 2013, Japan is the country with the lowest percentage (1.1%) of the female Directors at industrial market, whereas Hong Kong is ranked as the highest country (9.5%) in Asia. In National Institute of Technology (NIT), there are many female students working toward becoming engineers in the future. Career education is very important for students in order to consider their long-term career plans. The purpose of this study is to recognize the difference of work values between Hong Kong and Japanese students, and utilize the information for career education for Japanese students.

We conducted the survey among students of Department of Engineering in Hong Kong and Japan by asking them to complete some questionnaires. The contents of the questionnaires are about the motivation for their jobs and life plannings. Then we compared the differences of the results between the Hong Kong and Japanese students and it became clear that Japanese female students have concerns about continuing to work as an engineer after getting married and having children. As conclusion, it is very important to show female students the role model (women engineers) in their career education so that they can have a long-term image of their career as an engineer.

Keywords: *career education, work values, women engineers, career plan, questionnaire*

1. Introduction

Japan is facing problems of aging population now. The number of people aged 65 or over more than 25% of the population. The proportion of people aged 65 or over is forecasted to reach nearly 40% of the population in 2060. Meanwhile, the main working population aged 15 to 64 fell below 62%. It becomes more necessary to increase the number of women in workforce. According to surveys by Gender Equality Bureau Cabinet Office (*2014*), 27.7% of working women quit their job after getting married and 36% of working women quit after having a baby. In addition, it was found that Japan is the country with the lowest percentage (1.1%) of the female Directors at industrial market in Asia (Women on Boards Survey by GMI Ratings in 2013). On the other hand, Hong Kong is ranked as the highest country (9.5%) in Asia. In National Institute of Technology (NIT), there are many females students who would work as engineers in the future. However, according to the survey of female graduates, half of them have quit their job after getting married or having children. Therefore, career education during their college days is very important for them in order to think about their long-term career plans. In this study, we conducted surveys about the motivation for their jobs and life plannings among students of Department of Engineering in Hong Kong and Japan. From the result, we identified the difference of work values between Hong Kong and Japanese students. In this report, we will discuss how career education should be for Japanese students by utilizing the information of the result.

2. A Breakdown of respondents

We conducted a survey for Japanese students who belong to NIT (Tokyo, Takamatsu, Tomakomai College) on 2015, and obtained a total of 611 respondents. They are in the 4th grade or 5th grade in NIT, and their ages are around 19 to 20. For comparison, the survey was also conducted for a total of 81 Hong Kong students who belong to the department of

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engineering at Technological and Higher Education Institute of Hong Kong (THEi) on 2013. They are year 1 or year 2 students, and they are around 19 to 21 years old. Total number of the respondents of this survey is shown in Table 1. Both surveys were conducted by distributing to and collecting from students directly.

To compare their attitude and motivation for their jobs and life plannings between Japanese and Hong Kong students, the questionnaire includes 6 questions which are shown in Table 2.

Table 1. The number of students and respondents

	THEi(HK)	Tomakomai	Takamatsu	Tokyo	Total(JPN)
Male students	71	106	157	150	413
Female students	10	22	33	20	75
No answer on sex	0	111	3	5	123
Total	81	239	197	175	611

Table 2. Questions of the questionnaire

Q1. Why did you choose your major fields?
(Choose 2 items from 7 items)
Q2. What is the highest levels of education you are aiming for?
Q3.When you choose your job, what are key concerns?
Q4. What is your career plan?
(Check the job level by each age group on the table.)
Q5. For male students: Which life plan do you want for your partner?
For female students: Which life plan do you wish to pursue?
(Choose 1 items from 5 items)
Q6. The reason why you chose the life plan at Q5

3. Results of the survey

The results of the survey are shown in Figure 1 to Figure 7. Figure 1 to Figure 6 show the comparative results of Japanese and Hong Kong students. The analysis of Figure 5 and Figure 6 does not include the respondents of "No answer on sex" in Table1. Figure 7 shows concerns for future jobs for only Japanese students.

3.1 Reasons for choosing their major fields

Figure 1 shows the reasons for choosing their major fields. Two items were chosen from seven items. The upper bar of the graph represents Japanese students in NIT, and the lower bar represents Hong Kong students in THEi. The most common answer for both NIT and THEi students is "It is interesting/meaningful". In Hong Kong (THEi), 55% of students chose "Engineer salary is good". However, only 7% of NIT students chose it. On the other hand, more NIT students chose "Recommendation of my family" and "Recommendation of teacher or other people" than THEi students.

These results show that THEi students chose their major field by themselves based on not only their interest but also their financial aspect, while NIT students chose their major field with some influence from family members' opinion thought they think that engineering salary is not so good.

3.2 Students' aims for their highest levels of education

NIT is a well known technical college which has a five-year consistent engineering education for students from 15 years old. The education system is a combination of high school and college. Students get an associate degree in engineering when they graduate. In addition NIT has a two-year advanced course which gives bacherlor's degree. After graduation, 40% of students tranfer to the advanced course or the 3rd year of university. THEi has a bachelor's degree programme, although it does not have a master degree course yet. In such as situation, we asked the students of both NIT and THEi about the aims of their highest levels of education.

Only 21% of NIT students aim to have Master degree, whereas 46% of THEi students prefer to have Master degree. Hong Kong students tend to be more highly motivated to get a higher degree in their career.

3.3 Students' key concerns when choosing jobs

Figure 3 shows the key concerns for students when they choose their jobs. In this question, two items were chosen from eight items. The percentage of THEi students selecting "Good salary" and "Related to my skill" is almost double compared to NIT students. On the other hand, the biggest key concern of NIT students is "It is interesting/meaningful". Even though NIT students have studied technologies as their major fields

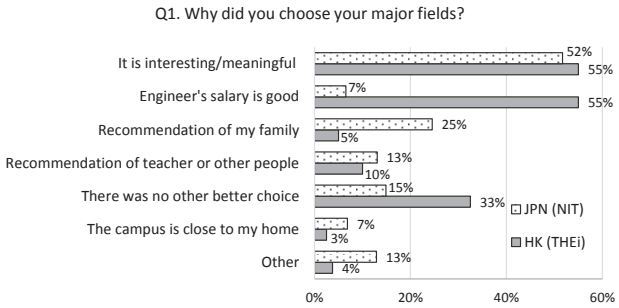


Figure 1 Reasons for choosing major fields

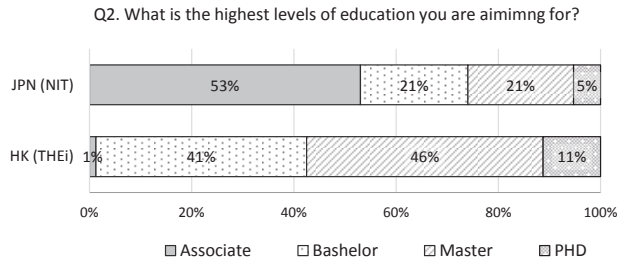


Figure 2 Students' aims for their highest levels of education

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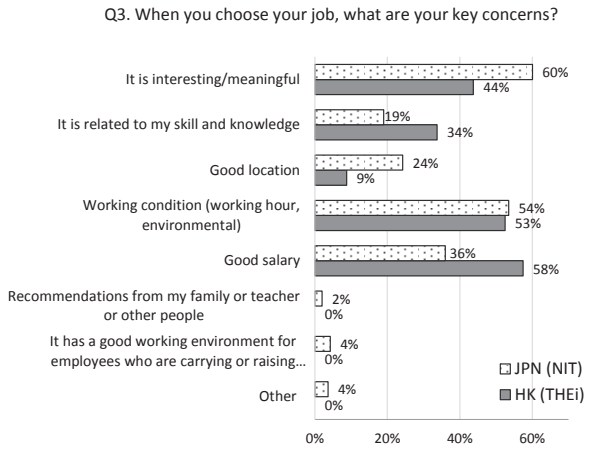


Figure 3 Students' key concerns when choosing jobs

for five years, they do not emphasize their skill and knowledge when choosing their jobs.

The percentage of "It has a good working environment for employees who are carrying or raising children" is 4% of NIT students. However, if the case is limited to only female students, the percentage of NIT students became 30 %, while that of THEi students was 0%. In Japan, all companies have to allow women employees to take 14 weeks maternity leave. Now, most companies also have 1 year childcare leave system. In Hong Kong, childcare leave is not very common and maternity leave is only 10 weeks. Despite the fact that child care system in Hong Kong is worse than Japan, Hong Kong students do not consider it too much. The result suggests that Hong Kong has other systems for parenting support other than the companies' own systems.

3.4 Students' career plans

To investigate the motivations for their jobs, we asked them their career plans (job levels) for each age group. The result is shown in Figure 4. THEi students have relatively stronger motivations for building their career. It can also be observed that the timing of promotion in the company is similar between Japan and Hong Kong. Becoming a manager requires approximately a decade of experience and the next promotion (becoming a director) requires another decade. Retirement ages are almost past 60 years old for both of Japan and Hong Kong.

3.5 Students' life plan

To research students' value towards female employees' life plans, we asked female and male students respectively about their expectation of the continuation of women's work after getting married. The options are as follows.

No.1 Getting married and having children, quit a job and not return to work.
No.2 Getting married and having children, quit a job temporarily and return to work .
No.3 Getting married and having children, continue working.
No.4 Getting married and not having children, continue working.
No.5 Not getting married, continue working.

Figure 5 shows the result by each group of students. As seen in Figure 5, most THEi students prefer to continue working. Only 10% of male students chose No.1. For NIT students, however, more than half of them chose No.1 or No.2. There is only 17% of male students choosing No.3. It was found that work values of the continuation of women's work after getting married have a huge difference between THEi students and NIT students.

The reasons of chosen answers at Q5 are shown in Figure 6. This question is for students who did not answer No. 1 at Q5. As a reason for continuing working, both THEi and NIT male students chose "Work is interesting/meaningful" and "It is a generally accepted practice" while half of THEi female students chose "Financial needs" and half of NIT female students chose "Social contribution" or "I want to be independent". The results shows the difference in the way of thinking between male and female students.

In addition, although 80% of THEi female students chose No.3 at Q5, only 17% chose "Working is interesting/meaningful" and the main reason for keeping working is "Financial needs". As it is reported in *International Housing Affordability Survey: 2015* that Hong Kong is the No.1 country in the world for the

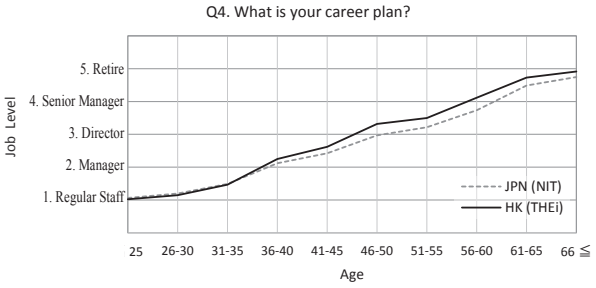


Figure 4 Students' career plan

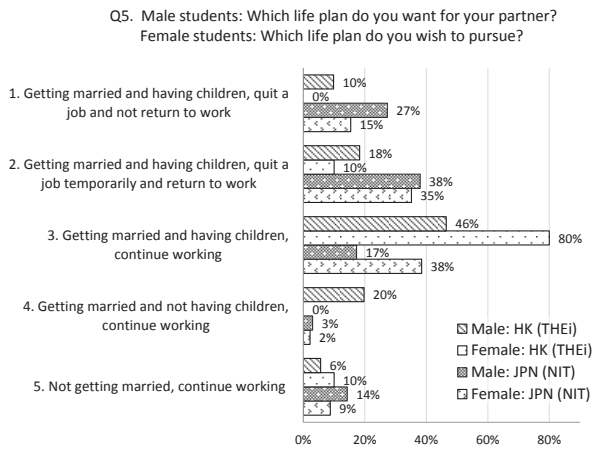


Figure 5 Students' life plan

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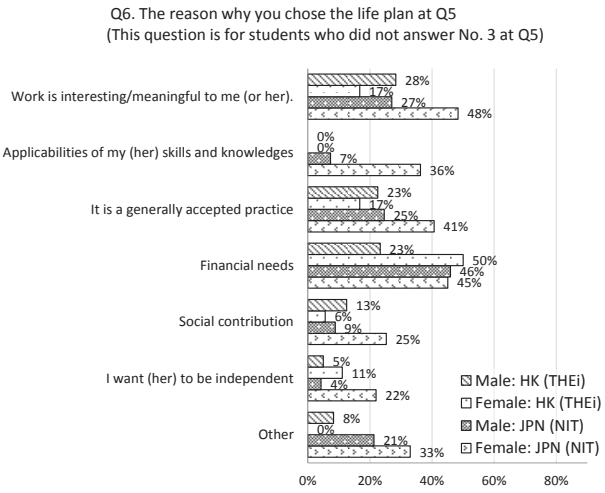


Figure 6 The reasons of chosen life plans in Q5 (except for No.3)

unaffordable housing, the cost of living in Hong Kong is quite expensive. Therefore, THEi female students might put much value on financial needs for their livings.

3.6 NIT Students' concerns when starting to work

Figure 7 shows the biggest concerns for NIT students when starting to work. This question was asked only to NIT students. More than half of NIT female students are concerned about work-life balance while only 23% of male students have the same concern. It implies that male students do not consider seriously work-life balance when they start to work. In Japan, it is still mainly women who do housework even though they have jobs. As for graduates of NIT, it is reported in Y.UCHIDA (*2011*) that 60% of female employees quit their job after getting married or having children even though they have technical skills and knowledge. Although some of them intend to go back to work after their children grow up, it would be quite difficult to find a technical job again. In addition, in most companies, there is only a small number of female employees

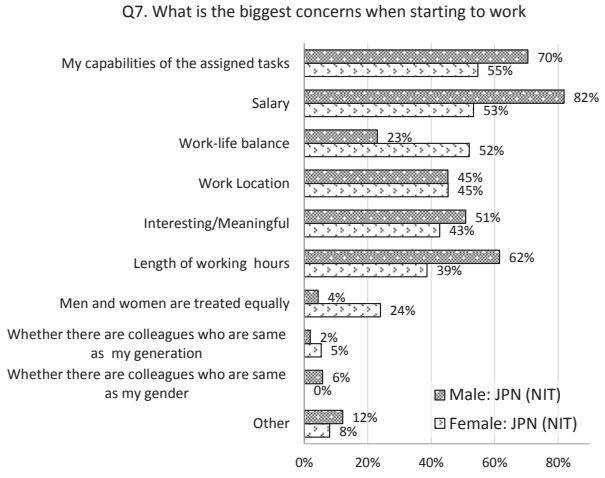


Figure 7 The biggest concerns when starting to work

working related to engineering. It implies that female engineers usually do not have a role model for balancing their family and career. To increase the number of women in the workforce, it is very important for female students to understand the difficulties to find a technical job again after quitting their jobs, and show them role models of women engineers who have a good work-life balance as their career education.

4 Conclusion

It follows from these results of the questionnaire that the key concerns of THEi students when they choose their jobs are "Good salary" and "Related to my skill", while that of NIT students is "interesting/meaningful". In addition, THEi students are more eager for women's continuous career than NIT students. It seems that that they have more role models who have a good work-life balance in the Hong Kong society so that they can have a better image about their long-term careers. In contrast, more than half of NIT male students prefer their partners to quit their jobs after getting married. Also, NIT female students consider quitting their jobs permanently or temporarily to do housework and take care of their children. Therefore, NIT female students don't have a long-term image of their career. In addition, balancing of work and life requires cooperation and supports from families and colleagues. It is also important for male students to understand the situations of the continuation of their partner's work and how they should contribute.

In conclusion, it is very important to provide a role model of female engineers in the career education for both male and female students of NIT so that they can have a long-term image of their career and life. Moreover, by creating more chances for NIT and THEi students to discuss their mutual career plans, it is possible to introduce new ideas into their current work values.

Acknowledgements

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CREATION OF AN ENVIRONMENT FOR ACTIVE LEARNING AND ITS PRACTICES IN NIT, GIFU COLLEGE

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Abstract

For more than fifteen years, National Institute of Technology (NIT), Gifu College has created new educational and learning environment extensively utilizing ICT to make students' voluntary learning possible at its higher level. These past educational practices were funded by the "Support Program for Contemporary Educational Needs (GP)" of MEXT, Japan (2004), etc. Based on this background, we have started to develop new educational program comprising of extensive use of active learning methods in and outside our formal curriculum. This program has been picked up as a project of the "Acceleration Program for Rebuilding of University Education (AP)" (2014) by MEXT. Since 2001, our college has prepared personal computers in all the classrooms for the fourth-year students so that each student can use a personal computer exclusively. Under the support of the AP program in 2014, we have accelerated this movement by creating an environment suitable for ICT-driven education also in the first-year students' classrooms. With this ICT environment, we have intensively introduced active learning methods into the classes. We are trying to expand this ICT environment further to the classes for the second and third-year students with the promotion of active learning methods in their education.

Keywords: *ICT-driven education, Active Learning, Learning Environment, Creation of an Educational Environment, Active Education, Learning Tools*

Introduction

In 1961, with the revision of the School Education Law, the "Colleges of Technology (the Kogyo Koto Senmon Gakko; KOSEN)" was established as a system of five-year higher educational institutions to meet the strong demand from Japanese industry. KOSEN accepted the first students in 1962 with a junior high school diploma, and educated them to become practical engineers against the background of the economically-industrially rapidly growing Japanese society. In 1962, the first twelve national colleges of technology were established, and in 1963, the second twelve colleges were founded; our college, currently "National Institute of Technology (NIT), Gifu College", was among the second twelve colleges, and celebrated our 50th anniversary in 2013.

We, National Institute of Technology (NIT), Gifu College applied for the "Acceleration Program for Rebuilding of University Education (AP)" started by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) in 2014, and our application was successfully adopted. Our "AP" project consists of two things: introduction of active learning (AL) into all the subjects and visualization of the learning outcomes.

For more than fifteen years, our college has strongly promoted advanced educational methods including development of e-learning contents and establishment of various types of Project-Based Learning (PBL). These are all to cultivate students' voluntary learning. Moreover, we have invented a system to give students incentives for voluntary learning and to evaluate its outcomes. These activities had been funded by the "Support Program for Contemporary Educational Needs (GP)" of MEXT, and these implementations received awards from several academic societies for education.

Before the AP program was started, students' voluntary learning was performed only in a few classes. Then, the AP program has triggered off introduction of the method into the classes of all teachers.

In our AP program, (1) we have expanded "Active Learning (AL)" to all the subjects in our formal curriculum so that some AL method is applied at least once per semester, (2) we also encourage students to voluntarily obtain, for example, vocationally useful public licenses as their activities outside the formal

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curriculum, and (3) finally, we apply our original method to visualize outcomes of these "active learning" in both non-curriculum and curriculum, based on the "practical engineering credit" system. See Lage, Platt, and Tandreglia (2000), Bergmann & Sams (2012), Khan Academy (2006), and Bonwell & Eison (1991) for various AL methods.

We also assist both teachers and students in their implementation of the AL in classrooms by providing the following environment: (1) to consolidate educational contents for teachers and learning assistance materials for students in a server and distribute them to both teachers and students through internet; the educational contents are prepared based on Model Core Curriculum (MCC) by the Institute of National Colleges of Technology, Japan so that the quality of contents is ensured, (2) to establish the classroom ICT environment.

In 2014, we prepared an ICT environment mainly in the first-year students' classrooms and introduced active learning mainly into these classes. We think it's vital for freshman students to become accustomed to active learning in order to understand its meaning, and to experience and master the skills of creating new things by him-/her-self and/or with friends in classes over a short time period; of course, these are true for students of the upper grades as well. So we are now developing the supporting system of students' voluntary learning; all the teachers learn how to use the electronic blackboard system, the LMS server, tablet PCs and software for creating teaching materials.

On starting this AP program, we have consulted with some senior graduates of our college, who have worked long and/or are currently working in Japanese industries as leading engineers, about knowledge and skills which they think important when students will enter into industry after their graduation. Specifically, at the question of 2014, they picked up important forty-four items among those included in MCC, and recommended visualization of educational outcomes of these items. More specifically, they suggested subjects, keywords, related matters, backgrounds, reasons, motivation, the introductory level, the intermediate level, the advanced level, familiar products and cases in use, using diagrams as well as texts when needed. From this academic year, we will create the learning contents and learning support contents of each item, based on the suggestions of the graduates. We will also create the contents while being conscious of the learning level of each content and the relations among the subjects.

The foundation for introducing active learning

In our college, from 2001 until the present, ICT-driven education has been practiced in the multimedia educational building where the fourth-year classrooms of all five departments reside.

The installation of ICT-driven equipment for teachers and desktop personal computers with desks having a storage feature for locking away each personal computer made it possible to perform ICT-driven education in all classes. (Figure 1)



Figure 1 ICT-driven equipment in the fourth-year classrooms

Additionally, supported by the "Support Program for Contemporary Educational Needs (GP)" which we acquired in 2004, we developed the contents and system for e-Learning. (Figure 2) Also, the program to provide two different kinds of consortium with lectures by using the e-Learning system has successfully been continued until today.

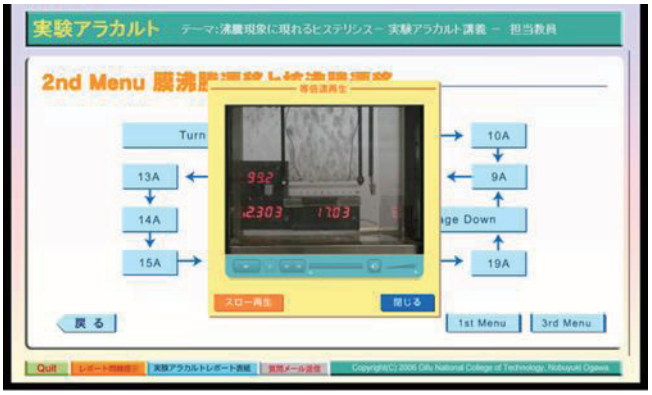


Figure 2 An example of a presentation using the e-Learning system

Two different kinds of consortium: One is a consortium formed among National Institutes of Technology, colleges and universities nationwide, agreed to credit transfer. The other is a consortium formed among neighboring colleges and universities within Gifu prefecture, agreed to credit transfer. The number of National Institutes of Technology which are participating in the consortium is increasing year after year. To this day, nearly half of all the National Institutes of Technology have already participated in the consortium.

Active learning before the acquisition of AP

Our college is presenting a plan that we will introduce active learning into all classes of our college and establish it within the term of the third-stage medium-term programs and objectives. In 2012, our college started active learning such as flipped learning in the classes of some subjects underlying engineering, more specifically, mathematics, physics, chemistry,

applied physics and applied mathematics. These subjects took a central role in promoting active learning in our college.

In active learning, where the utilization of knowledge is important, such class activities as group discussion, debate and group work are effective. Also, cooperative learning done in groups and presentation are indispensable. In order to do flexible education of active learning, it is beneficial that the equipment of the classrooms to be used is versatile.

Considering these points, in 2013 our college developed ICT environment by installing electronic blackboards, tablet computers, a file server for teaching materials and the like in the laboratory classrooms of applied physics, physics and chemistry.



Figure 3 ICT installment in the laboratory classroom of applied physics

The classroom has also been used for classroom lectures of applied physics and applied mathematics, and a new type of flipped learning where classroom lectures, practical experiments and ICT-driven education are combined has been practiced.

Our college has developed a learning environment by installing some custom-made trapezoidal tables which can be combined in various forms in addition to movable downsized whiteboards for group discussions in a 2nd floor classroom of the library.



Figure 4 The environment for active learning in a 2nd floor classroom of the library

ICT-driven equipment introduced by AP funds

ICT-driven equipment and the like were introduced by AP funds. The five items below were introduced in a bidding by AP funds.

(1) An electronic blackboard system that uses ICT
In 2014 we replaced the blackboards in the back of the first-year classrooms of all five departments with whiteboards, and introduced Epson-manufactured projectors which have the function of electronic blackboards. (Figure 5)

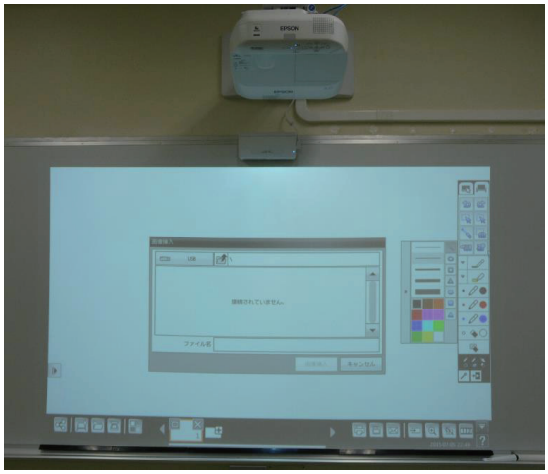


Figure 5 An electronic blackboard system introduced in the first-year classrooms in 2014

(2) Software for making teaching materials, STORM Maker
STORM Maker: Two licenses for the departments of liberal arts and natural science respectively. Three licenses for the specialized five departments respectively. It was decided that each department should install one license in a lending notebook personal computer which is stored in the library. The installment in the lending notebook personal computers which are stored in the library will help students to make teaching materials using the software. (Figure 6)

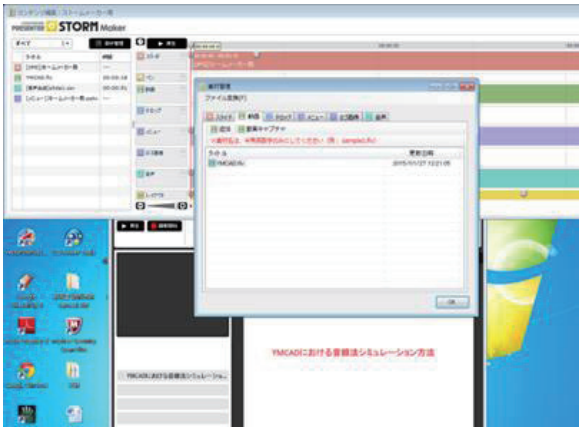


Figure 6 A screen of materials selection for making teaching materials using STORM Maker

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(3) Lease and maintenance operations of wireless LAN device
The wireless LAN device was set up for use in all the 25 classrooms of all the years (from the first to the fifth year) of all the five departments. The system was developed by providing two access points for the wireless LAN in each classroom and by controlling using MAC address to prevent injustice access. (Figure 7)



Figure 7 The equipment of wireless LAN

(4) Tablet computers
The same setting was conducted for more than 160 tablet computers (Toshiba). They can be connected to all the access points for the wireless LAN of 25 classrooms. So, though tablet computers are stored in the storage cabinets near the first-year classrooms, they can be used in other classrooms as well. (Figure 8)



Figure 8 Tablet computer storage cabinets placed in a corridor

(5) LMS server (Moodle) and DB server＋FileMaker
The LMS server was introduced so that personal computers and tablet computers within and outside the campus as well as smartphones could access. This enabled students to access it at home in addition to in the classroom.
In 2014, students used the LMS server for conducting “students evaluation” (Figure 9), and teachers used it for submitting “a report on active learning”. “DB server＋FileMaker” will be used for DB processing to visualize the learning outcomes and visualization itself.



Figure 9 Students evaluation using LMS (Moodle)

Results and Discussion

The educational environment for practicing active learning and our actual practices in our college were described.

ICT-driven education practiced in an educational building occupied by all of the fourth-year classrooms, active learning using ICT-driven equipment introduced in the laboratory classrooms, active learning using ICT-driven equipment introduced in the first-year classrooms by AP funds in 2014 — these are actively practiced in the classes of all teachers. With respect to teaching materials, a substantial amount of teaching materials created thus far, for the students of our college as well as other colleges and universities, are stored in the e-Learning system which was introduced with the support of the GP program. The system has become firmly rooted, increasing the number of colleges and universities which have agreed to credit transfer. Regarding the forty-four items suggested by some graduates of our college for creating teaching materials as part of the AP program, the teachers in charge from seven departments, including general education, are required to create teaching materials based on MCC by the end of the current academic year.

In our college, as just described, the creation of an environment conducted by introducing ICT-driven equipment, ICT-driven education and active learning, which had been practiced prior to the acquisition of the AP program, have successfully led all teachers of our college to conduct new styles of classes.

Conclusions

We are promoting improvement of our educational methods by introducing the teaching method where student-oriented interactive lectures, exercises and active learning such as discussions and debates are conducted. The aim that each student will acquire the ability to keep learning for him or herself and take the initiative in solving problems is paramount.

We consider it important to hold faculty development (FD) lecture sessions for all teachers for the purpose of promoting the college-wide program.

Henceforth, our faculty meetings will include an FD lecture session concerning two kinds of active learning, more specifically, the way to use ICT-driven equipment and the teaching method of active learning. In addition, the FD workshops on how to use ICT-driven equipment including an electronic blackboard, a document camera, a tablet computer and LMS are also held after school with advance notice to all teachers.

NIT is promoting ICT-driven education and active learning, so that all the National Institutes of Technology will be able to graduate students whose educational quality is ensured based on the sectoral attainment targets (MCC) and visualize that for everyone to see. Early in the current academic year, NIT introduced LMS called Blackboard which all the National Institutes of Technology can use in common. NIT is planning to operate an education integrated system for all the National Institutes of Technology in the academic year 2018. The system aims to integrate several kinds of systems related to the educational affairs including LMS, a teaching materials sharing system, a web syllabus and a system for administering students' academic achievement. Blackboard, which is used by all the National Institutes of Technology, is an earlier introduction of part of the education integrated system. The other functions of the system used in common by all the National Institutes of Technology will be developed, introduced and integrated from now on as well.

Our college has been using LMS (Moodle) which had been introduced as part of the AP program before NIT introduced LMS (Blackboard) for all the National Institutes of Technology. Our college is promoting active learning by using two different kinds of LMS: LMS (Moodle) introduced as part of the AP program is used for trial practices conducted within our college, and LMS (Blackboard) for all the National Institutes of Technology is for common use including our usual classes. The teaching materials used for trial practices related to LMS (Moodle) are also stored in LMS (Blackboard).

In this academic year, our college organized workshops on how to use LMS (Blackboard) . They were offered at three levels (basic, intermediate and advanced) and held nine times during a three-week period. A total of 131 teachers participated in the workshops. Due to teacher scheduling conflicts, the workshops were planned to be held during lunch break rather than after school. Conducted in a relaxed atmosphere and focused on the important functions for practical use, favorable comments were presented by the participants.

We will continue to develop the educational environment for using ICT-driven equipment and promote “active learning in all classes by all teachers” at a college-wide level in the current academic year and after. In the current academic year, we are planning to introduce the same ICT environment that we did into the first-year classrooms in the last academic year (a whiteboard, a projector with the function of an electronic blackboard and a document camera) into 10 additional classrooms. In our college, in this situation, the same ICT environment that we introduced into the first-year classrooms in the last academic year will also be introduced into all the classrooms of the second and third year, which will help promote ICT-driven education and active learning expansively and at an accelerated rate.

Acknowledgements

Development of the new educational system in NIT, Gifu College, comprising of extensive use of active learning methods, is being financially supported since 2014 through the “Acceleration Program for Rebuilding of University Education (abbreviated as AP)” by MEXT (the Ministry of Education, Culture, Sports, Science and Technology, Japan). We are also grateful to moral support for our educational practices by our mother organization “National Institute of Technology, Japan”.

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Development of Teaching Tool based on AR for the Experiments Using Oscilloscope

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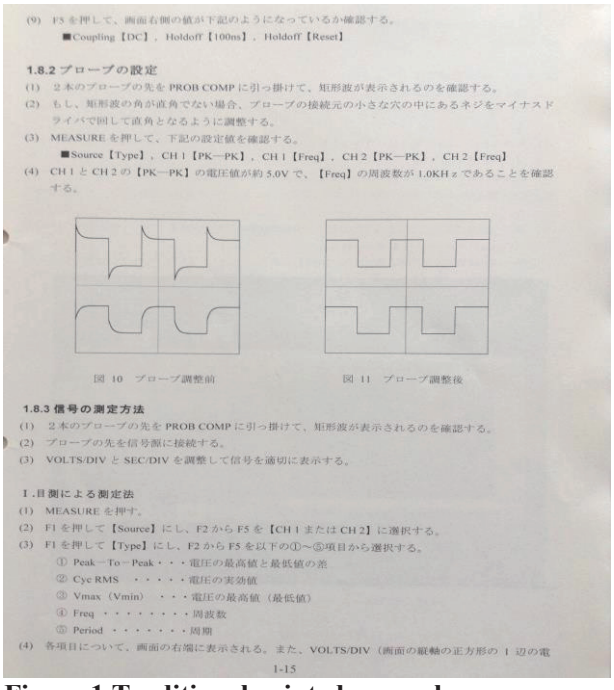
Abstract

In department of electrical and electronic engineering of NIT Nagano College, the students of lower grades often make electronic experiments by individuals, not a group. In the experiments, students use many various instruments. Especially, an oscilloscope is one such as those important instruments, but it is difficult for students to learn how to use it appropriately. In this study, it is a purpose to develop the teaching tool showing how to use clearly. In this teaching tool, following three important points are required. First is that it is easy to understand compared conventional printed operation manuals. Second is that it is easy to use. Because students need to operate instruments or make a circuit during experiment. Third is that it is fun to use. It is very important to arouse their interest when they learn how to operate it, because the interesting helps their own understanding of each student. We developed the learning tool including such elements based on Augmented Reality (AR) technology. When a student holds the backside of the tablet with the camera to the oscilloscope, all buttons on it are changed graphical buttons by using AR technology. Students touch one button, then the character of this system describes the function of the buttons in a unique voice. Therefore, the students can instantly know the function of the button in stead of looking for a part of textbooks that was written operation instruction. In addition, when holding the tablet in the circuit diagram, the breadboard appears on the tablet screen. Then, each circuit electronic element is gradually disposed on the breadboard with the animation in order. The character notes important points for making the diagram in a voice at that time. The student can display the larger circuit by bringing the tablet close to it and can look from a different angle. Since the student can confirm each time whether the made circuit is correct or not, it is possible to reduce mistakes of the circuit. The good answer to following questionnaire came back from the student of the second grader using this tool in the measuring experiment.

Keywords: *Teaching Tool, Tablet, Augmented Reality (AR), 3D, Speech Synthesis*

Introduction

In department of electrical and electronic engineering of NIT Nagano College, the style of an experiment using oscilloscope has been switched from groups to individuals a few years ago. This is because there are students who do not use the equipment in the group. In particular, since the oscilloscope is an important equipment, students must learn how to operate it. However, it is difficult for students to learn how to use the oscilloscope. It is one reason that the oscilloscope has a lot of buttons. In addition, these buttons often have multiple functions. Furthermore it is necessary to operate them in the correct order. Conventionally, the function and the procedure of the button had been explained by the printed manual (Figure 1). Since it has frequently a few figure and a lot of text, it is difficult to understand where the description is written.


(9) F5 を押して、画面右側の値が下記のようになっているか確認する。
■Coupling【DC】, Holdoff【100ns】, Holdoff【Reset】

1.8.2 プローブの設定
(1) 2本のプローブの先を PROB COMP に引っ掛けて、矩形波が表示されるのを確認する。
(2) もし、矩形波の角が直角でない場合、プローブの接続元の小さな穴の中にあるネジをマイナスドライバで回して直角となるように調整する。
(3) MEASURE を押して、下記の設定値を確認する。
■Source【Type】, CH 1【PK—PK】, CH 1【Freq】, CH 2【PK—PK】, CH 2【Freq】
(4) CH 1 と CH 2 の【PK—PK】の電圧値が約 5.0V で、【Freq】の周波数が 1.0KHz であることを確認する。

図 10 プローブ調整前　　図 11 プローブ調整後

1.8.3 信号の測定方法
(1) 2本のプローブの先を PROB COMP に引っ掛けて、矩形波が表示されるのを確認する。
(2) プローブの先を信号源に接続する。
(3) VOLTS/DIV と SEC/DIV を調整して信号を適切に表示する。

1.目測による測定法
(1) MEASURE を押す。
(2) F1 を押して【Source】にし、F2 から F5 を【CH 1 または CH 2】に選択する。
(3) F1 を押して【Type】にし、F2 から F5 を以下の①～⑤項目から選択する。
① Peak—To—Peak・・・電圧の最高値と最低値の差
② Cyc RMS ・・・・・電圧の実効値
③ Vmax（Vmin）・・・電圧の最高値（最低値）
④ Freq ・・・・・・・周波数
⑤ Period ・・・・・・周期
(4) 各項目について、画面の右端に表示される。また、VOLTS/DIV（画面の縦軸の正方形の 1 辺の電

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Figure 1 Traditional printed manual

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Moreover, it is necessary to make a circuit in order to perform the experiment, but many students cannot make a circuit immediately only by looking at the circuit diagram because they are inexperienced.

Therefore the purpose of this study is the development of a teaching tool, which support to explain how to use an oscilloscope and how to make a circuit.

In this teaching tool, following three important points are required.

First of all, this tool must be fun. What is the most important in using a tool is enjoyment, because an uninteresting tool bores students stiff and they do not use it immediately. Conversely, an interesting tool gives students an incentive to do the experiment.

Second, it should be easy to use. A user-unfriendly tool irritates students. Because students must use various experiment devices, a tool should not bother them while using their devices.

Last, it had better easy to understand compared with a conventional printed operation manual.

This paper introduces the teaching tool which has been developed based on the above (Figure 2).This tool has been used in the experiment for three years from 2013. We performed a questionnaire to students to confirm the effect of this tool after they use it.

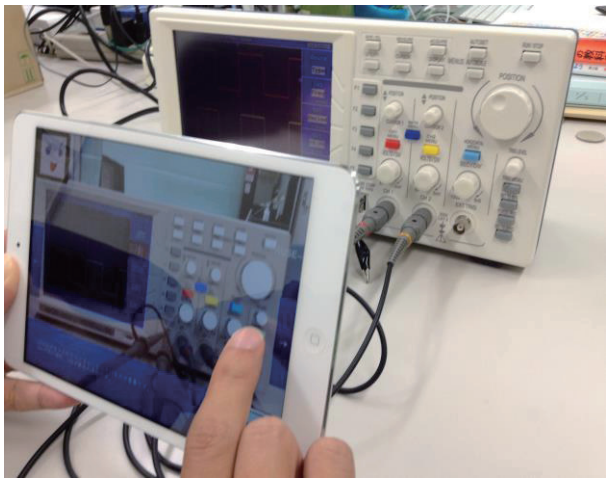


Figure 2 Developed teaching tool

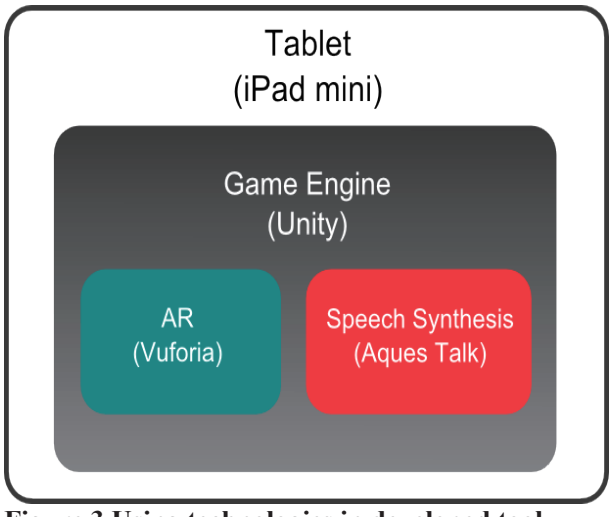


Figure 3 Using technologies in developed tool

Developed teaching tool

Developed teaching tool is made using a variety of techniques, for fun to use, easy to use and easy to understand. We focused on Augmented Reality (AR), Speech Synthesis, Tablet and Game Engine.

AR attracts attention in a field of the education (e.g., Yuen, Yaoyuneyong, and Johnson 2011; Schmitz, Specht, and Klemke 2012).

We selected Qualcomm's Vuforia that can be used as an oscilloscope or circuit diagrams with a marker-less.

Speech synthesis was selected Aquest's AquesTalk known as "Yukkuri" in video sharing service.

Tablet was selected Apple's iPad mini, which is appropriate size and which has a camera on the back.

Game engine was selected Unity Technologies Inc. Unity, which can be made animation easily such as buttons and circuit elements created with 3D. Moreover, it can unify the techniques mentioned above (Figure 3).

This tool is used in following procedure.

First, when built-in camera of a tablet shoot an oscilloscope or a circuit diagram, this tool determines which of explanation is necessary in automatic. Next, using AR, buttons are set on an oscilloscope, and circuit elements are added on a circuit diagram. Finally, by touching an item on tablet, unique characters speak about it (Figure 4).

This tool has the following three features. The first function is a description of the procedures for using the oscilloscope. To use an oscilloscope, it is necessary to perform the initial setting. It must operate buttons continuously in this setting, not only to operate a single button. Moreover each button does not have a specific role, it is changed by the current mode. Because an oscilloscope has a lot of buttons, it is difficult for students to find the button required operation. Therefore this tool flash the button. In addition, the above character explains the button, while issuing the voice (Figure 5).

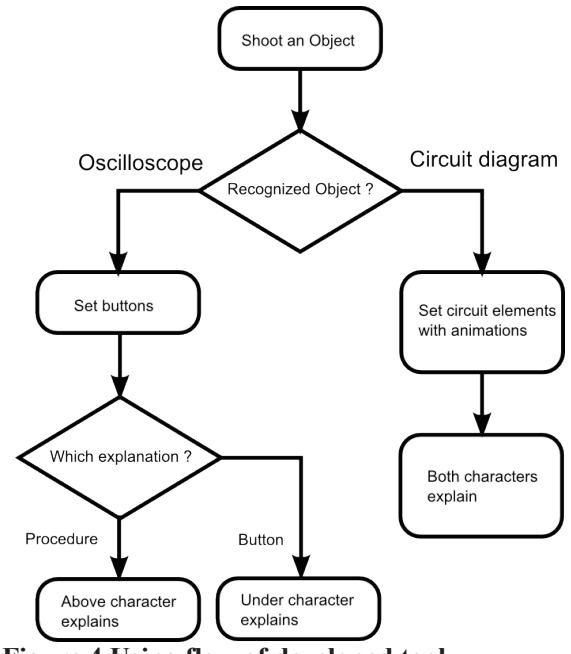


Figure 4 Using flow of developed tool

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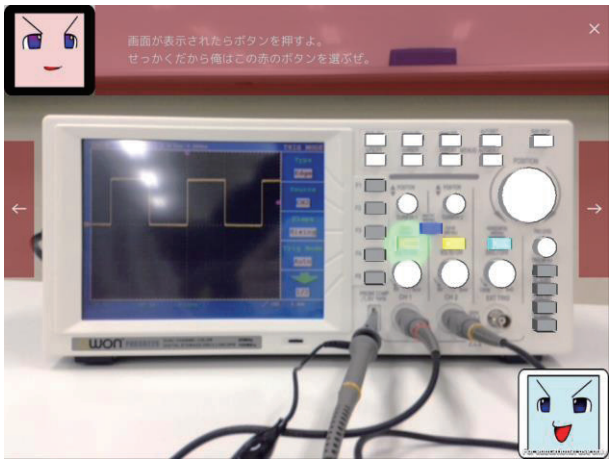


Figure 5 Description of an oscilloscope use procedure

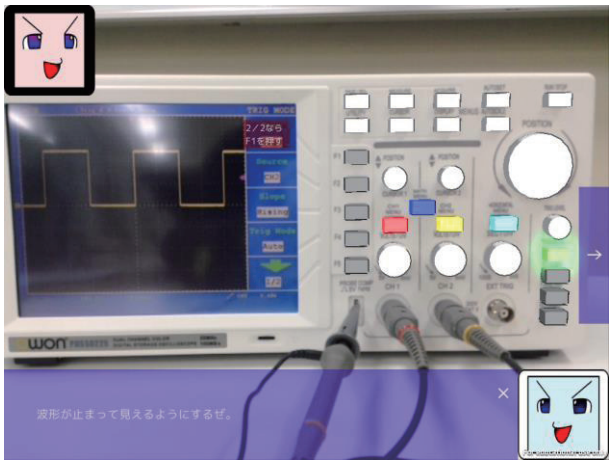


Figure 6 Description of each button of an oscilloscope

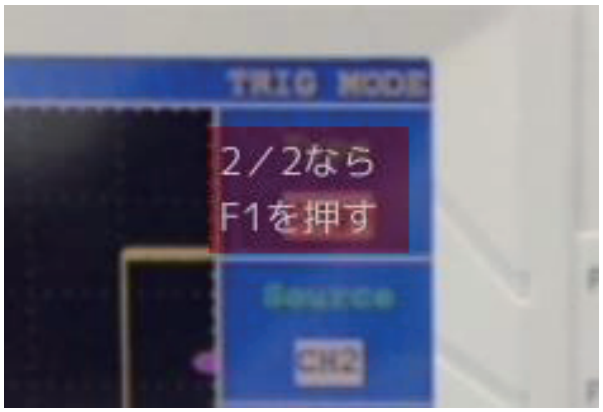


Figure 7 GUI covering setting items

The second feature is a description of each button of the oscilloscope. When the button on the teaching tool is touched, under character describes while talking (Figure 6).

GUI covers the setting item as necessary (Figure 7). Students can complete the configuration by harmonizing GUI with the setting item.

The third feature is an explanation of how to make a circuit. In description of circuit diagrams, disposing

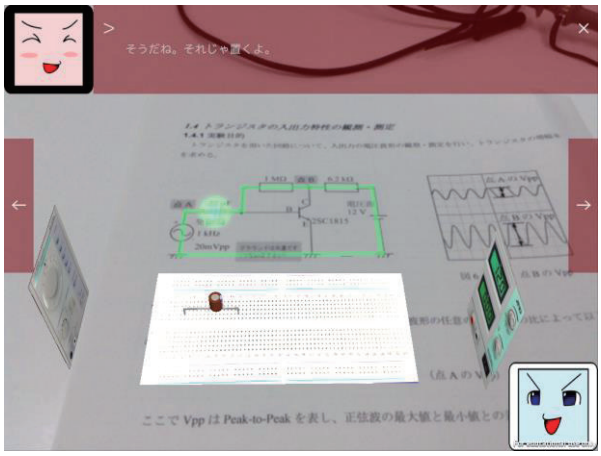


Figure 8 Description of circuit diagrams

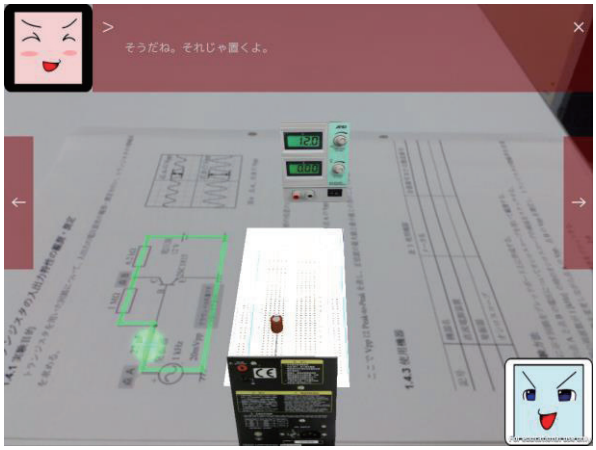


Figure 9 Different angle of Figure 4

circuit elements with animations make easy to understand what to do must be careful (Figure 8).

In this case, because circuit elements are created with model data in 3D, can be displayed larger by a tablet approaching to the circuit, and can be seen from a different angle (Figure 9).

Results and Discussion

After the educational tool is used in the experiments, the questionnaire for survey was conducted. The left side of the data is 2013 (38 students), the center of the data is 2014 (34 students), the right side of the data is 2015 (21 students).

About fun of this teaching tool, over 90% of students answered that this teaching tool was fun (Figure 10).

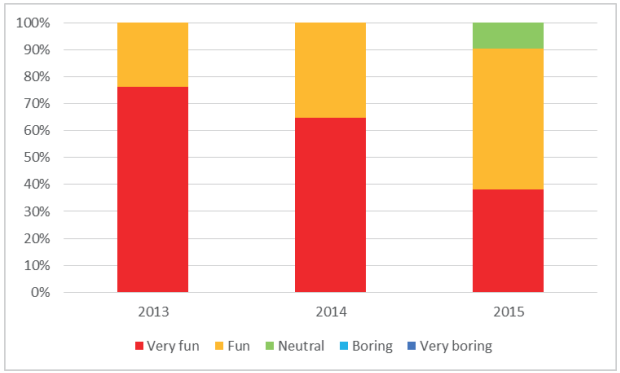


Figure 10 Fun of teaching tool

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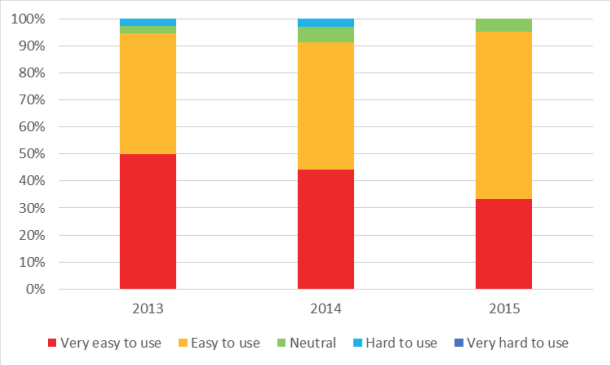


Figure 11 Operability of the teaching tool

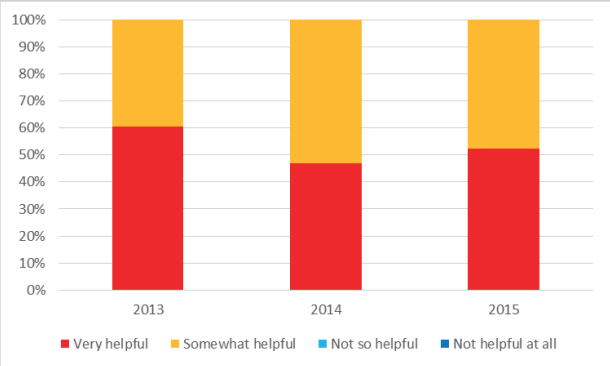


Figure 12 Description of an oscilloscope use procedure

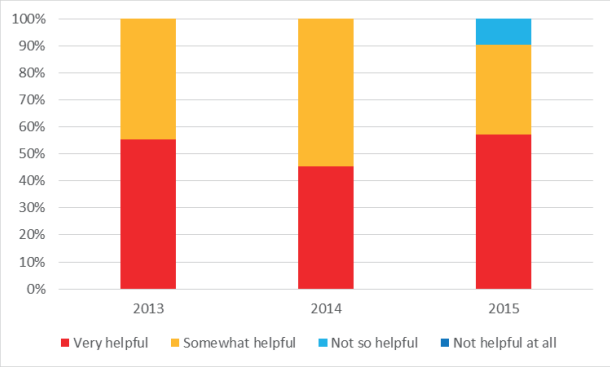


Figure 13 Description of the button of oscilloscope

About operability of this teaching tool, 90% of students answered that this teaching tool was easy to use (Figure 11).

About description of an oscilloscope use procedures, all students answered that this teaching tool was helpful (Figure 12).

About description of the button of an oscilloscope, 90% of students answered that this teaching tool was helpful (Figure 13).

About description of how to make the circuit, 90% of students answered that this teaching tool was helpful (Figure 14).

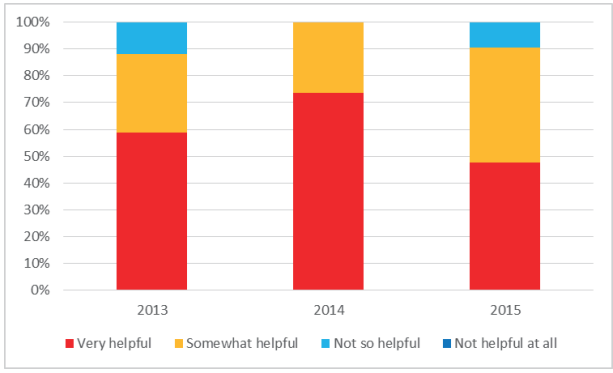


Figure 14 Description of how to make the circuit

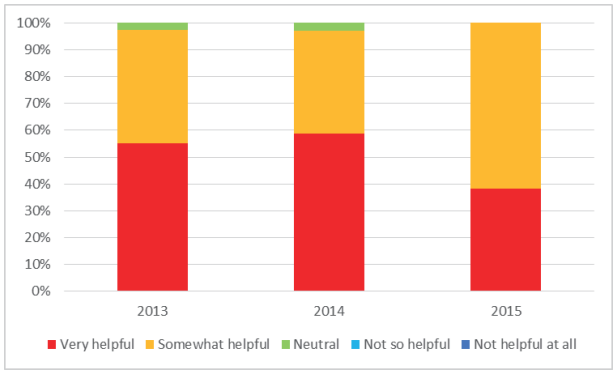


Figure 15 Ease of understanding compared with a conventional manual

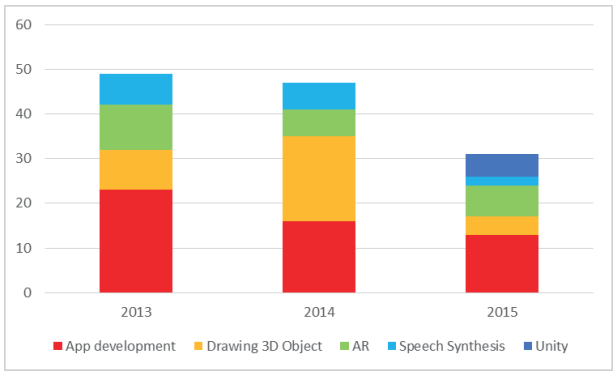


Figure 16 Interesting technology

About ease of understanding compared with a conventional manual, 95% of students answered that this teaching tool was more helpful (Figure 15).

Also, many students answered that it was interested in technology using in this tool (Figure 16).

Conclusions

This teaching tool that support the use of an oscilloscope and support making the circuit was developed. AR, Speech Synthesis, Tablet and Game Engine is used for it. This tool has three functions of a description of the procedures for using the oscilloscope, a description of each button of it and an explanation of how to make a circuit.

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This tool is fun to use, easy to use, and easy to understand than to understand using conventional printed manual.

Acknowledgements

I would like to thank students of NIT Nagano College who answered to the questionnaire using the developed teaching tool.
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An Attempt of Electronic-Mechanical Engineering Education Using Radio Controlled Tank

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Abstract

Education field of electronic-mechanical engineering consists of various fields, such as machinery or power electronics or electronic control. Therefore, it is difficult to understand the whole field of electronic-mechanical engineering in five year's curriculum. Production of robot in extracurricular activity for the robot contest 'Robocon' is a good opportunity to experience the electronic-mechanical technology, and staff of the robot club has developed a radio controlled tank to explain the technology using in robot contest to the general public. This paper describes an attempt of the practice using its radio controlled tank as teaching material in Mechatronic-Electronic Practice of fifth grader's curriculum in order to deepen the understanding of electro-mechanical engineering. Demonstration and description of the radio controlled tank are done, and students made the parts of interesting field of electronic-mechanical engineering. At the education of machinery field we design a tank's body using CAD and cut out parts with laser processing machine using CAM, and assemble its parts. Drive unit is made with assembling a marketed gear-box as tank's mechanism. At the education of power electronics field we make electronic circuit board in order to operate the drive unit by the signals from a microcomputer. At the education of electronic control field we make a microcomputer circuit board which had the equipment, such as reception of radio control signal or LED display or infrared transmission and reception or piezo buzzer. And it is programmed in C language to the desired operation. As a result of this electronic-mechanical engineering practice it seems that student's motivation is improve and individuality of the favourite field can be extended. On the other hand, the practice needs to prepare the materials and tools and the work time is long. Radio controlled tank is effective as a teaching material that can have interested to experience the production of various fields of electronic-mechanical engineering education.

Keywords: *Electronic mechanical engineering, Radio control, RC tank, Robocon, CAD/CAM, Electronic circuit, Microcomputer*

Introduction

Electronic-mechanical engineering education is necessary to learn various fields such as mechanical engineering or electronics or electronic control or programming etc. One of the practical electronic-mechanical education is Technical College Robocon. Technical College Robocon began as a creative education of manufacturing to compete ideas and originality, as Yoshida (1998) has been introduced. So the theme of Technical College Robocon changes each year, a variety of techniques has been constructed such as mechanism of the machine or electronic control system. As Fujimoto (2013) has summarized, it is established as a Manufacturing Education by PBL. Okanouchi (2003) have reported that the robot club has been working to Robocon mainly in our college. Okanouchi (2008) shows the constructed technology of electronic circuit and an electronic control in Robocon. Okanouchi & Hori (2010) had proposed a method of manufacturing a robot's body and mechanisms from plywood by using laser machine and CAD/CAM system. Members of robot club and okanouchi (2013) have developed a competitive game by radio control tanks to introduce friendly constructed technologies in Robocon. We are using these in the technical college PR, etc. This paper describes an attempt of the practice using its radio controlled tank as teaching material in Mechatronic-Electronic Practice of fifth grader's curriculum in order to deepen the understanding of electro-mechanical engineering.

Radio controlled tank for Electronic-mechanical engineering education

The concept of radio controlled tank is that it is possible to run the agility by radio control operation, and that we can enjoy. Therefore it is also possible to play a game that is reduced the opponent points by fired infrared. Using technology of radio controlled tank consist of machinery field and power electronics field and the electronic control field.

At the education of machinery field, to design a tank body using 3D-CAD. 3D-CAD software is using SolidWorks. Students are training the operation of CAD software at the time of the third grade. Self-study use online tutorial is also available. The tank body designed in 3D-CAD is shown in Figure 1.

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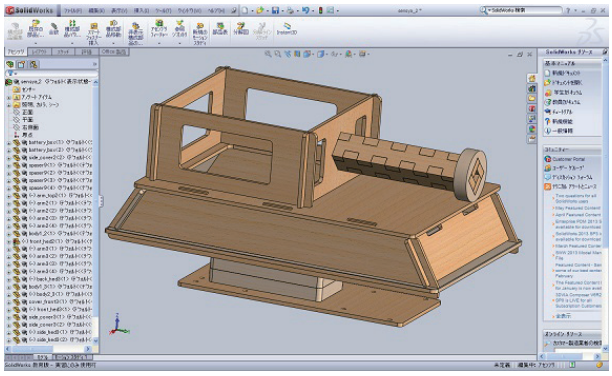


Figure 1. The tank body designed in 3D CAD

Tank body parts are cut out with a laser machine from the plywood of 2.5mm and 9mm, and make the body to assemble it. In order to cut by laser machine, it summarizes the parts data from 3D-CAD to 2D-CAD. Figure 2 is 2D-CAD data of the tank body parts. Parts assembly is devised so as to perform easily without screws or tools.

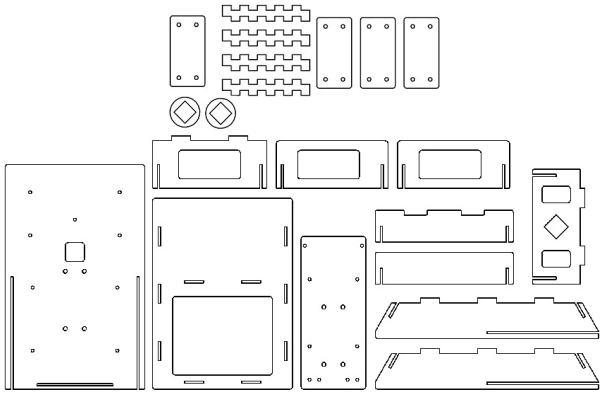


Figure 2. 2D-CAD data of the tank body parts

As shown in Figure 3, using CAM software, NC program of laser machine is created automatically from 2D-CAD data.

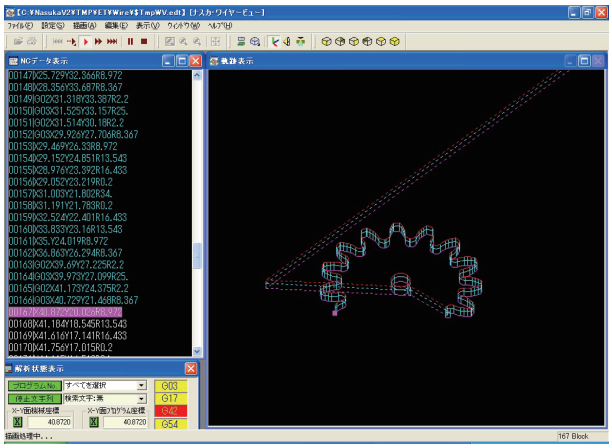


Figure 3. CAM software

And it cuts out the parts in the laser machine with created NC program. Figure 4 is appearance of laser machining.

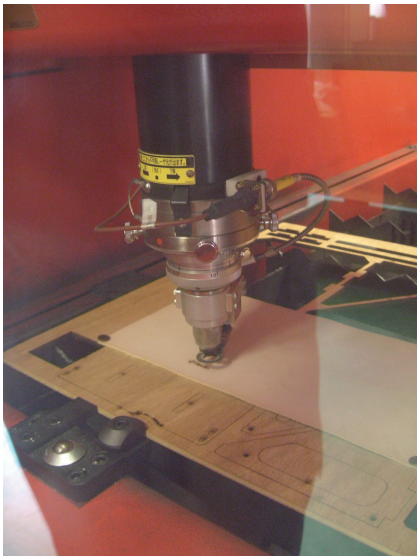


Figure 4. Appearance of laser machining

Drive unit is made with assembling a marketed gear-box and a set of caterpillar as tank's mechanism. Figure 5 is a photograph of the drive unit.

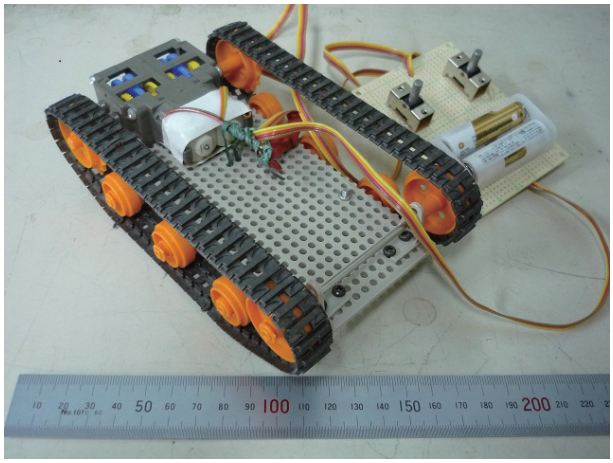


Figure 5. Drive unit

Assembly of drive unit which is operated by wired remote control is easy enough to be used in in the open lecture for junior high school students. We improve drive unit to operate by radio control. Tank's parts and assembled drive unit are assembled, and work of the mechanical system of radio-controlled tank is completed.

At the education of power electronics field, we are making a motor driving board for operating the drive unit with radio control. Circuit diagram of the motor drive board is shown in Figure 6.

Because of simple configuration which is use one microcomputer PIC16F84A, it is easy to manufacture and understanding.

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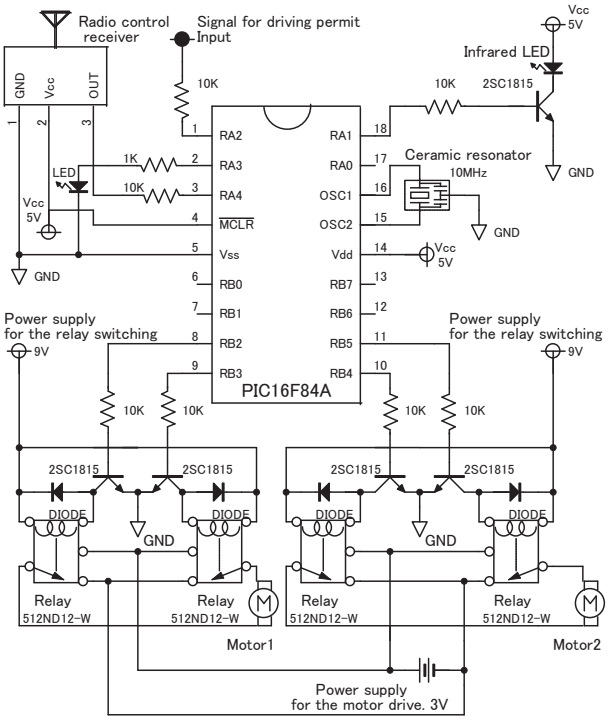


Figure 6. Circuit diagram of the motor drive board

At the education of electronic control field, we are making LED display board to display a single-digit number using 21 pieces LED. Circuit diagram of the LED display board is shown in Figure 7.

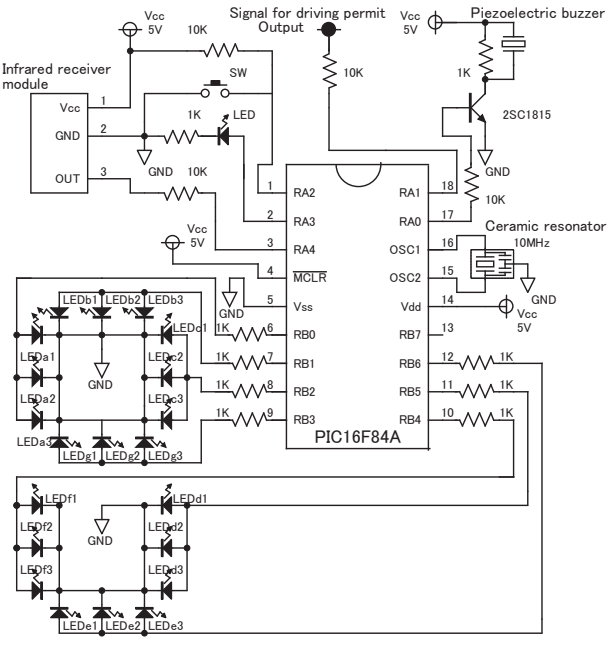


Figure 7. Circuit diagram of the LED display board

Similar to motor drive board, this board structure is simple using one PIC16F84A microcontroller. In order to play the game to reduce the opponent point, it must be equipped with infrared transmission and reception. When one pushes the fire button, infrared radiation is emitted from cannon. When infrared radiation hits the infrared light receiving portion of a radio controlled tank, it sounds the electronic sound, and the value of the count display is reduced. If the counter value is zero, the operation of the tank is stopped.

The microcomputer program is created by using the C language. The basic program is prepared in advance, and the arrangement work is left to students.

Results and Discussion

As electro-mechanical engineering practice, two students were experienced in machinery field and one student was experienced in power electronics field and one students was experience in electronic control field. The appearance of the radio controlled tank which was made is shown in Figure 8.

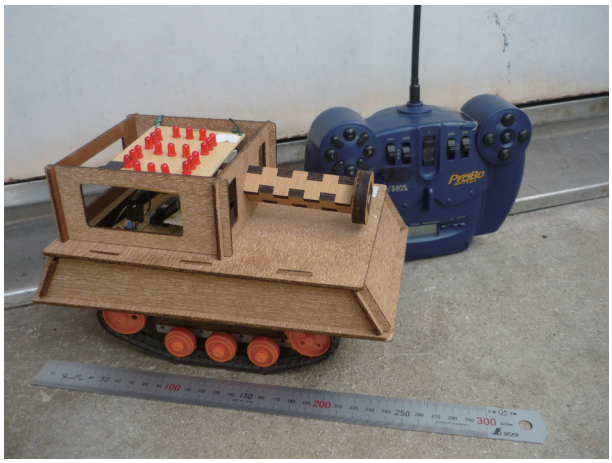


Figure 8.Radio controlled tank

Figure 9 is a photograph of an electronic circuit made by soldering an electronic component according to the circuit diagram of figure 6 and figure 7.

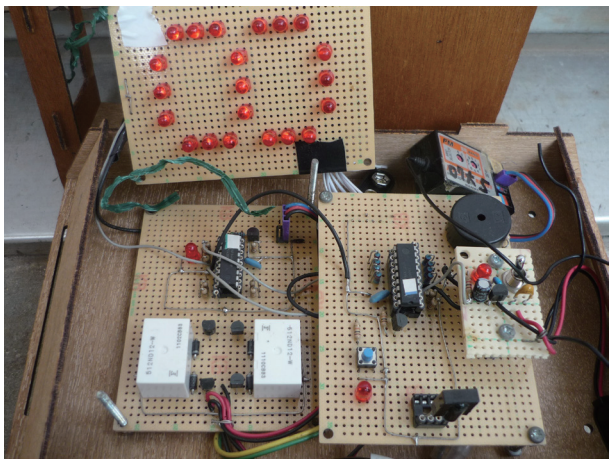


Figure 9. Electronic circuit

Motor drive board is left-hand side of figure 9, and LED display board is right-hand side. Single-digit count display which is arranged the 21 pieces of LED is upward of figure 9. Production cost of one was about 5,000 yen and production time was about 36 hours.

Conclusions

As a result of this electronic-mechanical engineering practice it seems that student's motivation is improve and individuality of the favorite field can be extended. On the other hand, the practice needs to prepare the materials and tools and the work time is long.

Radio controlled tank is effective as a teaching material that can have interested to experience the production of various fields of electronic-mechanical engineering education.

Acknowledgements

We pay tribute to all members of the robot club that have continued to robot production more than 25 years steadily. Special thanks for the construction of robotic production technology.

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TEACHING AND LEARNING SYSTEM IN MAKING EFFECTIVE PRACTICE OF PRECISION ENGINEERING FOR STUDENTS AND CITIZEN

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Abstract

In recent years, many engineering educations are executed as "more practical educations" for national college students and university students. Especially, in a mechanical engineering education of national institute of technology (Following "national institute of technology" is shown as "kosen".), it is important that students can take knowledge and experiences of mechanical designing and manufacturing by these education systems. Therefore, teachers have to consider a curriculum and a teaching system which students can learn a mechanical engineering interestingly. Furthermore, regional contributions including science educations and engineer up-brings are expected from local companies and the board of education. Authors have considered a curriculum of simple engineering education for 1st year students of kosen and citizen. In this report, two engineering education examples are executed as a theme of "precision engineering" for 1st year students and citizen are reported.

A trial for 1st year student of kosen is "metal mirror making grand prix". In this trial, students create a "metal mirror" with hand finishing process which learned at the mechanical shop practice. For example, a way using an emery paper, car wax and a fingernail file was observed as a student's idea. As a result, students designed various methods and they executed those methods actually.

It is thought that a precision engineering is difficult for citizen who has never learned engineering. Therefore, a school visit of "metal (stainless steel) polishing practice" is executed with no difficult techniques and lecturing. Participants are about 20 people from elementary school students to adults, and 4 teachers lecture this curriculum. All of participants experienced [1] a hand polishing process and [2] a machine polishing process, as a practice. As a result, they could feel a difficulty and pleasure of precision engineering. Because they executed a machine polishing process after a hand polishing process. These trials show the one method of a practical education system about difficult subjects like as precision engineering for students and citizen. It found that a system making which they can learn with pleasure is important.

Keywords: *mechanical engineering, basic technique, precision engineering, practical education, regional contribution, polishing technique, metal mirror grand prix*

1. Introduction

The education in national institute of technology (hereafter abbreviated as "kosen") has been evaluated as an excellent practice in the field of "monodukuri (=manufacturing)" in Japan. Because many graduate students during 50 years of kosen have participated in active part in industrial companies, laboratories and so on. Therefore engineering education programs of kosen style are recently considered to be adopted not only in some kosen but also in universities. Especially, the educational practice of mechanical engineering in kosen has attracted people's attention as a method to preserve high level of skill in Japan.

In our previous trials, teachers of Ariake kosen considered some programs of "mechanical shop", "experiment in mechanical engineering", "graduation research" and "mechanical design" to make students



Figure 1 A discussion by students and a teacher with polished metal mirror

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have those abilities. Students have to take basic skills and knowledges by practical trials and discussions with teachers and other students, as shown in Figure 1. For that, they practice the usage of some machines, they study "precision engineering" and "engineering materials" to know the best condition of machining.

On the other hand, teachers in kosen have to lecture for local citizen and company engineers as a regional education contribution. Authors have executed various approaches that cooperate in the education of region. It seems that a name and a goodness of engineering education system in kosen are possible to understand by working like these trials. In addition, it is also important to increase the junior high school students that are interested in "monodukuri" for a future of kosen and Japanese monodukuri fields.

In these backgrounds, authors have executed some trials of engineering education for young students of kosen and general citizen. Especially, general citizen is junior high school and elementary school students in these trials. In this trial, the "precision engineering" which is main author's major is selected as a theme of these trials. In this report, results of two engineering education about "precision engineering" executed for 1st year students in kosen and citizen are reported.

2. Results and Discussions

2.1 "Metal mirror surface making grand prix" in mechanical shop basic practice of kosen

"Metal mirror surface grand prix" started at 2010. At first, a report paper to write down contents of this trial is distributed to 1st year students. Students design a "metal mirror manufacturing process", and they write that contents with process figures. The condition given to students is as follows:

[1] Let's manufacture the metal mirror surface in rolled steel of SS400 in JIS. That size is 15 x 60 x t3.
[2] All methods are possible.
[3] You do not need to use an expensive machine and special tools and so on.
[4] Let's challenge without help of seniors and teachers.

In this trial, the material that was decided kinds and size was distributed to students. The base material is a structural rolled steel SS400 in JIS which is used in mechanical shop basic practice well, as shown in Figure 2 left. In addition, to work without help and advice was added as a condition, because many students had heard how to make metal mirror surface from their seniors.

Figure 3 shows the example of workpiece sample which was manufactured by a teacher. This sample size is twice from an actual workpiece size. The left part is an original metal surface, the center part is a ground surface with a metal file. The right surface is a polished surface by a jewellery cloth and toothpaste includes alumina components. As a result, it is observed that a rear lattice pattern reflects to the metal mirror surface of right part.

A real mirror surface of structural rolled steel SS400 finished by a student is shown in Figure 2 right. This

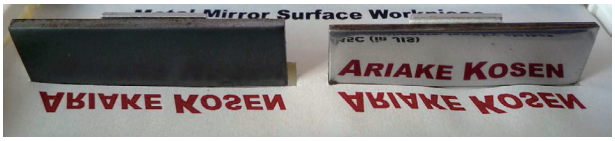


Figure 2 A base material (left) and a metal mirror workpiece (right) polished by students

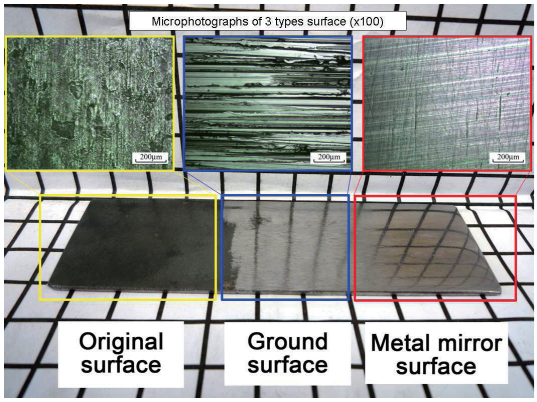
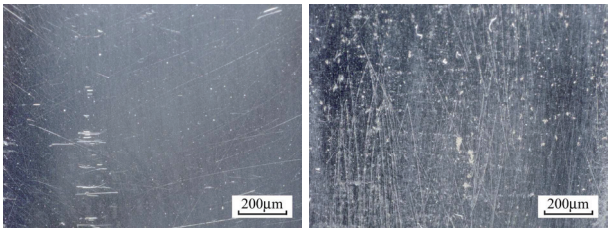
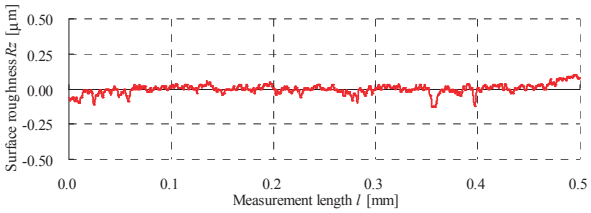


Figure 3 Overview of metal mirror example shown for 1st year students



(a) Metal mirror surface 1 (b) Metal mirror surface 2

Figure 4 Microphotographs of metal mirror surface made by two students



Rz=0.23μm(P-V), *Ra*=0.02μm

Figure 5 Surface roughness profile of the smoothest mirror surface shown in Figure 4 (a)

metal mirror surface was made by using emery papers (#384 and #1000) and a car wax include compound (grain size is 0.2 μm) that bought hardware store. In Figure 2, it is observed that the words put in front of workpiece reflect to the metal mirror surface, like Figure 3 right surface.

Figure 4 shows a comparison of microphotographs of two metal mirror surfaces. These surfaces were observed by microscope (VHX-1000, KEYENCE Co., Ltd.). Microphotographs of Figure 4 (a) and (b) are mirror surfaces as shown in Figure 2 and a workpiece that was made by other student respectively. It is known that many scratches are not observed at Figure 4 (a) surface than the surface shown in Figure 4 (b). From these results, it is difficult to understand a difference of these surface conditions and surface roughness for students.

The surface roughness profile of the smoothest mirror surface is shown in Figure 5. Students have never seen a real mirror surface and surface roughness profiles. So teachers thought that students can be interested in the high precision measurement and the unit of "micro-meter" and so on. Then some surface roughness of mirror surface is measured. The smoothest mirror's maximum roughness is 0.23 µm and average roughness is 0.02 µm. These values are similar to a ground surface with a grinding machine. Therefore we can say that polishing method of a student trial is comparatively high precision.

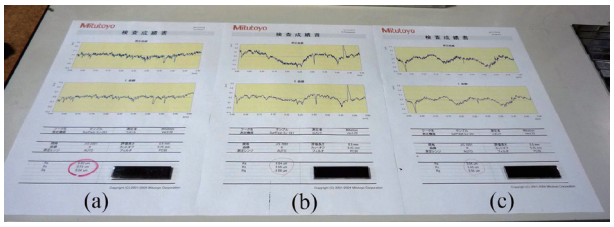


Figure 6 Results announcement of metal mirror making grand prix

Table 1 Relationship between a surface roughness of metal mirror and experience frequency of hand finishing section in mechanical shop

Order	Maximum surface roughness [µm]	Average surface roughness [µm]	Experience frequency of hand finishing section
1st	0.23	0.02	5
2nd	0.23	0.03	5
3rd	0.43	0.04	2
4th	0.55	0.04	5
5th	0.59	0.04	5
Average	0.41	0.03	---

To show these results for students, surface roughness inspection sheets and 3 metal mirrors which roughness value is smaller were prepared in mechanical shop basic practice of second semester, as shown in Figure 6. In the class, many students were interested in inspection sheets that students have seen first time. In Figure 6 (a), (b) and (c) are the smoothest surface, 2nd and 3rd smooth surface, respectively. Finally, in this trial, metal mirror workpieces of 3 students as shown in Figure 6 are machined as name plates with a machining center. So these name plats are presented to students.

In this trial, 1st year students who learned a mechanical shop basic practice only 5 months can make high precision metal mirror surfaces. These reasons are analysed by a experience of a section of mechanical shop. Table 1 shows a relationship between a surface roughness of metal mirror and experience frequency of hand finishing section in mechanical shop. 4 students who made smooth metal mirrors have already executed a hand finishing section, and a student learns that section then. In a hand finishing section of 1st year, students can learn haw to use a file, a cold chisel, a scraper and other tools to make smooth and clear surface. It can be thought, that techniques and knowledge are used for a metal mirror making. When some students saw these results, they said that they were very glad to have name plates of the metal mirror made by themselves.

50% students were satisfied with this trial. And 50% students said "they wanted to make in longer time" and "they could have much interests of hand manufacturing and precision engineering". In a mechanical shop basic practice, the word of "precision engineering" does not teach to students, but students could have many interests for that process thorough a practice of hand manufacturing. It can be said that this result is the biggest one of this trial.

2.2 The precision engineering lecture with "metal polishing practice" for citizen

In a home city of Ariake kosen, an approach of citizen college course has been executed for several years. The purpose of this approach is to make a place which many citizen gather and learn about interesting themes with teachers of college, university, company persons and so on. The authors agree to the purpose of this approach, so teachers and technical officials have executed some themes of "monodukuri" for 3 years. In current lectures, the mechanical techniques of coal mine are shown and explained for mainly adult citizen. However, we thought that such an approach is very effective for elementary school students and junior high school students to be interested in the science and engineering. From a point of view, the precision engineering lecture which was named "The world of precision engineering ! -Let's experience the skill of shining and polishing-" was executed for young students and their parents at December, 2014.

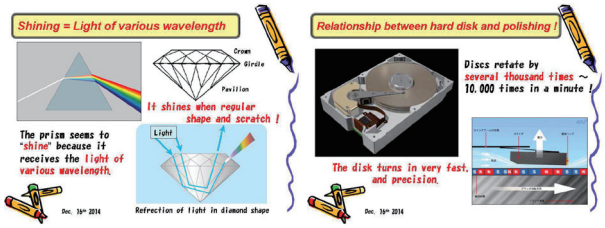
In this lecture, a difficult lecture and experiment are not executed, because a citizen who does not major a technology and a science can learn precision engineering with relaxing and interesting. Therefore participants execute two polishing practice of [1] a method of hand polishing, [2] a method of technical machine polishing in 2.5 hours. And then, they compare a difference of surface after polishing practice. A workpiece is used a stainless steel SUS304 in JIS of circular disc shape which diameter is 25 mm, and thickness is 2 mm. The main contents of lecture are as follows:

[1] A relationship between polished products and a light in our life
[2] Let's make a metal mirror with hand polishing !
[3] Let's make a metal mirror with polishing machine !
[4] "Precision engineering" is seems to be complex, but it is very useful !

Figure 7 shows a lecture view with about 20 participants of elementary school students, junior high school students and their parents. In this time, 4 teachers participated as a staff member. Firstly, precision products like a hard disk which is consisted of



Figure 7 An easy lecture about "Light" and "Polishing techniques" for all paticipants



(a) Shining and Light (b) Smooth disk of HDD

Figure 8 Examples of lecture slides

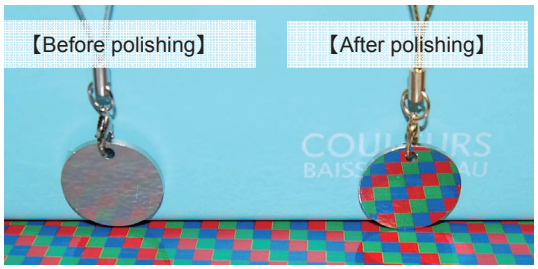


Figure 9 SUS304 workpiece samples of "before (left)" and "after (right)" polishing

polished parts, and a relationship between precision engineering and various lights is introduced. In this lecture, many Power Point slides used to introduce many real product pictures, mechanism schematic figures in our surroundings are shown as shown in Figure 8. Figure 8 (a) slide is a slide used to explain a relationship between lights and precision shapes. In Figure8 (b) slide, a mechanism of a high speed rotating disk polished precisely is shown. This lecture was taken about 20 minutes at a first of lecture.

Figure 9 shows SUS304 workpiece samples of "before" and "after" polishing. A SUS304 workpiece surface on a left side does not shine and no reflection. On the other hand, it is found that the lattice pattern put below reflects on SUS304 surface polished by teachers. All of participants can know these results, so they can have a purpose of this trial.

Figure 10 and 11 show the appearances of participants working on "hand polishing process" and "machine polishing process", respectively. Participants tried a hand polishing process harder as shown in Figure 10. Because they know a change of SUS304 polishing surface results by non-polishing and polishing samples. So they thought that they wanted to exceed a surface of machine polishing process. Emery papers, nail files, jewelry clothes and tooth pastes are prepared to use in



Figure 10 Hand polishing process



Figure 11 Machining process with a precision polishing machine

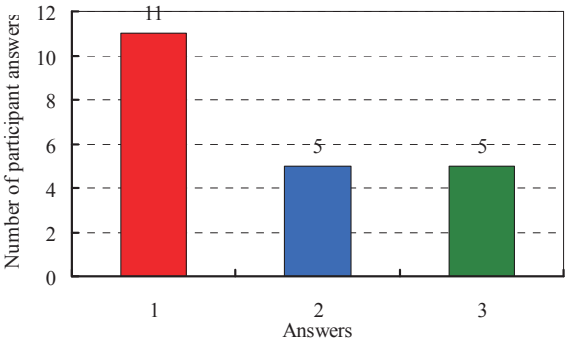
this process. When they polished for about 30 minutes, polished SUS304 workpiece surfaces have many scratches and as a white thin film putting on. No one was able to make the mirror surface like a sample in a hand finishing process. By this result, they felt a perplexity and a difficulty .

On the other hand, participants challenged a machine polishing process as shown in Figure 11. By using this machine, a metal mirror surface was made in below 10 minutes. Therefore they can feel that a machine polishing is highly effective and highly accurate. Some participants are afraid to use polishing machine with high rotating disk, then teacher supported for each participants. For "hand polishing process" and "machine polishing process", it was taken about 2 hours.

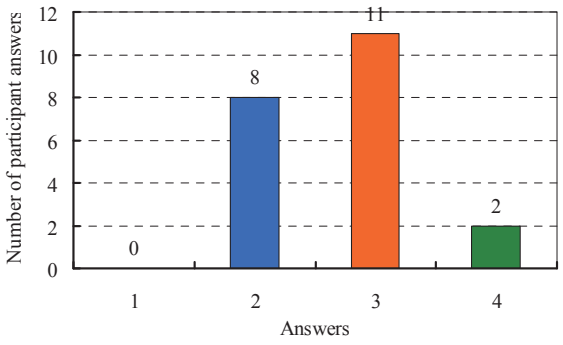
Teachers executed this trial to make participants being interested in a science and engineering by a practice and a lecture of polishing. Participants of this trial are almost an amateur for engineering. So after executing "metal polishing practice", some questions were given participants to have considerations and comments. Those questions are as follows:

Q.1) Had you been interested in the "polishing" technology before this lecture ?
Q.2) Have you tried to polish like this mirroring polishing ?
Q.3) Could you understand a lecture of "polishing" and "Light" and "color" ?
Q.4) Could you enjoy "hand polishing" and "machine polishing" process ?
Q.5) Are "hand polishing" and "machine polishing" process difficult ?
Q.6) Were you satisfied with this lecture ?

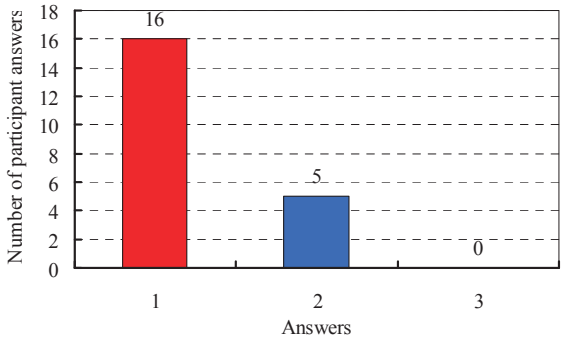
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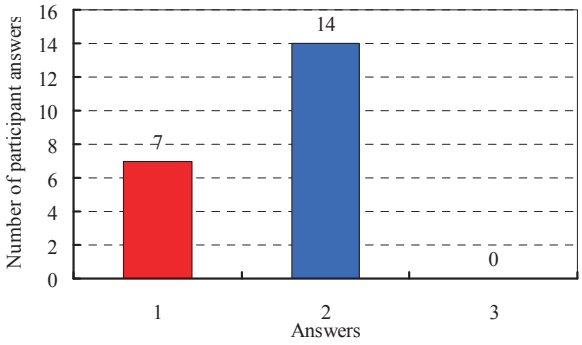
[1]Yes [2]I did not know that. [3]No
(a) Question 1



[1]Very easy [2]Easy [3]difficult [4]Very difficult
(c) Question 5



[1]Yes, very much. [2]Yes [3]No
(b) Question 4



[1]Yes, more than before. [2]Yes [3]No
(d) Question 7

Figure 12 Results of questionnaires to paticipants [Total number of paticipants: 21]

Q.7) Could you have much interests in "polishing techniques" ?
Q.8) Do you want to participate in it, if there will be such a next lecture ?

The answer for Question 1 is shown in Figure 12 (a). A half participants was interested in these techniques, and participants of a remainder did not know even the word of "polishing". It was found that they participated to deepen the interest, on the other hand, they participated with to obtain new knowledges before lecturing.

From a result of Question 4 as shown in Figure 12 (b), it was found that 75 % participants could enjoy this trial, though there were some participants that were not interested in "polishing process" before a lecture. Still, it was proven that participants liked a practical education with a experienced self practice system.

Figure 12 (c) shows a difficulty of hand polishing and machine polishing. In this answer, a half of participants saied that these process is difficult. These answers are obtain from parents and some junior high school students. Teachers thought that they considered about a difficult precision polishing techniques talked as an inside story while practicing. If they consider a trust polishing techniques, of course, it is difficult to execute it by a theory. Some elementary students answered that it is easy. Because, it is thought that they kept polishing without difficult theory. This results show the difference of the idea of participant's "playing" and "learning". However, both ideas are true in these trials.

All of participant had a much interests about "polishing techniques" after lecturing as shown in Figure 12 (d). If it compares with Question 1, 10 parents could know the polishing and precision engineering by a lecture and practice. In this trial, many participants had a knowledge by a lecturing as shown in Figure 7 and 8, and many interests about "precision engineering" are obtained by executing of real polishing process with hand polishing and machine polishing.

From these results, it is found that citizens who do not specialize in a technique can learn with the more interest a difficult contents as "precision engineering" by an easy lecture and a real practice. Especially, participants of junior high school can understand some technical contents, but they can really take it more practically by executing a hand practice process. Therefore, we can say that a practice like an education of kosen is important so that young students may learn with enjoying and interesting.

3. Conclusions

In this paper, results of two engineering educations are executed as a theme of "precision engineering" for 1st year students and citizen are shown. The main conclusions are as follows:

(1) In mechanical shop basic practice of kosen, students can get excellent results by ardently working more than assumption of teachers. "Metal mirror surface making GP" trial is very effective to take precision engineering knowledges and skills.

(2) 1st year students can learn an advanced techniques by teaching a surface roughness as a technical skill. In addition, it was found that polishing techniques which student tried is comparatively high precision, because the smoothest roughness is below 0.23 μm.
(3) An approach which Ariake kosen executed is useful to make a place of citizen gathering and learning. Because citizens who did not major a engineering and science can learn them with enjoying and interesting in short time.
(4) Young students can understand technical contents by executing some practice process. Therefore a practice like a education of kosen is very important as a method of understanding improvement.

Acknowledgements

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Enhancing the learning experience of engineering students using learner-centred strategies

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Abstract

Motivating students to learn technical subjects in an Engineering curriculum has always been a challenging task. Many students find it difficult to understand technical concepts, and this is made worse when the students are not able to see the relevance of their learning to their future workplace. Many of these unmotivated students are easily distracted from their lessons by mobile devices and online activities, hence limiting their own learning opportunities.

The Mechanical Engineering Division in the School of Engineering at Ngee Ann Polytechnic conducted a survey on their preference for learning for 200 third-year students doing the Engineering System Design 2 module. It was found that many did not enjoy the traditional method of delivery as they found it boring and irrelevant, and many would rather engage with their mobile devices than to learn in class. Lecturers also feedback that students lacked the ability to apply knowledge to solve an engineering problem.

The teaching team for the Engineering System Design 2 module decides to review their teaching strategies and make them more learner-centred. Lecturers in the team begin from creating more collaborative assignments for group learning to cultivating a positive learning relationship among students, and students and lecturers.

The second strategy focuses on students' preference for using ICT, leveraging on tools such as graphic animation to enhance their learning experience. Online assignments, discussion board and polling are also used to great advantage to monitor students' understanding and learning progress. Not only do students integrate the domain knowledge through collaborative learning, but they also use the power of digital tools to enhance their learning experience.

These two learner-centred learning strategies have enhanced students' motivation, and their performance has shown improvements. Students are also better able to transfer their learning from the classroom to practice. This paper will examine the use of the two learner-centred learning strategies to motivate students to engage with the subject matter and improve their ability to apply learned knowledge to create an engineering solution.

Keywords: *Relationship learning, collaborative learning, information communication technology, engineering design, interactions, motivation*

Introduction

Research by Michael Fullan (2014) indicates that societies are spending more time, money and resources than ever before on education, as an individual's education attainment is perceived to be important to his or her future success in life. Yet some of our existing teaching approaches are designed for the industrial era, such as the traditional mass lecture and tutorial, which are often perceived as outdated and irrelevant by students.

Ngee Ann Polytechnic (NP) is a national education institution for post-secondary students to nurture them to be professionals to support the technological and economic developments of Singapore. This report focuses on a group 200 final year Mechanical Engineering students doing the module Engineering System Design 2 (10ESD2). A survey on students' learning experience about the module indicated that students were not motivated by the module as they found the learning experience boring and irrelevant. Lecturers also gave feedback that students were difficult to engage in class and they were weak in applying their engineering knowledge and professional skills required when they were tasked to develop a design solution. Lecturers and the industries also highlighted that our graduates also lacked the ability to synthesis knowledge from various engineering modules to come up with innovative engineering solutions. This prompted the teaching team to review the effectiveness of their existing teaching approaches and explore new ways to motivate students, improve their learning experience and their ability to apply their engineering knowledge and skills.

Traditional Teaching Model

The Engineering System Design 2 module has 5 contact hours per week. It is divided into a 3-hour lecture cum tutorial session and another 2-hour session for individual case study. Learning takes place through face-to-face lecture sessions delivering the basic

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knowledge on various topics, which form the underpinning materials for the case study assignment. The case study serves to reinforce the knowledge acquired during the lecture.

In the traditional teaching model, the lessons are typically characterized by the Initiate-Respond-Evaluate structure, in which lecturers initiate discussion through questioning and students are required to respond. This is followed by presentation of new materials and evaluation of students' learning. The instructional mode and activities are summarized in Table 1.

Table 1: Traditional Teaching Model for 10ESD2

Instructional mode	Instructional Activities
Face-to-Face lessons	Lecturer: • Asks questions to recall prior learning. • Presents new materials. • Provides reading materials. • Asks questions to assess students' understanding of the issues in the topic.
Face-to-Face discussions	Lecturer: • Leads face-to-face discussions to ensure students understand the basic concepts/ theories.
Follow-up activities	Students: • Complete **individual** tutorial and case study.

Performance Gap in Learning

Most of the teaching team members who apply the traditional teaching approach find that students lack focus in their study and are difficult to engage during lessons., Many students display an apparent lack of motivation to learn and assignments are usually not submitted on time. Feedback from students indicates that they prefer a different way of interacting with their lecturers, and the traditional 3-hour long lecture is not conducive to their learning. The students feel that they are overwhelmed by the complexity of the case study assignment, and express their preference for collaborative learning by working in group to complete the assignment.

Another gap in the learning experience for students in this module is that learning is very much limited to theories in the classroom. Students find it difficult to make sense of what they learn and how it can be applied to their future work experience (transfer of knowledge). The quality of students' case study submissions usually falls short of expectation. While the reason for this may be partly due to the lack of exposure to the work environment, students fail to demonstrate the ability to apply previously-acquired knowledge to tackle real-world engineering issues. This translates to the lack of ability to synthesis and application of knowledge, critical thinking, team work, communications and the ability to use technology in learning are the repertoire of skills for them to effectively function in professional practice.

Based on the gaps in learning among students, the teaching team decided to review the module design so that more Learner-centred learning (Lcl) strategies can be adopted to improve learner engagement, student motivation and performance.

Strategy A – Collaborative learning through group tutorial, case study and project work

Now for 10ESD2 module, 60% of the course work involves collaborative learning through group tutorial, case study and project work respectively, see Table 2.

Table 2: Revised Teaching Model for 10ESD2

Instructional mode	Instructional Activities
Face-to-Face lessons	Lecturer: • Asks questions to recall prior learning. • Presents new materials. • Provides reading materials. • Asks questions to assess students' understanding of the issues in the topic.
Face-to-Face discussions	Lecturer: • Leads face-to-face discussions to ensure students understand the basic concepts/ theories.
Follow-up activities	Students: • Complete **group** tutorial and case study. • **Group** engineering design project.

The 3-hour lecture is now segmented to consist of different learning activities to address students' short attention span. It starts with the lecture incorporating active discussions to check whether students understand the topic well, followed by a simple group tutorial with the lecturer providing active guidance. A study done by Patrick T. Terenzini (2001) indicates that collaborative learning does promote the development of students' competency in engineering design better than the traditional lecture approach. Collaborative learning is beneficial, as students work in diverse student groups, and the interaction may bring them to re-formulate some of their ideas (Bruner, 1985).

The complexity of the students' group case study assignment is increased with emphasis on real-world applications, and the time allocated for the session is 2 hours per week. The approach creates a scaffolding effect for learning, progressing from simple tutorial questions to an integrating case study involving analysis

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and design. In the first term of the semester, the group tutorials and simpler case study assignments have provided the opportunities for students to interact with their peers and understand each other better. In a way the relationship built up prepares them for more effective collaborative learning in the second term. Students are motivated to learn through progressive migration from an approach that centres on individuals demonstrating their learning to one of groups demonstrating their learning. This emulates the practice in today's workplaces, where success most often relies on the ability of a team to work cohesively to integrate ideas in design or problem-solving.

In the second term, students within a span of five weeks have to take on a constructivist and active approach to learning and problem solving through working with their peers and their lecturer to address practical issues such as designing a cheaper alternative for a Mars land rover mobility platform. The group project, undertaken by students in the second term, enables them to synthesize knowledge from this and other engineering modules, such as Applied Mechanics, Engineering System Design 1, Design Thinking, Computer-Aided Drafting and Materials Technology. The process helps students develop and sharpen their higher-order thinking skills including reflective and critical thinking.

Improving Collaboration through Relationship building

Studies have also shown that establishing a positive learning relationship between teachers and students can result in a more conducive learning environment for the students. In a Relationship Learning model, the teacher is no longer the "sage on the stage" but is a person whom students can interact with and learn from. Mark Boynton and Christine Boynton (2005) conclude that "the most powerful weapon available to teachers who want to foster a favourable learning climate is a positive relationship with our students". This notion of building strong teacher-student relations for learning is also supported by Michael Fullan & Maria Langworthy (2014) who note that "when teachers and students connect the learning, it makes students feel less like gears in machines, and more like learning is something that is natural, instinctive and embedded in their aspirations". And for this relationship to be successful, students will need to sense that their opinions and ideas are valued and respected by the teachers (Zehm and Kottler (1993)). Research by Petraq Buka (2013) concludes that a positive relationship encourages students' motivation and engagement in learning. This model of education has emerged as a necessary strategy to meet the challenges of today's student-and-teacher alienation, which is often made worst by the growing digital access that distracts our student from effective learning.

In the re-designed 10ESD2 lessons, a 10-minute period is allocated before each formal lesson to allow the lecturer to interact with students and for students to interact with their peers. The purpose is to give students the opportunity to discuss topics relevant to engineering design in an informal setting. Some of the topics discussed may be questions raised about past topics or new topics that the lecturers intend to teach. The informal nature of the discussion allows for more openness among students, and creates a climate where students are more willing to share their concerns about the topics and raise issues that are normally not raised in a more formal lecture/tutorial setting. Positive reinforcements, in the form of praise and encouragements rather than criticisms, help build a more favourable classroom learning environment, where students trust their lecturer more, show more engagement in learning and behave better in class. A well-spent 10-minute conversation will serve to remove learning barriers between students themselves, and between the lecturer and students, leading to a better learning experience for collaboration and team work, and academic achievements at a higher level.

Outcome of Strategy A

In evaluating the new approach to delivering 10ESD2, the teaching team observes that students value their experience in collaborative learning as it develops their competencies in critical thinking, problem solving and communications. Mark & Christine Boynton (2005) highlight that students develop confidence in their communication skills when there are many opportunities for exchange of ideas among students, and lecturers and students. This process of working together also sharpens their clarity in thinking, which leads to improvements in critical thinking and communication skills. Early honing of these crucial life skills prepares our students well to enter professional practice and be an effective communicator in the engineering field.

Students give feedback that the weekly group tutorials and real-world case studies progressively help to build confidence in them to learn from each other and reinforce knowledge through collaborative learning. They do not see the case study as daunting now, as they work in teams to develop shared solutions. They also appreciate the opportunity to be exposed to real-world engineering issues and apply knowledge to address these issues. Students are observed to be actively participating in higher-level discussions with their peers and the lecturer. Students show more motivation in their study as learning becomes more manageable and progressive, and the submission of assignments is on time. Thus, collaborative learning is beneficial as students work in diverse student groups, and the interaction brings them to re-formulate some of their ideas, a point shared by Bruner, (1985). Furthermore, the effectiveness of collaborative learning can be enhanced through prior psychological conditioning of our students, especially the shy and introvert, through a positive relationship that also develops between students themselves.

For the remodelled 10ESD2, lecturers' feedback that the 10-minute pre-lesson conversation warms up the class, re-aligns students' focus on the module, and creates an atmosphere that primes them for effective collaborative learning. It is observed that once a favourable relationship is established, students demonstrate a more ready mindset to learn from the lecturer, which translates to better engagement in class. There are more higher-order constructive questions posted by the students. Students also display better classroom behaviour as observed by lecturers. Therefore, care and empathy on the part of the lecturer are important elements in creating a favourable learning relationship that leads to effective collaborative learning.

Strategy B – ICT enhanced learning

Fuelled by digital technology and increasing information processing power, a wide spectrum of Information and Communication Technology (ICT) tools are available to enhance learning, from multimedia videos in YouTube to online discussion forums. At NP, there is Mobile e-Learning (MeL), a learning management platform that incorporates a range of tools such as discussion board, online poll and Blackboard Collaborate. Blackboard Collaborate is an online collaborative learning solution that enables synchronous engagement between lecturers and students. Students are encouraged to interact with lecturers or among themselves in virtual lessons and virtual classrooms. MeL also has facilities such as application sharing, breakout rooms and feedback. YouTube materials on the simulation of motors construction and operation in the 'Learn Engineering' series, for instance, allow students to visualise and be engaged in engineering in ways that are just not possible with the traditional tool of pens and paper.

Implementation of Strategy B

In 10ESD2, online teaching materials deposited in MeL in rich digital multi-media (video and audio) format make learning interesting and engaging especially for students whose learning preference tends to be more visual and auditory. The material can be accessed by students anytime and anywhere. Pedretti & Mayer-Smith (1998) share that students find learning in a technology-enhanced setting more stimulating and student-centred than in a traditional classroom.

Lecturers engage students online for detailed discussions on the subject matter while monitoring their progress using Blackboard Collaborate. Asynchronous online discussion forum provides lecturers and students an effective and flexible way to interact with each other, even with lecturers and students from other classes.

An online poll has been set up in MeL to elicit instant feedback from the students during lessons, so that lecturers are able to find out quickly the areas that students have difficulty understanding and to fine-tune the lesson plan immediately to address these gaps.

Students are also encouraged to compile their project reports with Google Doc, so that teammates can collaborate and work on a single document. This allows all team members to make contributions at any time and any place, even on their way to school/home or in between classes.

Outcomes of Strategy B

The flexibility of asynchronous communication at their own pace, freeing up more time for them to tackle the assignments, share feedback with peers and construct meaning together and to learn from one another. Students become more reflective in their learning and are more willing to construct, re-construct and co-construct new ideas and knowledge. Lecturers are also able to monitor the development of the discussion and to provide guidance if there are mis-understanding of concepts. This online interaction can provide an additional platform for students to learn.

Asynchronous collaboration work such as the use of Google docs allow students who are shy and introverted to interact with their classmates behind the security of the computer, and also provide time for them to think and share their ideas which they otherwise would not do in a face-to-face setting. The increase confidence in these students not only enhance their own learning but can improve the overall team dynamics of group, leading to more effective learning experience.

A wider adoption of ICT for the delivery of 10ESD2 has given the teaching team an appreciation of the potential to create a more open learning environment. The shift plays an instrumental role in moving the emphasis from a lecturer-centred to a collaborative student-centred environment. Students have progressed from passively receiving information to being actively involved in their own learning.

Results and Discussion

Based on the module results summary in Table 3, the revised teaching model adopted shows progressive improvements over last five semesters since the two-prong strategies have been implemented.

Table 3: Average common test marks over the semesters

	Oct 11	**Apr 12**	**Oct 12**	**Apr 13**	**Oct 13**	**Apr 14**
	Pre-Implementation		Post Implementation with increased in common test question standard			
Average Marks	69.49	67.51	74.69	72.03	72.64	69.8
% Passed	100	100	99.12	100	100	99.15
No. of students	90	100	113	118	116	118

The key findings of a focus group survey conducted for 32 students are summarised as follows:

- Group assignments and projects allow learning to take place among classmates.
- Collaborative work gives us time to consolidate knowledge learned.
- Group project work and case study assignments give us the opportunity to integrate knowledge from other modules in developing solutions to real-world problems.
- Lecturers are friendly in facilitating learning of the module and this allows students to open up for active discussion and sharing of knowledge.
- MeL and discussion forum promote flexibility in learning.

While the table indicates a decline in the average marks obtained in the common test, this is not necessary a negative feedback on the new lesson design. There were changes made to the difficulty level of the common tests questions post-implementation which resulted in the use of more higher-order thinking questions to test students' ability to apply their knowledge (knowledge transfer). The decline in average marks is small, and based on the new difficulty level of common test, it is possible that students are in fact learning and understanding the content better and are demonstrating deep learning through their ability to answer higher-order questions.

The common test and focus group survey results point to improved quality of learning with the implementation of the two-prong strategies. The positive outcomes arise from more collaborative work injected into the learning process and a healthy teacher-students relationship resulting in better student engagement in and out of the classroom and higher students' motivation.

Effectiveness of Strategies

Adoption of the two-prong strategies has yielded positive results. The scaffolding of collaborative learning improves the quality of the deliverables of assignments, especially in the case study assignment. Students see relevance in their learning as they create solutions to real-world engineering problems. Students are more focused on their study and show active participation in class through in-depth group discussions. Establishing a good relationship with the students motivates them to learn and keeps them engaged with their lecturer during lessons.

For 10ESD2, the desired learning outcomes are achieved when students move from facts recall to knowledge application, with significant improvements in their attitude for learning, working together in groups to arriving at innovative solutions to problems. With a better relationship with peers and lecturers, students take initiative to discuss issues in groups and develop the confidence to manage their own learning. Students adopt a constructivist approach to learning, and achieve greater satisfaction upon completion of the assignment. Students learn to be more responsible, as evidenced by the fact that their assignment submission deadline is seldom missed. Students also share that as they learn through discussions with each other, they enjoy the process of knowledge acquisition.

Students find the approach of learning at any time and any place through mobile devices in line with their learning styles. Learning materials are easily accessible on NP's MeL platform, which incorporates a range of tools to make learning flexible. Students benefit from the opportunity to learn through a community of on-line learners involving their peers and lecturers.

The two-prong strategies thus allow greater flexibility for students to be engaged in effective collaborative learning with their peers, both face-to-face and online. The learning approach also creates a strong relationship with the lecturers acting as mentors to provide continuous guidance to individual students in their learning as in a modern knowledge-based organization. The regular feedback on students' performance motivates them to strive for continuous improvements in their learning process.

Conclusions

We will continue to refine the delivery of 10ESD2, particularly in our attempts to create real-life case studies relevant to the workplace. Lecturers have their respective unique ways to create a learning partnership with their students. There is no 'one-size-fits-all' approach. So are students' individual learning styles. However, the common goal is to understand and recognize the individual needs and learning styles of the students, so as to establish a relationship with them that promotes active collaborative learning. ICT tools serve to further deepen the engagement of students such as the use of mobile collaborative tools for learning and discussions. An integrated online learning space, such as MeL with a range of quality learning resources, will help students to understand engineering concept better, thus enriching their learning experience.

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Topic 2

Teaching and Learning

（教育方法論）

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USE OF VIRTUAL PHARMACY COURSEWARE FOR TRAINING OF PHARMACY SCIENCE STUDENTS

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Abstract

This paper describes an innovative approach to introducing workplace readiness for Pharmacy Science students by using a game-based simulation.

The Virtual Pharmacy courseware comprises four games which mimic the activities in a dispensing pharmacy. At each station, students are trained in a task such as receiving prescriptions, interpreting and typing prescriptions, packing medications accurately, as well as counselling patients on their medicines. Players are required to complete as many correct prescriptions as possible in a specified time, with both accuracy and speed being critical components of the score.

This courseware was first implemented in October 2013 in two modules in the first and second years of the Diploma in Pharmacy Science course (Introduction to Pharmacy and Pharmacology) to help students to better understand the application of their lessons to the job activities in a pharmacy. Through these games, students were able to revise topics in these modules such as the legal requirements for a prescription, interpretation of terminology, types of drug classes, actions and side effects as well as counselling points.

A post-implementation survey was carried out on first and second year students. A focus group was also conducted on third year students undergoing internship. Feedback on the courseware was very positive. Students agreed that the activities helped them to better understand key topics, were appropriate and relevant and helped them to understand the workflow of the pharmacy. They also found the game enjoyable and easy to play. Students were able to see how the coursework prepared them for their internship and work environment. The main issue that students faced was with technical issues faced in downloading the game.

Staff and industry partners surveyed also felt that the courseware was useful in preparing students for a career in pharmacy practice, especially in allowing simulated error situations which would be difficult to simulate in the workplace.

Keywords: *Virtual pharmacy, Game based simulation, Pharmacy practice, workplace readiness, Pharmacology*

Introduction

The Virtual Pharmacy courseware is an innovative courseware to prepare Diploma in Pharmacy Science students for work in a dispensing pharmacy. Students spend the first two years of their course at Ngee Ann Polytechnic before undergoing a year-long internship, in their final year, at the National University Hospital (NUH) pharmacy department.

This courseware was developed in response to staff and students' feedback that students found it challenging to relate the knowledge learnt in the first and second year of the course to real life pharmacy practice. The courseware also aimed to bridge identified gaps in the requisite skills and knowledge of our graduates. In addition, the team also wanted to reduce the "transitional shock" that students may face when embarking on their internship in their final year of studies.

With the above considerations, the Virtual Pharmacy courseware was developed. It mimics a typical hospital pharmacy to provide students with an authentic learning experience where they practice applying their knowledge and skills in a virtual pharmacy environment.

Design and Development of the courseware

Prior to the development of the courseware, the development team did an industry scan to find off-the-shelf courseware that is designed to train Pharmacy Science students to work in the outpatient pharmacy setting. However, such courseware was not available both locally and worldwide and the development team decided that they would create their own courseware for the Pharmacy Science students

The courseware development team comprised pharmacists with many years of experience in local pharmacy practice working with instructional designers and software developers. This enabled the team to design the courseware that is tailored to suit the local pharmacy context. For instance, the drugs prescribed in the courseware are those that are commonly used in Singapore. The prescription terminology mimics that used by local doctors. The medication errors included are those that are commonly seen in the hospital and polyclinic pharmacies.

The courseware tries to replicate the actual pharmacy environment as closely as possible so as to give students an authentic learning experience. For

example, the dispensing software in the courseware is designed to mimic the actual dispensing software (iPharm) used in many hospitals in Singapore.

Another consideration in the design of the courseware was to make it interesting and attractive to students, so that they are willing to participate in the courseware activities and to use it for learning. For this reason, the courseware design included features found in everyday operations in a typical pharmacy that would enhance the fun and excitement factor of the games. For example, the courseware displayed images of patients getting angry if they waited too long for their medications and a time challenge was included to make the game more exciting. Research has shown that by making learning "feel less like a chore and more of an enjoyable opportunity", it helps in retention of learning and promotes the intrinsic satisfaction of the learners (Mims, 2003).

Description of the courseware

(1) An authentic learning environment

There are four stand-alone scenarios in the Virtual Pharmacy courseware. These mimic the four primary stations in a typical dispensing pharmacy, which are the Receiving, Typing, Packing and Dispensing counters. The home screen of the game can be seen in Figure 1. The objectives of each station can be found in Figure 2.

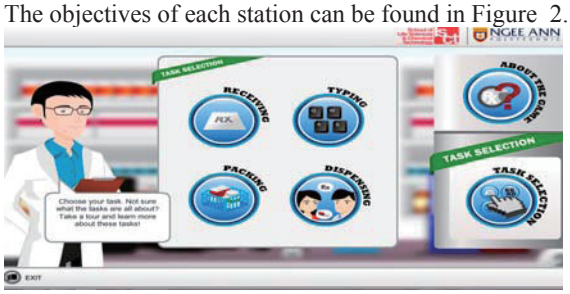


Figure 1: Homescreen of Virtual Pharmacy Courseware

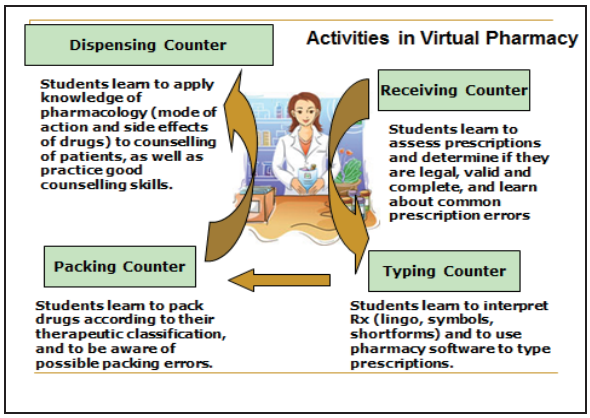


Figure 2 : Learning Objectives for each station

In each of the four games, students are required to learn and achieve specific skills and knowledge which will be relevant to their work in a pharmacy. For example, at the Receiving counter, students learn to assess prescriptions to determine if the prescriptions are legally valid and have all necessary information before they can accept the prescriptions. This simulates the real pharmacy situation where students may be assigned to the receiving counter during their internship.

In the real pharmacy workplace, students have to learn to deal with the pressure of dispensing the medication accurately within a limited time frame. The waiting time for patients as well as the medication error rate are some of the key process indicators to measure the performance of the pharmacy service. Students need to acquire the key competence of being fast yet accurate in their work. To help train students in these qualities, a time challenge in the form of a "ticking clock" was integrated into the game to remind students of the limited time they have for each task. In addition, the impatient and unhappy patients provide additional "pressure" for the students which is a reality that they will have to deal with in the actual pharmacy. These features of the game add to an authentic environment for learning and prepare students with the reality of the occupational stress that students might face in their future work environment.

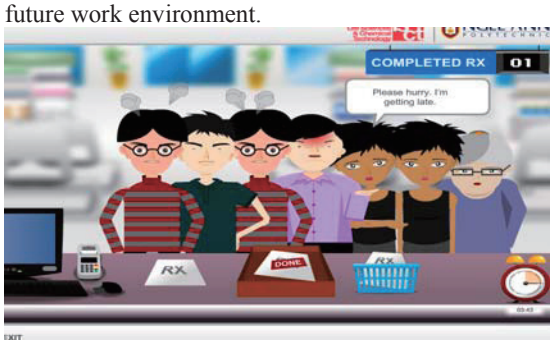


Figure 3: Screenshot of the Receiving game of the Virtual Pharmacy Courseware

In each station, students are required to complete as many correct prescriptions as possible in a specified time. Accuracy and speed of completion are both critical components of the score that students receive at the end of the game. Feedback is provided during the game and a competitive element is introduced via a "top scorer leaderboard".

(2) Development of Professional skills

The courseware was purposefully designed to reinforce certain essential values, skills and professional competencies required when working in a pharmacy and thus increase our students' readiness of the work environment.

Working with accuracy: As the work in the pharmacy requires speed and accuracy, students need to be able to have the opportunity to develop these skills. The "Right Drug, Right Dose, Right Patient, Right Time" concept is very important to prevent medication errors. In this game, students are trained to continually strive for accuracy at every stage. Students are not allowed to proceed with the game without checking that the patient identity, labels or prescriptions are correct and they are also penalized for inaccuracy.

Use of specialized software: One of the skills identified by pharmacy managers as being highly valuable in our graduates was the ability to use the pharmacy dispensing software to generate and modify

medication labels. The dispensing software in the typing game was painstakingly designed to mimic the current iPharm dispensing software used in most restructured hospitals and polyclinic pharmacies in Singapore as much as possible. A screenshot of the typing game can be seen in Figure 5.

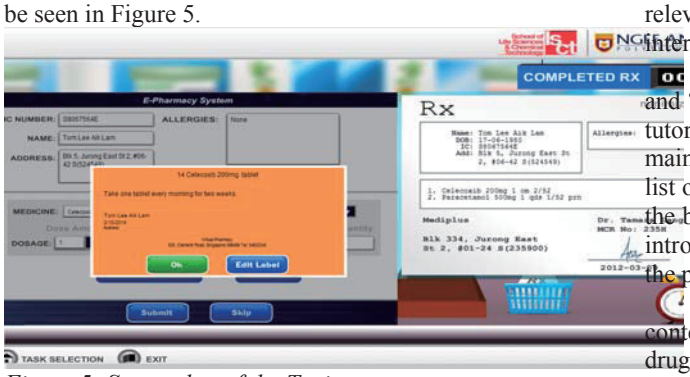


Figure 5: Screenshot of the Typing game

Communication skills: Another essential skill in pharmacy staff is being able to communicate effectively with patients. Through the interaction with the game avatars, students learn to develop good communication skills and the appropriate language used in counselling patients. There are certain key phrases that are essential when dispensing to patients and also specific phrases to be used when describing the mechanism of action and side effects of drugs. These key phrases are necessary to increase the clarity of instructions to patients.

In the dispensing game, students were required to "counsel" patients on their medications in simple terms that the patients can understand. For example, the phrase "this drug is used to lower your blood pressure" should be used as it is more easily understood by patients rather than the more technical phrase "this drug is for treating hypertension". The courseware thus reinforced the use of correct terminology throughout the game.

In order to reinforce the necessity of checking for the right identity of the patient and for possible allergies, the courseware incorporated an "automatic" dialogue which students had to go through before proceeding to dispense each prescription. These included phrases such as "Good Morning! May I check your identity card or appointment card please?", and "May I check if you have any allergies?"

The continual exposure to these key phrases, although repetitive, would help students to internalize this process and make it part of their routine when communicating with patients in future. Salomon and Perkins (1989) describe this as a reflexive process or the low road transfer of learning. That is, when the student is later placed in an environment that is similar to a prior context of learning, it is believed that this can trigger a well-developed semi-automatic response.

Implementation of the courseware

The courseware was first implemented in two modules of the Diploma in Pharmacy Science course, namely Introduction to Pharmacy and Pharmacology in October 2013.

The Introduction to Pharmacy module, which is taught in the first year, serves as the first touch-point to introduce students to the various aspects of pharmacy and the course. It covers the role of pharmacists and pharmacy technicians in a pharmacy, the various laws relevant to the pharmaceutical industry, and the interpretation and handling of prescriptions.

In this module, students play the "Receiving" and "Typing" games of the courseware as an e-learning tutorial. These games were designed to reinforce two main concepts which were taught in this module – the list of legal and other requirements for prescriptions and the basics of prescription interpretation. It also serves to introduce the work flow in the pharmacy and the role of the pharmacy technician to the students.

The second year Pharmacology module is a content-intensive module which covers many classes of drugs, their mechanism of action as well as side effects and basic counselling points. Tthrough the module evaluation surveys conducted prior to the implementation of the courseware, students provided feedback that the module required a lot of memorization and was dry and boring. Students felt that there were too many drug names and side effects which required plain memorization.

The Virtual Pharmacy courseware was introduced in Pharmacology as an in-class tutorial to help students to connect the information learnt to real life. The Packing game helps students to revise the drug classes while the Dispensing game helps students to revise the purpose and side effects of the medicines. The opportunity to practice and revise the drug names during the games is important to students as many of them have indicated that they find it difficult to remember drugs and their effects. Through these games, students were better able to understand the clinical context of the drugs and see how they are used in combination with other drugs for certain patients.

Feedback on the Effectiveness of the Courseware

Feedback on the courseware was sought from the students, teaching staff and industry partners who shared their views of the courseware in aiding students to learn more about the workings of a hospital pharmacy and the development of professional skills.

A triangulation method was used to seek feedback. First and second year students and teaching staff were surveyed on their immediate learning experience after completing the activity, as well as how the courseware achieved the learning objectives in the modules. Post-internship students in their final year and industry partners were asked about the usefulness and relevance of the courseware in preparing students for internship and work in the pharmacy.

(1) Feedback on learning experience

Feedback from students on their learning experience: Thirty-eight first and second year students were surveyed on their learning experience after completing the activity. The comments of the students were analysed qualitatively and correlated well with the quantitative scores. All students agreed or strongly

agreed that the activities helped them understand the topics better, stretched their thinking, were appropriate and relevant to their learning, and that the visuals were helpful for their learning. Figure 4 shows the responses of the students to the surveyed items.

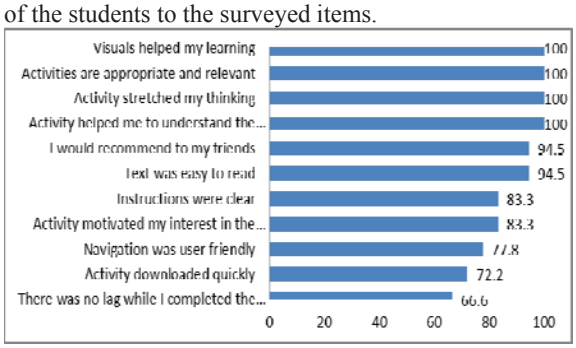


Figure 4: Response from Student feedback (% of students responding "Agree" or "Strongly Agree")

Students also felt that the courseware provided them with an authentic learning experience which is a good way of introducing students to the working environment of the pharmacy, equipping them with the professional skills and competencies required and preparing them for the fast pace of the pharmacy. Students recognised the authenticity of the learning experience and valuable learning opportunity the courseware provides them.

Comments from first year students indicated that the courseware was a good learning experience and it provided them with an exposure to the working environment of a typical pharmacy, e.g. " *the courseware gave us a scenario of what happens behind the pharmacy counter",* Second year students found the courseware useful in the revision of their drug knowledge and also highlighted the impact of the courseware in helping them gain a deeper understanding of the workings of a pharmacy that a text book could not provide. *"The courseware gave me a very good understanding of the pace of the pharmacy in reality and I have never expected it to be so fast!"* and "it *helped me to really rethink about the purpose of the drug and it expanded my learning. Learning and understanding the notes can only bring you to a certain extent but with games like this, my learning and understanding has been shifted to another greater level."*

These comments from students show that the courseware was successful in providing students with the authentic learning environment and to help them better understand the workings of a real pharmacy. They were able to appreciate the challenges that they would face and the professional skills and competencies that they would need to develop in order to become a competent pharmacist technician in future.

Feedback from Staff on the effectiveness of the courseware: Feedback was also obtained from the Pharmacy Science teaching team on their perceptions of the courseware to support students' learning needs, as well as how the courseware met the learning objectives.

Staff found the game useful in introducing the students to the realities of the working world. One staff who was involved in using the courseware in her module commented that it helped the students in reinforcing the drug knowledge of the students - *"I think it's excellent! I had my doubts in the beginning but seeing it develop; and seeing how students embrace it and learn from it, it has been an eye opener."*

This positive feedback from the teaching team is an important indicator that the courseware has achieved its aim to support students' learning, and that the teaching team was able to see the impact it has on students and their engagement with the learning a subject matter which most students found dry and difficult to manage.

(2) Feedback of courseware experience on internship

Feedback from students on preparedness for internship: As one of the main objectives of the courseware was to increase student preparedness and reduce the "transitional shock" that they may face during internship, the purpose of this discussion was to find out if the courseware would have been helpful in preparing them for their internship.

Five final year students who were undergoing their internship at NUH were invited to a focus group discussion to share how the courseware has impacted their internship experience. Students found the game to be useful in preparing them for internship at the outpatient and polyclinic pharmacy, as they would be made more aware of the workflow and more familiar with the dispensing software used in the pharmacies.

One student commented that the game would have *"helped me to know what to expect when we went for our internship."* Another student commented that it would have been helpful in enabling him to be more familiar with the dispensing software during his internship - "*at least I would know how to use ipharm*".

Feedback from Industry partners: Industry feedback indicates that this courseware would be very useful in helping our students to have more "hands-on" experience in the pharmacy dispensing software and thus allow them to "hit the ground running" during their internship or work so that they would be able to participate more fully in the pharmacy operations.

This courseware was also presented to the school's Advisory Committee where it received positive feedback from the committee members. In particular, Mr Wu Tuck Seng, President of the Singapore Pharmacy Council and head of NUH pharmacy complimented the courseware for its authentic learning environment as being a good way to train our students in handling common medication errors in the pharmacy. He felt that *"...the software is a useful tool as it could simulate error situations to test the students on their responses. It would be difficult to simulate error situations in actual pharmacy training."*

Moving Forward

This courseware was developed in two phases. Phase one of the courseware, as described above, has been completed and phase two is currently under development. The second phase of the game involves a

multi-player game and will include more complex scenarios. It will be implemented in the curriculum of the third year modules.

Feedback from the students as well as staff has been taken into consideration in the development of the phase two courseware. For example, the variety of characters in the pharmacy, as well as the number of drugs and types of problems faced by the students will be expanded to increase the variety of medication related issues.

This will increase the complexity of the game and allow students to be exposed to more clinically challenging cases as well as complex ethical issues that they would face in the pharmacy.

Conclusions

The Virtual Pharmacy courseware is an innovative approach to introducing workplace readiness for our students by using a game based simulation. It is directly relevant to the training of the Pharmacy Science students for the workplace and increases their workplace readiness. The students are trained in a authentic environment and acquire the relevant skills and knowledge that are required for them to practice professionally in the pharmacy, It allows students to relate the skills and knowledge taught in their first and second year to the real world of the pharmacy environment, as well as prepares them for the work flow and fast pace of the pharmacy.

Students and staff have provided positive feedback on the game and indicated that it was fun, easy to play and prepared them for their final year internship at the hospital pharmacy.

Acknowledgements

We wish to acknowledge the staff at the National University Hospital who gave valuable input during the development of the game as well as our students who participated in the development and provided us with their honest feedback through the surveys and focus groups. We would also like to acknowledge the invaluable assistance rendered by the staff at the Teaching and Learning Centre, Ngee Ann Polytechnic in the development of the courseware and in the preparation of this paper.

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THE MEXICAN KOSEN AT THE UNIVERSITY OF GUANAJUATO: AN INNOVATIVE APPROACH IN TECHNOLOGICAL AND SCIENTIFIC EDUCATION THROUGH INTERNATIONAL COOPERATION

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Abstract

The National High School System in Mexico provides capabilities for developing mathematical-logical thinking and communication skills, for the students to continue university studies. The Technical education offered in our country is mainly oriented to equipment operation, with occasional participation in solving or analyzing problems found in the industries. In The Bajio region, central Mexico, are being placed increasingly Japanese automotive assembling industries and many suppliers. This arrival has impacted the local economy and is requiring highly skilled professionals. Hence, the University of Guanajuato (UG) and Nagaoka University of Technology (NUT) designed a Technological High School Program with and International Profile, similar to the Japanese Kosen system. It is expected that the graduates from this program will be capable of solving complex problems by using a solid scientific and technological knowledge. In the beginning, two areas will be offered: Materials Science and Mechatronics, plus a consistent formation in fundamental scientific areas, engineering, human sciences, communication, and teamwork. Moreover, some short stays in industries will be carried out. The students will become fluent in English and Japanese languages for technical and daily communication. The students will be exposed to the Japanese culture through video conferences and seminars from Japan, and it count on with volunteer Japanese professors in Mexico. Moreover, Mexican students could carry out short stays in the Kosen's institutions in Japan. The overall program will last five years. The graduates after concluding the program could follow their bachelor studies at UG, or at NUT, or to work in the industry. This program will be supported by the Division of Natural and Exact Sciences, the Division of Engineering, and the High School System located in Guanajuato city and Salamanca city, from the UG, Mexico. From Japan, NUT, as well as Nagaoka and Oyama Colleges from the Kosen system, have recently celebrated a cooperation agreement with the UG. The Mexican Kosen is the first academic program of its kind offered in Mexico, where highly skilled professionals must count on with a strong scientific, engineering and language preparation. This way UG and NUT contribute to the development of the state of Guanajuato, Mexico.

Keywords: *Kosen, Mexican Kosen, high school system, mechatronics, materials science, international education*.

Introduction

According to the "Education to Employment: Designing a system that works" report by McKinsey & Co., in (Mourshed, D. Et al. 2014); which embraces nine countries, including Mexico, two related world crises are confronted: high levels of unemployment and a shortage of individuals with critical job skills. However, the governments have had difficulties to develop effective responses or even to define what they need to know.

The Organization for Economic Cooperation and Development (OECD) reported that there is more than one individual between 15 to 24 years old that are not employed nor are attending to school or are in training (OECD, 2012). Moreover, at a worldwide level, the International Labour Organization (ILO) estimates that 75 million of young people are unemployed. At the same time, there is a shortage of people with critical skills (ILO, 2014).

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In countries like Germany, Saudi Arabia, USA, Brazil, India, Morocco, Mexico, Turkey and the United Kingdom, only 43% of employers agreed that they could find workers with sufficient labor training. The McKinsey Global Institute (Moursherd, D. 2014) estimates that there will be a global deficit of 85 millions of workers with high and medium work skills.in 2020.

Over the recent years, in the state of Guanajuato, Mexico, a variety of companies have been established. The Study of Labor Market carried out in Guanajuato (2013 reported that of 320 companies surveyed, from four economic sectors, 71% of them are from the manufacturing sector. Moreover, it has led to the installation and opening of transnational corporations and, it is generating new jobs. These companies concentrate mostly in the auto parts sector with 77.34% out of them, followed by the leather and footwear, metal, and plastic industries (Secretary of Sustainable Economic Development, 2013).

A strategic dimension of the Development State Plan of Guanajuato 2035 indicates that there should be an education for competitiveness and effectiveness and training for work (Secretary of Sustainable Economic Development, 2015). This report entails the necessity of formulating and updating the study programs to provide education with quality at the high school and university levels, which it is efficient and relevant for international, national and state development.

In Mexico, the high school studies provide competencies and skills to pursue university studies or to integrate into the labor force.

An educational institution should be monitoring its environment and anticipate changes in its environment. Therefore, the higher education institutions should make contributions by designing innovative educational programs to drive the social and economic development of its inhabitants.

Therefore, the goal was to design a Technological High School Program with and International Profile (BTPI), similar to the Japanese Kosen system. It is expected that the graduates from this program will be capable of solving complex problems by using a solid scientific and technological knowledge.

In the beginning, two areas will be offered: Materials Science and Mechatronics, plus a consistent formation in fundamental scientific areas, engineering, human sciences, communication, and teamwork.

Methodology

Focus group to elaborate the proposal. A focus group developed this proposal. The members were from Directorate of the School of High School System; Directorate of Academic Cooperation; Department of Educational Model, and professors from the Departments of Electronic and Mechanical Engineering from Campus Irapuato-Salamanca and the Department of Chemistry from Campus Guanajuato. Moreover, Nagaoka University of Technology, Japan, also contributed to putting together this proposal.

Analysis of educational and industry needs. To know the requirements of the educational sector to prepare labor force; data from the Ministry of Public Education (SEP, 2014), the National Institute for Educational Evaluation (INEE, 2013), Ministry of Education of Guanajuato (SEG, 2014): Sustainable Economic Development Secretariat of Guanajuato (SEDS, 2013) were analyzed. Similarly, some officials attended several sessions of the Automotive Cluster of Guanajuato (CLAUGTO) to know desirable competencies of technicians and middle managers of this sector.

Access to Education. The Ministry of Education through the undersecretary of middle higher education estimates that in 2018, at least 80% of people will count with high school studies (SEP, 2013). Therefore, the University of Guanajuato has proposed to create a new high school program called Technological High School Program with International Profile (Bachillerato Técnico con Perfil Internacional, BTPI, by its Spanish acronym). This program is also denominated like Mexican Kosen. This way the University of Guanajuato is responding to the growing demand for skilled professionals in the automotive industry related areas: metal-mechanics and materials science.

Industries arrival impact. At present, there are many automotive industries settled in the state of Guanajuato, as well as the part suppliers are arriving. This situation is attracting more foreign investment due to the competitive situation for economic development. Besides, the Bajio region in the central part of Mexico offers an excellent connectivity with the American border, as well as there are skilled workers in the booming developing industry.

Results and Discussion

Structure of the Technological High School Program with International Profile. The overall program will last five years: the High School System will offer the first three years, and the last two will function with the participation of two Guanajuato University divisions. After completing the five-year program, the participants could continue their bachelor studies at the University of Guanajuato, or at the Nagaoka University of Technology (Figure 1).

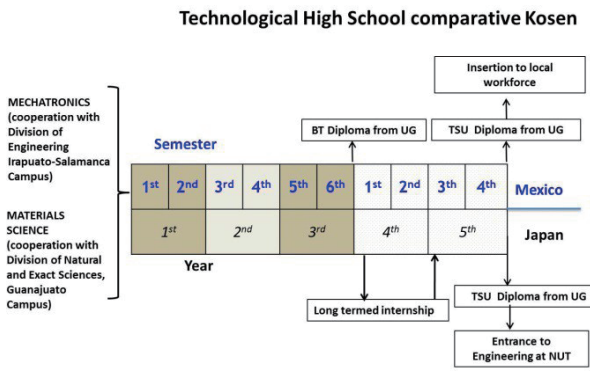


Figure 1. Course development and BTPI functioning.

The BTPI program will have two orientations: Mechatronics, which will be offered in Salamanca High School and Materials Science in Guanajuato High School. This program has four main education areas (Figure 2).

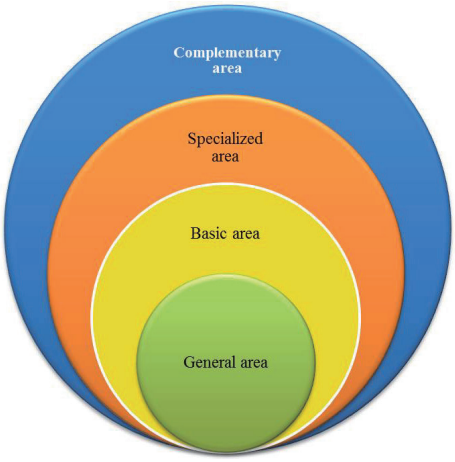


Figure 2. BTPI Curricular areas.

General area. The activities are focused to promote the personal development, social responsibility, creativity, and entrepreneurial spirit, as well as to develop cultural and intercultural skills.

Basic area. This area constitutes the BTPI Education Program nucleus. The area is made up of specific courses that will help the students to developing the specific skills to cope efficiently with different settings and situation throughout his/her life. The subject include mathematics, fundamentals science, communication, social sciences, English and Japanese languages, sports and cultural activities and management.

Complementary areas. The student will perform research under the professor guidance. Students will attend conferences, as well as industries stays, academic contests, and cultural events will be included to complement their personal and professional profile development.

Specialized area. The students will take either subject from Mechatronics or Materials Science that will allow them to perform in their professional life or to continue university studies. The subjects include practical workshops and experimentation in laboratories.

This program operates according to academic credits. Besides, the applicant and graduate profiles will be described later. Faculty from Japan and Mexico will participate to achieve the program goals in technical, human, cultural and language aspects.

Credits system. One academic credit corresponds to twenty-five hours of student work, inside and outside the classroom. The total number of academic credits is 136 for the BTPI.

Applicants profile. The student must possess knowledge of mathematics, physics, chemistry and English. The student must also show the capability to communicate effectively orally and in writing. The applicant must be willing to teamwork and show the desire to learn about other cultures.

Graduate profile. After finishing the program, the student will be able to solve current problems in industry. They will be aware of production processes for its improvement. Students will know the fundamentals of the different types of materials and the use of simple tools, as well as automated equipment. Graduates will show leadership skills and teamwork and intercultural abilities. It is expected that at the end of 6 semesters, the graduate shall communicate in their mother tongue as well as English and Japanese.

Faculty. Professors from UG hold M.Sc. and Ph.D. degrees in their specialization areas, as well as the ability to teach in English. Professors from Japan will also participate through short and long stays as well as by video conferences.

Languages: Spanish, Japanese, English languages will be utilized as a medium of instruction to put in practice theoretical skills, as well as the cooperation between professors from both countries. The students will accomplish 800 h of Japanese language, including basic courses as well as the specialized technical language. Native Japanese teachers will participate in this Program. The stays in Japan would help to develop the intercultural awareness and to practice the foreign languages in a natural environment (Figure 3).



Figure 3. Main features of the BTPI from UG. The program also integrates the exposure to Japanese culture through short and long stays in Japan and video conferences and participation of Japanese guest professors.

Support and international collaboration. This program will be supported by professors of the Division of Natural and Exact Sciences and the Division of Engineering, and the High School System located in Guanajuato city and Salamanca city, from the UG, Mexico. From Japan, Nagaoka University of Technology, as well as Nagaoka and Oyama Colleges from the Kosen system, will provide support. These institutions have recently celebrated a cooperation agreement with the University of Guanajuato.

Program approval. This Program was approved by the University of Guanajuato government bodies after submission of the complete curriculum description.

Conclusions

The Technological High School System with International Profile at UG will contribute to the UG internationalization goals by preparing highly skilled professionals to foster technology development in education institutions and industry. Our graduates will also work with a deep sense of social responsibility.

Back

The BTPI is the first academic program of its kind offered in Mexico, where highly skilled professionals must count on with a strong scientific, engineering, and foreign language preparation. This academic program is an example of international collaboration among Japanese Higher Education Institutions and the University of Guanajuato.

Acknowledgements

University of Guanajuato, Nagaoka University of Technology and Nagaoka and Oyama Kosen authorities are acknowledged of their strong support for developing the BTPI (Mexican Kosen).

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"FUKUI KIGYOGAKU": AN INSTANCE OF CAREER EDUCATION FOR NIT STUDENTS AS FUTURE GLOBAL ENGINEERS

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Abstract

In this paper, we would like to illustrate an instance of career education for NIT students as future global engineers.

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 is held every September. This seminar is 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 arrange 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 paper is a part of achievements supported by a government subsidy for aiding scientific research of 2013-2016.

Keywords: *Career Education, Collaboration between Industry, NIT and Government, Training Global Engineers, English Language Teaching, Regional Activity*

Introduction

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 discuss the design of an English teaching programme in a career seminar for NIT students as future global engineers

Setting "career education" as important, we seek a suitable educational programme.

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At first, for generalizing the notion of globalization, we pick up some NIT graduates' opinions about ideal global engineers. We depend on the two books about NIT system and its future prospects.

In these books some notable global engineers graduating from NIT are interviewed, and they expressed their ideas about the ideal image of global engineers. 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 Study of Globalization and Locality in Fukui Enterprises)". The following chapters were the whole process of planning the programme.

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. In the next chapter, we explain the process of planning the programme "Fukui Kigyogaku".

Materials and Methods or pedagogy

Fukui prefecture is located near the centre of the Japan Sea Coast in Chubu district. It has a population of around 800,000 people, and has 4,189.88km^2 area.

In common with the other local governments in Japan, Fukui prefectural government has also sought the way to find the effective English teaching, and has practiced various educational programmes especially for public junior and high school students. Among those, "The Division of Promoting the Development of Universities and Private Institutions of Learning (Fukui government)" at Fukui prefectural government has also sought to hold a new educational career seminar these years. That was why they asked NIT Fukui campus and universities in Fukui to plan as a joint team the new career seminar targeted for university and NIT students.

Fukui government intended to promote the interaction between NIT and universities through an educational programme, and more, to encourage students to revalue Fukui as the best place of their employment through this seminar. Being aware of their locality and their love for Fukui, they can understand important aspects of globalization. As a result, this could help to promote the development of local industries in Fukui.

Furthermore, this would lead to the revitalization of local community. This programme could also meet the policy of regional revitalization strongly promoted by the Japanese Government nowadays.

Based on these, Fukui government named this seminar "Fukui Kigyogaku (A Study of Globalization and Locality in Fukui Enterprises)".

To sum up, "Fukui Kigyogaku" was planned as a two-day career seminar aimed at offering each participant the opportunity to think about globalization as a member of local community. the participants were able to realize the important relationships between globalization and locality. In fact, through this seminar, they tried to cultivate not only their global mind but also their senses of locality. We would like to maintain that a global perspective should be attained through a local one in career education.

This seminar 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 good example of Regional Activity at NIT.

The staff of "Fukui Kigyogaku" was chosen among academics in NIT and three universities in Fukui. The head author of this paper was responsible for a plan of the programmes of the second day, and also served as one of the chief coordinators.

In a staff meeting for the last year's programme, the staff and the Fukui government discussed the notion of "Fukui Kigyogaku". The key notions of the programme were defined as the following (I) ~ (V):

(I) To promote the interaction among students at NIT and universities in Fukui, an educational programme, "Fukui Kigyogaku" for the students should be needed.

(II) "Fukui Kigyogaku" should be held as a model of a collaborative educational programme between industry, NIT and prefectural government in Fukui.

(III) "Fukui Kigyogaku" should be aimed at giving students the opportunity to think about their future career.

(IV) Through this programme, the participants should try to cultivate not only their global mind but also their senses of locality.

(V) This programme mainly consists of the two parts: some lectures including group discussions planned by local enterprises (the first day) and some English lectures (the second day).

As a result of role sharing among the staff, we were mainly responsible for a plan of the second part (the second day) of the seminar about English for global engineers.

Next, we explain the outline of "Fukui Kigyogaku".

Figure 1 is a brochure delivered to students in the recruiting. It enabled them to know the main three objectives of "Fukui Kigyogaku" as follows:

(I) Through various lectures by business people and discussions facilitated by them, the participants have an important opportunity not only to get much information of the leading enterprises in Fukui but also to learn the globalization specifically through the perspective of locality.

(II) Active interaction in the programme makes the participants find new aspects in themselves, and it helps them to enjoy their solid university lives hereafter.

(III) Through the group discussions and interaction facilitated by native speakers in English, the participants can have the opportunity to use English practically, and to learn the English faculty necessary for the global age.

As a team, we mainly concerned with the realization of the above (III).

Each of the staff was in charge of its recruiting. Last year, 32 students including 18 NIT students applied for this seminar.



Figure 1　A brochure on the programme

Figure 2 is another brochure on the programme. It showed the contents of the programme. "Fukui Kigyogaku" was a two-day seminar. The contents of the seminar were as follows:

On the first day, the participants had mainly vocational education.

At first, a special guest gave a keynote speech about a vocational education in the global age. For the last year's seminar, Mr Takashi Kumon, a CEO of T. Kumon Associates Inc., was invited as a keynote speaker.

Next, a few leading local enterprises gave a lecture about an ideal person with a secure sense of globalization and locality.

On these lectures, as the completion of the first day's programme, the participants were divided into a few groups and had the discussion about an ideal person with a sure sense of globalization and locality.

The first day's programme was mainly planned and held by Junior Chamber International Fukui and so forth.

Later, the participants also had a namecard-exchanging party with the lecturers and staff over dinner

Secondly, we explain about the programme of the second day aiming to give the participants to learn the essential of the global English.

As we mentioned before, we mainly concerned with the planning of the second day's programme. For the participants, using English should be the so-called gateway for enlarging their sure experience in the present globalized world.

The second day's programme began at 9:00 in the morning. The main contents were as follows: (I) keynote speech (50 minutes), (II) Group discussions with a facilitator (English native speaker) (2 hours), (III) Lunch break and presentation (10 minutes) by all groups.

After deliberate consideration and some discussion among the staff, this presentation was not planned as s competitive one. The programmes finished at 15:00 as scheduled. Figure 2 is another brochure telling the details of the programme.

■講演内容

回	日 時	内 容	講 師 等
1	9月20日（土）13:00～20:00	開会式・オリエンテーション	福井工業高等専門学校　准教授　原口　治 福井工業大学　准教授　入学　直哉
		講座趣旨および県内企業動向の説明	福井県立大学地域経済研究所 教授　丸屋　豊二郎
2		講演会① 《グローバルリーダーが語る》 これから求められるグローバル人材とは? ～アジアで働くという選択肢～	東京大学特任研究員／英九門振事務所 代表取締役　九門　崇
3		講演会② 《企業代表が語る》 企業が求める人材は ～これからの大学生活で学ぶべきこと～	江守商事㈱ セーレン㈱ ㈱ソーホーズインターナショナル　（50音順）
4		討論会① 《若手企業人を迎えたグループセッション》 福井で活躍する、世界で活躍する! 世界に通じるグローバル人材になるためには	公益社団法人 福井青年会議所 会員企業 ほか上記講師
5		交流会 《名刺交換による自己紹介やフリートーク》 社会人マナーや普段聞けない生きた情報を入手!	全員参加
6	9月21日（日）9:00～15:00	講演会③ 《ネイティブスピーカーが語る》 グローバル社会で必要とされる英語とは	英オックスフォード大学出版局 ティーチャートレーナー　ロバート・ピーコック
7		討論会② 《ネイティブスピーカーを迎えたグループディスカッション》 自分の考えをグローバルに発信しよう!	福井県立大学 インストラクター　ウィリアム・マクドナルド インストラクター　グリル・ボイド 福井工業大学 助教　ブラッドフォード・リー 助教　サム・トムソン 仁愛大学 教授　モーリス・ルイス・スプリチャル 講師　マシュー・ハウカ
8		グループ発表会 本講座の総括を行い、グループ別に発表	福井工業高等専門学校　准教授　原口　治 福井工業大学　准教授　入学　直哉
		講座総論・閉会式	

Figure 2　Another brochure on the programme

We asked the Oxford University Press to arrange the keynote speech for the second day's programme. They aptly chose as a keynote speaker Mr Robert Peacock, a teacher trainer of the OUP.　Needless to say, the OUP has a worldwide reputation as the top-class publisher of many famous textbooks for English education. We discussed the contents of the keynote speech, and reached the agreement on a framework for the keynote speech. This keynote speech were suitable for the participants to shift their mind to the group discussion without much difficulty, to learn the idea of English as a global language, and to ease their "Englishphobia", or hesitation and reluctance in using English and feel confident to use English as much as possible.

We allotted approximately 50 minutes to the keynote speech.

As we shall mention later, the English of keynote speech was perhaps a little difficult for the participants to understand. However, their interest in it was above the average in the questionnaire, and this proved that planning the keynote speech succeeded.

Figure 3 and 4 are the parts of the slides made and used by the keynote speaker, Mr Robert Peacock, a

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teacher trainer of the OUP, and Figure 5 is a work sheet jointly made by the OUP and us.

This work sheet gave the participants the opportunity to think about the utility of a qualifying examination such as TOEIC® or STEP as 21st century skills. As one of recent problems at NIT Fukui campus, we can point out a marked decrease in the number of examinee in TOEIC®. To solve the problem, this task was effective as facilitation of a life plan because the participants were able to realize the importance of highly-motivated attitude in their student life and such examinations would help them in their career design.

Figure 6 is a snapshot of the keynote speech. You can see how the programme was interactive and active.



Figure 3 A Slide for the keynote speech



Figure 4 A Slide for the keynote speech



Figure 5 A worksheet for the keynote speech



Figure 6 A snapshot of the keynote speech

As the programme following the keynote speech, we set the group discussion. The contents were as follows (I) ~ (III): (I) One native teacher as a facilitator helped a group of the participants to complete the task. (II) This was not a competition among all groups: No ranking. (III) The goal was to learn globalization through locality, and so we arranged that each group had to make a few minutes' promotion model titled "Fukui to the World".

As good examples, we select five slides made by each group and how deeply their understanding of the relationships between globalization and locality was.

We especially regarded as important an integrated programme of both the first day focused on the practical vocational education and the second day. In Figure 7 we can express the ideal programme in a pyramid shaped image ("G. E." in Figure 7 means "Global Engineer"). It is inappropriate to disintegrate the consistency between the first and second day's programme.

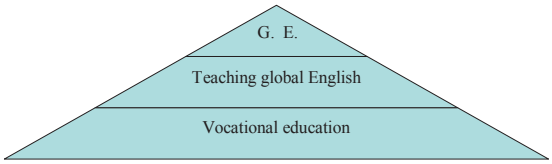


Figure 7 The image of the ideal programme

Figure 8 is a snapshot of the group discussion. We suppose that you can find how well the participants enjoyed the programme. Although in a rather different circumstances from their usual classroom, the participants did their work actively in cooperation with each other. They were able to understand the importance of teamwork and good interpersonal relations among the participants themselves.

During the programme, they were able to use Japanese, but encouraged to use English properly, although they certainly needed to use English in asking their facilitators (native English speakers) of questions and so forth. The participants were able to use the so-called "English for Life". In this programme, English was acted as an important tool for communication, and they had to add to their experience of using English outside their usual classroom.

As a result, we gave the participants an educational opportunity to ease their "Englishphobia", or hesitation and reluctance in using English and to feel confident to use English as much as possible.



Figure 8 A snapshot of the group discussion

As the satisfactory completion of this programme, all groups had to give a presentation of their own sales and marketing of Fukui. We set the theme as "Fukui to the World". In the next chapter, we deal with how the participants achieved their task as the product of teamwork.

In Figure 9, one of the NIT students was giving a presentation in English on behalf of his group members.



Figure 9 A NIT student giving a presentation

Results and Discussion (I)

All groups had a lively discussion under the theme, "Fukui to the World". It was effective to emphasize the consistency between the first and second day programmes. Picking up some slides made by each group during the discussion, we analyse how they created their own sales and marketing of Fukui.

Figure 10 shows the opening slide made by the group A. "Fukui to the World" was the theme given to all groups. To give presentation under this theme was obligatory for all groups. As to the slides, they had to make them during the group discussion.



Figure 10 The opening slide made by the group A

Figure 11 is the slide about the traditional culture of Fukui. The group A referred to "Echizen Washi (Japanese traditional handmade paper)". As a start of the presentation, focusing on the traditional culture was successful. In a similar way, the other groups also mentioned the local history or traditional culture in their presentation.



Figure 11 A slide made by the group B

Looking into Figure 12, it can be said that their sense of the balance between traditional and modern characteristic about the local area is to be praised.

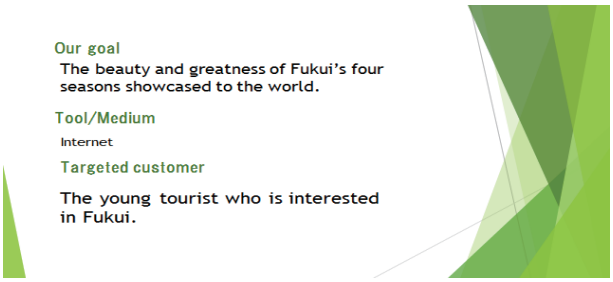


Figure 12 A slide made by the group C

The Group D focused their interest on the local sights. Fukui is famous for the excavation of a fossilized dinosaur. They were also skillful at handling computer graphics. Figure 13 is a good example of it.



Figure 13 A slide made by the group D



Figure 14 A slide made by the group E

Figure 14 is the closing slide made by the group E. It contained an assortment of many symbols representing the identity of Fukui. We can find famous Eiheiji Temple or the outstanding mechanical precision parts made with titanium. Both aspects of industry and

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cultural history in Fukui were deeply impressed by this slide. The participants were able to realize their local identity through the process of producing English globally.



Figure 15 A snapshot of the participants with the staff

Results and Discussion (II)

A questionnaire to the participants about the programme was conducted by the Fukui government and the results were shared among the staff.

This questionnaire asked 11 simple questions mainly about all lectures. The participants made their assessment of all lectures on a scale of one to five.

All the participants returned this questionnaire. We present the questionnaire as Figure 16, and also give the outline of the result as Figure 17.

First of all, all the programmes were overtly highly evaluated by the participants.

As to their comprehension of the second day's programme, the English of keynote speech was perhaps a little difficult for the participants to understand. Nearly 50 percent of all rated their comprehension of the keynote speech at the grade five, although it was a little lower than of the other programme. However, their interest in the second day's programme was above the average (around 60 percent), and it can be said that the second day's programme succeeded.

As a whole, the results of a questionnaire to the participants proved this seminar was able to yield educational benefits as a kind of active learning. Their positive attitudes towards "Fukui Kigyogaku" would be effectively applied for their student life.

問３　今回の講座の内容について、あなたの満足度・理解度は次のどれに最も近いですか。

		理解度 高	理解度 低	満足度 高	満足度 低	コメント
一日目	グローバルリーダーが語る	5・4・3・2・1		5・4・3・2・1		
	県内企業代表が語る	5・4・3・2・1		5・4・3・2・1		
	若手企業人を迎えたグループ討論	5・4・3・2・1		5・4・3・2・1		
	講師陣との交流・親睦	5・4・3・2・1		5・4・3・2・1		
二日目	ネイティブスピーカーが語る	5・4・3・2・1		5・4・3・2・1		
	ネイティブスピーカーを迎えたグループ討論	5・4・3・2・1		5・4・3・2・1		
	グループ発表	5・4・3・2・1		5・4・3・2・1		

問４　今回の講座は、今後の学生生活や就職等を考え直すきっかけになりましたか。
①きっかけになった　②きっかけにならなかった

問５　今回の講座を受講して、来年開講されれば後輩に参加を勧めたいですか。
①勧めたい　②勧めたくない

問６　学生がもっと参加しやすくなるためのアイディア、希望について記載してください。

問７　その他今回の講座への感想・意見を自由に記載してください。

Figure 16 A part of the questionnaire

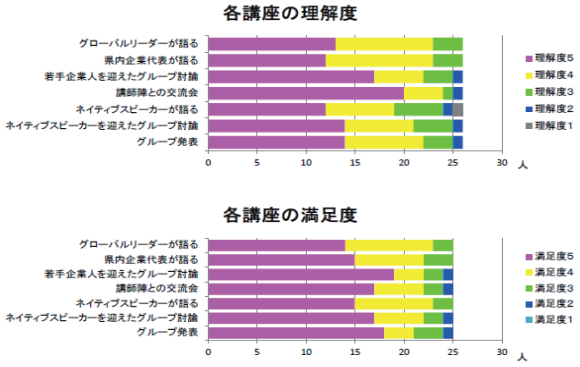


Figure 17 The results of a questionnaire

Conclusions

As a conclusion, we would like to confirm that "Fukui Kigyogaku" succeeded as a career seminar for NIT students. Fukui prefectural government has already decided that this programme deserved to be held every year.

This paper does not cover a joint analysis of the second day's programme with native speakers acting as able group facilitators. We would like to discuss the subject further in another article.

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. That is to say, English education can act as an influence for promoting the training of global engineers practically even outside the classroom.

Nowadays training global engineers is widely required in higher education worldwide. To achieve this as an educational curriculum, we emphasize that a programme of career education offered by the collaboration between Industry, NIT and government would be effective. It is because that an ideal global engineers should have the so-called "glocal (=global + local)" mind, and for cultivating it, such a career seminar as "Fukui Kigyogaku" should be needed for NIT students. By keeping this perspective, English Language Teaching would be greatly helpful for the training of NIT students as future global engineers.

Acknowledgements

We should like to record our thanks to all the people involved in the plan of "Fukui Kigyogaku and especially Mr Robert Peacock, a teacher trainer of the OUP and Ms Sakie Ishibashi, an ELT consultant of the OUP".

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DEVELOPING AN ACTIVE LEARNING CURRICULUM TO TEACH WORKPLACE COMMUNICATION SKILLS TO ENGINEERING STUDENTS

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Abstract

Research has shown that Active Learning provides opportunities for higher-order thinking skills, increases student retention as well as achievement, connects the content to real life, builds students' self-esteem and promotes alternative forms of assessment. The purpose of this paper is to share how a student-driven and Active-Learning curriculum was developed for the subject, Organisational Communication Skills. The main objective of the subject is to teach Engineering students workplace communication skills, to better prepare them for their student internship experience.
This paper highlights the approaches taken to plan, develop and deliver the subject, student-driven teaching methodology as well as the assessments that were designed. Quantitative and qualitative feedback was obtained from the students and facilitators. Based on the feedback, the Active Learning curriculum was successful in equipping students with the knowledge and skills to manage the language and communicative aspects of their student internship.

Keywords: *Active Learning, workplace communication skills, Constructivism, student-driven, engagement.*

Introduction

According to (Levitt, 2001), good communication skills are undoubtedly important for practicing engineers as "communication can be an engineer's strongest ally or his/her worst enemy". Literature states that employers rank communication skills as top of the list of qualities for entry level, executive and blue-collar positions, but these are generally not demonstrated effectively in job interviews (Mc Kay, 2007). Engineers in the 21st century are not only required to be technically competent, but be armed with relevant "soft" skills for effective workplace communication purposes (Patil, 2005). Students in the School of Engineering, Temasek Polytechnic have to successfully complete four communication skills subjects as part of the pre-requisites for graduation – *Writing, Oral Presentation & Effective Communication Skills (Year 1), Organisational Communication Skills (Year 2) and Career Communication Skills (Year 3).* In Year 1, the focus is on effective communication skills, basic technical writing and oral presentation skills. To prepare students for workplace communication challenges during their Student Internship Program (SIP), the Year 2 curriculum covers "soft" skills such as Interpersonal/Intercultural Communication (IPIC), Workplace Report Writing, Meeting and Minutes Writing skills. In Year 3, students are taught employability skills. In addition, they learn how to write cover letters, resumes, and ace job interviews and deliver technical presentations.

Curriculum Revision

In 2014, the Communication Skills Department embarked on an extensive curriculum revision project. The aim was to review the relevance of the existing pedagogical approach, curriculum, and effectiveness of assessments and depth of student learning for all four subjects.

Curriculum Review of Organisational Communication Skills

The subject team worked together to evaluate the existing topics, theoretical framework, currency of skills taught, types of activities used and the appropriateness of assessments. The evaluation was done to assess if the students were well-prepared for communication challenges during their SIP.

Curriculum Review Process & Methodologies

Performing Needs Analysis

SIP Supervisors, graduates and student interns who had completed their internship were interviewed to obtain useful qualitative feedback on key workplace communication challenges (i.e. both verbal and non-verbal communication). The qualitative feedback showed that students preparing for internship required more **practical** help in interpersonal and intercultural communication, email writing, report writing and group communication skills.

Determining Gaps and Identifying Areas for Improvement

The qualitative feedback indicated that the existing topics – IPIC Skills, Workplace Report Writing, Meeting Skills, Minutes Writing were relevant, but the curriculum was generic in content. Furthermore, it was not customised adequately for authentic workplace communication situations and greater student engagement in the learning activities.

Determining the Theoretical Framework – Constructivism

As Engineering students are largely kinaesthetic learners, it was decided that some key tenets of Constructivism be used as the theoretical framework to develop the new curriculum. According to (Jonassen, 1991), in the Constructivist approach, the focus is on knowledge construction, not reproduction. In addition, learners are presented with authentic learning tasks and encouraged to cultivate reflective practices. Besides these characteristics, the learning environment provides more for *learner* not teacher control and errors are used as a platform to provide feedback (Wilson & Cole, 1991). Learning takes place in a realistic and relevant context, where students are spurred to take ownership of the learning process. The teacher acts as a guide or facilitator and lessons are structured to promote higher-order thinking skills and collaborative learning (Honebin, 1996). Constructivism offers several advantages to students. It enables them to pursue their personal interests, enhance their abilities, tap on prior knowledge and develop life-long learning skills (Christie, 2005).

The seven principles for good practice in undergraduate education espoused by (Chickering & Gamson, 1987) were also considered. These include increasing contact between peers and lecturers, promoting cooperation among students, giving of prompt feedback, emphasising time on task, communicating high expectations, respecting diverse talents and ways of learning and encouraging active learning.

Determining Teaching Approach – Active Learning & Student Engagement

Active Learning is the School of Engineering's key pedagogical approach. Active Learning is generally defined as any teaching method that engages students in the learning process. In this approach, students are involved in performing meaningful activities and reflecting about what they are doing. When students reflect on what they are learning, how they are learning, its value, and what else they need to know, they are more inclined to both "own" and appreciate the learning. Active Learning is evident when students are not passive listeners, are engaged in activities, focused on developing skills, receive immediate feedback from instructors and are involved in higher-order thinking skills (e.g. analysis, synthesis, evaluation) (Bonwell & Eison, 1991). Learning happens especially aptly when the learner is consciously engaged in meaningful activities that can be shared with others (Papert & Harel, 1991). The core elements of Active Learning are student activities and engagement in the learning process.

In "Understanding by Design", (Wiggins G & Mc Tighe, 1998), the authors stress that good activities develop deep understanding of the important ideas to be learned. To do this, activities must be designed around important learning outcomes and promote thoughtful engagement on the part of the student.

Planning & Linking Active Learning Lessons

Having determined the theoretical framework, teaching approach and student engagement issues, clear and achievable learning objectives for each topic were identified. This was followed by the development of detailed Active Learning Lesson Plans and course material that were seamlessly woven from topic to topic. The new curriculum was pilot-tested in October 2014.

Role of the Teacher

As the new curriculum was designed to be more learner-controlled than teacher-controlled, it was important to evaluate the role of the teacher when using the Constructivist framework and Active Learning approach. It was highlighted to the teaching team, that the teacher will act as a facilitator of knowledge, guiding students to discover the meaning and relevance of the learning activities and process (Brooks & Brooks, 1999).

New Curriculum - Constructivism & Active Learning in Action

Effective Communication vs Transitioning to the Workplace

The previous introductory topic, Effective Communication focused on general workplace communication with a brief reference to Message (M.) Audience (A.) Purpose (P.) and Strategies (S.) to consider when communicating.

The new topic – *Transitioning to the Workplace* was designed to enable students to **discover themselves** the differences between academic studies and work life, with a substantial emphasis on M.A.P.S. The following Active Learning strategies were used to engage learners:

- *Authentic Case studies*

Customised and authentic case studies of student interns involved in workplace conflicts were presented to students for analysis. Students were also challenged

to propose the appropriate strategy and message for the given audience and purpose.

- *Debates*

Students debated on cases of working professionals who wrote disparaging comments about their companies,or posted racist remarks on their personal Facebook pages. They also assessed the consequences of such unprofessional work conduct. Furthermore, students had to to justify why it was right or not right to post negative comments about the internship company/personnel on Facebook, Twitter or other social media tools. Through the debates, students explored varying perspectives on the need to exercise discretion and caution when using social media for workplace communication purposes.

IPIC Skills

Previously, the tutor taught this topic for two hours and an MCQ Assessment was set to assess students' knowledge of related IPIC concepts and principles. There were no opportunities for students to demonstrate their IPIC skills.

However, the new curriculum for this topic spanned 10 hours with an authentic assessment that required students from various ethnic backgrounds and nationalities to work together on an IPIC project.

To provide an engaging prelude and scaffolding for the topic, students did the following Active Learning activities:

- *Quizzes*

Students performed fun quiz activities to discover barriers to interpersonal communication. This was followed by reflection on how such barriers could affect communication (spoken and written) at the workplace.

- *You Tube videos*

To introduce students to intercultural conflicts/miscommunication, a You Tube video on intercultural barriers was shown by the facilitators. Questions were posed by the facilitator, requiring students to identify the intercultural barriers from the perspectives of all the characters involved in the situation. Students were also instructed to propose strategies on how to minimise intercultural conflicts and identify ways to avoid such situations at the workplace.

- *Collaborative Learning & Group Project Assessment*

  - *Problem Analysis & Solution*s

To provide students with opportunities to demonstrate effective IPIC skills, case studies/role plays were given for analysis. These were presented in dialogue scripts and described difficult IPIC situations involving interns, colleagues and supervisors. Students had to work in groups of 5 to analyse the causes (verbal, non-verbal, cultural differences etc.) using the comprehensive resources in the coursebook and additional research. Through the group collaboration, a platform was created for students to listen to different perspectives and construct knowledge. Thereafter, they were tasked to propose appropriate communication strategies to resolve the conflict.

- *Oral Presentation*

In the next part of the project, students were required to do a group presentation of the problem analysis and the proposed solutions.

- *Video Production*

Besides the group presentation, each project group was to display knowledge of interpersonal and intercultural communication skills by acting out the problem and solutions. A narration was to be included highlighting what caused the problem and its resolution through suitable verbal and non-verbal communication strategies.

- *Feedback*

The facilitator played an important role in guiding and enabling the students to identify errors, find the correct solutions, thereby increasing the students' confidence to complete the IPIC project successfully.

- *Individual Reflection*

For the last part of the IPIC Assessment, each student had to present an Oral Reflection. They were to identify the IPIC skills they applied while working on the group project. In addition, students had to share personal experiences on the team dynamics, lessons learnt and how these will be transferred to their SIP.

- *Higher-order thinking skills*

Overall, the new authentic project assessment for IPIC, showed that students acquired numerous higher - order thinking skills in the process of completing the project. These included problem solving, critical thinking, logical reasoning, analysing, evaluating, reflective thinking and synthesising skills. Besides these higher-order thinking skills, students independently learnt how to create a video, which was not taught in this subject. Furthermore, learning took place in a relevant context and was directly applicable to their SIP. To sum up, students had substantial ownership and voice in the learning process.

Email Writing

In the previous curriculum, students were given samples of formal and informal emails and the tutor briefly explained the differences. Students were also not tested on their email-writing skills. On the other hand, in the new curriculum, students were required to do cognitively stimulating tasks. These included the following:

- *Analysing authentic emails*

Students were provided with five authentic samples of impolite and poorly written work emails and challenged to rewrite them. This was to be done, keeping in mind the key message to be conveyed, the intended audience, purpose and understanding which strategy would be most appropriate.

- *Gallery Walk*

The re-written emails on A0 size paper were displayed on the classroom walls, and the students worked in groups to compare and contrast the authentic emails with the re-written ones.

- *Use of Classroom Response Systems*

Student Response Systems also called Classroom Response Systems have been found to enhance student learning objectives when used effectively. In particular, researchers find that the use of response systems increases student motivation and engagement, provides immediate feedback to students about the shortcomings of their knowledge and helps them self-assess where they need to progress. Such systems also assist students to consolidate new knowledge, manage errors, enhance communication and social skills, foster an active learning class, and provide instructors with a quick method of formative assessment (Beatty, 2004).

- *Use of Padlets*

Given the numerous advantages of Classroom Response Systems, Padlets were used by the facilitators for collaborative learning. Padlet is an online virtual "bulletin" board, where students and teachers can collaborate, reflect, share links and pictures, in a secure location (Putnam, 2014). Students were instructed to analyse the rewritten emails, keeping in mind the M.A.P.S. provided and answer relevant analytical questions on Padlets. Thereafter, each group's peer analyses were viewed real-time and discussions were held on the effectiveness of the rewritten emails.

Besides enhancing student engagement, this Active Learning activity showed students the immediate relevance and importance of writing professional emails at work. Moreover, the facilitator could immediately assess the students' comprehension of professional email writing and give immediate feedback and address misconceptions.

- *Email Writing Assignment*

An authentic email writing scenario was set as an assignment. It mirrored the classroom activity on rewriting impolite and rudely written emails. Based on the students' submissions of this assignment, most of them demonstrated a good comprehension of professional email writing. They were also able to justify how their rewritten emails were appropriate for the audience and purpose in terms of language, content, structure and tone. The email writing Active Learning activities and assignment provided students with practical experience in writing effective workplace emails. Through this hands-on experience, students also realised that good interpersonal skills are even more critical for written communication. In sum, students can directly transfer the skills acquired to their student internship.

Workplace Report Writing

When contrasted to the old curriculum, which focused on prescribed and generic workplace reports, the new curriculum stretched students intellectually.

- *Visual Stimulus & Reflective Thinking*

You Tube videos of various real-life incidents were shown to the students. Thereafter, they were tasked to identify possible workplace reports as well as explain their respective structure. Subsequently, students grouped these workplace reports in two categories – factual and persuasive.

- *Leading questions*

Using leading questions, students were directed to analyse customised samples of factual and persuasive reports written during internship. Leading questions were posed to enable students to identify the distinguishing features of factual and persuasive reports in terms of content, structure, purpose and language features.

- *Educational Games and Socrative*

To further engage students, *Socrative*, a Smart Student Response System was used in the classroom (Reid, 2014). Through the use of a real-time questioning (MCQ) game on factual and persuasive reports, instant results were aggregated and visualized. The facilitators were able to better gauge the current level of understanding of factual and persuasive reports of the whole class. *Socrative* also enabled monitoring of individual student performance and provided immediate data to aid both the students and facilitators to customize learning. This was done by highlighting strengths and areas for improvement on the topic. As

(Beatty et al.,2004) explains, students recognise the system's value for engaging them in the course material. Students also concede that listening to other students' reasoning helps to illuminate their own thinking. They also like class-wide histograms: they like the reassurance that they are part of a "community of learners" all grappling with the same ideas.

- *Workplace Report Writing Assessment*

The former curriculum used a prescriptive approach, which required students to memorise a specific format and write a standard workplace report using the details given in a scenario. Unlike this approach, the new curriculum required students to analyse specific factual and persuasive reports commonly written during their student internship. Besides promoting higher-order thinking skills, the intention was to adequately prepare students to write different workplace reports expected of them during their internship. It was also to enable them to transfer the skills acquired in the classroom to the workplace.

Group Communication - Meeting Skills

The existing curriculum used several Active Learning strategies to engage students in the learning process for this topic. These were retained; however, more Active Learning activities were added to engage students cognitively, discover and construct knowledge about meetings.

- *Experiential Activities*

Through experiential activities, students uncovered meeting essentials and reflected on the importance of effective interpersonal skills and teamwork in group communication situations.

- *Customised Scenarios & Meeting Demonstrations*

Besides practice meetings in small groups, students were asked to do demonstration meetings using customised problem scenarios they could relate to.

- *Video Recording, Self-evaluation & Peer Feedback*

The demonstration meetings were video-recorded and played back to the class for analysis. Students were given the autonomy to pause the video at any time to self-evaluate their performance. They were also urged to highlight the strengths and areas for improvement for each member in the demonstration meeting. There was substantial peer feedback with the facilitator guiding and controlling the feedback process skilfully.

- *Meeting Skills Test*

The Meeting Skills Test was designed to be similar to the demonstration meetings.

Overall, these Active Learning strategies and test cultivated collaborative and cooperative learning skills. Moreover, they clearly engaged the students and equipped them with the required skills to manage various group communicative situations at the workplace.

Quantitative Feedback from Students

759 students out of 1392 students provided feedback on the new curriculum. The quantitative data is presented in the tables below. The quantitative feedback for the new curriculum, Active Learning activities and mode of assessment was very positive.

For the introductory topic, *Transitioning to the Workplace*, 97.9% agreed that the activities taught them how to use the right mode of communication at the workplace. 97.4% were aware of the importance of M.A.P.S. in workplace communication.

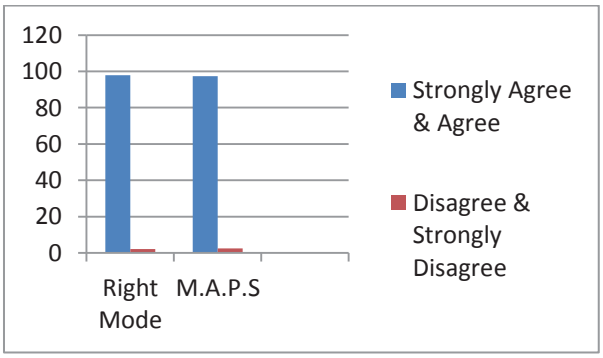


Figure 1: Transitioning to the Workplace

Next for *IPIC*, 91.5% of the respondents found the classroom activities for IPIC engaging. On the other hand, 95.6% agreed that the group project helped them to identify miscommunication/conflict in a given situation. 93.4% felt that the role plays for the assessment were realistic and 95.9% used thir IPIC knowledge to produce the group video. Moreover, 95.9% indicated that the Oral Reflection helped them to think of how to apply effective IPIC skills to their internship.

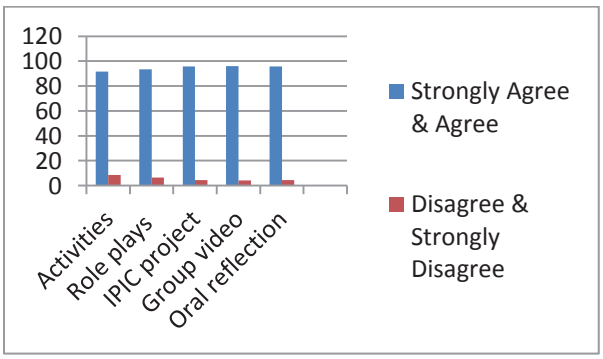


Figure 2: IPIC Skills

The quantitative feedback for Emails and Workplace Report Writing was equally encouraging and positive. 95.5% of the students found the email

examples provided in the course book realistic and 96.7% indicated that they now know how to use the correct language and tone when writing a formal email. Furthermore, 95% agreed that the mode of assessment for emails was helpful in reinforcing the Politeness Principles when writing. For Workplace Report Writing, 91.3% of the respondents found the Active Learning activities engaging and 97.4% were now aware of different types of reports written in the workplace.

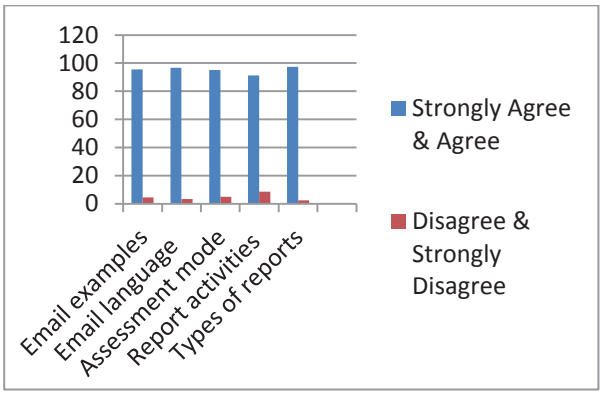


Figure 3: Emails & Workplace Report Writing

For Meeting Skillls, 97% agreed that they now know the correct meeting procedures that can improve the effectiveness of a meeting. 95.8% of the students felt that the demonstration meetings were helpful in reinforcing the correct procedures to be followed in a formal meeting. With regards to the Meeting Skills Test, 95.9% agreed that it gave them an opportunity to learn about their strengths and weaknesses as a meeting participant, secretary or chairperson.

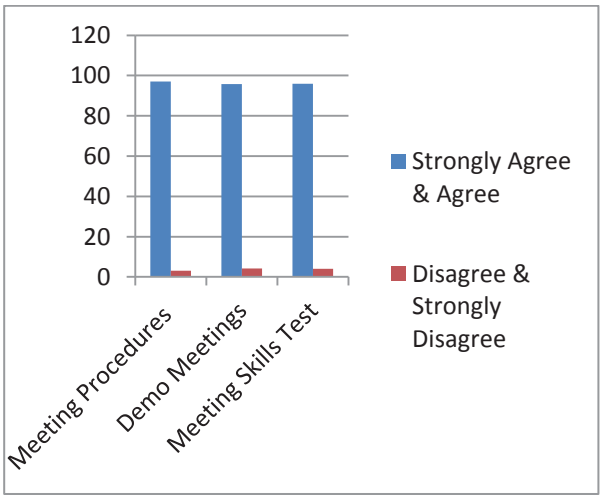


Figure 4: Meeting Skills

Qualitative Feedback from Students

The qualitative feeback was very conclusive too. Students requested even more Active Learning activities for all the topics and additional resources (print, audio-visual and online) for even greater engagement.

Qualititative Feedback from Facilitators

All the facilitators agreed that it was easy to faciltitate the Active Learning activities for the various topics. They also observed marked student engagement in the learning activities. Although, the facilitators were initially apprehensive to give learners more autonomy, it was shared that the quality of learning and work produced by the students were of high standard. Overall, all the facilitators agreed that they enjoyed teaching the new curriculum for Organisational Communication.

Conclusion

To conclude, the Constructivist framework and Active Learning approach incorporated in the new curriculum produced notable results. Based on the feedback from the students and facilitators, students were given many opportunities to acquire higher-order thinking skills, develop greater self-confidence, construct new knowledge by tapping on prior experience, engage in authentic tasks, connect with real world experiences and reflect on the meaning and purpose of their learning. Students also demonstrated greater preparedness to manage the diverse communication challenges during their internship (both spoken and written).

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DEVELOPING A PORTABLE MEDIA PLAYER WITH PARENTAL CONTROL CAPABILITIES AS STUDENT FINAL YEAR PROJECTS*

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Abstract

Final Year Project (FYP) is an integral part of Polytechnic education, and an important one. It is the time that student work on a significant assignment in term of size and difficulties, and it is also the platform to equip them with practical skills to work on future projects in the industry. The key objective of having FYP in our teaching curriculum is to expose students to the challenges, realities and considerations while working on an Information Technology (IT) project within the industry. We seek to equip our students with the intellect, and practical skills needed to solve real world problems by engaging them in realistic FYPs with tangible requirements.

Due to the rapid development in IT, one of the real world problems that parents faced today is the unprecedented access to digital media by children and adolescents. Given the double-edged sword digital media has become, parents, teachers and policymakers have concerns about the negative impact that digital media exerts on children and adolescents. This leads to a growing need for digital media content regulation and censorship. However, current suppression of content in Singapore is mild and insufficient. Only a small number of films or TV shows that have explicit sensitive or offensive content were censored. A vast amount of inappropriate media content is still accessible to children and adolescents. Parents are encouraged by the MCI (Ministry of Communications and Information) to guide their children on digital media consumption. Some companies have developed computer programmes that cleanse movies containing offensive scenes. However, existing computer programmes have limited ability in allowing users to adjust the filtering levels, or generating seamless cutting results.

Motivated by the above observations, students from the Republic Polytechnic School of Infocomm (SOI) had developed a novel media player to facilitate home users to suppress content, rate and classify digital media. The software permits its user to select various degrees of content suppression according to the user's level of acumen and discretion. Based on the properties of the sub-file objects pre-set by the user, the software will make use of its dynamic sub-file filter to examine the data set at the sub-file level for scrutiny before the substantiated content is consented for screening.

This paper discusses on how SOI students has adopted open source tools to bring FYP commensurable to the way projects are developed in the software industry.

Keywords: *final year project, software development, digital media, parental control, content suppression*.

Introduction

A comprehensive system of film classifications and ratings, adult-interest magazines, broadcast programmes, and consumer advisories allow the Media Development Authority (MDA) in Singapore to provide consumers with diverse choices while guiding and enabling consumers to make choices for themselves and for their children. The Censorship Review Committee (CRC) was formed in 1991 as an advisory panel to review and update censorship objectives and principles to meet the long-term interests of our society. In 2010, the CRC issued its report with the recommendation that Internet Service Providers (ISPs) be mandated to offer optional Internet filters in order to give parents more control and responsibility over what their children can access online. In response to the CRC 2010 report, the MCI

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had agreed with their recommendations on the fundamental principles guiding content regulation. More choices are also provided through a contextual and flexible approach that MDA takes in regulating media content.

Censorship is, in fact, rarely applied to films nowadays. If needed, MDA will only apply it to more sensitive or offensive content, as reported by Corrie Tan (2014). Hence, more explicit scenes of nudity are allowed if they are relevant to the theme and storyline of the film. Over the last three years, only a very small number of films and arts events have been disallowed. Out of 2,351 films classified during the period, only nine films (0.4%) were forbidden. Thus, a wide variety of diverse choices has been made available to Singapore consumers. This means even primary school children could watch any film, even though some parents may object to violence and sexual themes. PG-rated films will become milder and more innocuous. So long as warnings are prominently displayed, R21 films may also be permitted on cable and Internet TV.

Retorting to the CRC 2010 report, MCI had advised parents that they must take responsibility for protecting and guiding their children, and government shall provide parents with tools to enable them to exercise control over their children's media consumption. The industry that comprises the film makers, arts groups, broadcasters, publishers, content providers and ISPs must prepare to exercise greater responsibility and sensitivity. Unfortunately as the nation increasingly moves towards co-regulation, current technology such as Internet filter and parental lock systems have limited capabilities to effectively block contents that may be harmful to their children's learning and development.

The aim of the FYP is to provide home users with a technology that permits them to select various degrees of content suppression according to their level of acumens and discretions. The software is capable of liberalising the content suppression of digital media by allowing Internet service providers, digital content providers, and home users the empowerment to censor, rate and classifies digital media. By making use of the predefined content suppression pre-set earlier, the media player with built-in parental control capabilities allows viewers to access digital content directly from the repository stored in computer hard disk drives, set-top box, Blu-ray/DVD drives, CD-ROM or Internet television. When the media player in the computer plays a digital movie, the media player is capable of muting potentially objectionable words, skips over scenes or masks out images that might be offensive. The software is also capable of preserving different categories of media classification from an unimpeded multimedia file.

Media Player with Different Video Classification

The overview of the software architecture is shown in Figure 1. To retrieve a content suppressed digital file from the original media file, the software consists of four steps. First, the team invited the user to watch the original digital media file, and asked him/her to seek the objectionable scenes. The user could pause the video and mark out the expurgated data according to the time codes in the original media file. The software then fragments the original media file into smaller sub-file objects with equivalent size which was pre-defined by the user. After that, the Dynamic Sub-file Filter (DSF) would automatically associate the sub-file objects to their respective expurgated data marked in the first step. It would also edit the metadata information of these objects, such as the viewership permission and security attributes defined by the user. To store these metadata, the team leveraged the lightweight SQL database. Finally the censored file would be played back to user.

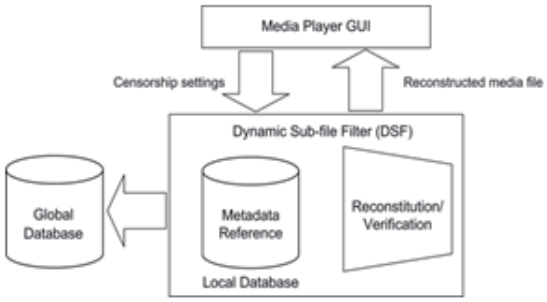


Figure 1: Overview of the system architecture

The FYP teams had adopted the user-selectable obscuration framework documented by Guo et al (2013). In order to allow parents to block scenes in the multimedia file that were deemed unsuitable for their children's viewing, they have integrated the parental controls functionality into the GUI of the media player. Content and service providers could also make use of the software to edit, censor and rate their digital videos before it is released to the public. Besides being capable of playing back most of the popular digital media formats, the software empowers the user to skip a potentially offensive scene by specifying its start and end times, mute or overlay "beep" to objectionable audio words, and blur out the unsavory objects in the scenes.

The media player is also capable of categorizing multiple marked out regions for different ratings. It would retrieve different classifications of digital content to different groups of viewer. For example,

when a 17 years old teenager tries to play a R21 multimedia file, the software would verify the permission and security attributes of the sub-file objects against the teenager's user identifier and authorization level before consigning those respective sub-file objects designated as NC-16 to him (see Figure 4). With the software, the user could create and manage different categories of media classification. Based on the properties of the media previously established by the user, the media player is capable of retrieving full, partial or censored digital media to the user.

The details of the grain size of the sub-file object, DSF (including object-based metadata reference, file-to-object mapping mechanisms and sub-file object reconstitution and verification algorithm) will be discussed in the following sections.

The Granularity of the Sub-file Objects

Before DSF examined the data set, the original media file was sliced into smaller segments with equivalent size. Upon the file fragmentation process, these sub-file objects would be stored in the local storage. They may also be stored across multiple storage devices to reduce redundancy. The grain size of these sub-file objects was pre-configured on per-file basis by user. It could be tremendously large or tiny. According to a separated study by a FYP team, when the size of the sub-file object increased, the processing time of assembling multimedia file would decrease. However, for the larger grain size of these sub-file objects, the more video frames would get cut off during video playback, viewers may experience discontinuing scenes. In contrast, if the size of the sub-file objects is very small, the processing time for the CPU to assemble the multimedia content would increase. But the audio and video playback would be much smoother. Such a fine-grained object size is adequate to mask out viewable details of any obscenity in the movie. By considering the efficiency of the process in the testing, the team set a proximate size of sub-file video objects to 128Kbytes or 256Kbytes, and the audio objects to 4Kbytes. In addition, during the file fragmentation process, each sub-file is prudently extricated and managed by a separate metadata with unique attributes. Each sub-file object could embrace discrete attributes that exhibited dissimilar behaviour at different operating condition. In the testing, the metadata information of the sub-files was managed by a lightweight SQL database.

A segment grouping was done for each classification profile. This information was stored as metadata in the database. Grouping is often different for different classification profiles. Each sub-file may be in a different group depending upon the censorship classification.

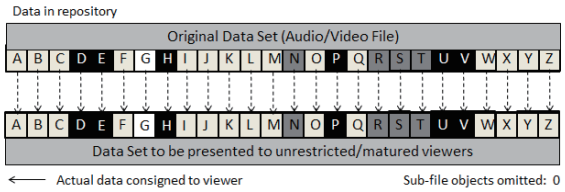


Figure 2: Digital content with no classification

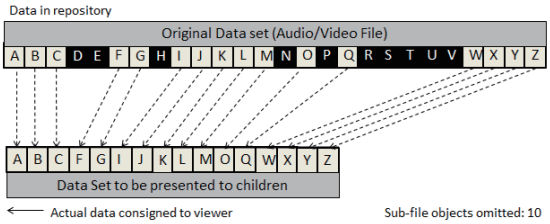


Figure 3: Digital content with sub-file objects been omitted by parents (PG classification)

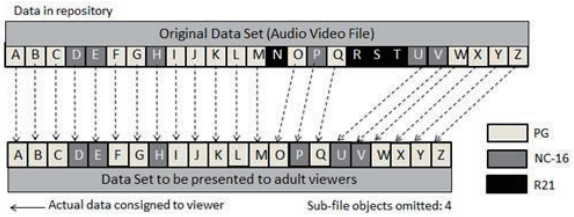


Figure 4: Digital content that unveiled only NC-16 classification

Dynamic Sub-file Filter

The DSF is designed and developed to examine the media file at the sub-file level after the file fragmentation process. After the sub-file objects are generated, the expurgated data marked according to the time codes in each film by the authority or user in step one was mapped to its respective sub-file objects. Then the software updates its metadata reference. The media player would need a manifest file which indexed all the multimedia files stored in the audio-video repository.

The repository can be any logical volume created by the system administrator. Once the credential was established, the media player would sift the manifest file to validate the existence of the specified multimedia file. If it returns a hit, it would then access the metadata reference to lookout for the list of qualified sub-file objects to be extracted from the local data storage, based on the existing permission and security information written on the attributes of each sub-file object stowed in the metadata reference.

Before the software retrieves and plays back the censored file to viewer, all sub-file objects entreated by the user must carry out the verification and reconstitution process. These processes were handled by the DSF, as illustrated in Figure 1. The project team has premeditated a sub-file object reconstitution and verification algorithm to optimize file segmentation and the reconstruction of digital contents in the DSF. Based on the parental control settings user defined, the algorithm further generates a censored media file to users without tampering the original media file. If a viewer has the access rights to the multimedia file, no sub-file objects should be omitted (see Figure 2).

There were two cases to consider for sub-file object reconstitution. Both were implemented by a slightly modified version of divide and conquer algorithm.

In the first case, when the sub-file size was set before division. Given that a video file of size 'N' kb and duration 'T' seconds has to be divided into sub-files every '*t*' seconds, then the sub file size was calculated by:

$$Sub\text{-}file\ size = (t/T) * N\ kb.$$

Conversely, given a sub-file size of '*S*' kb, the time spanned by each sub-file was given by:

$$t = (S / N) * T\ seconds.$$

Once the sub-file size was known, the video file was divided into '*n*' parts given by:

$$n = N / S,$$

where '*N*' refers to the total file size and '*S*' referred as the size of one sub-file. Chunks of size '*S* 'kb were read and stored in memory for further processing.

This method greatly improved the speed of reconstituting a video file because individual sub-files have to be 'added' to each other to obtain a reconstructed video.

For example, assume a video file was divided into 10 sub-files from A_1 to A_{10}. Say, we want to censor the times represented by sub-files A_7 and A_8. The team could obtain the censored file by:

$$Reconstituted\ file = A_1 + A_2 + A_3 + A_4 + A_5 + A_6 + A_9 + A_{10}$$

This method made it very convenient to create censored videos from sub-files since all that is needed to reconstruct a file was to append the sub-files to each other sequentially.

In the second method, sub-files were of varying sizes and were created depending upon the section of the video which has to be censored. Reconstruction happens by stitching together the sub-files as before. The advantage of this method is that it allowed for greater precision; it also makes division and reconstruction faster. For example, given a video file of '*T*' seconds having '*N*' censored, then the number of sub-files needed is reduced to:

$$Total\ sub\text{-}files = 2N + 1$$

This resulted in a lesser number of sub-files created as compared to the previous method.

During the multimedia playback, the software would process the read request to the specific multimedia file initiated by the user using a particular set of predefined rules and specifications. The software would authenticate the identity of the user and examine his/her credentials before retrieving the censored file to the user.

If a specific video has identical censorship classification that applies to a group of audiences, its metadata reference is portable and can be downloaded from any online file sharing services to different machines for viewership. This flexibility permits various Parent Support Groups (PSGs) to share content suppression information of popular movies online.

Transforming Software Design to Product Deliverable

The development process of the FYP was divided into 2 main building blocks called 'modules'. Due to the huge amount of software development work needed to be accomplished in the portable media player, each module has to be developed separately by different teams of FYP students in consecutive semesters.

- The media player was developed by students using Python 2.7.3. The Graphical User Interface (GUI) was implemented by wxPython 2.8.12.1. The GUI integrated with the MPlayer via the tool of MplayerCtrl 0.3.3. The project team further explored the FFMPEG library to extract digital media metadata and enable cross format conversion. The software is capable of playback across multiple digital media formats, such as MP4, AVI, WMV, MOV, FLV, Real, MKV, MP3 and CD/DVD/Blu-ray. FFMPEG is also used for frame extraction for object tracking and video masking purpose, and frame interpolation for video smoothening which was to

ameliorate the video discontinuity. For relational database management, the team had leveraged on Sqlite3 2.6.0.

- The functionalities of video segmentation and selective retrieval were developed by our students using Python programming language. The key purpose of these functions is to empower the user to skip a potentially offensive scene by specifying its start and end times, mute or overlay "beep" to objectionable audio words, and blur out the unsavory objects in the scenes. These tasks were accomplished by the DSF discussed earlier. After the duration of play time where scenes were omitted during the playback marked out by user, the software would map the marked out duration to the respective sub-file objects and edit the permission and security attributes associated with these objects. The next time when the viewer plays back the multimedia file, the software would verify these attributes in the sub-file objects for consent before consigning them to the viewer.

Under careful supervision, 3 teams of FYP students in each semester would contend each other to complete their assigned project as best as they could. For traceability and project grading purpose, our students manage their project development works using our in-house project module system.

As the overall process of students' work carried a much higher weightage than the quality of the deliverable in supervisor's assessment, we have to assure that our students were able to conform to the use of the conventional *Waterfall* model. Students would inertly learn this Software Development Life Cycle (SDLC) process of requirements gathering, analysis, designing, coding and testing phases through practicum.

Conclusion

FYP is a crucial part of polytechnic education in Singapore. This is the period where students work on significantly large projects, and therefore it is also an opportunity to learn project management and software development. The development of the parental control media player was carried out over a period of 4 academic semesters by 8 different teams of final year students, with close guidance by the lecturers from SOI. The final deliverable is capable of playing back digital media via audio and video files that has been censored by user using the dynamic sub-file filtering algorithm. It is also portable and it supports all sub-file objects cached in the video streaming server.

By engaging the students in FYPs, supervisors seek to provide them with the intellectual and practical skills needed to solve realistic problems. We are certain that through FYPs, our students will not only enrich themselves from the learning experience, but can also contribute something significant and relevant to the society at the same time.

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RESEARCH REPORT AND BUSINESS COMMUNICATIONS WRITING FOR KOSEN STUDENTS

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Abstract

Recently, systematic efforts to improve the English education at National Institutes of Technology (Kosens) in Japan have been undertaken. The implementation of standardized proficiency testing with a writing component (the GTEC), and the development of the Model Core Curriculum, can be cited as examples of this effort.
With regard to writing ability, many Institutes of Technology have expressed a desire for students to be able to do basic research writing and business communications (related to technology) in English. However, any effort to teach these in courses is hampered by two basic problems. The first is a lack of basic writing instruction to give students a foundation in composing skills, and second is the large number of students in classes, which makes it challenging to have students turn in significant numbers of reports that need to be graded by the teachers.
The implementation of the GTEC largely solves the first problem. This paper first explains why this is so. Next, it takes up the second problem of teaching research and business communications writing to large classes in the upper grades. The methods devised to do this at one National Institute of Technology are explained. A modified "process writing" approach is used, in which students write up to eight business emails in their 3rd year and up to eight Research Reports in their 4th year. With guidance as to organization and content, students write a first draft. Next they self-edit it, sometimes with feedback from peers or the teacher, and write a second draft. Individual writing conferences with teachers are brief or not included, as a trade off with the large numbers of students in each class. Grading is simplified so that large numbers of reports or emails can be scored relatively quickly. However, the crucial element of doing the task repeatedly is preserved, and thus students can "learn by doing".

Keywords: *English education, writing, research reports, business communications, process writing, genre*

Introduction

The teaching of writing in English programs at National Institutes of Technology has not had, until recently, any particular impetus for systematic implementation and development. This will change with the introduction of the GTEC, a standardized English proficiency testing program with a writing component. Kosens that use the GTEC will have a strong incentive to improve the basic writing abilities of their students so that they score higher on the test. The average scores of Kosens that have writing instruction will be higher than those that do not. Moreover, and this is not a trivial point, students who write more not only become better writers in English, but their overall all English ability increases because of the extensive practice (or output) that writing requires.

The writing component of the GTEC requires lower level students to compose short essays about topics that are familiar to them, such as "something you want to try, or think that you should try", and higher level students to write about more academic topics, including social problems or intercultural issues. To succeed in these tasks, students must have an idea what an appropriate essay looks like, and what is required in it. They must also have confidence that they have to skills to write a good essay. That is to say, they know how to introduce the topic, how to proceed through an explanation of the topic, how to use examples to enrich their explanation, how to organize the essay logically, and how to conclude effectively. It is important to point out here that these involve *cognitive* skills, in addition to grammar knowledge. Grammar instruction is important and necessary, but alone does not provide sufficient basis to develop composing ability. A brief explanation of this point will follow.

Starting in the 1970s, researchers began to inquire about the differences between experienced writers and inexperienced writers, in an effort to find ways to improve the writing abilities of college undergraduates. One result of this work was an important paper by Flower (1979) which explained rather conclusively the differences between experienced writers, who are able to produce effective texts, and inexperienced writers, who are not able to do this.

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Some of the striking differences are that experienced writers can plan their writing in advance, revise often to make their writing clearer, and are able to adopt the perspective of the reader in organizing the text. Inexperienced writers, on the other hand, have difficulty planning their writing, revise infrequently, and have difficulty adopting a reader's perspective. As a result, their writing tends to be poorly organized, lacking in explanation of important points, and unable to deliver a clear portrayal of the topic to the reader.

With this understanding of the plight of the inexperienced student writer, researchers proposed teaching methods that would help students compose more effectively. They proposed ways for students to think about the topics, such as brainstorming, and ways of writing more regularly, such as journals. They encouraged teachers to have students write drafts, which they would improve based upon the comments of the teacher, and they encouraged teachers to help students learn how to edit their own writing and to offer suggestions to others for improvement.

This approach became known as the "process approach to teaching writing", or simply "process writing". A good overview of the development of this approach and other important approaches can be found in Raimes (1991). Researchers also argued that the same basic principles of the process approach could be applied for the teaching of second language writing in either an ESL (English as a Second Language) setting, or in an EFL (English as a Foreign Language) setting, such as in Japan. When writing in English students not only practice the English structures that they have learned, they can also more quickly identify the vocabulary and grammar tools that they need to explain their ideas and express their feelings.

The process approach was not the only important new approach to be developed. The "genre orientation" (Hyland 2003), among others, provides an intensive understanding of the social context in which writing is used. That is, who the audience is, what the expectations are regarding form and content, what typical rhetorical patterns are used, and so on. A truly modern approach to teaching second language writing thus involves a synthetic approach that utilizes elements from different approaches in order to achieve the learning outcomes specified in the curriculum, taking the needs of the local context into consideration (Hyland, 2003). This is particularly true for the Kosen context, where English proficiency levels are generally low (approximately TOEIC 320), and where students are constrained in their writing by their knowledge of English vocabulary and grammar, in addition to being inexperienced writers.

Assuming a basic writing course will be put in place for the lower grades in Kosen English programs, it will be much easier to provide students with instruction in research and business communications writing in the upper grades. This leads to the main purpose of this paper, which is how to teach these types of writing to large classes in the upper grade levels. The method described below uses a modified process approach in a framework that requires students to write a lot. Here 'modified' means that students are instructed in the genres they will work in, and they write only two drafts of their paper. The teacher provides a limited amount of feedback to students on their first draft by circulating in the classroom and helping students. This latter point is regrettable, as feedback is a key feature of the learning process, but it is a reasonable trade off in order to preserve the repeated practice necessary to build up students' skills and knowledge.

As an aside, the methods described below have been implemented into a curriculum without the benefit of a basic composition course in the lower grade levels. This may have resulted in providing too much guidance to make up for the challenges in teaching low English proficiency, inexperienced writers. In any case, it is up the program designers and teachers to decide the appropriate amount of guidance versus challenge when devising the learning activities and assignments.

Materials, Methods and Pedagogy: Business Email

Students at the National Institute of Technology, Tsuyama College begin their English studies using primarily Education Ministry approved textbooks. However, starting in their 3rd year they use a textbook titled *Technical English: intermediate to advanced level* (2011), along with TOEIC books. In the *Technical English* book, they read and compose business communication emails and research reports. This textbook was jointly authored by Engineering and General Studies faculty at Tsuyama College, with the goal of exposing students to the type of English texts they will encounter in the worlds of research and business. The book does not focus on technical English *per se*, but is broader and more general. Its primary purpose is to introduce students to basic business communications (Part I) and research reading and writing (Part II).

This paper will proceed by first explaining a sample reading and writing assignment from Part I of the textbook, and discussing the teaching methods and desired outcomes. In Unit 5, students read an email about a company hoping to find a joint venture manufacturing partner. They first study the vocabulary, which includes words such as *planning, committee, joint venture, efficient, competition, strategic, state of the art,* and *negotiate*. Learning and understanding these words is important for understanding the text, and especially for writing the email at the end of the unit. An excerpt of the reading is shown in Figure 1.

Significant time is spent learning these words and basic concepts. The vocabulary, including meaning and spelling, is practiced using reading aloud, dictation and quizzes. This also includes studying parts of speech (compete-competition, strategy-strategic, etc.) as well as common collocations (*compete with, strategy for*, etc.). Additionally one or two specific language items are studied in each unit. In this unit, students study the use of "parallel verb structures", as in the first sentence of the first and last paragraphs in Figure 1. From a conceptual point of view, students must also learn what *joint ventures* are in the real world. The instructor provides simple examples of companies in Japan that

engage in joint ventures in order to help students understand why companies would want to engage in a joint venture.

TO:	Strategic Planning Committee
FROM:	Hugh Matheson, Director of Operations
RE:	Search for Joint Venture partner company
DATE:	July 20, 20__

As you know we are planning to design, manufacture, and sell an all new business jet, the Galaxy Hawk I.

The market for business jets is highly competitive. However, we have new design technology... But we are still too small to build the aircraft by ourselves. So we must find a partner company with advanced manufacturing expertise and propose a joint venture.

I have selected two companies that could be good partners. They are: Yokohama Precision Technologies (YPT) and…

YPT designs and manufactures a broad range of heavy machinery, ... It is headquartered in Yokohama, Japan, has annual sales of $11 billion, and has 23,500 employees. Most importantly for us, YPT manufactures wings for passenger jets. This is state of the art composite material manufacturing...

Figure 1. Excerpt from *Technical English* (2011), p. 29. Reprinted with permission from the publisher.

It should be noted that this study of joint ventures can be made very interesting and motivating for students. Kosen students, and engineering students in general, are devoted users of machinery like smart phones and motorcycles. They know the companies that make these products, and have developed feelings of loyalty to certain companies. But the larger picture of how companies operate in the business world is a step up for most of these students. Teachers are thus tasked with giving concrete examples to help students learn these concepts at a basic level (Given the status of English as an international language for business and technology, this type of knowledge is important for English teachers to be able to use for materials design.)

The critical information in the email is the purpose (the "search for a joint venture partner company") and the specific company information (for YPT), which includes *products*, *headquarters*, *sales*, *employees*, and *expertise*. Students also learn these words and concepts, and then are tasked with writing an email in which they select two companies to recommend for a joint venture. The context changes from airplanes to automobiles, and the students read the assignment guidelines shown in Figure 2.

Once students understand the situation, they must select two companies and find the basic information for each company (products, headquarters, sales, and employees). This can be easily accomplished by consulting Wikipedia, among other websites. A little more challenging is finding a particular area of expertise for each company. Once armed with this information, however, the email is relatively easy to write.

The Situation

You work for a Japanese car company that is developing a new all electric "Green Car". In order to reduce risk and gain expertise, your boss wants to form a joint venture with foreign car company.

Your boss tells you to research one American company and one European company. Choose two of the companies below. Next, research the companies on the internet. Then write your email report on the companies to the "Vice President for Joint Ventures".

（あなたは新しい電動の「グリーンカー」を開発している日本の自動車会社で働いています...）

American Companies	▸ Ford Motor Company ▸ General Motors Company ▸ Chrysler Group LLC
European Companies	▸ Bayerische Motoren Werke AG (BMW) ▸ Volkswagen AG ▸ PSA Peugeot Citroën (Peugeot S.A.) ▸ etc.

Figure 2. Excerpt from *Technical English* (2011), p. 32. Reprinted with permission.

First the instructor queries the students as to the purpose of the email, and to whom it is addressed. Next he or she queries the students as to the organization of the email, that is, the statement of purpose and the explanatory paragraphs. Some students, based on their work in the first four units, will likely suggest an introduction, separate paragraphs for each of the selected companies, and a final paragraph for concluding remarks. The instructor has students choose their two companies, and for homework, to do the basic research, print the information, and bring it to the next class.

In some cases, the skeletal information based on the teacher's queries mentioned above may be enough for students to get started on the email. In the case of the author's classes, which comprised up to four classes of about 40 students in each class, it was not sufficient, and more detailed guidance was necessary because of the mixed English and motivation levels of the students. Some students could handle the assignment without the guidance, others would struggle without it. Therefore, in the next class, the guidance regarding organization and content shown in Figure 3 was provided by projector.

Students begin their first draft in class, writing directly in the textbook. This allows the instructor to circulate in the classroom, helping students and answering questions. Students tend to work diligently on the email. It is worth mentioning at this point that the email, along with quizzes, is worth 50% of the students' course grade. Therefore, students have good reason to take the assignment seriously. Moreover, many students see this as work worth doing, that will help improve their command of English. Students type the second draft for homework, endeavouring to lengthen the explanation, utilize the expressions learned in classes, and, of course, spell check the document.

TO: _____
FROM: _____ (your name)
RE: _____
DATE: _____

As you know, we are developing an all new electric "Green Car". We need to find a good _____ _____ partner company to help us develop and… In this email I will ...

The first company is _____. I will explain my research on this company. The headquarters is in… This company makes… The annual sales are… The strong points…

The second company is _____ . I will explain my research…

Both of these companies…

Figure 3. Guidance for the Email.

Turning next to assessment, the emails are graded mainly on content and explanation. Thus if students have clearly stated the purpose, and then gone on to explain the main points and the reasons that support their positions, they will receive a good grade. However, the formatting of the email, the use of the target expressions, generally correct grammar, and correct spelling also count towards the grade. Based on these criteria, shown below in Figure 4, the teacher assigns a grade, without writing comments on the paper, or highlighting mistakes. While this lack of feedback is regrettable, it is the only way a large number of papers can be scored without placing undue burdens on teachers. (In the author's classes, typically the mistakes in the first email are thoroughly pointed out, but after this it is up to the student to consult the teacher if he or she wishes to see the grammar mistakes before or after submitting the email)

1. The formatting of the email is correct.
2. The organization of the email is logical.
3. The main points are explained clearly.
4. The target expressions or structures are used correctly.
5. The grammar is generally correct.
6. The spelling is correct.

Figure 4. Criteria for grading of the Email.

Students are told that the main grading criterion is their effort to explain the main points. To do this they will have to take chances, and the more they try to explain, the more grammar mistakes they are likely to make. Therefore, grammar mistakes result in the loss of some points, but if the main points are explained in comprehensible English, and the overall organization is logical, they will still receive a reasonably good grade.

Materials, Methods and Pedagogy: Research Reports

A similar explanation will be given for the Research Reports, which are done in the 4th year using Part II of the *Technical English* textbook. Students again begin with vocabulary study, and read a research report. The reports are authentic, that is, written by engineering professors using standard organization for profession reports. However, they are simplified and reduced to one page.

In the example in Figure 5, students read a report titled "Drag force and car design". By the time they get to this unit, they are thoroughly familiar with the typical INTRODUCTION - METHOD - RESULTS - CONCLUSION basic organization (along with some variations, such as CIRCUIT in place of METHOD). They learn about the function of the Abstract, about the importance of quoting and citing references. They know about, and practice, ways to point the reader to figures and charts and how to explain these in the text of the report.

Drag force and car design

Abstract

...Small car models were placed in a wind tunnel, and the drag force was calculated...

1. Introduction

An object which is placed in a flow is subjected to a drag force. In this experiment, we measure the drag of a car body. Figure 1 shows…

2. Method

Figure 3 shows the apparatus that was used to…

3. Results

Table 1 shows the measurement results for one car body shape, the Ferrari…

4. Conclusion

In this experiment we determined the drag acting on a car body. By improving the…

Figure 5. Excerpt from *Technical English* (2011), p. 99. Reprinted with permission.

Next they do the integrated skills exercise, shown in Figure 6, in which they demonstrate their understanding of the reading. The discussion of this activity, something of a digression, has been included here to underscore the connections between reading, writing, and speaking in language learning. For the author's classes, time is needed for students to plan before they begin the exercise with their partner. Regarding step 3, students know that some people will be selected randomly to stand up and speak, which adds some useful tension to the activity and tends to motivate students to take step 2 more seriously. Most importantly, this activity gives students practice looking for important points in a research report, and being able to "see" the whole project in their head. This is an essential skill for students to develop, so that they can

use research papers written in English, even if they cannot understand everything in the paper.

1. Prepare a **verbal summary** of the study. Use the following cues:
   - The purpose of this ... - The results showed...
   - The method is to... - The conclusion is...
2. Practice with a partner.
3. Stand up and summarize the study for the class.

▸ I gave my summary confidently, with good English:
☐ Yes ☐ Need improvement

Figure 6. Excerpt from *Technical English* (2011), p. 100. Reprinted with permission.

Having thoroughly studied the reading text, students turn to writing their report for the unit, and think about the brief guidance provided in the book and shown below in Figure 7. (Students must download the data tables and charts from the publisher's homepage. These are the figures and tables referred to in Figure 7.) Since students write up to 8 reports, they become used to downloading the data, formatting it on the page, and explaining it in the sections of the report. What this achieves, in effect, is a lot of practice for students. Thus with a limited amount of class time, and in large classes, students are able (or rather, required) to write several reports.

Title: **Pressure drag for different car types**

INTRODUCTION:
- Reducing drag is necessary for car design. Why? See Figs. 1, 2.
- Measure the drag coefficient for Honda Fit and Lamborghini Countach.

METHOD:
- See Figs. 1, 2, 3. Explain them.

RESULTS:
- See Tables 1, 2, 3. Explain and interpret the results.

CONCLUSION:
- Restate the results and comment.

Figure 7. Excerpt from *Technical English* (2011), p. 101. Reprinted with permission.

To begin the report, the instructor queries the students about the purpose and structure of the report, and then on how to explain and interpret the figures. In the author's classes, the guidance shown in Figure 8 (which is also included in the teacher's manual for the textbook) is used to help structure the queries to the students. Students begin writing, and again the instructor circulates, answering questions and checking work. Students complete their reports outside of class and submit them at the beginning of next class. Students can help each other understand the assignment, but they must write the report on their own. If a report is copied from another student, both the writer and the copier are strictly penalized.

I. _____

Reducing drag is...
The purpose of this experiment is...
Figure 1 shows... The formula for...

Fig. 1 Body of a car traveling at...

2. _____

Please see Fig. 2. It shows...
As you can see... Our research question is...

3. _____

Table 1 shows...As you can see...
Why is this? ...

4. _____

In this experiment we measured... We found that...

Figure 8. Excerpt of guidance for the Research Report.

Assessment is similar to the procedures for the Email, following the criteria shown in Figure 9. Again, the assessment is focused on content and explanation, particularly with regard to explanation and interpretation of the figures and tables.

1. The formatting of the report is correct.
2. The organization of the report is logical.
3. The main points are explained clearly.
4. The figures are explained well in the text, and the data is interpreted effectively.
5. The target expressions or structures are used correctly.
6. The grammar is generally correct.
7. The spelling is correct.

Figure 9. Criteria for grading of the Report.

Results and Discussion

For both the Email and the Research Reports, all students in the required 3rd and 4th year English classes submit typed documents, with the Reports including figures and tables. The quality of the student work is varied, but most of the students' work meets the requirements discussed above in a generally satisfactory manner.

When students have problems with formatting or organization, these are usually remedied in the next paper. More challenging is for students to write longer explanations, and the most challenging is to develop a confident writing voice in English. The basic goals for the assignments, however, are met by most students. That is to say, they know how to plan an Email and a Research Report in English, they have cognitive and linguistic strategies that they can employ in order to write the paper, they are able to revise and improve the document to some degree, and they have some fundamental understanding about the genres.

Most of the papers contain grammatical errors, and most display simple explanation patterns. This is to be

expected with students at this English proficiency level. Since the errors are not corrected during the grading, this represents a missed learning opportunity. Similarly, since places in the text that need to be expanded or reorganized are not brought to the students' attention (unless individual students ask for this, which many do), this represents another missed learning opportunity. However, the students write often and receive the support they need to develop their writing skills and their vocabulary and grammar competency. In so far as they achieve these goals, the materials and approaches are successful.

Much effort has been put into finding a good balance between having students write a lot (that is, to write 8 emails in one year, and 8 research reports the next) and having their work being grammatically and formally correct. Initially too much emphasis was placed on writing a lot, and some students likely felt frustrated by not having the linguistic tools needed to do the assignments well. Therefore teachers were encouraged to devise and teach students on basic grammar points important for the writing, and the number of "finished product" emails and reports was reduced.

Conclusions

This paper has discussed the methodology used to teach basic business communications and research writing at one National Institute of Technology in Japan. A modified process approach is used that emphasizes teaching students about the genres of business email and research reports, provides instruction regarding vocabulary and grammar used in those genres, and, most importantly, requires students to write and edit several two-draft Emails and Research Reports.

The author argues that this approach, which can be characterized as a synthetic approach (Hyland 2003), has proven effective in teaching basic research and business communications writing to Kosen students in large class settings. It would be even more effective should a basic composition course, geared to the GTEC, be introduced in the lower grades.

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A REVIEW ON ADOPTING ENGLISH TEXTBOOK FOR ELECTRIC CIRCUIT – APPLYING FLIPPED TEACHING -

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Abstract

Innovation in telecommunications, Information technology and transportation has dramatically changed our life style and promoted globalization. Because of such backgrounds, the Japanese government has established many special programs to help Japanese students to become transnational leaders. The Japanese government is focusing on English education in Japan and English became a compulsory course at elementary schools to improve young people's English skills. Kumamoto College is no exception and all our students have to take English lessons; Year-4 students have to take Technical English I and some of Year-5 students can take Technical English II which is subsequent of Technical English I. One of our school ideas is to educate students to become engineers who play an important role for the world. Therefore it's good for our students to acquire/study technical knowledge and skills on computer science, electric circuits and so forth in English.

This paper presents the adopting of English textbook in the teaching electric circuit I, a third year technical course in Department of Control and Information systems (CI) in Kumamoto College. According to curriculum of CI dept., all year-1 students have to study Fundamental electric circuit that covers Direct Current (DC) circuits and its applications, and Fundamental electric circuit II covering Alternating Current (AC) circuits is compulsory to students to study. Therefore all of third year students of CI dept. have fundamental knowledge on electric circuits, and the knowledge helps students to understand some circuit theorems that are new to students even though explained in English. Furthermore, in order to keep students' motivation high, I adopted flipped teaching approach to this class. Students can study the content via learning video over and over again before they attend a class and the videos promote students' understanding of electric circuit.

I performed an analysis of effects and problems of adopting English textbook with flipped teaching approach based on the results of a questionnaire and feedback from students.

Keywords: *Adopting technical books written in English, flipped classroom*

Introduction

Recently, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) has tried to change English education dramatically in order to respond to a rapid globalization and MEXT announced the English Education Reform Plan responding to the Rapid Globalization on December 2013. According to the report made by MEXT [the Ministry of Education, Culture, Sports, Science and Technology 2014], the development of students' English proficiency is crucial for Japan's future.

It is obvious that English is one of the common international languages and nowadays English is the most important language to greatly expand opportunities for students who will live in the global society. Based on this idea, MEXT adopted An Action Plan to Cultivate "Japanese with English Abilities" in 2003. To speak of extremes, MEXT decided on a policy to improve students' English proficiency and has encouraged institutions to change English teaching style. For example, they adopted the Top Global University Project that is a funding project for universities in Japan. This project aims to enhance the international compatibility and competitiveness of university in Japan.

National Institute of Technology, of course, has encouraged each college to enhance English education for several years. In Kumamoto College, English lecturers have also tried aggressively to foster students' English abilities. They holds English vocabulary contest several times in a year, English interview and so on. Moreover, some lecturers of technical departments deliver technical knowledge in English and others adopted textbooks written in English. This paper reports on introducing English textbooks for technical class in Kumamoto College.

Target students and classes

In Kumamoto College, students belonging to Department of Control and Information Systems Engineering (CI) have to study direct current circuit in the first year and alternative current circuit in the second year. These two courses provide students with a solid foundation of knowledge on electric circuits and concepts, to prepare them for subsequent circuit-related courses. In the third year, students have to learn advanced electrical theory of circuit. These courses' contents are closely linked to each other.

Because of poor English proficiency, it is easy to imagine that JP students may not understand any contents of classes if they don't have prerequisite knowledge when they use a textbook written in English as learning material. From the viewpoint of students' grasping knowledge, it seems to be better to introduce English textbook to such technical classes that continue for several years. Therefore I decided to adopt English textbook as one of teaching materials for Year-3 students belonging to Dept. of CI. In order to help students understand contents of the textbook, I chose the one that contains lots of figures, diagrams, graphs and equations. Also, practice problems and examples are useful to enrich students' understanding.

Methodology

A new instructional strategy, flipped classroom [KNEWTON], has been getting popular since 2000. Recent rapid progress of computer and IT technology brought great benefits to us and it enabled us to implement flipped using tablet PC, Open Educational Resources, and the Internet. In Japan, flipped classroom is currently grabbing attention of educational institutions, not only elementary schools and secondary schools, but also universities, colleges and institutions of technology [Katsusuke SHIGETA(2013)]. K. SHIGETA reports advantages of flipped classroom and implies flipped classroom is expected to improve students' outcomes. Prof. Hanawa in Yamanashi University is a pioneer who introduced flipped classroom to his university, and the university is now publishing a video of his class through the Internet [Yamanashi University].

In my class, 15 mins long teaching video is uploaded to the web server in advance. Content of the video is technical topic of the week and students can watch the video over and over again. Figure 1 shows an example of the teaching video. As shown in Figure 1, I recorded PowerPoint presentation only in order for students to be able to concentrate on the teaching video.

At the beginning of the class, each student receives a sheet of handout. Some practical problems are printed on the handout and students have to solve the problems collaborating with other students by the class ends. Therefore only students who watched the video can participate in class otherwise he/she cannot discuss how to solve the problems. At the end of the class, all students need to submit the handout as a report of the class.

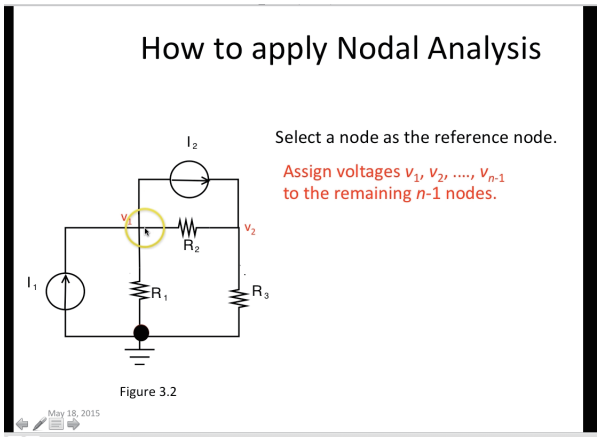


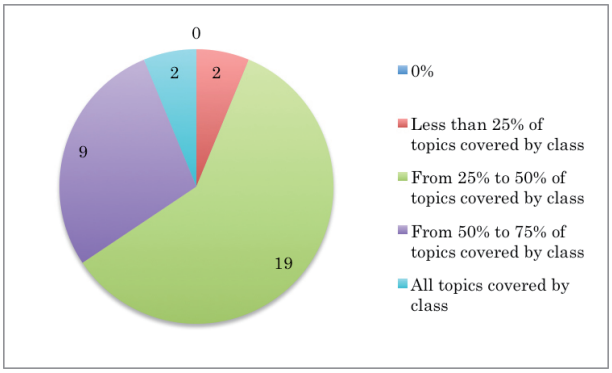
Figure 1 Example of teaching video

CI Year-3 students follow this learning procedure every week, and then they have midterm exams in June.

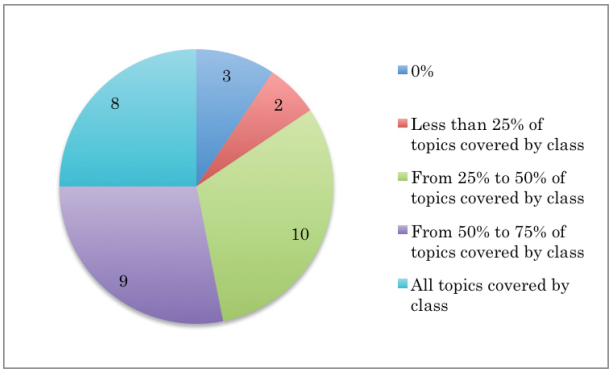
Questionnaire survey result and Feedback from students

I conducted survey on the students' study habits and got feedback from 32 students. Each answer from students is shown in each pie chart.

Q1. What percentage of contents covered by class did you study by reading textbooks written in English?

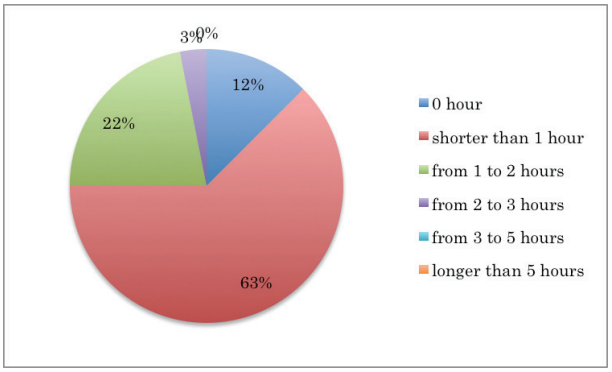


Q2. What percentage of contents covered by class do you usually study by reading textbooks written in Japanese?

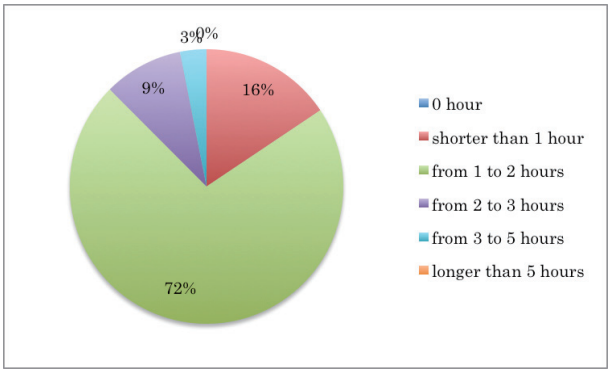


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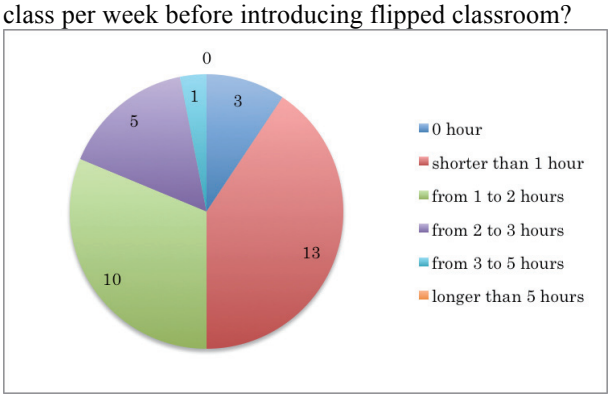
Q3. How many hours did you study for preparation of a class a week before introducing flipped classroom?



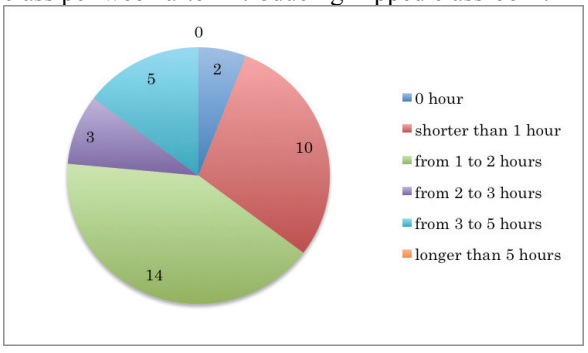
Q4. How many hours did you study for preparation of a class a week after introducing flipped classroom?



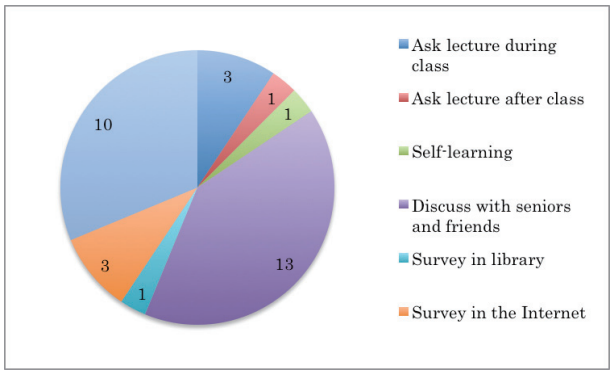
Q5. How many hours did you study for reviewing a class per week before introducing flipped classroom?



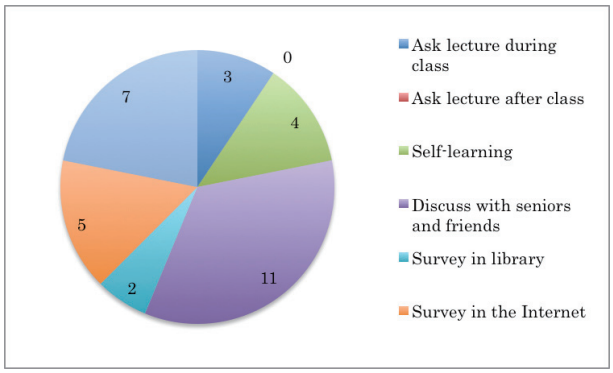
Q6. How many hours did you study for reviewing a class per week after introducing flipped classroom?



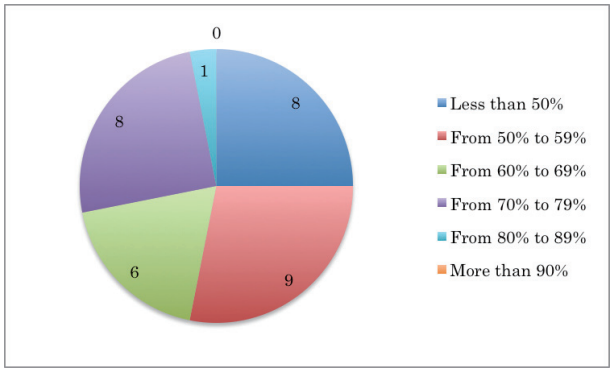
Q7. What was the most effective for you to understand contents of class?



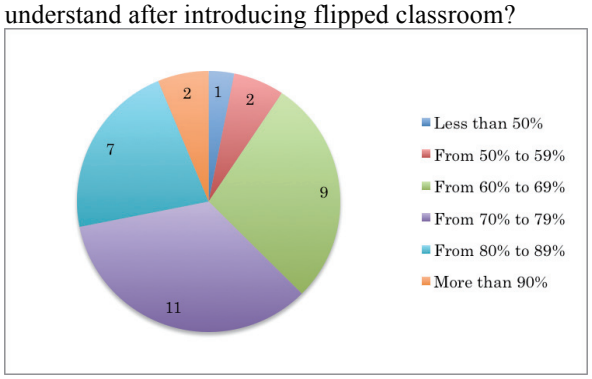
Q8. What was the second effective for you to understand contents of class?ng a class per week after introducing flipped classroom?



Q9.How much of contents of class did you understand before introducing flipped classroom?

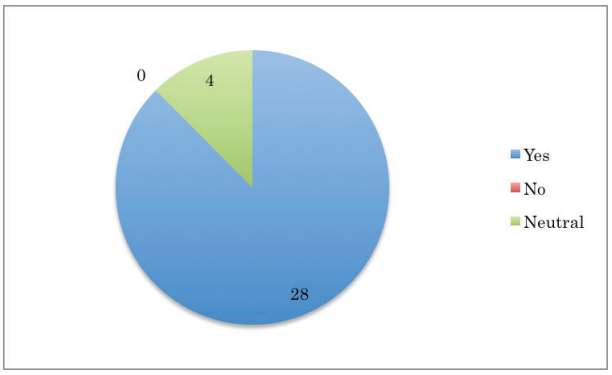


Q10.How much of contents of class did you understand after introducing flipped classroom?



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Q11.Do you agree to introduce flipped classroom?



Some of comments from students are listed below.

- It was not easy to read English textbook, but teaching video helped me to understand contents of the textbook.
- I could watch the video whenever I wanted to study, so the video was very helpful.
- This video gave me motivation to do preparation for class every week.
- It's better to improve recording quality.

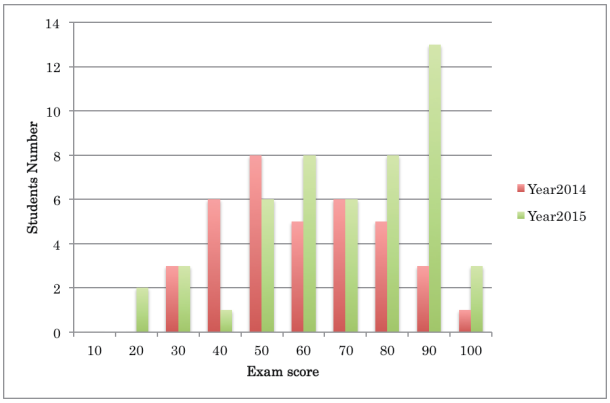


Figure 2 Exam score distribution in 2014 and 2015 of Electric circuit

Results and Discussion

Difference between answers of Q1 and Q2 shows that less than half of the students couldn't study 50% of topics covered in class by reading textbook written in English. This evidence implies that it was not easy for the students to read English textbook, but they tried to read the textbook hard because every student read at least a few pages of the textbook though 3 out of the students don't read Japanese textbooks.

Comparing answers for Q3 and Q4, it is obvious that students studied longer after introducing flipped classroom. Furthermore answers for Q5 and Q6 show similar result that students' study hours for reviewing got longer by introducing flipped classroom.

Answers for Q9 and Q10 show that flipped classroom enriched students' understanding. Answer for Q11 shows that all students agree to introduceing flipped classroom and they found flipped teaching style helps students to study deeply.

Finally, Figure 2 shows exam score of mid-term exams in 2014 and 2015. When the examination was conducted in 2014, flipped classroom was not adopted yet. Therefore we can see the effectiveness on exam score of flipped classroom. As shown in this figure, exam scores in 2015 is slightly higher than the one in 2014.

Conclusions

As shown in questionnaire survey result and feedback from students, flipped classroom enriched students' learning effect and most of students prefer participating in flipped classroom rather than traditional lecture. Also the exam score distribution shows that All in all, even though teaching materials were written in English, level of students' understanding was not degraded.

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SYSTEM DESIGN EDUCATION PROGRAM TO PRODUCE INNOVATIVE PERSONNEL

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Abstract

Our college established a new program called "System Design Education Program", which is managed by System Design Innovation Center to provide an excellent opportunity to learn about system thinking, design thinking and facilitation skill. The education program consistently opens the Basic Course from the fourth grade of the regular course and the Expert Course from the first grade of the advanced course. Study of Self-Development Subject and Basic Seminar of Program Study are arranged for the Basic Course, and Study of Debate Skill, Special Seminar of Program Study I, II and Engineering Design Exercise are arranged for the Expert Course. For example, Study of Self-Development Subject provides the chance to learn logical thinking, management method of meeting and planning. Engineering Design Exercise provides the chance to learn communication skill, agreement formation of working group, and psychology of creative activity, since such basic social skills for working with a variety of people are essential as well as basic academic skills in these days. One principle to manage the education program is "Regional Cooperation of Education". As an example of the principle, a practice theme of planning for Study of Self-Development Subject is construction management of a concrete building, which is practically engaged by a regional constructor. At the last class, regional constructors participated the presentation session of planning and gave planners some advice from a view of a customer. Another principle to manage the education program is the Japanese language "Hangaku Hankyou", which is advocated by Keio University Founder Yukichi Fukuzawa. The Japanese meaning is a mutual learning spirit regardless of the role of professor or student in college. For instance, new professors of our college participate in Engineering Design Exercise as a member of students. They can learn not only the basic social skills but also class design for active learning or project-based learning without additional cost of training.

Keywords: *Innovative personnel, Sysem thinking, Design thinking, Facilitation, Regional Cooperation, Hangaku Hankyou*

Introduction

The rapid development of technology and globalization embarrass engineers to face large-scale and complicated problems. Also, shortening of product life cycle compels engineers to find swiftly proper solutions in upstream side of manufacturing. Such change of the industrial structure yields a demand of personnel to promote innovation. The innovative personnel to lead the future can create something, sympathize others, excel the pattern recognition, and find the meaning in a matter (Pink, D.H., 2006).

Our college established a new education program called System Design Education Program (SDEP) to learn about system thinking, design thinking and facilitation skill, which seem to be required as innovative personnel. System thinking means paying attention to connection during each element and interaction related to 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 support of consensus building and mutual understanding in meetings (Oishi, K., 2011).

Figure 1 shows the curriculum of SDEP established from the fourth grade of the regular course to the second grade of the advanced course. The education program consistently opens the Basic Course from the fourth grade of the regular course and the Expert Course from the first grade of the advanced course. Study of Self-Development Subject and Basic Seminar of Program Study are arranged for the Basic Course, and Study of Debate Skill, Special Seminar of Program Study I, II and Engineering Design Exercise are arranged for the Expert Course.

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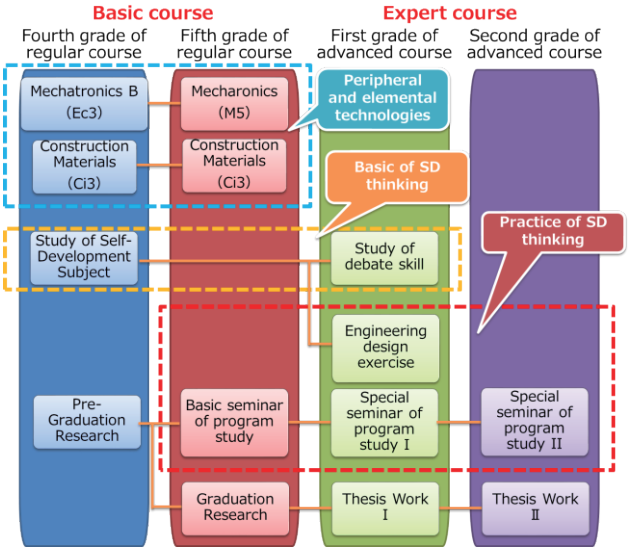


Figure 1 Curriculum of System Design Education Program in NIT, Nagaoka College

Table 1 Educational content in Engineering Design Exercise

Week	Content
1	Guidance, Dividing all students into each group, Ice-break 1, Lecture and practice of meeting method with engineering facilitation
2	Lecture and practice of consensus building with engineering facilitation, Ice-break 2
3	Lecture and practice “What is planning?”
4	Explanation of design theme, Planning
5	Planning
6	Preparation for presentation of planning
7	Presentation of planning
8	Trial based PDCA cycle
9	Trial based PDCA cycle
10	Design review
11	Trial based PDCA cycle
12	Trial based PDCA cycle
13	Final examination and evaluation
14	Preparation for presentation of outcome
15	Presentation of outcome

For example, Table 1 shows the educational content in Engineering Design Exercise (Toyama, S., Tokoi, Y., and Iyama, T., 2014, Toyama, S., Miyakoshi, K., and Tasaki, Y., 2015, Iyama, T., Toyama, S., and Tokoi, Y., 2015). From Week 1 to Week 3, some lectures and practices are prepared as shown in Figure 2. From Week 4, the students challenge planning for a design theme, present their planning, and discuss with teachers as shown in Figure 3. After the presentation of planning, the students continue trial and error process based on PDCA cycle from Week 8 to Week 14 as shown in Figure 4. Finally, they present their outcome for the design theme.



Figure 2 Practice of consensus building with engineering facilitation



(a)Presentation of planning



(b)Discussion with teachers

Figure 3 Presentation of planning



Figure 4 Trial based PDCA cycle



Figure 5 Presentation of outcome

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The new education program is steered by System Design Innovation Center, whose staff consist of various departments in our college. The principles of the center are "Regional Cooperation of Education" and the Japanese language "Hangaku Hankyou". Based on those principles, the center devise management of the education program.

Regional cooperation of education

One principle to manage the education program is "Regional Cooperation of Education". Study of Self-Development Subject, which has the educational content shown in Table 2, is a representative example. The students learn logical thinking and its basic tools, such as pyramid structure, logic tree, frame type tool and flow type tool, from Week 1 to Week 5, and learn facilitation skills, such as ice-break, meeting method and consensus building, from Week 6 to Week 8. After that, they start planning of a design theme by utilizing such thinking and skills.

The design theme is offered by regional companies. For example, the design theme in 2014 was construction management of a concrete building, which was practically engaged by a regional constructor as shown in Figure 6 and Figure 7. After placing concrete for such concrete building, operators adequately should compact it with a vibrator to avoid cold joint. However, it is difficult for them to insert the vibrator to appropriate height shown in Figure 8, since the distance between the operators and the vibrator is several meters and the tip of the vibrator is into the darkness. Therefore, the students designed some systems to manage the height of the vibration.

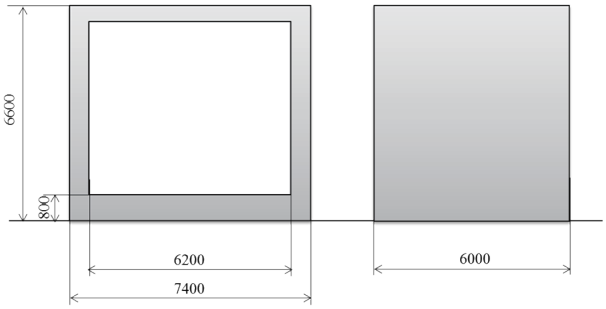
At the last class, regional constructors participated the presentation session of planning and gave planners some advice from a view of a customer as shown in Figure 9.

Table 2 Educational content in Study of Self-Development

Week	Content
1	Guidance, Logical thinking
2	Logical thinking
3	Logical thinking
4	Logical thinking
5	Logical thinking
6	Engineering facilitation
7	Engineering facilitation
8	Engineering facilitation
9	Planning for design theme
10	Planning for design theme
11	Planning for design theme
12	Planning for design theme
13	Planning for design theme
14	Presentation of planning
15	Report



(a) Overview of box culvert building site



(b) Model of box culvert

Figure 6 Box culvert building site in Nagaoka west to east road



Figure 7 Placing and compaction of concrete

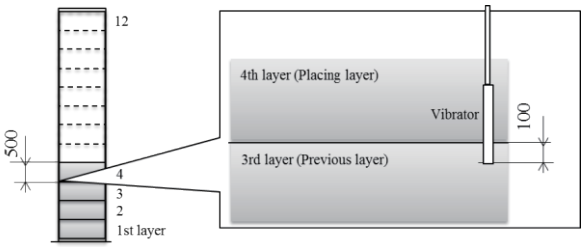


Figure8 Appropriate height of vibrator to avoid cold joint



Figure 9 Presentation of planning with regional constructors

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Hangaku hankyou

Another principle to manage the education program is the Japanese language "Hangaku Hankyou", which is advocated by Keio University Founder Yukichi Fukuzawa. The Japanese meaning is a mutual learning spirit regardless of the role of professor or student in college. For instance, new professors of our college participate in Engineering Design Exercise as a member of students as shown in Figure 10. They can learn not only the basic social skills but also class design for active learning or project-based learning without additional cost of training.



Figure 10 New professors in Engineering Design Exercise

Conclusions

Our college established a new program called "System Design Education Program", which is managed by System Design Innovation Center to provide an excellent opportunity to learn about system thinking, design thinking and facilitation skill. System Design Innovation Center will utilize the knowledge obtained through the management of the project based learnings, such as Engineering Design Exercise and Study of Self-Development Subject, for activating multidisciplinary cooperation of our college in order to acquire large-scale external funds. As a result, the center aims at a synergy effect of education and academic study.

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Investigation of the Introduction of English in the major subjects using classroom trainer skills of CTT+

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Abstract

Recently, the instructional style of major subjects in Japanese schools has changed, not only because technical knowledge is necessary but also, problem solving abilities, and English communication skills are required for global engineers in engineering fields. Several educational institutes have proceeded with the introduction of Active Learning, e.g. Problem-based/Project-based learning, in response to this social situation.

With this in mind, we focused on the improvement of our lecture skills using CompTIA Certified Technical Trainer (CTT+) certification. CTT+ is one of the international certificates that cover instructor skills including presentation, communication and facilitation. We think that the reinforcement of teacher's lecture skills is essential to develop the class adapting to globalization. It is necessary to pass two examinations, one which is a computer-based test and the other a performance-based test, to attain certification. In our college, two teachers, Assoc. prof. Yamamoto and Assoc. prof. Yoshida, have gained certification in CTT+ in recent years, and we have started offering classes utilizing CTT+ skills, which include using a variety of media, active listening techniques and a number of types and levels of questions, and major subjects using English.

In fermentation technology which is a major subject for 4th grade students conducted by Assoc. Prof. Yamamoto, for example, pair or group work, several types of questions, active listening and creating of discussion time were adopted positively utilizing English during the review section of the class lasting around ten minutes. It is thought that the feeling of participation of students in the class is enhanced by the use of CTT+ skills.

From the results of the class evaluation questionnaire, on the other hand, it was clear that resistance to learning major subjects in English was strong even though students recognized the necessity of English. Thus, we think that further consideration is needed on the methods of the class that relates English to major subjects.

Keywords: *CTT+, Active Learning, Major subject in English, Presentation, Facilitation*

Introduction

In recent years, with the background of globalization of corporate activities and so forth, the vision of desired human resources is changing. Language ability, problem solving ability, cultural competency and cross-cultural understanding ability are required for engineers as well as technical knowledge and skills (Figure 1). In fact, the job opening-to-application ratio for engineers as a global human resource maintains a high level of demand in a wide range of industries (Table 1).

Based on such social background, the educational front is forced to realign the instructional system. Several educational institutes have proceeded with the introduction of Active Learning, e.g. Problem-based/Project-based learning, in response to this global situation.



Figure 1. Vision of global human resource.

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Table 1. Ratio of job offers to applicants for global job-change in 2014

	2014												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Ave**
IT engineer	1.84	1.76	2.97	2.04	2.47	2.78	2.54	2.73	2.57	2.68	2.51	1.97	**2.41**
Electrical engineer	2.60	0.73	0.75	1.36	1.37	2.33	2.00	3.33	2.12	2.12	1.82	3.57	**2.01**
Mechanical engineer	3.06	3.28	2.48	5.23	2.89	2.79	4.38	4.00	7.60	2.52	5.00	2.07	**3.78**
Medical/Bio/Food engineer	2.91	1.85	2.89	2.36	0.85	2.47	1.63	3.78	2.42	4.13	5.60	1.80	**2.72**
Civil/Architect engineer	2.11	1.11	2.50	3.80	1.00	2.13	2.57	1.10	3.00	0.86	2.00	3.00	**2.10**
Office work	1.34	0.81	0.94	1.24	0.99	1.33	1.33	1.09	1.00	0.88	1.10	0.80	**1.07**
Hotel/Leisure/Travel/Food service	0.50	0.00	0.40	0.50	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	**0.13**

(Reference: News Release of Daijob HR Club, NO41-20150226DGR)

For example, since 2010, NIT, Hachinohe College has been working on global PBL workshops with Temasek Polytechnic, a national polytechnic located in Singapore. To develop an attainment as global talent, in this workshop, the group consisting of mixed members of both Japanese and Singaporean students perform workshops related to bio-engineering, electronics and cross-cultural understanding.

We believe that the improvement of our lecture skills is most important to guarantee educational quality corresponding to globalization, and focus on the using CompTIA, which is the Computing Technology Industry Association, Certified Technical Trainer (CTT+) certification. CTT+ is an international, vendor-neutral certification that covers core instructor skills, including preparation, presentation, communication, facilitation and evaluation in both a traditional and virtual classroom environment (Reference: CompTIA Homepage). This qualification is recommended to trainers in Dell, Microsoft, Novell, Ricoh and IBM. CTT+ is comprised of three skills including presentation skill, communication skill and instruction skill (Figure 2). All of these skills are necessary to perform more effective classes, and are common in Japanese and English. We think that the reinforcement of teacher's lecture skills is essential to develop the class adapting to globalization. It is necessary to pass two examinations, one which is a computer-based test and the other a performance-based test, to attain certification. In our college, two teachers, Assoc. Prof. Yamamoto and Assoc. Prof. Yoshida, have gained certification in CTT+ in recent years.

In this article, we will report the utilization results of the CTT+ competence in major subjects using English.

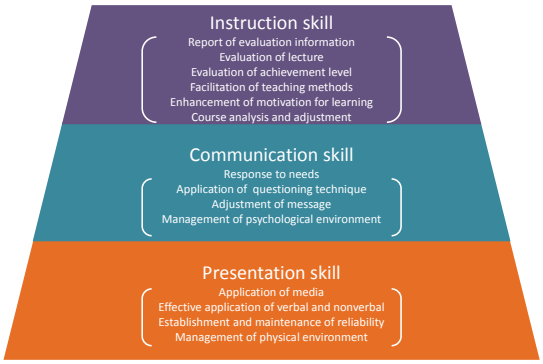


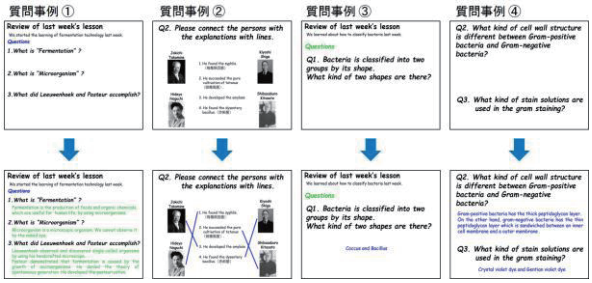
Figure 2. Construction of CTT+ competences.

Pedagogy

It is possible that the introduction of English into major subjects influence academic ability, comprehension levels and acquirement of expertise. Accordingly, in fermentation engineering which is a major subject for 4th grade students conducted by Assoc. Prof. Yamamoto, and in fundamental mathematics which is required for 1st grade students conducted by Assoc. Prof. Yoshida, for example, pair or group work, several types of questions, active listening and creating of discussion time, which were basic skills of CTT+ competence, were adopted positively, utilizing English during the review section of the class lasting around ten minutes using power point slides (Figure 3). The ideal of these classes is to allow students to answer questions in English. However, to prevent a decrease in motivation for learning, students were allowed to answer in Japanese.

We evaluated this trial using class evaluation questionnaires composed of 15 questions, which was created by Prof. Shimizu of NIT, Toyama College, described as Figure 4.

a) Example of the power point slide in fermentation engineering



b) Class in session with question to the whole class



Figure 3. Practice case in fermentation engineering class.

Results and Discussion

Using the competences of CTT+, there was an enhanced incentive to learn, as well as increased concentration in classes with interactive communication.

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It is thought that the number of disinterested students decreased by using CTT+ skills with active communication. However, because it is difficult to clarify the difference in degree of achievement with or without CTT+ skills, we have not been able to quantify it. Thus, we would like to consider this point, including evaluation method, for the future.

The result of class evaluation questionnaire is shown in Figure 5. From these results, it was clear that resistance to learning major subjects in English was strong even though students recognized the necessity of English. Thus, we think that further consideration is needed on the methods of classes that relate English to major subjects. The overall tendency was the same between 1st grade students and 4th grade students. Interestingly, an upper-class student had a strong consciousness for the necessity of learning of special subjects in English. Therefore, it is important to point out how we familiarize students with English in major subjects. In Japan, now, English usage in major classes are accelerating in the higher education system, especially at the University level, regardless of the faculty whether it is liberal arts or physical science (Reference: DAIGAKU NO YAKUSOKU, 2014). In our college, we start the "Global Citizenship program from 15 years old", which is constructed with two main projects. One is an international exchange program which the students from 15 years old can participate, and the other is the improvement of the lecture competence of the teacher. This lecture competence contains active-learning techniques, English presentation skills and lecture skills utilizing CTT+. Because Assoc. Prof. Yamamoto and Assoc. Prof. Yoshida strongly realize the usefulness of CTT+ competence through this program, we have created the working group to promote CTT+ competence to many teachers in our college (Figure 6a) (Reference: EIGOJYUGYOU KOUGIRYOKU KYOUKA PUROGURAMU JISSENSYU, 2015). Additionally, we made the case examples of the several classes using English by the collaboration with NIT, Toyama College (Figure 6b).

Nevertheless, while many activities related to the development of global human resources are carried out throughout Japan, because the vision of global human resource needed in an economic and social environment still has not been clarified, the situation that necessary global human resource is not at a high enough level yet (Reference: H. Fukushima, 2015). We consider that the improvement of the quality of the teacher is the groundwork of the development of global human resource. To achieve this improvement, we think the reinforcement of lecture competencies using CTT+ skills is exceedingly useful. It is the forthcoming challenges of how to develop and expand of this activity.

	下記についてどう思いますか？	極めてそう思う	そう思う	どちらでもない	思わない	全然思わない
1	英語による授業は楽しいかったですか。	5	4	3	2	1
2	授業内容は理解できましたか。	5	4	3	2	1
3	集中して授業にのぞむことができましたか。	5	4	3	2	1
4	自ら発言しようと思いましたか。	5	4	3	2	1
5	自分の英語力育成に役立ったと思いますか。	5	4	3	2	1
6	英語に対する苦手意識は減ったと思いますか。	5	4	3	2	1
7	英語は自分の将来に必要だと思いますか。	5	4	3	2	1
8	他の科目も英語を取り入れた授業を受けたいと思いますか。	5	4	3	2	1
9	専門科目を英語で学ぶことは必要だと思いますか。	5	4	3	2	1
10	授業に積極的に参加しようと思いましたか。	5	4	3	2	1
11	専門科目を英語で学ぶことは難しいと思いましたか。	5	4	3	2	1
12	将来はグローバルな社会で活躍してみたいですか。	5	4	3	2	1
13	英語をもっと勉強してみたいと思いましたか。	5	4	3	2	1
14	英語のヒアリングはほとんどできましたか。	5	4	3	2	1
15	今の英語力であれば専門科目の学習でも学力の向上につながると思う。	5	4	3	2	1

Please write any comments: 英語による授業を通して、自分が考えたり思ったりしたことを自由に書いてください。

Figure 4. Questionnaire sheet for class evaluation.

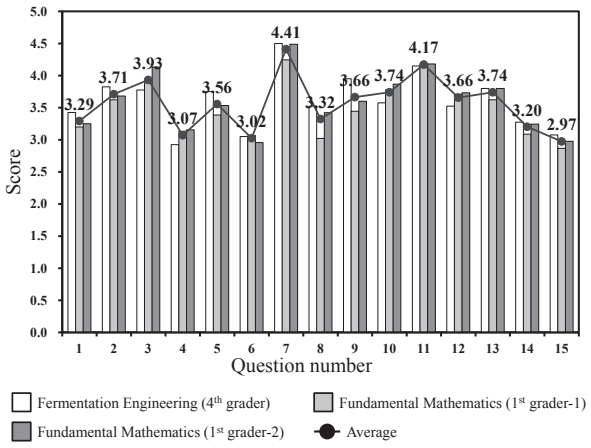


Figure 5. Histogram of the results of Questionnaire.

a) Study meeting for CTT+ skill



b) Case Examples of the lesson using English

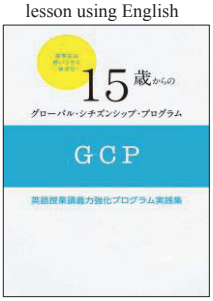


Figure 6. Activities for the promotion of the lecture competence.

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Conclusions

Through this pedagogical activity, we recognaized that student understood the importance of English in engineering fields, but the feeling of strong resistance against English prevented them to grow to become a global human resource. It is important to give every opportunity to use English, even if it is just a small amount in every class. We will continue to perform the development of the groundwork as global human resource through the activity of specialized classes using English combined with CTT+ skills, continuously.

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HELPING ENGINEERING-MAJOR LEARNERS LEARN FOREIGN LANGUAGE PRONUNCIATION IN THE CLASSROOM

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Abstract

The impact of *Form-Focused Instruction* (FFI) on second language pronunciation has been investigated in several foreign language learning settings in the last decade (Abe, 2010; Chang, 2006; Couper, 2009; Park, 2000; Saito, 2012; among others). 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). However, there still remains the question of whether the *focus-on-form* (FonF) is unambiguously effective in L2 pronunciation instruction. The current study presents an attempt to remedy this situation by reporting the findings of an inquiry which examined the effect of FFI with *phonetic negotiation of form* as corrective feedback on the pronunciation of weak forms at a regularly scheduled classroom, in which one experimental group (EG, n=30) and one control group (CG, n=31) participated in a quasi-experiment. The treatment in the 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 FonF practice, whilst the CG followed a traditional forms-focused instruction (FonFs) in two sessions of perception and production. The participants' ability to perceive and pronounce the weak forms was assessed on a pre- and a post-test which included weak-form discrimination, dictation, a passage-reading, and a dialogue task. Despite several limitations and the developmental changes, the current study demonstrated a significant difference of receptive and productive acquisition of weak forms, unambiguously demonstrate that the formal instruction deploying FFI does make a difference for L2 pronunciation, helping learners notice the target form, establishing meta-competence through explicit instruction, and using declarative knowledge in actual communication.

Keywords: *FFI, FonF, FonFs, pronunciation, second language (L2), weak forms*

Introduction

This research programme originates from approximately twenty years of experience in teaching English as a Foreign Language to engineering-major students, and an ongoing interest in the effects of instruction on the development of L2 pronunciation. The fundamental questions motivating the research reported here were (a) what should be taught at a specific stage of L2 development, and (b) how should languages be taught to facilitate more effective and efficient acquisition? (Muranoi, 1996)

L2 pronunciation studies in the 2000s shifted their interest to examining the assumption that FonF vigorously investigated in morphosyntactics might contribute to the betterment of L2 pronunciation (cf. Saito, 2012). However, the FonF type of instruction does not always and completely outperform *Focus on FormS* (FonFs), in which sequenced and fragmented items are presented to the learners stepwise, in the hope that the learners will acquire the system of the target language with the passage of time (Abe, 2015; Chang, 2006; Yam, 2005). Further investigation is thus required to answer the question, *Is FFI appropriate to promote the acquisition of L2 pronunciation in the classroom?* At present, this line of inquiry has just started.

Background to Form-Focused Instruction in SLA

The last two decades have witnessed a growing body of research on the effectiveness of L2 instruction from the perspective of FFI (de Graaff & Housen, 2009; Doughty, 2003; Ellis, 2008; Long & Robinson, 1998; Norris & Ortega, 2000). Ongoing research 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 morphosyntactic development (Muranoi, 1996, 2006; Takasima, 2011). 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, as shown in Table 1 (Housen & Pierrard, 2005, p. 10).

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Table 1
Implicit and Explicit Forms of FFI (Housen & Pierrard, 2005, p. 10)[1]

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 • encourages free use of target form
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

Despite the acknowledged benefits of FFI demonstrated by SLA research in the past decade, the question regarding the adequacy of FFI remains. As noted by Tragant & Munoz (2004), for instance, 'an important issue in relation to the benefits of instruction is whether all learners can equally benefit from it' (p. 212). The question relates to the case in which, despite the significant role of output-promoting tasks in the SLA process, a basic-level learner often fails to notice the mismatch between the interlanguage and the target form, and hence fails in that particular aspect of SLA. Some proponents of FFI posit that the optimal level for FFI might be the CEFR B1 or B2 (de Graaff & Housen, 2009, p. 279). If this assumption is correct, the level of Japanese secondary school students may not be adequate for effective FFI[2].

To overcome this problem, Takashima (2011) proposed a *FonF Approach* by which basic-level learners can process the input by negotiating the target form and receiving explicit feedback, with activities facilitating the noticing and processing mechanism. Muranoi (2006) suggested an attempt to integrate such FonF activities with traditional FonFs style learning, so that even basic-level learners can process the input through form-focused communicative lessons. Unfortunately, L2 pronunciation instruction has not kept pace with the development of modified FFI, although such an approach might help learners with their EFL pronunciation (Abe, 2015).

Weak Forms in L2 Pronunciation Pedagogy

Until fairly recently, with the publication of Jenkins (2000), only a few researchers seemed to question the high priority placed on native-speech-based models, such as Received Pronunciation or General American, in teaching L2 pronunciation. More precisely, EFL teaching has gradually shifted its emphasis from a native-speech-oriented model to an intelligibility-oriented model in the 1970s. However, the proponents of the traditional model still claim the significance of learning native-like weak forms, as they are by far the most frequent among the 20 vowels and 24 consonants in English, and are one of the prime features of the language (Gimson, 1980, p. 309). Meanwhile, in recent literature on English as an international language (EIL), it has been shown that weak forms (reduced vowels) are not considered to be important segments by international non-native and native interlocutors. Jenkins (2000) excluded weak forms from her *Lingua Franca Core* (LFC; a phonological syllabus designed specifically for L2 learners of English, to be used by and with non-L1 English speakers). The LFC is intended to include the phonological features crucial for mutual intelligibility among EFL speakers, so the omission of weak forms is notable in this context. At the same time, careful reading of Jenkins (2000) also reveals that she did admit the use of weak forms in the LFC, albeit in a limited sense: 'those learners will still need to work on weak forms (in the traditional sense) *receptively* in the classroom' (p. 148, italics in the original).

It is also well known that the acquisition of English weak forms poses ongoing difficulties for non-native speakers in perception and production (Abe, 2015; Kohmoto, 1982; Rojczyk & Porzuczek, 2012). This has motivated many researchers to investigate the effects and effectiveness of teaching weak forms in the formal setting (Abe, 2010; Gómez Lacabex, García Lecumberri & Cooke, 2009; Porzuczek, 2010 among others). Nevertheless, there is thus far a paucity of research devoted to the question of the teachability and learnability of weak forms amongst adolescent learners in the EFL classroom.

The findings suggest that secondary school learners may be able to perceive weak forms after instruction, but their production ability shows little improvement. An intervention study by Gomez Lacabex et al. (2009) investigated the receptive abilities of 41 teenagers (mean age 15.8 years) who received 12 sessions of either perception training (Group A), productive training (Group B), or no training (control group) over a period of three months. The results indicated that both types of training (i.e. perception and production) led to significant improvement after instruction. However, Gomez Lacabex and Garcia Lecumberri (2010) showed only a moderate effect of instruction on the production of 34 teenage learners after three weekly sessions of 30 minute each. A similar result is reported by Gutierrez and Monroy (2003), cited in Gomez Lacabex et al. (2009), indicating that the effect of instruction on teens'

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productive abilities was limited. Furthermore, at a secondary school in Poland, Bogacka, Scwartz, Zydorowicz, Polezynska-Fiser, & Orzechowska (2006), cited in Rojczyk and Porzuczek (2012), suggested that L1 influence remained evident in the production data of adolescent learners.

The current literature appears to lack such a classroom-based analysis of the effects of various types of instruction on phonological forms such as English weak forms. The study explores the effects of an instructional technique in which pronunciation errors were made explicit in order to activate learner cognition. The study aims to address three main research questions:

(1) Does FFI, in which a teacher provides explicit instruction through phonetic negotiation of form, affect the interlanguage phonology of Japanese EFL students?
(2) Does the above-mentioned FFI have an effect on the receptive and/or productive acquisition of English weak forms among Japanese EFL students?
(3) Is it appropriate to teach English weak vowel forms to EFL learners whose English proficiency is around level A, i.e. that of a basic user, according to the *Common European Framework of Reference for Languages* (CEFR)?

Current Study

Research setting and participants. This study was conducted during a regularly scheduled class taught by the author at a college located in northern Japan. Most of the students in the class come from the same prefecture where the college is located, which implies that they are relatively similar in terms of their background, goals in learning English, level of English proficiency, and engagement in the subject. The number of participants was 30 in the experimental group (EG) and 31 in the control group (CG).

Treatment. The EG and the CG participated in a quasi-experiment focused on both perception and production, in which two classes were devoted to perception instruction and production instruction, respectively. 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 1 and 2, in both groups. Then, in week 3, the participants took the post-test.

The instruction for the EG. 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. Note that the instruction for the EG had dual characteristics of FonF (implicit FFI) and FonFs (explicit FFI) (cf. Table 1), which was deliberate, as Muranoi (2006) and Takashima (2011) contend that FonF in secondary schools, or among basic-level learners, should be integrated and enhanced with FonFs activities. In the production classes, the instruction of the EG shifted to implicit FFI, based on the premise that not only input-based but also output-promoting tasks play a critical role in L2 learning experiences. Corrective feedback 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.

Student: *I' m good* [a]*t playing baseball*.
Teacher: *Good* [a]*t? Now, listen. Yours, good* [a]*t. Normally, good* [ə]*t. Can you see the difference?*
Student : *I'm good* [a~ə] *t.*

In this way, it was assumed that phonetic negotiation of form would help participants to discover rules governing the use of weak forms or to gain declarative knowledge of weak forms more successfully than would merely presenting the target forms with an explicit explanation.

The instruction for the CG. The perception classes, 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. Unlike the EG, the production sessions for the CG used explicit FFI (FonFs) (cf. Table 1). In doing so, the author played a crucial role in explicitly informing participants of the rules underlying the target prosodic features. This helped them to gain declarative knowledge of weak forms by means of FonFs instruction. This entails 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.

Assessment. The evaluation instrument used to assess the participants' pre- and post-treatment performance was divided into four subtests: two for perception and two for production. The perception test consisted of 10 sound discrimination and 20 dictation tests, thus the full mark was 30 points. 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. The data collected from the pre- and post-tests of production were analysed by two American native speaker teachers, both of whom were EFL experts, and the author. Each examiner had 10 points to award, which were given in accordance with the subjects' performance: five points for the reading task and five points for the picture description task. Thus, the full score of each participant was a total of the three examiners' scores, 30 points.

Inter-rater reliability was measured, and was α=0.72 for the pre-test and α=0.74 for the post-test, which is acceptable in the context of statistical analysis. For cases in which auditory analysis was insufficient for the examiners to be sure of the quality of schwa,

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spectrographic analysis was undertaken by means of *Praat*[3]. Questions among examiners were thus resolved by resorting to acoustic analysis.

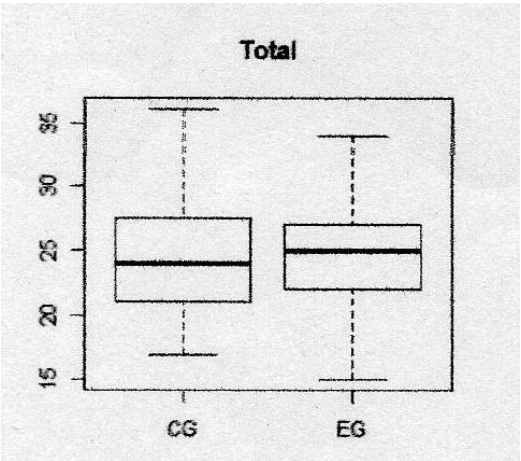
Results

The data demonstrated a significant change in the total (perception and production) scores: though the difference was not significant at the pre-test, it turned out to be significant at the post-test. A student's t-test was performed in order to compare the pre-test scores of the EG and the CG in the pre-test phase. The result indicated no significant difference between the two groups for the total pre-test scores in perception, in production and, most importantly, for the total scores of perception and production (no effect size: *Cohen's d*=0). The between-group comparisons for the integrated ability reveal a significant main effect of instruction with a large effect size in the total score (*d*=1.00); in perception, the EG significantly outperformed the CG with a large effect size (*d*=0.94); and in production, the EG did significantly better than the CG with a medium effect size (*d*=0.62), as shown in Table 2. Figure 1 shows the distribution.

Table 2
Descriptive Statistics of Total Scores in Pre- and Post-test of Perception and Production of Weak Forms[4]

	Test Score	EG (n=30) *M*	CG (n=31) *M*	*p-value*
PRE	PC	11.57 ±1.92	11.55 ±2.20	0.97
	PD	13.27±3.19	13.26±4.27	0.99
	Total	24.84±4.04	24.81±4.72	0.98
POST	PC	16.20±2.82	14.52±2.66	0.02
	PD	13.3±1.47	11.97±1.64	0.0014
	Total	29.5±3.42	26.48±3.12	p<0.001

Pre-Test



Post-Test

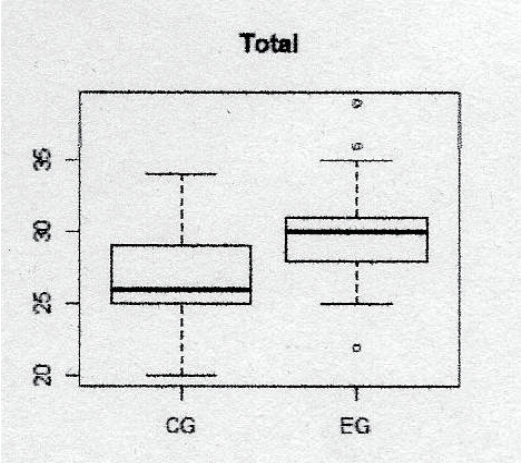


Figure 1 The distribution of the total scores of the EG and the CG at pre- and post-test stage

The between-group comparisons for integrated ability at the post-test phase reveal a significant main effect of instruction with a large effect size in the total score. In perception, the EG outperformed the CG with a medium effect size, which does not completely reach the significant level of p<0.017 due to the Bonferroni correction, and in production, the EG significantly outperformed the CG with a large effect size.

The Wald test below is an examination of the difference in the total scores of the EG and the CG, which demonstrates the significance of the difference where the EG outperformed the CG at the post-test phase. The Wald test also shows that the difference in the development of perception reached the significant level, whilst the development in production was quite limited.

Table 3
Result of Wald Test in the Difference of Perception and Production

	Coefficient			
	Estimate	95% CI		
		Lower	Upper	*p-value*
PC	1.67	0.041	3.290	0.05
PD	1.32	-0.367	3.014	0.18
Total	2.99	0.971	5.007	0.0052

The between-test data in Table 4 demonstrate that there was a significant difference in the perception and production scores, with a large effect size in the EG, a medium effect size in the CG. There was also a significant difference in the perception data, again with a large effect size in the EG, as well as in the CG. However, no significant change was found in the production data, with no effect size in the EG, and in the CG.

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Table 4
Result of the Wilcoxon Test on the Development of the EG and the CG

		M	*p-value*	r^5
PC	EG	4.63 ±3.43	p< 0.001	0.81
	CG	2.97 ±3.04	p< 0.001	0.71
PD	EG	0.03 ±2.43	0.935	0.02
	CG	1.29 ±4.08	0.20	0.31
Total	EG	4.67 ±4.25	p< 0.001	0.75
	CG	1.68 ±3.79	0.02597	0.41

Discussion and Conclusion

Until quite recently, L2 pronunciation studies in FFI have yielded mixed results: unlike in the acquisition of L2 morphosyntax, FoFs could also contribute non-trivially to the successful acquisition of a specific form in pronunciation (Abe, 2015). The present data demonstrated a significant change in the total (perception and production) scores: though the difference was not significant at the pre-test phase, it turned out to be significant at the post-test stage. These data naturally suggest that the EG outperformed the CG in the output performance at the post-test. Accordingly, the data also display noticeable development of both the EG and the CG in terms of the accuracy of the learners' performance in several receptive and productive tasks, demonstrating that the FonFs type of instruction contributed moderately to the development of L2 pronunciation.

However, the fact that the EG significantly outperformed the CG can be attributed to the cognitively more challenging tasks the EG engaged in. The CG was instructed using a familiar passage in the perception practice, and its production training was not as challenging as in the EG treatment, in which perception (input) and production (output) practice required concentration on the target form but helped with corrective feedback. Therefore, the findings contribute to solving a currently contentious question in instructed SLA of speech: whether FFI approach can significantly facilitate the development of L2 pronunciation. It can be suggested that for L2 pronunciation, FFI could be the best possible option in the EFL classroom, and that, more importantly, FonF could make a more significant change.

Nonetheless, the production ability of the learners was quite limited. 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 yet be ready to the learning of L2 weak forms production from the developmental perspective; that is, it is not simply that they had had insufficient time and effort to practice the weak forms.

Despite the limitations, helping learners discover rules or declarative knowledge of vowel reduction in FonF would be more successful than merely presenting the target form in FonFs, even with explicit explanation. The present author hopes that the findings of this study, demonstrating that carefully designed pronunciation instruction can help learners improve their performance, would motivate future attempts to teach foreign language pronunciation in the EFL classroom

Notes

[1] I have slightly modified the table of Housen & Pierrard (2005, p. 10) to follow the style of *ISATE*.
[2] According to a recent official survey by the Japanese Ministry of Education, Culture, Sports, Science, and Technology (MEXT), the EFL competence of high school seniors in Japan across the four skill components places approximately 10% of them at the B1 or B2 level, with the majority (90%) at the A1 level.
[3] This is the computer program developed by P. Boersma and D. Weenink (Version 5.2.19, retrieved from http://www.praat.org/).
[4] The abbreviations in this table, and hereafter, PRE, POST, PC, and PD stand for pre-test, post-test, perception, and production respectively. The values, e.g. ±1.92, denote *Standard Deviation (SD)*.
[5] This *r* represents effect size *r* here.

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USE OF AUTOMATED ASSESSMENT AND GAME BASED LEARNING TO MOTIVATE LEARNING FOR COMPUTER PROGRAMMING

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Abstract

Computer programming is a common module for all engineering students in year 1. This is the first programming module for all engineering students. Majority of the students are learning the computer language for the first time and it requires them not only to understand the syntax but also spend time practicing. Many students find the process of learning programming challenging and this often results in students becoming unmotivated.

Two strategies were used to scaffold students in their initial exposure to computer programming, and to help student progress in their understanding of this new topic.

(1) Game Based Learning
A set of games, named SAVVY was developed as part of the strategy to motivate students to learn more about Computer programming using the C language. There are multiple levels in SAVVY which allow students to learn the fundamentals of C language: declaring variables, writing printf and scanf statements. The games involve shooting cannon balls and using swords to slash moving targets, and at the same time require the students to have knowledge of the fundamentals of C language in order to achieve high scores. By playing these games, students will have more opportunities to engage with C language and be motivated to learn even when they are having "fun".

(2) Automated assessment of programming
Students new to computer programming tend to make many mistakes, and the lecturer needs to review each student's programming individually to identify these mistakes. This process is time consuming and inefficient for both the lecturer and student especially when there is only one lecturer to 25 students. Students may have to wait some time before they are attended to, and this long wait time can be disruptive to the student's learning, which results in them being unmotivated to learn the computer language.

To reduce the wait time for students, an automatic marking system, named ALLY, was developed to identify the mistakes made by students while programming and gives the student a grade. This programme makes it easier for the student to identify mistakes made during programming without the help of the lecturer, enabling students to learn at their own pace.

Keywords: *automated assessment, game based learning, computer programming, C programming, games*

Introduction

The Diploma in Electronic & Computer Engineering (ECE) teaches students about how electronics shape the way people live, work and play. ECE gives students a strong foundation in electronics, computer and communication engineering. With an industry-relevant curriculum, students are well-paced to meet the needs of the industry when they graduate.

One of the common modules that all students in the first year of their ECE diploma in Ngee Ann Polytechnic take is that of Computer Programming. This module serves as the foundation for students in this course. However, many students struggle with this module as many of them have not studied computer programming before and may be the first time that they are they are confronted with a new computer language . Students would have to put in much effort to make sense of the programming language and also to spend time to practice if they want to be competent in the module.

Challenges in teaching Computer Programming

(1) Overcome the barrier to learning the computing language

Many students taking this computer programming module have little prior knowledge and have difficulty making sense of the programming language and the syntax required for them to code. This gap in the understanding hinders the students' progress as the ability to understand and code with the right syntax is a basic requirement of the module.

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(2) *Current teaching method is time consuming & inefficient*

Students new to computer programming tend to make many mistakes, and the lecturer needs to review each student's program individually to identify these mistakes. This process is time consuming and inefficient for both the lecturer and student especially when there is only one lecturer to 25 students. Every student needs to write up to 3 programs during each lesson and much time is required of the lecturer to manually review and grade up to 75 programs for each lesson, or 150 programs each week for a class, which can comes up to 7.5 hours per week. A system is required to help staff to reduce the time required for marking.

(1) Feedback is not timely for progression

When learning to write a computer program, a student needs feedback from the lecturer to know whether he/she has made any mistakes and how to correct the mistakes. With this new knowledge, he/she can improve when he/she writes the next program. Since lecturers do not have the time to finish marking all programs during the lesson, students usually submit their programs and need to wait up to one to two weeks before they receive feedback from the lecturer. This means that students may continue making the same mistakes when they write new programs.

Faced with these challenges, the teaching team needs to identify a way of helping the students learn so that they are able to receive timely feedback for them to progress and not have to wait for their turn to receive help from the lecturer in order to complete their assignment. One solution is to develop a system that will enable students to practice the use of the correct syntax when coding and also one that can check the program output and helps the student to identify his/her own mistakes will make it more efficient and effective for the student to learn computer programming. These solutions should also be able to help students learn and progress in a manner that would motivate them to learn more about computer programming in a "fun" manner.

Materials and Methods

In order to help students' progress in their learning of computer programming, 2 programmes were developed to meet the students' learning challenges. They are SAVVY and ALLY.

SAVVY

The learning of computer language is complex and requires students to be precise and accurate with their use of the syntax, for example in C programming, every statement must end with a semi-colon, how to declare variables, how to use functions, etc. Most students find it tedious to learn and remember the many different rules, and many become unmotivated to learn because they find it difficult.

The use of "games" in the learning can provide students with a "fun" and "motivating" environment for learning. Games are the ideal learning environment as they not only provide motivation for the students to succeed but also with their built-in permission to fail, encouragement of out-of-box thinking, and sense of control. People play games for the sense of engagement, immediate feedback, feeling of accomplishment, and success of striving against a challenge and overcoming it. To progress in a game is to learn; when we are actively engaged with a game, our minds are experiencing the pleasure of grappling with (and coming to understand) a new system. Effective, interactive experiences can motivate and actively engage the students in the learning process. (Trybus, 2014).

It is based on the unique features of games and learning that SAVVY is developed with the intention to produce a highly motivating learning environment for students to learn the basic syntax of C programming. The SAVVY games provide immediate feedback and the ranking of scores and awarding of gold badges give students a feeling of accomplishment. In order for the students to achieve high scores in the games, they must be able to demonstrate their knowledge of C programming very well.

The SAVVY games have three levels.

Level 1: Declare Variables

Before playing level 1, students are taught how to declare variables. They must know the basic rules for creating variables or identifiers in C programming. When the student start to "Play" they would need to identify the labels and to examine this declaration statement and check that it is declared correctly based on what the lecturer has taught him.

If the declaration is wrong, students would need to "shoot" down the label with a red ball. This practice allows students to identify the correct composition of the declaration quickly and to gain "rewards" for their correct selection.

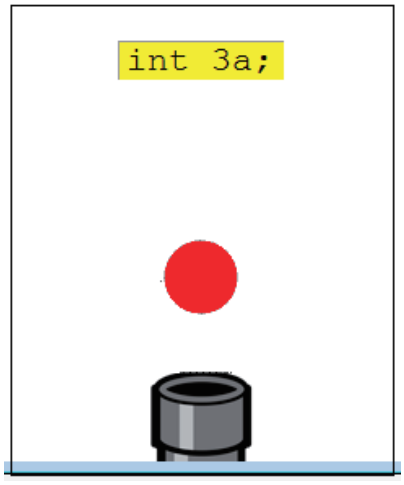


Figure 1: Level 1 of the SAVVY games

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A total of 20 labels containing different declaration statements will float pass. The student replays the game as many times as he likes. Each time he replays, a different set of declaration statements will be displayed, so the more the students play, the more they become familiar with the different declaration statements and thus learning while having "fun". When the game is over, the student's score is ranked against all the other students in the class in the leader board as shown below:

Name	Score	Ranking
KOH	100	1
NOOR	100	1
SOH	100	1
TAN	95	4
NASHERET	85	5
GOH	85	5

Figure 2: Leader board of scores

Students are also motivated to play the game repeatedly in order to get a better ranking in the leader board. The fundamentals of C programming is reinforced in the process of playing. Without the benefit of learning and rehearsing through playing the games, most students find it difficult to remember all the rules and tend to make mistakes when writing programs.

Level 2: Using printf

In Level 2, students must understand the structure of a simple C program, and also the syntax of the printf statement before they are ready for this game. In this level, a simple C program is broken up into small parts and shuffled. A label containing a segment of the C program drops on the left hand side of the screen. The student needs to click on the appropriate cell on the grid to place the segment in the correct sequence. For example, the label contains "printf". Since printf is a function and should appear at the beginning of a statement, the student clicks and place the printf as shown in Figure 3.

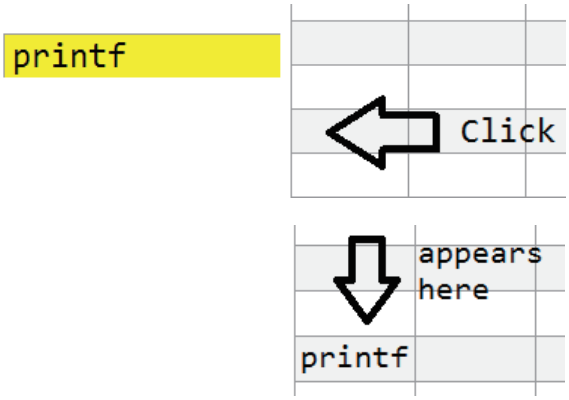


Figure 3: Level 2 of the SAVVY games

If the student does not know where to place the label, and if the label hits the bottom of the screen, it will not appear again. In the process of playing the game, students need to place the different parts of the program together in the correct sequence. If the student starts over again, the sequence of the parts are shuffled and students must know where to place each part very well in order to earn perfect scores. The fundamental rules of C programming are reinforced in the process.

Level 3: Using scanf

For level 3, students learn how to use scanf to read the inputs for one or two variables. They are trained to know the syntax of the scanf function and learn recognize their own mistakes in their programming. This level requires the students to identify the labels with mistakes in the scanf statements

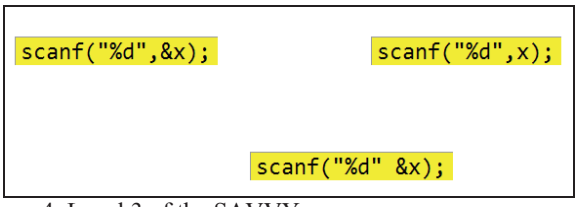


Figure 4: Level 3 of the SAVVY games

Badges

The SAVVY games incorporates badges, leader boards, points and levels and these games mechanics keep the students engaged and motivated in the process of learning the fundamentals of C programming which will otherwise be very tedious.

If the student scores 100 for level 1, he/she will earn the number 1 gold badge. If he/she scores 100 for level 2, he/she will earn the number 2 gold badge, and the same for level 3.



Figure 5: Gold badge

ALLY

ALLY is an automatic marking system for computer programs. This system provides students with immediate feedback to how well they did in their computer programming without having to wait for the lecturer and slow down students' progress in learning. There is little point in giving student feedback on knowledge or skills when there is no time left for them to act upon it. Feedback should be provided at an appropriate point in the learning process (Brown & Knight, 1994). It also should have embedded within it some degree of prescription about what must be done (William & Black, 1996; p. 543) in order for students to improve their performance. When large numbers of students or lengthy pieces of work are involved, practical constraints (such as time or workload pressure)

may make it difficult for tutors to provide feedback which is both timely and useful to the student (Buchanan, 2000). ALLY is designed to provide this swift and useful feedback.

The administrator can setup any program written in the C programming language. He/she can also setup the marking scheme for each program. For each new program, the administrator can setup multiple sets of input values as shown below.

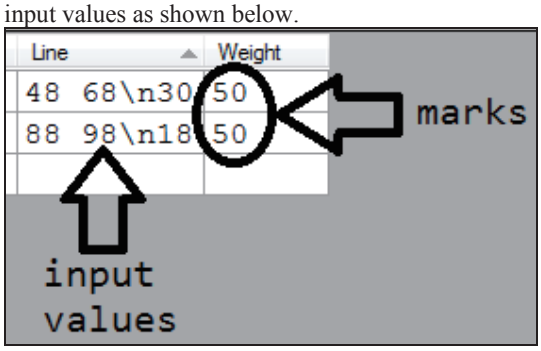


Figure 6: Configuring the programs in ALLY

Each set of input values produces a unique set of output. Marks can be assigned to each line in the output.

Currently 34 programs have been setup in ALLY and ALLY is capable of handling thousands of different programs. Since all programs submitted by students are marked using the same marking scheme, ALLY ensures a fair and accurate marking scheme for all the programs.

Students are able to submit their programs and view their grades instantaneously. When they login to ALLY, they will see the complete list of programs which they need to submit. If they have already submitted the program, for example, io2_3.c, io2_4.c and io3_2.c, the grades and submission date times are displayed.

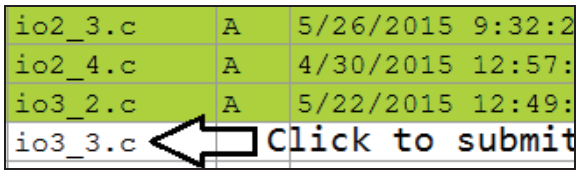


Figure 7: List of student programs

Using ALLY, once the student completes his program, he pastes the program into ALLY and clicks the SUBMIT button. His grade is shown instantly at the bottom half of the screen.

```
Your grade is A
Total marks = 99.2857142857143
****************RESULTS ANALYSIS*****************
Correct answer :Enter the value of resistance 1:
Your answer    :Ent the value of resistance 1:
 Result: (6/7)MATCHED
```

Figure 8: Instant feedback of grades in ALLY

If the student makes a mistake with the program output, ALLY compares the correct answer with the student's answer and shows the results. This makes it easier for the student to identify and correct his own mistake. The student can then re-code and submit his program for re-marking until he gets all the codes correct.

If the student makes a mistake with the calculation, ALLY shows the correct answer against the student's answer so that he knows there is a problem with his calculation.

```
Correct answer :        resistance = 4.134688 ohm
Your answer    :        resistance = 0.241856 ohm
 Result: (10/12)MATCHED
```

Figure 9: Results analysis for calculation

ALLY tests the program using multiple sets of inputs so that it is not possible for students to hardcode their answers. An important feature is that while mistakes are pointed out, correct answers are not given as part of the learning for students is for them to analyse the output and then independently locate their own mistakes in their programs.

Most students are able to identify and correct their own mistakes by looking at the results analysis. The ability to know their grades instantly motivate them to try harder and learn at their own pace. Since they do not need to wait for lecturers to mark their programs, they can finish their programs quickly and are motivated to learn more independently. The weak students are also motivated since they can re-submit as many times as needed in order to get the perfect grade. The program assignments in ALLY are ordered from very simple to moderate to difficult which slowly builds up the confidence in students to write programs.

Lecturers are able to view the grades for every program submitted by students in his class immediately after the submission, as shown in Figure 9. The lecturer is able to identify the weaker students easily by looking at the table.

name	io2_3	io2_4	io3_2	io3_3	io4_2
CHONG	A	A	A	A	C
CHIA	A	A	A	A	A
CHIEN	A	A	A	A	A
HOON	A	A	C	C	A
ARMAN	A	A	A	A	A
LAW	A	A	A	A	B
LIEW	A	A	A	A	

Figure 9: Grades for all students in class (anonymised)

Results and Discussion

SAVVY and the ALLY games are a complete system which trains students in learning the programming rules and syntax, as well as writing programs that produce exactly what the users require.

During each lesson, the lecturer first teaches one section of the syntax of C programming. The students then play one level in the SAVVY games to reinforce their understanding of the syntax. Then each student is required to write 2 to 3 computer programs according to the requirements and submit the programs to ALLY for automatic marking.

SAVVY: Feedback from Students

A survey is completed by a group of 429 students. The results are shown in the following table.

Question	Agree
1. The SAVVY games motivate me to learn the basics of C programming in order to earn high scores.	73%
2. Knowing my ranking in class for each level motivates me to play the games repeatedly in order to get a higher position.	81%
3. By playing the SAVVY games repeatedly, I am able to reinforce my understanding of the basics of C programming.	81%
4. Each level in the SAVVY games focuses on a few fundamental rules of C programming which makes it easier for me to learn.	79%
5. The gold badges motivate me to try harder to earn perfect scores for each level.	73%
6. The instant feedback motivates me to try harder in order to get better scores.	77%
7. The SAVVY games enhance my overall learning experience of computer programming.	78%

The following are comments by students about the SAVVY games:

- *It actually really helps my knowledge and fundamentals of C programming.*
- *its a fun and interesting way to learn computer programming*
- *Savvy games can be play for multiple times to increase my grade. Encourage me to play more times so that I can memorise the codes better.*
- *It allows multiple redo's hence we are able to spot our mistakes. It is like self learning.*
- *The SAVVY games are simple to play and makes learning the foundations of C programming much easier.*
- *I certainly like the fact that there is a game for C programming- a dry subject with nothing but trail and error and texts that can drive me crazy*
- *Very addictive, repetitive nature motivates me to earn higher scores*

The response from the students show that by combining the fun of game mechanics with the learning of computer programming fundamentals, students are motivated to play the SAVVY games repeatedly. In the process, they reinforce their understanding of computer programming. Students are more motivated to learn C programming. In future, more levels and different games will be incorporated so that all aspects of computer programming are covered.

The following are comments written by the lecturers about the SAVVY games:

- *All my three groups of students are so crazy about the savvy games that they keep redoing and redoing in class. After the games, I found them to have much better command of naming variables.*
- *The SAVVY games is refreshing for the students as they compete with one another to aim for the perfect score of 100. The gold medal is a reward to entice them. It promotes their interest in learning C programming and is a constructive tool to further develop their programming skills.*
- *Almost all students in my two classes have completed the games with score of 100. The games help them to revise and understand important concepts/syntax of C Programming. I think the games are very good for the overall learning of the student.*
- *The games is very engaging and interesting which enhance the overall learning experience. The games are effective for "drilling" the fundamentals of the syntax into their instinctive/muscle memory.*

ALLY : Feedback from Students

A survey for ALLY is completed by 306 students. The results are shown in the following table.

Question	Agree
1. ALLY helps me to ensure correct logical sequence in the program output.	86%
2. ALLY helps me to ensure accuracy in the program output.	89%
3. ALLY helps me to identify errors in my program.	83%
4. The instant feedback of grades motivates me to try harder in order to achieve better grades.	86%
5. ALLY allows me to learn at my own pace.	79%
6. ALLY gives instant feedback to help me debug my program.	79%
7. ALLY is an effective tool that enhances my overall learning experience of computer programming.	86%

The following are some comments written by students:

- *If only ally can be use for other modules...*
- *Ally encourages me to do more practices for my compro.*
- *It's an effective platform whereby upon submission, students can receive their results on the spot. Therefore, students can edit their work quickly so as to maximise learning.*
- *i just like it, it's a really good tool and it's almost perfect, really. It has the program list which we can access to, helping us complete stuff at our own pace. Also, the immediate grading thing is really good.*
- *What I like about ALLY is that, the program give instant feedback on my coding and also it is a very convenience for me to hand up my work.*

The response from the students show that the instant grading and identification of errors in ALLY are very helpful in motivating students when learning computer programming. The majority of the students agree that

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ALLY enhances their learning experience. In future, more programs will be included in ALLY so that students can have more practice to reinforce their programming skills.

ALLY : Feedback from Lecturers

A survey is also conducted for a group of 15 lecturers teaching computer programming. The results of the survey is shown in the following table:

Question	**Agree**
1. ALLY enables me to have more time to better help weaker students on a one-to-one basis.	93%
2. ALLY enables me to assign more practice questions to students without compromising on the quality of feedback.	86%
3. ALLY gives instant, detailed and accurate feedback to students.	100%
4. ALLY ensures fair and accurate marking scheme for all students.	93%
5. ALLY is a learner centered approach since each student can discover his/her own mistakes and correct them.	86%
6. ALLY is a learner centered approach since each student can learn at his/her own pace.	100%
7. ALLY is an effective tool that enhances my overall teaching experience of computer programming.	100%

The following are comments by lecturers about ALLY:

- *The instant feedback given to users to enable them to improve their programming skills.*
- *Uncomplicated, very easy to use.*
- *Students are able to practise more questions on their own and results will be feedback to them immediately.*
- *Ally provides detailed results between the model answers and students' output helps students to learn to code the C program correctly. It is a great help in learning C programming.*
- *I have more time to help the students during the class and prepare my lecture at home.*
- *Ally minimise the requirement for marking.*
- *Easy to use. Nice user interface. Good feedback provided to students in the marking process. Helps us to easily monitor students' performance. Helps the students to do well for the assignments component.*
- *it is a very good system, not only the auto marking but the results/error descriptions help to train our students to follow instructions, which is very good.*

ALLY was first released during the Oct 2014 Semester. The following table shows that the passing rate has improved compared with the past semesters and that ALLY appears to have a positive impact on students' learning. Data will continue to be monitored for the Apr 2015 semester and beyond to have a clearer sense of the impact.

Semester	Passing Rate
Apr 2013	92.28%
Oct 2013	97.19%
Apr 2014	95.15%
Oct 2014	99.21%

Conclusions

Learning computer programming is a challenge for most engineering students since there are many rules and syntax which the students need to master. Students also need to learn how to use computer programming to produce the output required by users.

According to the survey results, the majority of students also agree that the SAVVY games motivate them to play repeatedly and reinforce their understanding of C programming and most students agree that the instant feedback from ALLY motivates them to try harder to achieve better grades and also allow them to learn at their own pace. All lecturers using ALLY to teach their students agree that ALLY is a learner centered approach and enhances their overall teaching experience.

Hence, it can be concluded that the use of SAVVY and ALLY which incorporate automated assessment, game based learning has made students more motivated to learn the computing language and to help them progress more effectively.

Acknowledgements

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A Study on Architectural Education by Collaboration with a Local Community －The Achievements and Problems for the Last 10 Years for Approaching Project Based Learning－

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Abstract

Since 2001, a new engineering education program with a local community has been implemented in the Department of Architecture and Civil Engineering of National Institute of Technology, Kumamoto College, JAPAN. It is designed to develop students as engineers who understand not only scientific technology, but also culture and local history, and who can understand problems from the local residents' point of view.

Students meet real life complex problems and they are required to propose an innovative solution by collaboration with a local community. From the assessment of these programs by EQ (Emotional Intelligence, Golman, 1995) scores, it is confirmed that students' active trend is sharply as the school year become higher. In addition, recently the qualifier's number of the Design Competition in National Institute of Technology has been increasing.

Through the inspection of the Aalborg Model of Project Based Learning at Aalborg University in 2012, it has been found that our approach has much in common with it. But at the same time, it has been found that there are significant points of difference, the purpose of learning and the curriculum. Our curriculum is traditional. To enhance the quality of our program, it is necessary to improve our traditional curriculum approaching to the project based learning.

Keywords: *Architectural Education, Local Community, Emotional Intelligence, Aalborg PBL Model, Traditional curriculum*

Introduction

It is the purpose of this paper to discuss the achievements of a new engineering education program with a local community for the last 10 years which has been implemented in the Department of Architecture and Civil Engineering (AC), National Institute of Technology, Kumamoto College (NIT, Kumamoto) and to consider the problems it needs to overcome for approaching the Problem - based and Project – organized Learning (PBL). Since 2001, our AC department has started a trial of new engineering education programs with a local community by laying the foundation of mutual reliance. As illustrated in Figure 1, approximate goals are set for each school year, which are coordinated in connection with social activities in accordance with each goal. Students acquire specific skills, corresponding to their school year while building up their overall knowledge in a spiral.

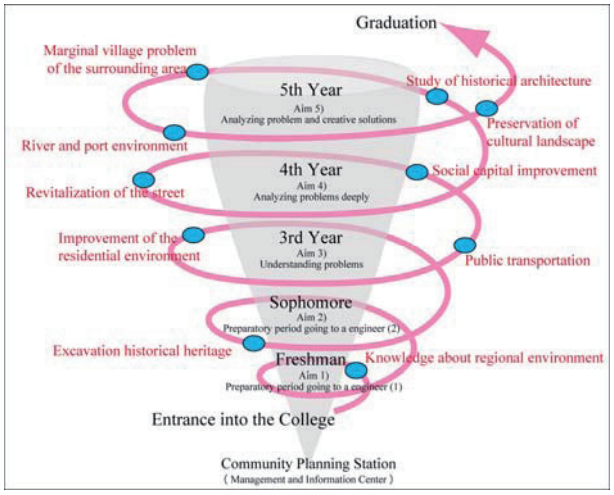


Figure 1, Relationship between the Curriculum of Department of Architecture and Civil Engineering and New Engineering Education in Collaboration with the Community

For example, the 3rd year Drafting and Design class mainly develops basic learning skills, technology skills and ability to gather information. This class is collaboration with a local community for collecting information. The 4th year Architectural Design class focuses on applied skills such as proposals, design and involvements with the local community shifts to problem identification. The 5th year Architectural Design class focuses on the ability to propose, to design, such as solutions of problems and creative new ideas. And also it develops skills that can be explained and can be easily understood presentation about designing own proposals and ideas. We considered EQ to be a fair assessment of attitudes towards work and students can realize their own growth by EQ assessment.

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Table1: Past projects which is concerned with a local community (2001 – 2012)

GP1(Receiving funds from Japanese Ministry of Education)									GP2(Receiving funds from Japanese Ministry of Education)			Subject Class ●Architectural Design ( )Number of Projects	Number of Subjects	Number of Projects	School Year
2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012				
							□Architectural Exhibition Collaboration with Local Architects	【C】Film Festival/【C】HIKOICHI Display /□ Architectural Exhibition Collaboration with Local Architects	【C】Film Festival/【C】HIKOICHI Display display/□ Architectural Exhibition Collaboration with Local Architects	【C】Film Festival【C】HIKOICHI Display【C】Kyushyu Shinkansen Opening Event /□ YATSHIRO Architectural Guide Map Project /□ Architectural Exhibition Collaboration with Local Architects	□Hospital Gallery Project /□YATSHIRO Architectural Guide Map Project /□ Architectural Exhibition Collaboration with Local Architects /□ Sea of YATTSUSHIRO Renovation project	・After-school activities (16)		16 (17%)	All years
						【H】HINAGU Guide Film Project		【H】Historical Landscape Design Project /【H】Universal Design in Historical Town Project/【H】Heat Island Survey Project			【H】Survey of Landscape Characteristics in HINAGU	●Landscape Design and Planning(2) ・Design Theory for Industrial Production(1) ・Residential Environment(1)	3 (16%)	5 (5%)	AD 2nd
		【H】Bnboo Lighting Design Project	【H】Bnboo Lighting Design Project	【H】Bnboo Rest House Project	【H】Sign Design & Creation of Japanese inn ORIYA	【H】Hearing Survey/【H】SANTOKA Installation Project	【H】Hearing Survey 【H】Paper Lighting Design Project / 【H】Bench Project		【H】HINAGU Main Street Design Project/【H】UCHIWA,Post card and Guide Video Project	【C】Vacant Shop Renovation TAMARINBA-Project	□Hospital Gallery Project	・Regional Planning(3) ●Design of Environmental Institution(10)	2 (11%)	13 (14%)	AD 1st
【H】HINAGU Revitalization Project	□KOUDA Civic Center Project	【C】New YATSUSHIRO City Library Project	□FRUSHIRO Public Housing Renovation Project	【Y】YATSUSHIRO City Centre Revitalization Project	【C】Usage Project of a Former Large Commercial Facility	【H】Hearing Survey/【H】Survey of Japanese Historical Inn/【H】Construction Survey of Historical Ware House/【H】HINAGU Sign Project/【H】Community Space Project for the People /【H】HINAGU ONSEN Shrine Parking Project	【H】Hearing Survey/【H】Survey of Japanese Historical Inn/【H】Construction Survey of Historical Ware House【H】Community House Sign Project/【H】HINAGU Port Development Project/【H】HINAGU Community Planning	【H】Survey of Japanese Historical Inn/【H】Old Ware House Renovation Project/【H】HINAGU Disaster Prevention Plan Project	【H】HINAGU Main Street Urban Design Project/【C】Japanese Tea Ceremony House Project in the HOSOKAWA SANSAI Garden	Satellite Campus Open to a Community(Design Competition of National Institute of Technology) (【H】・【Y】・【C】)/□Public Transportation of the Semi-Mountainous Area/【H】Landscape Condition and Proposal	【C】EARTHTECTURE (Design Competition of National Institute of Technology) /【C】YATSUSHIRO Town Centre Project	・Urban Design(3) ・History of Japanese Architecture(3) ・Structural Design(2) ●Architectural Design Ⅱ (14) ・Traffic Engineering(1) ・Landscape Design Ⅰ(1) ・Landscape DesignⅡ(2) ●Structural Design(2)	8 (42%)	28 (30%)	5th Year
	【H】Red Brick Ware House Renovation Project	【H】Revitalization Project	【C】Group Home Project	【C】Town Library Project	【C】Town Library Project	【H】 Old Ware House Renovation Project	【H】HINAGU Elementary School Project Collaboration with school boys	【H】HINAGU Elementary School Project	【C】Group Home Project /【C】Myouken Festival Hall Project /□ UYANAGI Elementary School Project	【C】Group Home Project/【C】Myouken Festival Hall Project/【C】TAIYO Elementary School Project /□ Marginal Settlements Problems & Proposal	□IZUMI Unified Elementary through Junior High School Project	●Architectural Design Ⅰ (15)/ Civil Planning(1)	2 (11%)	16 (17%)	4th Year
						【H】HINAGU public Restroom Project	【H】HINAGU public Restroom Project	【H】HINAGU Leafy Housing Project /【H】HINAGU public Restroom Project	【Y】Low－Rise Housing Complex Project/【H】HINAGU Station Plaza Project	【Y】Low－Rise Housing Complex Project/【H】New HINAGU Station Plaza Project	□SASHIKI Station Project	●Drawing and Design Ⅱ (8)	1 (5%)	9 (10%)	3rd Year
【H】=HINAGU Area 【C】=City Centre Area 【Y】=YATSUSIRO Station Area □=Others UD=Universal Design LD=Landscape Design										□Local Resources Survey and Making a Map Project	□Local Resources Survey and Making a Map Project	Integrated Study for Engineering(1)	1 (5%)	2 (2%)	2nd Year
							【H】Making a Lantern Project/【H】Repairing Old Plaster Wall Project	Making a Lantern Project 【H】		□Architecture and a Picture Book, body and a Life Style	□Architecture and a Picture Book, a Body and a Life Style	・Practice of Construction Creation(3) ・Introduction of Engineering(1)	2 (11%)	5 (5%)	1st Year
						GP1:The support program for Contemporary Educational Needs of the Japanese Ministry Education GP2:the support program for Promoting High-Quality University Education							19(100%) 14(1st～5th)	94(100%) 61(1st～5th)	Total



Figure 2: HINAGU Wear House Renovation Project collaboration with local residents & Yatsushiro City_4th year_2007



Figure 3: MIYAJI Project collaboration with a paper craftsman_4th &5th year_2014



Figure 4: HINAGU Event Court Roof Project collaboration with a bamboo craftsman_4th &5th year_2014



Figure 5: HINAGU Elementary School Project collaboration with elementary school boys _4th year_2008



Figure 6: HINAGU Sign Project collaboration with local residents & Yatsushiro City_5th year_2007



Figure 7: HINAGU New Station Project collaboration with local residents & Yatsushiro City_3rd year_2011



Figure 8: Hospital Gallery Project collaboration with doctors, nurses, constructer, and high school students_AD1st & all the years_2012



Figure 9: Vacant store Renovation Project collaboration with the chamber of commerce _AD1st & all the years_2011



Figure 10: Presentation to a local government officer, architect and urban planner _5thyear_2014



Figure 11: Group work_5th year_2012



Figure 12: Senior students (5th year) are giving advices to their juniors (3rdyear) _2014



Figure 13: Assoc. Prof. Moriyama Studio_4th &5th year students' group_2014 _2014)

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The Achievements for the Last 10 Years

1. Past Projects

The Department of AC has made efforts on projects based on actively involvement with a local community for over 10 years as shown in the Table 1. The 94 projects were undertaken as part of this effort in the 19 subjects, accounting for approximately 20% of all of lectures and seminar classes. The 5th year has eight subjects (28 projects) that apply to this effort, which is the largest number for any year. Two of the subjects (16 projects) are in the 4th year and three subjects (16 projects) belong to the 1st-3rd years. Extra-curricular activities outside the classroom have also been performed, including co-exhibitions of architecture with local architects and a collaboration project with the Chamber of Commerce regarding revitalization of the downtown. Extracurricular activities are multidiscipline cross the year, and have a great potential to promote active learning by students.

2. The Characteristics of Our Learning Methods

The characteristic learning style of our Architectural Design Class has been developing to as followings. However, it is important to develop contentiously upward.

(1) The collaboration with a community

The collaboration with a local community i.e. local residents, governments, architects, planner, craftsman, school boys and our graduates are shown in Figure 2～10. The reason that we can work these multiple collaboration without any difficulty is mainly that our city is medium scale. It's population is about one hundred and thirty thousand. And there are the historical area and down town area near by our college. They are true supporters for our education. In the students' presentation, it is very important to get opinions by various kinds of persons from viewpoint of real life. To keep our collaboration with local community, it is necessary to keep with strong mutual relationship in our daily lives.

(2) Group work

It has been considered generally that architectural design is individual work. But in our Architectural Design Classes without the lower year, all students' works are by group (Figure 11). Methods of a group formation are as follows; in the 3rd year, teachers decide group members by considering balance of group members, in the 4th year, teachers decide or students decide by talking together, in the 5th year, students decide by talking together.

(3) Supervision by multiple teachers

We have taken supervision in the Architectural Design Classes by multiple teachers. From last year, we have introduced "Supervisor's Studio System". We have realized to enhance more deeply learning from this result (Figure 13).

(4) The learning together and beyond the year

In this year, we have tried to open of the 5thyear's and the 4thyear's Architectural Design class at the same time. Each studio group composes 5th and 4th students mixed. About from last year, there are some 5th year students who join in the lower Architectural Design Class presentation and give advices to junior students (Figure 12). And some students have started up a study session independently and lower-class students help upper-class students to make models in their graduate design.

(5) The real life problems in the local community

As mentioned before, students are required to solve real life problems. In the 5th year, students are required to discover and to solve problems and they have to design a physical plan. In the 4th year, students are given the planning area and the problems to be solved, and they are required architectural solutions. They make an on-site inspection frequently and deep relationship among the local residents as the year goes up. The planning should be in response to the wishes of the community residents.

Educational effect of our programs

1. EQ (Emotional Intelligence)

The Department of AC requires much comprehensive knowledge for students, because projects are closely related to a society. In addition, the engineering work environment requires extensive collaboration with other specialized fields, and ability to exchange various opinions and work together is necessary. As such abilities are related to internal attitudes towards society and others, EQ (Emotional Intelligence) as advanced by Daniel Goleman (Goleman, D., 1995) was fund to be useful. Goleman states that sense of values and ability to respect consideration, self-control, cooperation, and harmony are important. They are considered to form the background of the desire to learn and willingness to contribute to social activities. Therefore, we considered EQ to be a fair assessment of attitudes towards work. For the education of engineers in our department, EQ is related to the following. They can be learned through group activities and involvement with the community and enhance their learning motivation, so students aim to produce good work in cooperation. Trough EQ tests on a regular basis, we can continue to observe whether the students have mastered basic abilities and attitudes of engineering education.

We prepared an EQ test of 40 questions in total with reference to the Uchiyama's questions (Uchiyama, K., 1997). The four questions correspond to 10 items. Each question was graded on a Likert scale of 1 to 5 corresponding to "completely disagree" "somewhat disagree" "cannot say" "somewhat agree" "completely agree". The questionnaire has been conducted on all students of Department of AC once every year. We show the EQ result from 2010 to 2013. The number of each school year students is about 40. And the number from 1styear to 5thyear students is about 200 in total. Figures 14 - 21 show the results. We identified trends and changes in students EQ values based on these results. Figures 14 - 17 show the averages of the four questions corresponding to the 10 items by school year from 2010 to 2013. Scores over 3.0 indicates positive trends and scores under 3.0 indicates negative trends.

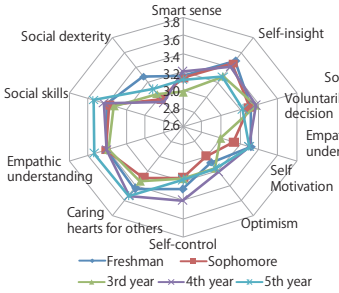


Figure 18: Changes in the same class (Graduated in the school year 2012)

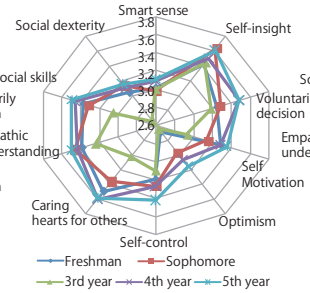


Figure 19: Changes in the same class (Graduated in the school year 2013)

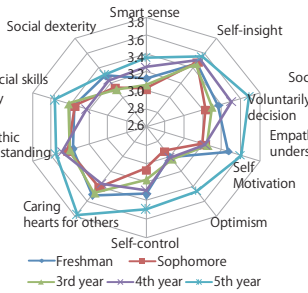


Figure 20: Changes in the same class (5th year in 2014)

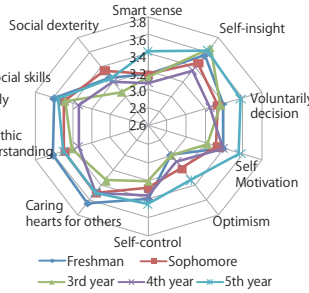


Figure 21: Changes in the same class (4th year in 2014)

Results of the analysis are as follows. Almost the 4th year and 5th year results spread outward compared to other years, and 2nd and 3rd year results tend to fall near the center of the circle. Thus the EQ value tends to rise as the school year increases. Changes in the EQ value in the same class are shown in Figure 18 - 21. Figure 18 and 19 show the changes in the value of EQ of the graduates. Figure 20 and 21 show changes in the value of EQ of the 5th and the 4th years in the school year of 2014. As shown in Figures 18 and 19, the outermost spread occurs at 4th and 5th years, Figure 18 is remarkable. We believe this shows that students have been able to master basic abilities and attitudes toward learning through this engineering education with a local community as classroom. The EQ in Figure20 and Figure21 are almost unchanged and tend to be not so smaller in the 3rd year. This is considered that they have been experienced our PBL approaches from entrance of our college.

In every question, the EQ value of Smart Sense, Social Dexterity and Optimism tend to be small, on the other hand, Caring Hearts for Others, Self-Insight, and Empathic Understanding tend to be high.

2. The Design Competition

Students have been acquired professional skills on the work competency surely. In the Design Competition of National Institute of Technology, number of qualifier in our department has been increasing recently (Table2). Our students got the most-valuable award in the category of Spacial Design in 2014. It is considered that this is one of achievements of our program.

Problems

1. The Traditional Curriculum

The Aalborg PBL Model and the diagram of our AC department curriculum are shown in Figures 22 and 23. The Aalborg PBL Model is well known in the world as the project- organized problem-based learning (Kolmos, 2013) in the engineering education. It is the hybrid curriculum with courses and project. Every semester is set within a 'thematic framework' for sustainable development. The courses are almost traditional lectures. There are only 3 courses in the semester. Courses are developed and taught with reference to the theme of the semester (Kolmos, 2013). Some of the three parallel courses do support the project. Almost project work is carried out in groups and the same model is followed from the 1st semester until the completion of a master degree. The characteristic is that a project occupies one half of the full credits in the semester. The courses occupy the other half.

Contrary to the Aalborg PBL Model, our AC curriculum is traditional. It is common to almost all engineering Japanese universities and our National Institute of Technology. There are many special subjects and they have almost no relevance to each other. Teaching is generally left to the professors. PBL method (group work) is only used in a few courses under the traditional curriculum (Figure 23). Most so-called PBL approaches in Japan are in almost the same situation.

2. Students' Work Load in Each Learning Item

The students' work load in each learning item of AAU (1st semester ～ 6th semester) and our AC Department (1st year～5th year) are shown in Figure 24～25. The students' work load of the project of AAU is much remarkably. As semester promoting, the students' work load increases. The MSc01-Department of

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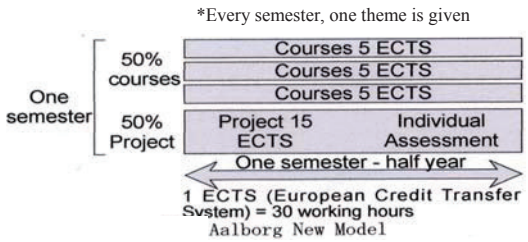


Figure22: The Aalborg PBL Model

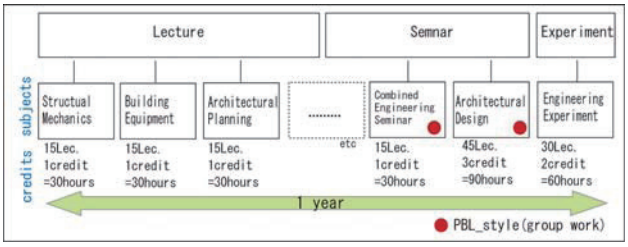


Figure23: The diagram of our AC Department curriculum of NIT, Kumamoto

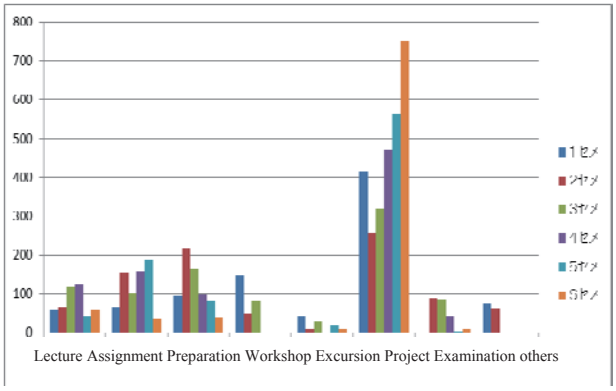


Figure24: Students' work load in each learning item(Department of Architecture, AAU)

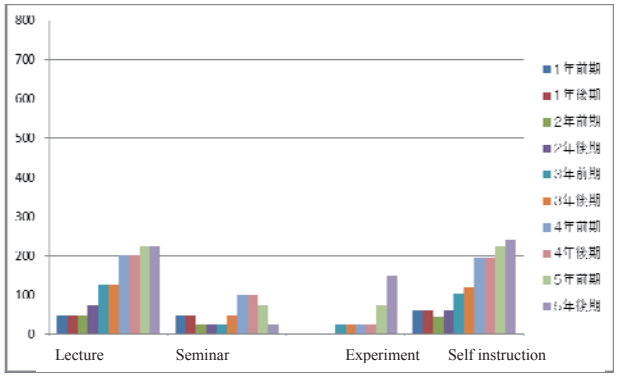


Figure25: Students' work load in each learning item(AC Department of NIT, Kumamoto)

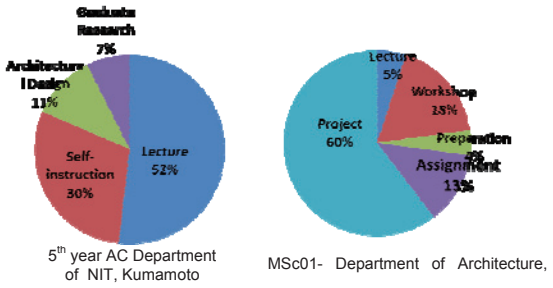


Figure26: The ratio of Students' work load in each learning item

Table3: Comparison of the main purpose of learning

Aalborg University	NIT, Kumamoto College
To secure continued professional development throughout the student's career via lifelong learning, i.e. "learning to learn"(Dahms, M.2012)	To ensure professional and technical knowledge
PBL Introduction, The Department of Development and Planning, Aalborg University, Sep. 1st 2012	Handbook for student of NIT, Kumamoto

Architecture of AAU and the 5thyear of our AC Department of the ratio of Students' work load in each learning item are shown in Figure 26. A 95% of the students' work load of AAU is student's independent or active work. On the other hand, our AC Department students' work load in student's independent or active work is 46%. About work load in lectures, the ratio of its share of our AC Department is 52%, on the other hand, it of AAU is only 5%.

3. The purpose of learning

Table3 compares our college of purpose of learning with those of Aalborg University. The main purpose of learning of our college is to ensure professional and technical knowledge. The main purpose of Aalborg University is to secure continued professional development throughout the student's career via lifelong learning, i.e. "learning to learn" (Dahms, M., 2012). The project of the Aalborg Model is desired a new proposal that is carried out in people's surroundings development. It is importance to be innovative or creative. Contrary to his, our learning purpose is an understanding-level of Bloom's Taxonomy.

Conclusions

We have shown our characteristic learning methods, achievements and problems of our New Engineering Education; mainly the Architectural Design Subject in the AC Department of NIT, Kumamoto on the basis of our approaches for over 10 years. We understand that the educational effects are students' internally development, so we have tried to take EQ as an assessment of educational effect. As the result, it became clear the educational effects in our approaches.

On the other hand, there are a lot of problems. Our approaches of the Architectural Design Class are under the traditional curriculum. In the learning present situation are mixed in a traditional learning and PBL. This learning environment put too much load on students. And also educational development can't be expected further more. We have to improve our traditional curriculum to the students-cantered one as the Aalborg PBL model. Further practically investigation and discussing with a large number of our colleagues is necessary.

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Acknowledgments

We would like to express our thanks to those who gave advice for the study of the Aalborg PBL Model in 2012, Prof. Arne Remmen, Prof. Anette Kolmos, Assoc. Prof. Mona-Lisa Dahms in the Department of Development and Planning, Dr. Michael Mullins, Assoc. Prof. Adrian Carter in the Department of Architecture of Aalborg University. And also we would like to express our thanks to the people of Yatsushiro and Kumamoto City who collabolated with our students and us in our program.

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A case study of the experimental guidance with "Interactive Experiment Notebook" for the purpose of cultivation of Literacy and PBL perspective

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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 by experimental reports that written by student. On the other hand, even if it understands that the guidance of the "Experiment Notebook" is important for a student of science and technology, it is the fact that the teacher cannot start experiment notebooks guidance by many enormous quantity powers. However, the guidance of the experiment notebooks is important for students, paying our attention to the side of "the notebook as the record" and "the notebook as the thought tool" and "the cultivation of the scientific literacy". In "Experiments in Electrical Machiner", experiment notebook guidance are tried. This experiment are made for students belong of fourth year class of our department and students measure characteristic of electric machines like "AC Excited Synchronous Machine" and "Induction Motor" etc.. Notebook guidance is tried mentioned blow. Namely, 1) to all students, notebook and seal on which the table templates are printed are distributed. Student has to fill the blanks of the table template with basically contents of experiments (date, time, collaborator's name, aims of experiments, experimental methods, specifications of measuring instruments, etc.) and put a seal on the notebook. By this attempt, student learns the style of recording format, by trial and error. 2) Student draw actual wirering diagram for accurate record and practical understanding of electric circuits. 3) We also make another seal for notebook on which "consideration and idea on experiment" could be described .4) Effective use of the inheriting sheet concerning know-how and instructions and so on; this experiment are made by the team of students (consist of 4 or 5 students) and team conduct a different experiment in every tine. So, prevenient team records on inheriting sheet about "the notes (especially for safety)", "the idea", and "the advice" for a follower team. We were able to carry out the conversion of these attempts from "passive experiment" to "active experiment".

Keywords: *Experiment notebook, PBL, Technology Literacy, Interactivity*

Introduction

This paper reports the effectiveness of guidance of experiment notebook writing. Many Student experiments were 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 evaporations of student's achievement were 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", for students belong to the course of science and technology, actually and intelligible note taking trainings were very important. As the fundamental study, analyses for state of student research were made by questionnaires for teachers. As a result, it was found that little guidance for experiment note were made. Then, in our school at the subject of "experiments in machine experiment", guidance of experiment that mainly situated notebook training were tried. As a system of cultivate the active consciousness and actions of student about experiments, the system for accumulating and passing on the technical know-how and knowledge about machines and analysis methods were employed. This system is considered as "Paper based Cloud System" and is very efficient and achieved a big result.

Methods

As a fundamental study, a questionnaire wide survey among all teachers and stuff that belong to National college of Technology at Kyushu area in Japan was implemented. I received 190 copies of the questionnaire results. The survey was planned to investigate the student experiments especially focus on research notebook. As a result, it was found that the overall aims of student experiment were almost to understand of the theories and to learn experimental techniques. And also, it was found that little guidance for experiment note were made. For paying attention to various aspects of experiment notebook such as "Recording-tools",

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"Thinking tools" and "Cultivation tools for science literacy", for students belong to the course of science and technology, actually and intelligible note taking trainings were very important. Then, in our school at the class subject of "Experiments in Electrical Machinery" (Figure 1), guidance of experiment that mainly situated notebook training was tried.



Figure 1 The states of the experiment "Experiments in Electrical Machinery"

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. Two teachers and two technical assistants directed these experiments. The methods used in this attempt will be described in detail below..

(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 commercial-available laboratory notebook: Commercial-available laboratory notebook (KOKUYO RESEARCH LAB NOTE<SD>: Type LB208SN) that had adopted at many research laboratories and universities in Japan were distributed to all students (Figure 2).

(3) Using Table-type template seals: As shown in Figure 3, Table-type template seals were employed to learn how to record basic information about experiments (i.e. Date, Title, Collaborators, Experimental equipment's details and so on). Students cut the seals and attach them to notebook and fill in the blanks. (Figure 4)

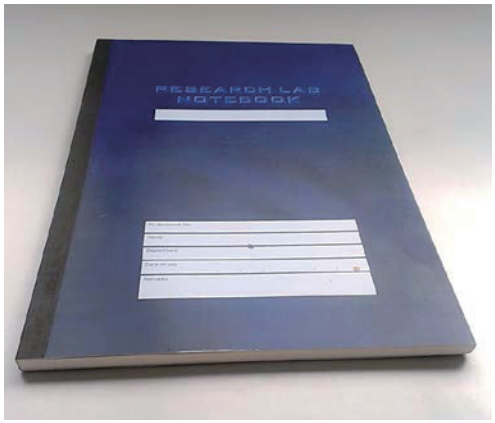


Figure 2 Appearance of Notebook which was used in this trial

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 3 Table-type template seal using in this trial. Original type of template which student used is written in Japanese.

It was possible to learn the contents of the format to be referred to the notebook through this work. In addition, there were items of "Awareness" and "Consideration" 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".

(4) Sketch of practical wiring diagram: For the student's specific understanding about electric circuits connections students had to draw freehand practical wiring diagram (Figure 5).

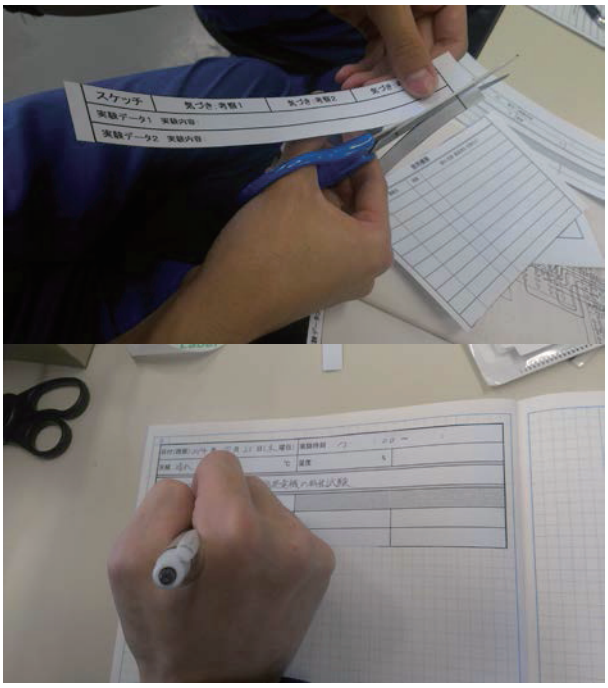


Figure 4 Student cut and pasted the seal on notebook and filled in the blanks.

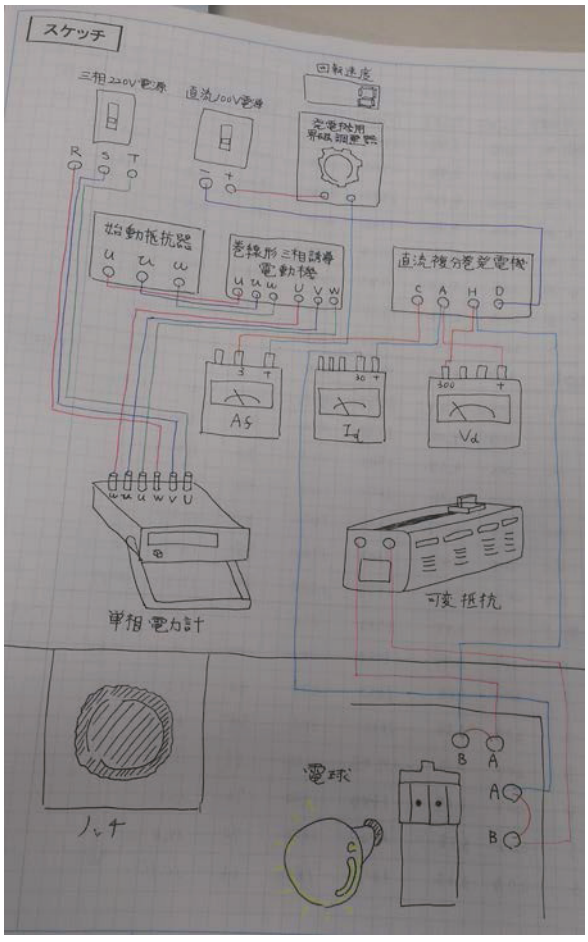


Figure 5 an example of "Sketch of practical wiring diagram" which written by freehand.

(5) Using "The hand-off memo about technical know-how and knowledge": At student experiment, Students assemble teams and every student teams carried out different experiment in rotation at every class time. At the most of previous student experiments, there was little transition from predecessor team.

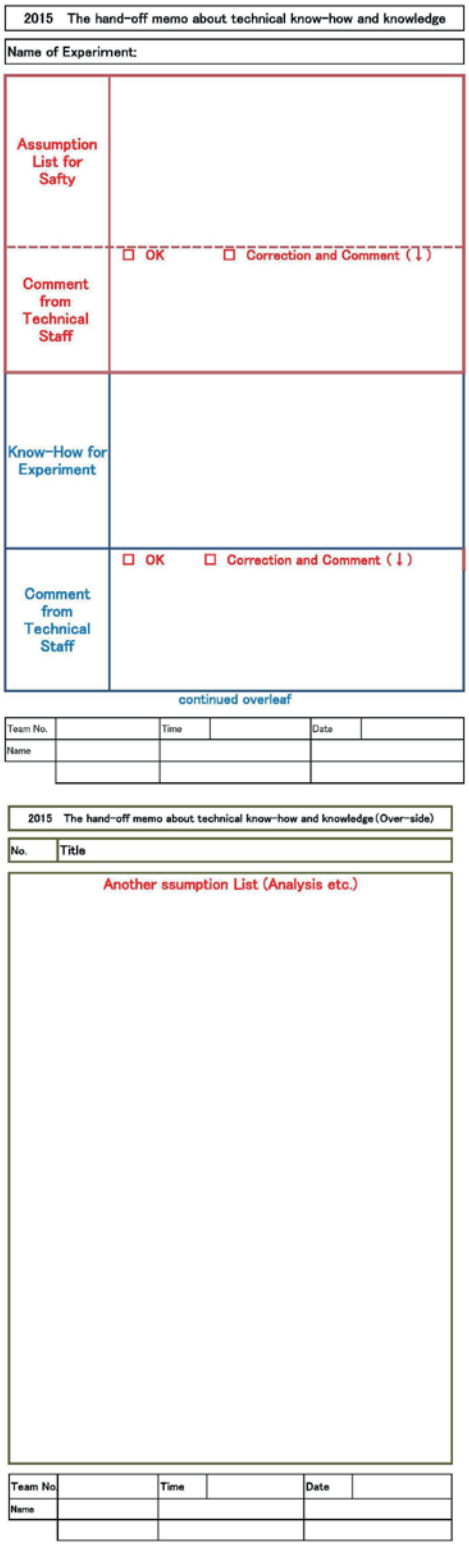


Figure 6 the hand-off memo about technical know-how and knowledge" (front and rear view).
The Original memo is written in Japanese.

Back

As mentioned before in this trial, 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 7).

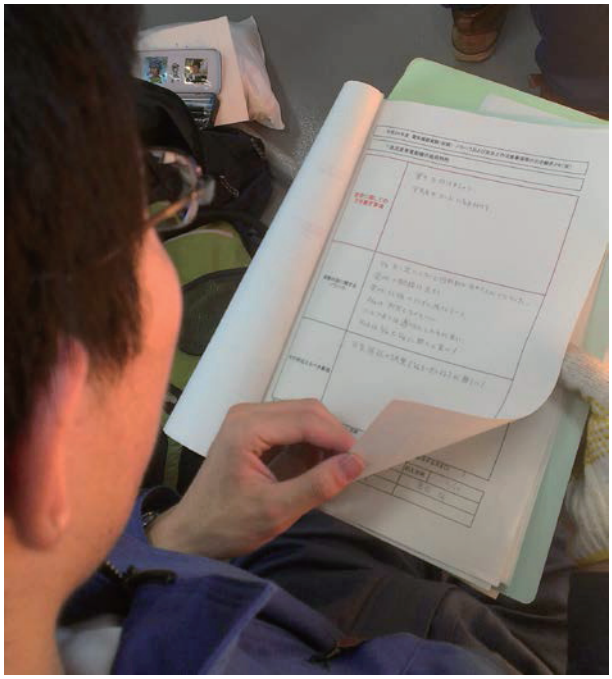


Figure 7 Snapshot of when the students have checked "the hand-off memo" prior to the experiment

(6) Using Check-list: Students had to be able to check if there are any deficiencies for the information and experimental content to make a check list of contents and experimental what has been described in the experimental notebook.

Results and Discussion

As the first step of the overall, it was carried a survey on this attempt to students. Questionnaire results were generally well received. It can be said that student only do a task that given in the conventional student experiment. But this time student by conducting the PBL approach of performing experiments while understand the contents of the experiment by writing a report in advance, students were many opinions that could be addressed to actively in the experiments. Science literacy training using seal that printing table was also popular with students. In particular, the notice and the notes is recorded in actively notebook, through the work of taking over them in following group, students became the training of Active Learning training of performing project actively with the problem consciousness. This is also said to be a challenging attempt to "Cloud of information in paper-based" to share the obtained information and know-how through a student experiments. Through this study, the student experiment has been conducted as a routine work until now, by conducting the various attempts, we were able to find the possibility of them with active work. In the future, we will carry out a more extensive questionnaire survey.

it is expected to make efforts to collect further information. In addition and in the future, we will adopt the ICT technology such as "Moodle system" and "digitization of experiment notes using an electric scanner and bar-code etc." (Figure 8) is expected to achieve a further increase in efficiently and labor savings. And real time analysis by using of personal computer is expected, too. (Figure 9)



Figure 8 In building integrated electronic system: by the left of the scanner is scheduled to carry out the digitization of handwritten reports, it is planned to carry out the digitization of the experimental notebook by the right side of the three-dimensional scanner.



Figure 9 Aggressive students are doing the analysis of experimental data in real time using the spreadsheet software bring their laptops to the laboratory. Eventually distribute single degree laptop one group to, also trimmed their surroundings are immediate goal is to provide for rapid data analysis.

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.

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DIFFERENTIATED INSTRUCTION IN A TERTIARY INSTITUTION: TEACHERS' PERSPECTIVES

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Abstract

This is an education research done to gain more insight into differentiated instruction in a technology faculty in the higher education in Singapore. While it is believed that differentiated instruction can make a positive impact on teachers' and students behaviour and therefore student achievement, this paper seeks to pursue the knowledge and views of differentiated instruction from the perspective of a teacher. This study would attempt to investigate the understanding and implementation of differentiated instruction in a tertiary institution and attempt to answer the following questions: Do years of teaching experience affect the probability of implementing differentiated instructions in the classrooms? What are the teachers' perceptions of differentiated instruction in a tertiary institution? What are some of the barriers and obstacles for implementing differentiated instruction? The fact that all teachers who had participated in this study felt that time is a major barrier for their implementation of differentiated instruction in their classroom suggested that there is a need for a review in terms of time allocation for classroom content preparation. This may be an intrinsic reward that will strengthen the teachers' commitment to implementing differentiated instruction. While many had documented the positive effects of differentiated instruction on students, this study can be extended to a longer longitudinal study so that other hypothesis relating to the implementation of differentiated instruction in classroom can be tested.

Keywords: *Differentiated Instruction, Tertiary Institution, DI*

Introduction

Polytechnics were set up in Singapore with an aim to train professionals to support the technological and economic development of the island. Taking into consideration the wide range of abilities, aptitudes and interests of the potential students, polytechnics seek to equip students with relevant and specific skills for the workplace to give Singapore a competitive edge as it moved into a knowledge-based economy.

With a strong emphasis on practice-based learning, polytechnics offer the atmosphere, challenge and excitement of life in a tertiary institution. The courses offered are market-driven and career-oriented, leading students to fulfilling and rewarding careers as well as preparing them for further education, opening doors to professional career and other avenues for career advancement gaining recognition by professional bodies.

With the polytechnics opening up also to adults and foreigners, it is inevitable that the classrooms in polytechnics are becoming significantly more diverse. Today's classrooms are characterised by academic diversity (Darling Hammond, Wise, & Klein, 1999; Meier, 1995). For years, educators have dealt with issues related to meeting all students' needs in their classroom.

An effective way to accomplish this task is through differentiated instruction (Tomlinson, 2001). Practicing differentiated instruction includes an understanding of what makes learning of specific topics easy or difficult; the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning in the classrooms. Given that students are unlikely to appear before them as blank states, teachers would need knowledge of and adopt the strategies that are most likely to be fruitful in organizing and re-organizing the understanding of their Learners. Balance between content and pedagogy is a persistent issue in teacher education programmes.

The last decade has seen significant changes in the student population in various schools. Ruddell (2005) points out that increasingly, students represent diverse needs as they differ in different ways, for example, cultural background, social economic states, past learning experience and ethnicity. Gunzenhauser (1996) shared that students range in intellectual capacity, process capacity and learning orientation. Emotionally, students differ in terms of maturity, conformity and motivation. Socially, students differ in terms of family issues or social engagement preferences. Schools are welcoming increasing numbers of students from other countries, traditions, languages and cultures making high diversity classrooms one of the defining features of

schools. As students learning needs are getting more recognised, one of the many challenges is to look for ways that address these differing needs.

We all know that the current school type classes and examinations that we have all been familiar with are not sufficient to maximise students learning. Responsive and innovative teaching processes that recognise a diversity of learning needs and styles needs to be put in place to meet the changing needs of students. Differentiated instruction being a flexible learning system that takes into consideration students' academic abilities is one solution for this. But are the teachers' perception of differentiated instruction the same as what they are practicing in their classrooms? Are there any factors which are preventing the teachers from implementing differentiated instruction in their classrooms?

Background

In the current teaching and learning system in a polytechnic, a common set of teaching materials will be prepared for lesson delivery typically through lecture, tutorial or laboratory sessions. To enable students to achieve the learning outcomes of each specific subject, three broad areas are considered, namely, the curriculum, teaching strategies and assessment. The curriculum states the aim and objectives, the content and the skills and competencies required for the syllabi and the values and attitudes that the syllabi hope to impart to the students. Appropriate teaching strategies are designed for successful classroom delivery of the syllabi, using effecting teaching and learning materials. To evaluate if the students have learned what they have been taught, students will be tested through formative and summative assessments.

Purpose of Study

The Singapore education system has entered a phase with a greater focus on quality, more than quantity; new initiatives in pedagogy, curriculum and assessment, and re-structuring of higher education and education policies have also ensued.

Singapore has reached a stage in the development of its education system where there is probably no single systematic solution that would bring about all the improvements that we need. There is a need to adopt a more differentiated approach, where different part of the system is allowed to respond to local needs and conditions.

As today's classrooms become more diversified, differentiated instruction referring to classroom practices focusing on student learning approaches, interests and prior knowledge (Benjamin, 2002) seems like a good match with the MOE's initiative. To ensure that the needs of different students in a classroom are well taken care of, differentiated instruction could be an adoptable approach in teaching as the major purpose of differentiated instruction is to maximize each student's growth by meeting each student where he or she is.

In this research, the focus will solely be on the teachers' perspective on differentiating instructions. The research responses will be teachers' accounts of how they did or did not differentiate instruction in their classrooms. I will not be making any reference to students' assessment performance nor gather any feedbacks from students in the school. This exclusion is deliberate as any attempts to correlate the two would require an exhaustive, longitudinal study which is beyond the scope of my study.

This research review was exploratory in nature and conducted to provide information to help a tertiary institution in their on-going efforts to enhance and support differentiated instruction to improve students learning. This paper does not attempt to capture readily applicable pedagogies as "procedures", but instead attempts to document a range of perceptions, practices, processes and strategies shared by teachers that supported the implementation of differentiated instruction. More effectively, we will be documenting and then disseminating the findings within the jurisdiction for educators not involved in the research.

Literature Review

Differentiated instruction refers to classroom teaching and learning that are tailored to students with different learning methods and ability. It is not a new notion and teachers of the one-room schoolhouse have attempted to meet the needs of all students centuries ago (Anderson, 2007). Similarly, the main purpose of differentiated instruction is to help capitalize on the learning of each student by identifying and catering our teaching to their level of ability (Hall, Strangman & Meyer, 2011). Differentiating instruction means providing multiple tracks so that students of different aptitudes, interest or learning needs experience equally suitable ways to absorb, use, develop and present concepts as a part of the daily learning process. This means providing three or four different options for students in any given class. It allows students to take greater responsibility and ownership for their own learning, and provides opportunities for peer teaching and cooperative learning (Theroux, 2004). Readiness, learning styles and interest can be very different among students and even within an individual over time. In a differentiated classroom all students should have equally engaging learning activities.

Differentiated instruction was regarded as a way of thinking about and approaching the planning and implementation of curriculum and instruction that recognizes that individual learners may have different levels of aptitude, achievement, interest, motivation, needs and ability (Tomlinson, 1995). The realities of student variance was acknowledged and accommodated by offering multiple possibilities and options for students to access curricular content, make sense of concepts and skills and make evident learning.

To date, no specific or definitive model for differentiated instruction has been clearly established as best practice. Identifying student variance and selecting

students for participation in exclusive activities have been common practices for many years in schools.

O'Brien & Guiney (2001) clearly enumerated the following as major principles of differentiated instruction:

1) Every student can learn and every teacher can learn
2) All students have the right to high quality education
3) Progress for all students will be expected, recognised and rewarded
4) Learners in a classroom have common needs, distinct needs, and individual needs.

The curriculum should be built on what has already been learnt and experienced. It should also develop the knowledge and skills that students need to move on confidently through school and from school to the world of work and/or further education.

Edyburn (2004) who agreed with Tomlinson (1999) mentioned in his article that teachers should focus on essentials in learning, should attend to student differences, should work together with students on learning, and should not isolate assessment from instruction. The teacher should constantly make changes to the content, process and products produced from learning. Teachers should also allow students to participate in respectful work while maintaining a flexible working rapport.

Why Differentiated Instruction?

In addition to difference in cognitive, emotional, physical, and communicative development, today's classrooms are diverse with respect to culture, ethnicity, language and socioeconomic background. A typical classroom might consist of students from varied cultural background; students with different capability – some classified as gifted, some average while some who are below average; students with behavioural and medical conditions; students whose first language might not be the language of instruction; students with disabilities and special needs. These change in demographic creates new challenges for today's educators. How can educators ensure that each and every student in their classroom learns and reach their highest level of achievement?

For years, educators have dealt with issues related to meeting all students' needs in their classrooms. Innovations around educational practices have been piloted in schools with the aim of improving students learning in noticeable and quantifiable ways.

"We should explore if we can offer variations besides the core curriculum, that caters to the interests and aspirations of students who are keen to progress on a more applied and practice-oriented path of education" (Tharman, 2005).

As Fullan and Pomfret (1977) pointed out, the actual use or putting into practice of a curriculum differs from the planned or intended use and is a phenomenon in its own rights. The purpose for differentiating teaching and practice is to increase the quality and quantity of instruction resulting in effective support for learning in classrooms. To effectively teach a range of students, teachers must exercise flexibility in the use of time, space, resources, student groupings and instructional exchange with learners. Teachers should not assume students are essentially similar in their learning needs, and cannot presume that teaching one topic in one way according to one timetable is a feasible practice (Tomlinson, 2005).

In other words, differentiating instruction helps to bring one subject down to different levels for students at different starting points. By doing so, differentiated instruction has enough breadth and depth to demonstrate competence for fostering students' deep understandings of content areas.

Materials and Methods or pedagogy

A mixed research approach which leverage on the complementary strengths of both the qualitative and quantitative research approaches was used for this study. Quantitative data collection was first conducted through survey questionnaires as a means to outline broad relationships from the data. Results from the quantitative findings were used as a guide for the selection of participants for the qualitative data collection. From the information discovered through quantitative surveys, qualitative methods were used to explore the said information further and the explanation that could only be uncovered through interviews.

The survey is descriptive and exploratory in nature as well as designed to investigate teachers' perception of differentiated instruction and whether they have implemented it in their classrooms. According to Krathwohl (1998), qualitative research is characterized by an inductive approach that begins with semi-structured protocol and proceeds by exploring to find out what is significant in the situation by trying to understand and explain it. Krathwohl explained further by describing qualitative research as gathering data, describing situations of interest and letting the explanations emerge. The uniqueness of adopting the qualitative design in this study is that behaviors (teachers' perceptions) are gathered in a natural setting and the process is studied as it occurs naturally.

In this research, the descriptive data were collected over questionnaires and interviews which consisted of both open and close ended questions for content analysis and interpretations. Actual perceptions and experience of the teachers during the process of the interview would be presented descriptively. However, there would be no explanation as to why or how these teachers possessed such perceptions or experiences as it would be out of the scope of this study. As Oppenheim (1992) had suggested, descriptive surveys primarily report on how many members of a population have a certain opinion or characteristics or how frequent certain events occur together rather than explain the reasons or show the causal relationships between the different variables.

In this research, triangulation of data was done via comparison of information over participants as well as comparison between the interviews and the questionnaire.

Structured Questionaires

Prior to interviewing the teachers, a survey questionnaire was administered online to collect background information such as the mentor teachers' previous experience as well as their expectations of implementing differentiated instruction in classrooms as well as preliminary data relative to each research questions.

The questionnaire was divided into two main sections, "Demographics" questions and "Perceptions" questions. Both sections contained closed ended questions.

The first section served to allow the participant to provide a profile of them and allows for a follow up if necessary. It comprised demographic questions such as designation and years of teaching experience.

The second section consisting of the "perception" questions served to obtain the participants perceptions and views of differentiated instruction. The second section consisted of two parts. The first part in the second section comprised of a series of questions that used a four-point Likert scale (labeled "Strongly Disagree", "Disagree", "Agree", "Strongly Agree") with questions related to the participants' views of the external factors related to their practicing of differentiated instruction in their classrooms.

The second part of the second section comprised questions relating to the participants' level of understanding of the elements of differentiated instruction. It allowed me to have a better understanding of the participants' perception of the elements of differentiated instruction.

The questionnaire survey was conducted through an electronic survey system. Questions were entered into the electronic survey system and a link together with the survey information was sent to the participants. Once the survey was closed, the survey system compiled and generated the data. The consolidated data was then used for analysis purpose.

Semi-Structured Interviews

A series of in-depth interviews (appendix 2) for selected teachers were conducted over a period of two months to gather the teachers' responses relative to each research questions. Face to face interviews for each participant were conducted to obtain main data for this study because such interviews have been considered the most reliable method for collecting attitudinal and opinion from some special group population group (Weinberg, 1988).

The questions were divided into three categories, staff perception and practice of differentiated instruction in their classrooms, support provided by the school to the staff for the implementation of differentiated instruction and barriers and obstacles which prevents staff from implementing differentiated instruction or encountered by the staff during the implementation of differentiated instruction in their classrooms.

Time was set aside to meet informally with each teacher. Each teacher was asked to reflect on their own lesson or activity conducted in the classroom and share if those activities differentiated instruction. Teachers were also asked on how they think the school had supported them in terms of implementing differentiated instruction in their classrooms.

All conversations were informal, yet informative as the teachers share how they each planned for instruction based on the needs of their students.

Sampling

For this research, the main group of participants was the teachers teaching in a tertiary institution in Singapore. An ideal population will be all higher education institution teachers. However, because of the different course structure, such generalization would not be justifiable.

The suitability of the participants was also one considering factor during the selection process. Based on the answers given by the participants through the survey questionnaire, I had selected the participants who have indicated that they understood what differentiated instruction is and either did not practice or have practiced or wanted to practice differentiated instruction in their classrooms for the semi-structured interview.

All teacher participants who were chosen through this purposive sampling should ideally have at least 2 years of teaching experience in the tertiary institution and will also have a basic and common understanding of what differentiated instruction is.

Results and Discussion

The following tables represent the specific information about the participants that is important to acknowledge based on the research questions.

Table 1: Teaching Experience of teachers

Teaching Experience	Response Percentage (%)	Response Count
Less than 2 years	8.4	2
2 to 5 years	25	4
6 to 10 years	33.3	3
More than 10 years	33.3	3

Table 2: Implementation of Differentiated Instructions in Classrooms by Teaching Experience

Teaching Experience	Response Percentage (%)		Response Count	
	Yes	No	Yes	No
Less than 2 years	0	100	0	2
2 to 5 years	50	50	2	2
6 to 10 years	100	0	3	0
More than 10 years	66.7	33.3	2	1

The table illustrates that both teachers with teaching experience of less than two years did not implement differentiated instruction in his or her classroom. Half of the teachers with two to five years of teaching experience had implemented differentiated instruction in their classrooms. Out of the three teachers with six to 10 years of teaching experience, all had implemented differentiated instruction in their classrooms. One out of the three teachers with more than 10 years of teaching experience did not implement differentiated instruction in their classrooms.

Based on the quantitative findings above, the following hypothesis was formulated: "Teachers who have more teaching experience will have a higher level of implementation of the overall process of differentiated instruction."

This hypothesis looked for a comparison within two groups: participants who have more than five years of teaching experience as compared to participants with less than five years of teaching experience. Based on the responses from the survey results, participants were divided into two groups for the purpose of examining this hypothesis: "I have implemented differentiated instruction" and "I have not implemented differentiated instruction". Of the 12 responses, seven reported that they have implemented differentiated instruction in their classrooms while five reported that they had not implemented differentiated instruction in their classrooms.

Out of the seven who responded that they have implemented differentiated instruction in their classrooms, five had more than five years of teaching experience. The results of the analysis indicated that more participants with more than five years of teaching experience had reported that they had implemented differentiated instruction in their classrooms. In other words, years of teaching experience does affect the probability of implementing differentiated instructions in the classrooms.

Having said that, there were a few limitations that could have affected the validity of this research. First would be the sample size. With the small numbers from each group of interest, it might not be representative enough to give an accurate conclusion. Secondly, honesty could have threatened the internal validity of the research. Teachers may have been hesitant to articulate their limited ability of implementing differentiated instruction in the classroom.

It is a known fact that differentiated instruction can help students achieve their individual utmost potential. However, it is not a framework which can be understood and implemented easily.

According to the research findings, most of the teacher participants had a good understanding of differentiated instruction and were fully aware that differentiated instruction is a useful tool for classroom teaching. But due to the lack of time, the teachers felt that it would be difficult for them to keep up with all the work needed to prepare for the implementation of differentiated instruction in their classrooms. Most had highlighted that it would be useful if they had received better support in terms of non-teaching tasks, for example, administrative work.

Before the school decides to make differentiated instruction mandatory, it is essential to understand the extent to which teachers understand differentiated instruction prior to implementing any changes and training. Various factors, such as lack of planning time and materials are the major barriers in the implementation of these instructional models and strategies. The implementation of differentiated instruction can be inconsistent so it is important to survey teachers as a way to assess their understanding of key strategies to improve instruction.

No general conclusions can be drawn because the study was limited to only twelve teachers but the data has provided a good perspective of teachers' understanding of differentiated instruction and what are some of the barriers and obstacles which could have prevented them from implementing or further practice differentiated instruction in their classrooms.

It would be most ideal if this study could be carried out over a longer period of time so as to track the development of differentiated instruction for the teachers. In addition, while effort is being made to ensure the reliability and validity of this study, generalization of the results cannot be made due to the small sample size and the inductive procedures used to interpret the data.

Conclusions

From the questionnaire responses, and the interviews, all teachers felt that they need to examine their own teaching approaches and techniques, attitudes as well as subject matter knowledge in greater depth and more critically than they normally do in order to implement differentiated instruction in their classroom. This will result in them re-examining and modifying their overall philosophy of teaching, pedagogical knowledge, content knowledge and even behaviour in the classroom.

As shared by Tomlinson, et al (1994), beginning teachers tend to focus more on classroom management issues and instructional planning during the early years of their teaching experience, making it difficult to focus on differentiating instruction to meet students' needs. This is exactly what some of the younger teachers had mentioned during the interview. Mature teachers, with more teaching experience, tend to have better teaching skills to handle the art of differentiating instruction.

The data reported in this study indicated that all teachers have a good understanding of differentiated instruction and also feel that differentiated instruction is beneficial to their students. Overall, time is the main factor which is stopping some of them from implementing differentiated instruction in their classrooms.

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Creating online teaching method tool using in a class for faculty development

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Abstract

As an activity of faculty development, improving our lecture skills; for example, lecture construction and behavior in a lecture, we attend lectures to learn the teaching techniques or be watched by the others giving comments that held in several Kosen and university as well. But if we suddenly think to need any ideas or methods of teaching, we could not get them easily and with fully satisfied due to the limit of time and occasion to learn. Before we created the tools, which help teachers to learn teaching techniques, we set three directions. The first direction is user can use the tool wherever and whenever they want. The second is contents have concrete and practical teaching methods that a user can use them in the class as soon as possible. The third is the system develops the educational archives, which are classified by the lecture hints. In this reason, we created the website that contains videos Kosen teachers talking about useful teaching methods that they are using in a class. In this paper, we explain the characteristics and contents of the websites we made. We collected videos from 27 teachers working for Kosen and Toyohashi University of Technology who have a special or useful teaching method whole of Japan. They're teaching different subjects, Japanese, English, Chemistry, Engineering and more. We went there where they work and took an interview of a teaching method with recording. We edited these interview data into a short movie, from 1 to 3 minutes, because users don't avoid watching for taking long time. After editing, we classified them into five categories, Lecture Planning, Lecture Preparation, Lecture Structure, Attitude in Lecture, and Grading. These interview videos were published online and users watch the videos on each teaching categories and search the movie what they want on the top page.

Keywords: *ICT, Teaching Methods, VTR Archives, Lecture Construction, Lecture Preparation, Bahavior in Lecture*

Introduction

Most of the teachers belong to National Institute of Technology, Kosen, are not specialised in education, despite one of the purposes of Kosen is to provide higher education where teachers teach specific engineering subjects; for example, Mechanics, Electronics, Civil Engineering and others, to students, who enter Kosen at 15 years old. The statement in the annual plan of National Institute of Technology Organization describes that the ratio of teachers that have various social background do not have to be under 60 percent, because of guaranteeing the higher ability level of teachers through the original selecting method or acceptance situation of each Kosen College. The meaning of "having various social background" is the experience that a person had worked at a university or a company or stayed at overseas over one year as a researcher. This planning seems to shift Kosen to improve the multi-diversity system for Kosen education. However, the teacher having a experience to have taught their subjects in a university would be confused the difference of the academic knowledge level and the mental development stage between Kosen students and university's when they have a first experience standing in front of Kosen student. The works that they teach to subordinates and research at overseas are not similar with work at Kosen.

The syllabus has been already created, which includes the purpose, the goal and planning at two or three months before the new season starts. In this

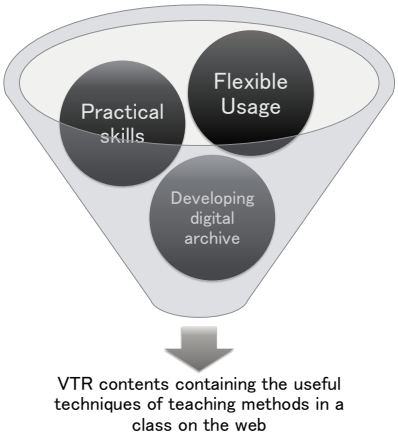


Figure 1 The directions of our educational activity

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occasion, the first-year teachers have to teach the subject following that syllabus, which they didn't write. In addition, they don't have any opportunities to learn the skill of writing on a blackboard, asking questions to students, method of creating a exam and how to deal with the student trouble behaviors before they attend the workshop for first-year teachers. Therefor, the first-year teachers hired by Kosen don't have enough chances to learn educational methods and skills before teaching their subjects in class. They learn some classroom skills; for example, setting lecture purpose, goal, planning and evaluating grades and even in the lecture structure, introduction, main body and conclusion, and attitude in lecture, asking questions, dealing trouble behavior through the class, that means they learn these skills as On-Job-Training style.

Most of all Kosen colleges offer some activities of faculty development. Students evaluate the lecture at the end of the semester and teachers observe the other teachers lecture and give some comments are one of the FD activity in Kosen. Although teachers find some modifying points from them, these are not useful information for teachers because of based on the observed teacher view advices, not teacher-centre. Consequently, there are not enough occasions to improve their educational skills getting from the information and FD activities.

On the other hand, some teachers that have several and advantaged educational skills and methods in a class work for each Kosen, but these skills are not shared with others in organised FD activities, only shared with personalised advice on each other. We suppose a reason not to be shared these abilities is difficult to find the time to discuss with them because teachers are so busy to do their jobs. And lacking a confidential relationship between teachers prevents sharing these skills.

According to these backgrounds, senior teachers introduce lecture skills to junior teachers as an FD activity in recent years (Senichi U., 2008). We consider that these activities should be expanded to the whole of Kosen organization that would improve teachers' educational skills. In this research as one of the systems sharing educational skills, we created Lecture Skill Tool on the web. This tool contains VTR that interviewed teachers, who have advanced educational skills work for Kosen. We recorded these interviews, and after that, we edited them and uploaded on a website we created originally. Our activity is able to provide practical skills and methods for a class to all Kosen teachers.

Activities

Characteristics of lecture skills and methods

We created the tool to supply skills and methods efficiently to teachers, who try to do better lecture and improve their lectures.

The characteristics of our system have below directions (Figure 1),

1) Teachers can use the system whenever and wherever they want.
2) The contents include practical skills, and teachers are able to use them in a class
3) The system develops the educational archives, which are classified by the lecture hints

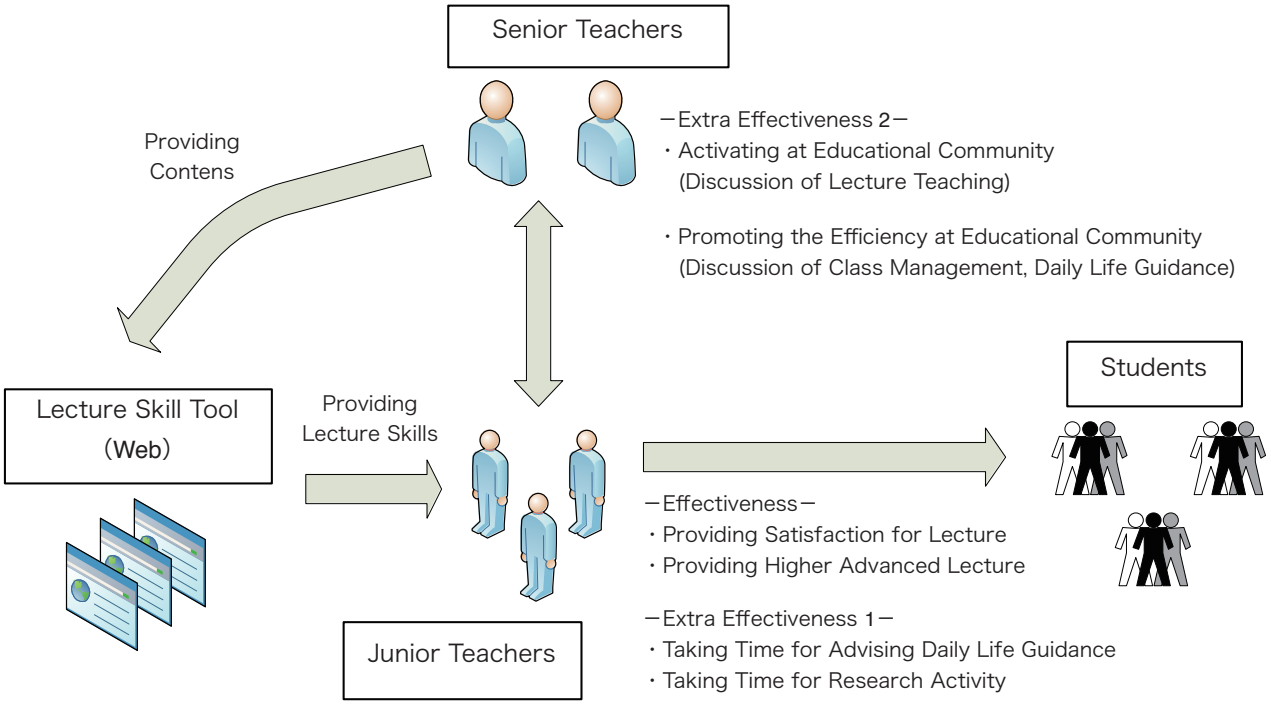


Figure 2 The educational effectiveness of our educational activity to being relationship between senior teachers and junior teachers, and students in Kosen.



Fig 3 Top Page of Tool for Teaching skills and methods we originally created on a web.



Figure 4 VTR contents on Lecture Method Tool

Most of the teachers rely on the FD activity, observing other teacher lecture and the evaluation from students held in each Kosen College. But teachers don't have enough time to observe the class and discuss the lecture skills each other due to being busy for preparing own lecture materials and other school works. The evaluation from students has a useful to improve our educational skills, whereas a part of this evaluation doesn't have high reliability for data.

Comparing previous FD activities, our tool can provide the practical advice and skills in a class by the VTR, ICT method and teachers can access them on the website. Teachers can take several types of educational skills in class from this tool when they want to know them or struggle with education.

Anticipated effect

If teachers use this tool, firstly, the quality of lecture would be expected to be advanced (Figure. 2). Secondly, we suppose that the communication opportunity to discuss with each other and work-sharing would increase because using this FD supporting tool leads the discussion of the educational problems and methods on a face to face. And thirdly, we avoid missing the advanced teaching skills and methods, which each teacher has developed, due to recording and collecting these skills in the interviews and digital archives.

Methodology of FD supporting system

We collected some information from colleagues who have an advanced teaching skill in Kosen College. After collecting information, we selected the teacher to interview, manage the schedule and go to meet him/her to talk and record the interview. We collected some materials that teachers use in class for supporting the smoothly understanding. The server of this system is setting on the Toyota College.

Process of FD supporting system

Methodology of Interview

After permitting the recording interview, we mainly asked the characteristics of teaching skills, the reason for introducing these skills, the effect of them to improve the class. We used the video camera, which was sold in an electrical shop to record the interview from the front of the interviewee. We recorded the interview from one hour to one and half hour about teaching skills, in addition, we collected opinions how to teach their subjects to students or how Kosen teacher should be. We also collected the supporting materials, which is a handout, by recorded as a photo.

Classification of teaching skill

We picked up 12 practical teaching skills based on our experience. These skills were managed five categories according to "students and teachers" (Institute for Development of Higher Education, 1971). "Lecture Planning" is used as the skill to create syllabus; for example, long-term, middle-term and short-term lecture plan. "Lecture Preparation" is the skill to prepare the lecture; for example, quiz, handout and extra materials. "Lecture Structure" is the structure, introduction, main body and conclusion, in one lecture. "Attitude in Lecture" includes the behavior, voice tone and news topics teacher talks in the lecture. The last skill is "Grading" that contains the homework, quiz and evaluation.

Editing

The VTR recorded the interview were classified as each five teaching skills. The most of VTR were edited to short length, one to three minutes, in order to watch easier for users. Some VTR added a subscript to clarify a main idea of what teacher said.

Web Design

We created the web page to show edited VTR files. We designed the web page as users can access to VTR, which they want to watch, through both kinds of routes, teacher's name searching-route or skill route (Figure 3).

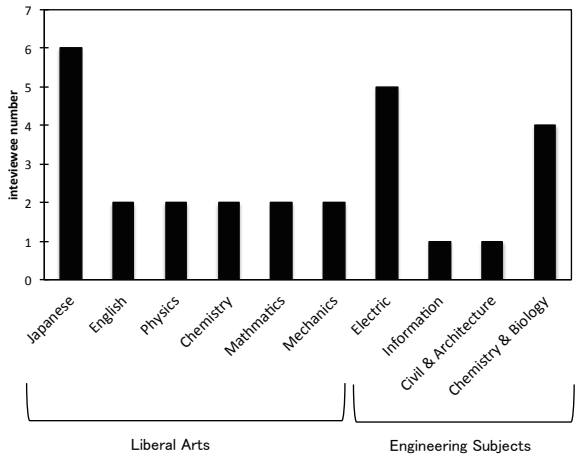


Figure 5 Number of teachers we interviewed about educational skills and methods on each academic field.

The purpose, structure and classification of this FD activity put on the top page of this web page; that offers the first user to surf easily. The abstract of VTR put above the VTR movie to understand fluently (Figure 4). In addition, we add the search engine to find skills in this web page easily. This search engine improves the tool accessibility, so user access skills smoothly.

Collecting Contents

We interviewed 27 teachers have a various academic field. 14 teachers are working for the Department of Liberal Arts and others are a specific field; for example, Mechanics, Electronics and Chemistry and so on (Figure 5). That means we collected teaching skills covered almost all of Kosen educational field. If a teacher wants to know their field, they can access to it.

We collected 78 contents provided from 27 teachers and still are collecting (Table 1). The skill of most collecting contents is “Attitude in Lecture”, 22 contents. There are many skills to have a relationship with students in a class. A teacher talked us the developing reliable relationship between students and teacher is one of the essential matter to teach in class. Makoto K. & Yoshitaka M. (2014) also described that having a communication between students and teachers, which they collected student opinions and questions by using the student opinion sheet at the end of every lecture, let students improving the satisfaction with the lecture. We suppose that teachers provide not only knowledge but also encourage the spontaneous behavior to study for students that are the most effective skill in class.

The second number of contents, 17, we collected is “Preparation for Lecture”. Six teachers prepare the handout as preparation for a lecture. The reason for it is to reduce the writing time to copy words on a blackboard and they can use that time to solve the extra quizzes. Although making a handout makes a load of teachers, once making it, a teacher only modifies light mistakes continuously. So the handout promotes the understanding of lecture for students and that is the one

Table 1 Collecting contents of advanced lecture skills in a class

Classification of Teaching skills		Collecting contents
Lecture Planning	Long Term	8
	Middle Term	
	Short Term	
Lecture Preparation	Quiz	17
	Handout, Extra Material	
Lecture Structure	Introduction, Main Body, Conclusion	11
Attitude in Lecture	Behavior, Voice Tone, Talking Speed	22
	Topics	
Grading	Homework, Quiz	4
	Evaluation	
Others		16

of the sustainable development teaching skill for teachers.

Conclusion

We’ve done the faculty development activity, creating a new tool for educational development for teachers, in order to share those skills and improve their teaching skills for all of Kosen teachers. We also decided the three directions of this system, 1) Teachers can use the system whenever and wherever they want, 2) The contents include a practical skills, and teachers are able to use them in class, and 3) The system develops the educational archives, which are classified by the lecture hints. We collected many VTR contents that include advanced teaching skills in class from a various academic field in Kosen. After collecting those, we edited them to a short movie VTR and uploaded to the website we made and contains both access routes, skill-searching route and teacher-searching route, for users want to reach a content. According to the data, many teachers have an effort to prepare their original handout and extra materials to enhance the understanding of lecture contents for students.These data and analysis provide the useful and important information for developing FD activity. And we realised that creating the reliable relationship between teacher and students in a class is one of the effective educational

skills not only in a lecture but also class management and daily life guidance.

Acknowledgements

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CURRICULUM REDESIGN WITH CDIO IN CHEMICAL AND MATERIALS ENGINEERING

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Abstract

The paper describes the CDIO based redesign of Turku University of Applied Sciences based in Chemical Engineering programme. The process was started in 2012 with a self-assessment procedure and continued through various stages to a redesigned curriculum in 2014. The greatest challenge in the redesign work was to keep the focus on and strive for larger modules which cover all general engineering as well as innovation competences. The aim of this paper is to describe the redesign process and elements that constituted the new curricula.

Keywords: *CDIO, curriculum, redesign, Chemical and Materials Engineering, self-assessment*

Introduction

During the past decades engineering education has been widely criticized as the focus has been on theoretical studies instead of practical work. Figure 1. Engineers need both these skills as well as interpersonal skills. This common viewpoint has been adopted in the Chemical and Materials Engineering education in TUAS. The chosen CDIO framework is widely considered a working solution for improving engineering students' work life skills.

The CDIO model was initially developed as a Swedish-American university collaboration with the initialization from the industry and is now continuing as an international network developing the engineering education worldwide. TUAS has been an active participant in the network and the CDIO model is implemented trough the educations in the University of Applied Sciences. The curricula development work at Chemical and Materials Engineering started as a part of the department development work combined with the messages received from industry. The existing traditional curriculum was no longer sufficient to address the contemporary industry concerns for improved graduate competency. The curriculum was fragmented and concentrated on specific subjects rather than larger entities developing holistic views. The need was for improved professional skills such as critical thinking, problem solving and interpersonal skills. By implementing the CDIO model the goal was to renew the education and to develop the teaching methods to activate the students learning. The active learning can more effectively take place in premises planned for this rather than traditional classrooms.

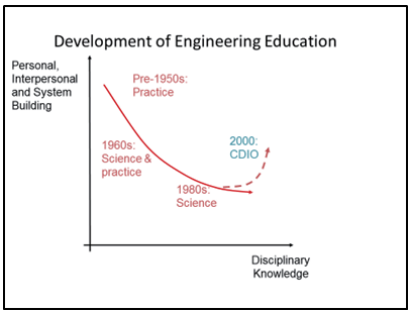


Figure 1. Development of Engineering Education from the 1950s to 2000. Costa (2014)

Materials and Methods or pedagogy

CDIO is a model where the aim is to develop and renew the engineering education by integration of various subjects and topics. A CDIO-based curriculum is organized around the disciplines, but with CDIO activities interwoven. Traditionally have mathematical subjects been placed in the early stage of the curriculum as the professional subjects deepening the engineering know-how have been placed in the end of the studies. The goal of CDIO (*conceive, design, implement, operate*) is to provide the engineering students with a holistic view of the professional know-hows they will need in their future work.

At the first stage (*conceive*) should an evaluation of the start point be made. The real problems the students are dealing with have to be identified. At the next stage (*design*) are plans for solving these problems made and analyzed. At the third stage (*implement*) are the planned solutions tested and the best performing is chosen to be used. The whole process culminates in the final stage (*operate*) where the chosen solution method is used for problem solving and the results processed and recycled. In real life industrial processes are problems rarely

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connected to only one issue rather joint effects of several issues cause the problem. This is why the education should consist of projects including interdisciplinary subjects. Stenroos-Vuorio ed. (2012) found that the content of the education can be described by three pinpoints.

- Deep knowledge of technical fundamentals
- Ability to work as an engineer (developing, leading and collaborating)
- Understanding the importance and strategic impact of research and product development

The redesign process

The redesign process started 2012 with a self-assessment of the present state. Figure 2. Table 1. The staff worked in small groups collecting information and knowledge about good practices and strengths in the education. Student representatives were part of each small team and gave their input to the curricula redesign work. The goal of the redesign was defined as well as the actions to achieve the goal.

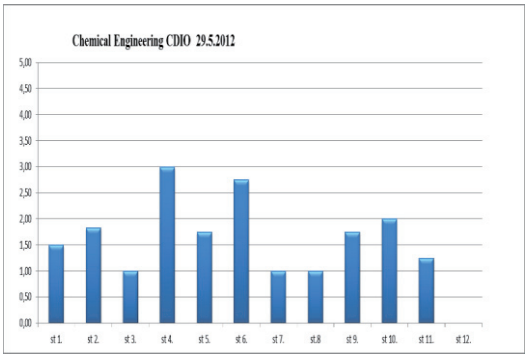


Figure 2 and Table 1. Results of the first self-assessment in Chemical Engineering 2012.

	Standard	Score
st 1.	CDIO as Context	1,5
st 2.	CDIO Syllabus Outcomes	1,8
st 3.	Integrated Curriculum	1
st 4.	Introduction to Engineering	3
st 5.	Design-Build Experiences	1,75
st 6.	CDIO workspaces	2,75
st 7.	Integrated Learning Experinces	1
st.8	Active Learning	1
st 9.	Enhancement of Faculty CDIO Skills	1,75
st 10.	Enhancement of Faculty Teaching Skills	2
st 11.	CDIO Skills Assessment	1,25
st 12.	CDIO Program Evaluation	

The results of the first self-assessment made in Chemical and Materials Engineering indicate a general score between levels 1 and 2. Levels 1 and 2 indicate that the degree program recognizes the need and has a process made up for the change. Level 3 corresponding to a started process was only reached in standard 2, Introduction to engineering. This was due to the fact that the whole curricula redesign process started here one year earlier. A new self-assessment will take place in fall 2015.

As the next step in the redesign work the representatives from industry were contacted. They were asked for input of up-to-date competences to be included in the new curricula. A summary of the input is presented below.

- Defined competences; technical knowledge, communicational skills, problem solving, creativity etc.
- Integrated curriculum; different courses should connect to each other and support the versatile learning.
- Learning environments should be planned to enhance hands on learning, interactivity and cooperative learning
- Integrated learning experiences and active learning, methods, brain storming, analysis etc.
- Education of the teachers, pedagogical skills vs. competences required in the industry, development of teaching methods

Industry representatives were a part of the whole process as the curricula was presented to them regularly during the entire development process. As the required competences were identified we faced the fact that they were hard to include into the curricula as such. This has also been noticed before and pointed out in the literature by Schrey-Niemenmaa, Karhu, Ristola and Sirkjärvi (2010). Several competences require both contextual and methodological learning.

Apart from the curriculum redesign aspects related to methodology, a new strategy for TUAS was designed in spring 2015. The changes made in the curricula are well justified as the strategy was explored more closely. The strategy define our operational method as to create an innopeda® based learning continuum, which combines learning and applied research, development and innovation activities with development needs of working life. In addition to competence-based degree education our learning continuum include development targeted at working life and services for life-long learning. Our learning environments in the future consist of our working life partners, the state of art laboratories and exercise premises which act as our students' workplaces, used and developed in cooperation with working life and virtual environments. Traditional lecture based teaching in classrooms will be renounced.

The aim has been to increase the amount of project activities in the laboratory environment. The program includes several student projects complemented by internships in industry, and features active, experimental, and group learning in both the classroom and a modern learning workshop-laboratory. This is more discussed by Sutherland and Bonwell, 1996; Hall, Waitz, Brodeur, Soderholm and Nasr 2002. The projects can be working-life oriented development projects or in-house research projects. The main thing is that the actors in the projects will be students as employees and

teachers as trainers. The education is moving from the traditional theoretical classrooms into more educationally inspiring premises. Figures 3. & 4. Present the study environment at TUAS Salo campus. The change process from the theoretical classrooms at Turku campus is still ongoing but will take a major step forward during 2015.



Figure 3. Brainstorming and training room at Turku University of Applied Sciences, Salo campus.



Figure 4. A computer classroom at TUAS Salo campus.

The next step towards a renewed curriculum in Chemical and Materials Engineering was taken in fall 2012. A first-year theoretical study module was replaced a CDIO based project, *introduction to engineering*. Learning was taken out of classrooms and brought on via teamwork and practical problem solving. This change was the first concrete opportunity for both students and teachers to learn how to work within the CDIO framework. The good experiences and feedback gained from the first year CDIO introduction project encouraged to proceed in the same direction. The first year introduction project was planned to give students a realistic picture of what they are studying and motivating them in the longer run.

This rather small step where only a part of the curriculum was changed followed 2014 by a larger step where the whole curricula for Chemical and Materials Engineering changed towards the CDIO model. The crucial change in the curriculum was the competence based curricula. In a competence base curricula will the learning gain as long as competences gathered in projects are combined with knowledge from theoretical studies and training sessions. According to the CDIO model is a large interdisciplinary project, *capstone project*, planned to the third year. The model was slightly modified and larger projects were planned to both second and the third year studies. These projects, often implemented in collaboration with real-life R&D, include studies in English language communication and professional growth as integrated elements. The amount of free eligible subjects in the new curriculum increased from 15 to 30 CTS. This gives the students the possibility to broaden their education with subjects closely related to their main interest. The basic studies are in entities of 5 CTS and the more advanced studies in the third and fourth year are in modules of 15 CTS.

The redesign of the curriculum naturally results in changes also for the personnel. The projects are from the staff point of view mostly accomplished as joint efforts between two or more teachers as well as representatives from various companies. Interpersonal skills, active learning, active teaching are qualities also needed among the staff. As the new curriculum is mostly project based and several subjects are integrated in one project has the collaboration between the staff members increased considerably. During years 2014 and 2015 have several internal training sessions been organized to the personnel in order to introduce teaching and pedagogical methods frequently used within CDIO. A change from a more traditional teacher into an invigorating coach does not take place overnight and require education as well as support from the employer.

Results and Discussion

After one year of work with the redesigned curriculum several observations can be made. Only the first year students follow the new curriculum as the rest of the department students follow the old curriculum. This is naturally challenging but mostly for the personnel. This issue will decrease as majority of the study program will within a couple of years follow the redesigned curriculum. The introduction to engineering project for the first year students resulted in amazing results and pleased comments from industry involved. The feedback from both students and the personnel has generally been positive and enthusiastic.

A self-assessment will be done in fall 2015. The general level recorded to 1,5 at 2012 has come up as several actions towards a curriculum according to CDIO model have been made. Actions taken during the redesign process indicate that considering the requirements stated in the CDIO standard can the current level of Chemical and Materials Engineering be 3; Implementation of the plan is underway across the program. The self-assessment is a good tool for improving quality assurance in higher education and will be used on a regular basis.

Conclusions

This paper focused on the redesign process of the curriculum in Chemical and Materials Engineering. The

change from a highly detailed, fragmented and classroom based curriculum towards a flexible and working life connected, project based curriculum is remarkable. Survey results from spring 2015 indicate that the CDIO based learning has received positive feedback among the students. The new teaching techniques are welcomed and highly appreciated.

The challenge of the future is to find innovative ways to make double duty of teaching time so that the students develop deeper working knowledge of the technical fundamentals while simultaneously learning CDIO skills. This still requires changes and fine tuning in curricular structures but also exploiting additional campus learning opportunities, development of new teaching materials and integration of new teaching techniques. The mindset is right and personnel is highly motivated in accomplishing this change as the planning is done as a joint effort.

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Classroom Research: Reflections on the Learning Mindset of an English Student

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Abstract

In this study, a three-day interview conducted by the homeroom teacher—the author—with a first-year student named "S," who was the only student that had failed the General English course. The interview was held in March 2015, in the spring break, after the completion of the first year (April 2014—February 2015). The break between school years allowed the teacher and student to optimally utilize the time for the interview. During this interview, S's learning mindset with regard to learning English was reflected upon to analyze his English proficiency. Further, this study was conducted to design tangible action plans to support S in the subsequent year's English class to be taught by the author.

Keywords: *reflections, learning mindset, classroom research, action plans*

Introduction

Of the 40 students in the author's homeroom, Class1, only one student named S, failed in the subject General English, which was taught as one of the first-year subjects at NIT, Hakodate Collage in 2014. This subject was taught by an English associate professor, who has a six-year teaching experience in the subject. Table 1 shows the examination pass rate for 201 students from five different classes. Scores were allotted out of 100 points.

Table 1: The examination pass rate for General English in 2014 (Note: SD = standard deviation)

	Student number	Average scores	SD	Highest score in class	Lowest score in class	Failed number	Passing rate
Class1	40	72.4	14.1	97	50	1	98%
Class2	40	73.4	12.5	98	40	3	93%
Class3	41	72.2	10.2	94	60	0	100%
Class4	40	71.4	10.6	93	38	2	95%
Class5	40	73.9	9.9	93	38	1	98%
Total	201	72.66	11.4	98	38	7	97%

S's final score was 50 points, i.e., 10 points less than the qualifying mark. The teacher undertook supplementary study with him and assigned extra tests. Despite the additional attention paid to him, he did not achieve the required points of 60. Although the author is an English teacher, she was not assigned to teach English to her homeroom. Therefore, as a homeroom teacher, at the time of clean-up duty, and after class, the author undertook additional work with S and others who had experienced difficulty in passing the required subjects. However, the observation time was limited and it was difficult to allocate more time considering the requirements forming part of the teacher's duty and the need to care for the other students.

Unfortunately, S did not pass English test despite being allowed to move up in the curriculum. As per the requirements (N.I.T., Hakodate College, 2014, pp.109-115), he will have to pass and extra supplementary test over the next two years or face expulsion from the school. Following the decision to allow him to advance to the second year at the final teachers' meeting, the author asked S for a three-day-interview to counsel S for the second General English makeup test. The interview was held during spring break in March 2015 after the completion of the first year (April 2014—February 2015), as the break between the school years allowed both the teacher and student to make optimum use of time for the interview, without pressures of the school curriculum schedule. During the interview, which was conducted with S's consent, a review of his mindset with regard to learning English was conducted, so as to analyze his English proficiency and his attitude toward learning English; through this review, tangible action plans will be designed to support him in the subsequent year's English. The author will be his new English teacher.

Findings from the Interview

(1) S's History with Learning English

For three years, S studied English at a junior high school for four hours a week. He has not learnt English through private lessons or at a cram school. He could comprehend the English curriculum well until the second year of junior high school, at which point his English score was higher than the class average. However, at the start of the third year, he began to face challenges in studying English. Moreover, he knew that

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other classmates had started learning English at cram schools after school. In April that year, S fell behind in English lessons at school. The grammar concept that he found highly challenging was usage of the passive voice. According to Nakamori (2009, pp.162-175), most Japanese learners find it difficult to change from the active voice to the passive voice by swapping the subject and object of a sentence. Although S could not understand the rule, he did not attempt to understand it, because until then, he had managed to study English without having to extend any extra effort.

When asked about the tasks he found difficult, S nominated reading comprehension, and composition. Of the four skills, he ranked writing, reading, speaking, and listening as his order of difficulty. He recalled an English lesson held at the end of his junior high school, in which he was given very difficult questions and only received a score of 30 out of 100 points. Since then, he became anxious about his inability to answer English questions at more advanced levels in upper schools.

At N.I.T., Hakodate College, he became more confident with English subjects than with Mathematics. However, he was unable to pass the English tests because he did not review the lessons at home after school. His old classmates from his junior high school were surprised by his failure.

(2) S's Attitude toward learning English

During the three-day-interview, the author assisted S with a review of grammar questions from the sentence pattern drills using the first-year textbook (2013). He was observed to rush through his answers without thoroughly reading hints of the questions. He would spend only a few seconds in thinking about his answer before writing it down. After finishing the questions, he did not review his answers before asking for the corrections. Moreover, he told the author that he considered it a waste of time to review all the answers. He would review the only incorrect parts after checking the answers. He tended to place emphasis on the results rather than the thought process required for learning English.

In questions related to defining the elements of sentences, he made the same mistake four times by confusing complements with modifiers. When the author asked him to outline a sorting rule for modifiers, he recognized that prepositions were included as modifiers. By suggesting that he think deductively, he was able to pay attention to subject-complement and object-complement relationship. After this discussion, he did not make any further mistakes in the questions.

(3) S's pencil grip

Figure 1 shows the way S uses a pencil and chopsticks. Figure 2 illustrates the correct way to write using a pencil as suggested on a Japanese stationery company's homepage (2015). Figure 3 displays the correct way to use chopsticks as suggested on a Japanese cooking homepage (2015). When observing his writing, he often shook his head and shoulders during writing on a note. To hold a pencil, he had exerted extra pressure through his right thumb to keep the pencil between the index finger and thumb of his right hand. The author demonstrated the correct way to hold a pencil with three fingers—the index finger, middle finger and thumb—assisted by the fourth and the fifth fingers; however, he found this technique uncomfortable to use. Takahashi (2005, pp.1-11) indicated that holding a pencil or chopsticks incorrectly can cause extra stress on the fingers, arms, and shoulders of the user. If he continues to write in his original way rather than mastering the correct way of holding a pencil, he may be placing extra pressure on his right thumb to control the pencil, which can cause unnecessary strain on his right arm, shoulders, and his neck. Miyamae, Sonoda, et al. (1986, pp.61-65) stated that an incorrect pencil grip can lead to slow writing speeds compared with others using the correct method. According to Heath & Heath (2013, pp.8-12), when people exhaust their self-control, they experience a depletion in the mental capability required to think creatively, focus, inhibit their impulses, and persist in the face of frustration or failure. S was observed to be exhausting himself mentally—more so than other students—when using the pencil in his original style. Consequently, he may have been too exhausted to review his work.



Figure 1: Student S's way of using a pencil and chopsticks



Figure 2: Suggested way to hold a pencil



Figure 3: Suggested way to hold chopsticks

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(4) S's English pronunciation skills

Using the software GlobalvoiceCALL2, produced by HOYA Service Corporation, his oral reading performance was objectively checked. Figure 4 provides an example of the pronunciation feedback analysed using the software. His English pronunciation was evaluated as average. He had no difficulty in reading sentences aloud with correct rhythm.

S liked having his English pronunciation evaluated using this software, as it provided a visual of both the strong and weak points of his English pronunciation through numbers and graphs. Therefore, he could determine the next step to improving his pronunciation skills by studying the figures.

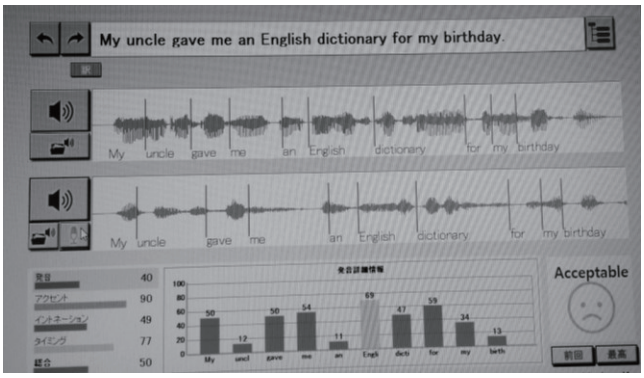


Figure4: Analytical Result of Student S's English pronunciation using *GlobalvoiceCaLL2*

Analysis of S's English Learning Mindset

In the interview, two unique perspectives regarding S's learning mindset were analyzed. The following are his self-reflections regarding the reason for his ideas along with an analysis of each reason.

1)-1 "Studying hard is in vain."

During junior high school, S had once made an effort to achieve the highest score in his class; however, he achieved the third-highest score in class. When he knew that he was unable to reach the top, he felt that he was losing out.

1)-2 Analysis: "Studying hard is in vain."

S's negative thoughts toward hard work can be explained as Learned helplessness as per Peterson, Maier, & Seligman (1993 p.8). Learned helplessness has three essential components: 1. a contingency of uncontrollability; 2. cognition to perceive, explain and extrapolate the contingency; and 3. passive behavior expecting future helplessness. Reaching the top of his class was S's motivation to study hard. After his first attempt was unsuccessful, he assumed that he would be unable to reach the top even if he made the additional effort. Therefore, he decided to avoid unnecessary efforts to reach the top.

2) -1 "If I try, I can do it."

S had been told in the past, that if he tried, he could do it—by his parents and former teachers in his junior high school. This led him to infer that he could justify his incapability if he did not try. Therefore, he procrastinated about studying hard.

2)-2 Analysis: "If I try, I can do it."

Dweck (2008, pp.71-74) underscored the danger of praising student's ability, rather than their efforts. Her research team conducted studies with hundreds of students, mostly early adolescents. Presented with fairly difficult problems from a nonverbal IQ test, they praised students who had performed fairly well on the tests in two different ways. To one group, they praised their ability by saying, "That's a really good score. You must be really smart." To the other group, they praised their efforts by saying, "This is a really good score. You must have worked really hard." Thus, one group was praised by being made to feel that they were talented, whereas the other group was praised for working hard and doing what it takes to succeed. Both groups were equal to begin with; however, after receiving the praise, differences began to appear. The praise received for their ability pushed the students into a fixed mindset; therefore, they tended to reject a challenging new task that they could learn from, as they did not want to do anything that could expose their flaws and question their talent. In contrast, in the group that was praised for effort, 90% of the students wanted to attempt challenging new tasks, knowing that they could learn from it, which demonstrated a growth mindset. S seems to be content with his past accomplishments during his junior high school days and does not wish to be challenged by difficult tasks: he appears to have a fixed mindset.

S's changing perspectives on making effort before and after the interview

During the closing session, the author gave S a simple questionnaire that involved prioritizing four different cause—effect scenarios: Do and succeed, Do but fail, Undo but succeed, Undo and fail. S's feedback is shown in Figure 5. He reflected that before the interview, he placed more value on effortless success (undo but succeed) than on success resulting from effort. After the interview, he prioritized the process of "doing" more than effortless success. This change suggests that the interview has possibly affected his

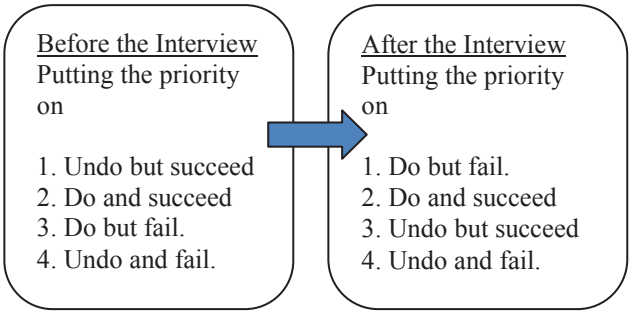


Figure 5: Student S's Changing Perspectives on Making an Effort

perspectives to place more value on doing rather than undoing. Reflecting on the interview, initially, his motivation to study was reviewing his English learning style and grammatical practices. In the process of solving English grammar questions, positive feedback was provided by the author on his learning attitude and his way of thinking. On the final day of the interview, S realized that he had understood the sentence patterns of the text and made no further grammatical errors. Further, he realized that his way of holding a pencil was potentially causing additional stress on his neck and shoulders and reducing his writing speed. These aspects, which he had not considered before the interview, would have contributed to the change in his perspective toward the positively of doing. Gagne, translated by Suzuki (2006, p.13), describes a rationally consistent basis for instructional design based in cognitive psychology and information-processing theory. He suggested that teachers should design and develop their instructions outlining the nine stages of instructional design procedure and corresponding cognitive processes (Figure 6).

However, S still placed some value on effortless success rather than undoing something followed by failure. Even after the interview, the author felt that S expected that he would be able to have an easy life without making any effort. The results indicate that the author should build up better instructional skills to assist S in channelling his efforts toward success.

1. Gaining attention (reception)
2. Informing learners of the objective (expectancy)
3. Stimulating recall of prior learning (retrieval)
4. Presenting the stimulus (selective perception)
5. Providing learning guidance (semantic encoding)
6. Eliciting performance (responding)
7. Providing feedback (reinforcement)
8. Assessing performance (retrieval)
9. Enhancing retention and transfer (generalization).

Figure 6: Nine steps of instruction and corresponding

Action Plans to support Student S

As a new homeroom teacher and English teacher, the author was nominated by the president to commence teaching S from April in the fiscal school year 2015. Reflecting on the interview and analyzing S's learning mindset, three action plans were designed to encourage change. These plans are presented as the research conclusion: (1) to arrange a mentor group in class to support S in improving his self-management skills, (2) to frequently assess student understanding in English classes so as to assist students working with S by reminding them about what they had learnt in previous lessons, and (3) to praise the whole class including S, on their English study efforts to enhance their learning in a proactive manner. These three action plans were designed to elicit a change in S and his classmates from having a fixed mindset to more of a growth mindset. Currently, it is only three months into the new fiscal year, and as such, it is too early to reach a definitive conclusion about the classroom research in this paper. As these action plans are implemented, the research will be further evaluated during the fiscal year until February 2016. As the author as homeroom and English teacher of S, it is necessary to—*not view him as a finished product but believe in the growth of intellect and talent and remain encouraged by the fascinating process of learning* (Dweck, 2006, p.193-212).

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The Recent Effort of Global Human Resources Development at National Institute of Technology, Ube College

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Abstract

This paper describes a recent effort of global human resources development at the National Institute of Technology, Ube College (NIT, UC). We, in particular, deal with the recent efforts of international exchange of NITUC in this paper, such as history, purpose, curriculum, students dispatch program, students acceptance program, support system (scholarship loan, dormitory for overseas students), establishment of organization, English café (English conversation support) and so on.

We launched an international exchange in earnest from being adopted in the GP project (Support Program for Contemporary Educational Needs 2007-2009) about 10 years ago. As a continuation of our international exchange activities under the GP project, we have promoted friendly relationship with Dong-Eui Institute of Technology (DIT), Harbin Institute of Technology at Weihai (HITWH), Komsomolsk -na- Amure State Technical University (KnASTU), and Amur State University of Humanities and Pedagogy (ASUHP). In addition, some of our students attend the English language intensive courses at the University of Newcastle (NoU) every year. The number of participants is increasing. Moreover, we had a new academic exchange agreement with National United University (NUU) in Taiwan last November. Consequently, we have academic exchange agreements with seven overseas universities at present, with whom we have continued the mutual exchange by students and professors.

We have developed and improved our overseas training programs with partner institutions and particularly, we have two / three overseas internship programs for our Advanced Course students. Further, we need to improve our acceptance program for the purpose of deepening our mutual exchange.

Keywords: *Overseas internship program, Intercultural understanding, Mutual exchange program, Cooperation with local government, Focus on Asia , Geographical convenience*

Introduction

With the development of information technology and transportation in recent years, globalization of the economy is progressing speedily. We seek human resources who can play an active role in the global economy. Global human resources have language skills and communication skills. They have broad liberal arts and deep speciality. Besides they have intercultural understanding and identity as Japanese. They have a lot of other qualities, such as assertiveness, cooperativeness, leadership, sense of liability, and so on.. In order to meet this needs of the times, we have made the efforts of Global human resources development, for example foreign language training, overseas internship. This paper describes a recent effort of global human resources development at NIT, UC.

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Overview of global human resources development

The global human resources development of NIT,UC began in earnest since it was adopted in the GP (Good Practice) program of Ministry of Education, Culture, Sports, Science and Technology (MEXT) in 2007. Then, we have conducted the global human resources development in the two paths. One is the programs that NIT,UC has with mutual agreements, the other is the programs that NIT has with mutual agreements. The former is the international exchange program with China, South Korea, and, Russia, which we began from GP program. In addition to these programs, we have also begun international exchange with one of the universities in Australia according to the sister city relationship between Ube and Newcastle. On the other hand, The latter is the international exchange program with Taiwan and Singapore, which NIT has developed. Nine years have passed since we started the global human resources development in earnest. So far, we have made a lot of efforts on the global human resources development, for example organization of international exchange office, the credit system of international exchange, the creation of the international exchange scholarship, an extension to the lower grades of the international exchange program, English café

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(English conversation class), maintenance of foreign students dormitory, and establishment of Home stay system and so on. We have sent more than about 300 students in total in nine years.

Purpose of global human resources development

The purpose of the global human resources development of NIT,UC is to develop practical engineers who can work abroad. In particular, we are aiming to train engineers who can play an active role in the Asia-Oceania region. First, we began the GP program with the aim of the international exchanges with North-east Asia, such as China, South Korea, and Russia. The reason why the North-east Asia was the activity area in the GP program, we carry out the international exchange program that we have in collaboration with Ube City (which takes part in the Union of Machinery Industrial Cities in North-East Asia). Although the main activity areas of the three years of the GP program were China, South Korea and Russia, our ideal aim is to develop human resources that can be active in Asia. In addition, in order to develop practical engineers who can work in Asia, NIT had developed an international exchange program in Southeast Asia. From 2014, NIT,UC began to dispatch students to Singapore English training which NIT began to propose. Moreover, we began the international exchange program with National United University in Taiwan that NIT has comprehensive agreements. It also aims to develop engineers who can play an active role in the Asia-Oceania.

Characteristics of global human resources development

International exchange of NIT,UC is characterized by the following four points.

1) Geopolitical characteristics
NIT,UC is in Ube City, Yamaguchi Prefecture. Yamaguchi Prefecture is close to China and South Korea, and Russia which is in the favourable position to trade. For regional economic development, it is important to carry out economic exchange with geopolitical neighbouring Asian countries. We must provide the human resources that can contribute to the regional economy.

2) Cooperation of local government
Each city of Yamaguchi Prefecture has been actively interacting with East Asia (Figure 1). First, Yamaguchi Prefecture has the friendly relations with Shandong Province in China and South Gyeongsang Province in South Korea. In addition, Ube City, Shimonoseki City, and Yamaguchi City, the local governments of the Yamaguchi Midwest district, in particular, have a sister city relationship with cities in China and South and They are doing a regular exchange. We held a lecture of international exchange members who are in the Prefectural government as a pre-education of overseas training. We were allowed to join the students in Ube City tourism program by the international office of Ube City .

Figure 1.Sister relationship

Japan	China	South Korea	Other
Yamaguchi Prefecture	Shandong Province	South Gyeongsang Province	Comunidad Foral de Navarra
Ube City	Weihai City	—	Newcastle City
Shimonoseki City	Qingdao City	Busan City	Istanbul City
Yamaguchi City	Jinan City	Gongju City	Pamplona City

3) Traffic convenience
Near the NIT,UC there is a Shimonoseki Port which has a regular route to Busan in South Korea and regular routes to Shanghai and Qingdao in China . Also, away from NIT,UC of about 10 minutes by car, there is Yamaguchi- Ube Airport, which makes us possible to go abroad via Haneda Airport. In addition, there is a Fukuoka Airport and Hakata Port in 2 hours within by car from Ube City. Fukuoka Airport which has a lot of scheduled flights to Asia, from the viewpoint of international exchange with the Asia, is the most convenient regional airports in Japan. We usually use the Fukuoka Airport for international exchange program.

4) Advantage of cost performance
We were able to carry out the international exchange program of NIT,UC by relatively low price. Our partner universities are in Busan City , in Weihai City, in Komsomolsk -na- Amure City, and in Miaoli City. With the exception of Russia, it is possible to suppress travel costs because our partner universities is a good place in the access, close to Fukuoka City,. In fact, we have three weeks program about 60,000 yen in Korea, about 90,000 yen in Taiwan, and about 100,000 yen in China. This includes travel expenses, accommodation expenses, and tuition fees.

Dispatch program of NIT,UC

1) The GP program
As for the dispatch program of NIT, UC, 3-year modern GP from 2009 to 2011 made its foundation. First year, we visited China and South Korea. Alternating current at this time, campus tour of the academic partner universities, factory visits, tourism several meetings were held together for deepening the exchange of each other in the main. Students belonging to the department of management information visited South Korea, making graduate research on the basis of the data collected in the cluster group of Hyundai Motor and Changwon.

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In the second year, we also started exchanges with Russia. We visited as Ube delegation for participating the meeting of "North-east Asia mechanical city Union". China and South Korea visit was supposed to carry out academic recital from this year. Graduate School students made their research announcement in China or Korea University. It was a good opportunity to know what kind of researches were made in each of the university. As a result, mutual exchange of students by performing scientific recital became deeper than the year before.

Especially, training in China and Russia has become the internship for one weeks training of overseas from the final year of the GP program. Mutual exchange of students by performing scientific recital became deeper and deeper than the year before in order to increase opportunities that students are in contact with each other

2) Overseas Internship after the GP program

After the GP program, we were supposed to continue the international exchange in the funds from the support group of NIT, UC. In three years of the GP program, we did not necessarily have carried out all the objectives of the GP program. The remaining objectives became our efforts at the time.

The objectives of the GP program are a) participation in collaborative activities with local government, b) implementation of graduate studies and special research, and c) creation of overseas internship curriculum. For the objectives of a) and b), we have achieved in three years GP program. For the objectives of c), it was requested to establish a sufficient content from our college. The international exchange program with HITWH in China in fourth year was recognized as an overseas internship of three weeks. The international exchange program with DIT in Korea in fifth year was recognized as an overseas internship of three weeks. In particular, in the exchange program with DIT, which Busan office of SPEC, the IT company in Ube City participate, our students carried out joint development of i-phone apps along with the Korean students. The following year, they carried out joint development of Android apps along with the Korean students. In addition, we opened new training programs in the automotive department of DIT. As a result of the above efforts, NIT,UC recognized international program as a formal internship curriculum.

3) Cross-cultural training for first, second, and third students

The international exchange program in NIT,UC started a school event that major department students, fourth grade and fifth grade undergraduate students can participate in. In other words, first, second, and third grade students cannot take part in the international exchange program even if they want to participate them. As first, second, and third grade students can take part in them, we made a cross-cultural training in NUU in Taiwan in 2014. In addition, we recruited students so as to participate in Singapore English training of NIT.

Acceptance program of NIT,UC

We started an acceptance of short-term exchange students from 2013 in earnest. First of all, we accepted two students from KnASTU of Russia in April. In addition, we accepted the eight students from DIT of Korea in July. Both were accepted for one week. Russian students stayed with Japanese students in our dormitory. Although we had previously accepted overseas student twice before, this was the first time that we accepted overseas students in dormitory. The main program is a student's research workshop. Russian students and Korean students made their research announcement in NIT,UC Japan. It was a good opportunity to know what kind of researches were made in each of the university. As a result, mutual exchange of student scientific recital became wider than dispatch program.

Also, we accepted three students from KnASTU of Russia in April 2014. The main program is a student's research workshop. Russian students made their research announcement in NIT,UC Japan too. It was a good opportunity to know what kind of researches were made in each of the university. As a result, mutual exchange of students scientific recital became wider than dispatch the year before.

In 2015, we accepted eight students from NUU of Taiwan for a week in May. In addition, from June to July, we accepted 4 Chinese Department's students of NUU as internship training of Chinese. They teach Chinese to students of NIT,UC.

We accepted eight students from UoN in Australia in June. Australian students made their research announcement in NIT,UC Japan. It was a good opportunity to know what kind of researches were made in each of the university. As a result, mutual exchange of students by performing scientific recital became wider and wider than the year before.

We found that foreign Students had a strong interest in Japanese culture. They hoped to experience Japanese culture such as, Kyudo (Japanese archer), karate, Judo, Kendo, and tea ceremony etc. In addition, we found that by accepting foreign students, not only foreign students but also our students were greatly affected. Dormitory students, laboratory of students, students to participate in the conference, students who attend classes, students of club activities, many students in NIT,UC were able to have the opportunity to contact with the foreign student. We were confident that our students are affected in terms of improvement of language skills, understanding against a different culture, hospitality attitude etc.

Figure 3.the number of accepted students

	08	09	10	11	12	13	14	15	sum
Korea Students	2	—	—	—	—	8	—	—	10
China Students	—	—	1	—	—	—	—	—	1
Russia Students	—	—	—	—	—	2	3	—	5
Taiwan Students	—	—	—	—	—	—	—	17	17
Australian Students	—	—	—	—	—	—	—	8	8
									41

Picture 1.Conference of NUU students



Picture2. The tea ceremony



Other efforts on global human resources development

We worked on the following point of view so as not to put an end to the international exchange of NIT,UC which began from the GP.

1) The setting of international exchange office

During the initial three years, the representatives and cooperative professors carried out the GP program. Since the work of the international exchange is not the efforts of the entire college, the international exchange office was organized. Firstly the office is organized by professors only. In accordance with the efforts of partner universities, it became more difficult to carry out the work by professors only The international exchange office, including the professional administrative staff about the international exchange was launched.

2) Establishment of international exchange assistance funds

NIT,UC established the fund for international exchange support to commemorate the 50th anniversary of NIT,UC. This fund is established by the effort of the faculty and staff, the companies involved in NIT,UC, and many of the graduates. Our students can apply for funds when they participate in the international exchange program by NIT,UC and NIT.

3) The enhancement of international exchange programs

We have six international exchange programs made by NIT,UC and 10 international exchange programs made by NIT. From now on, we are going to give a beneficial program to global human resource development to our students.

Conclusion and future work

Somehow, we have continued our global human resources development for nine years. It cannot be said that our every efforts is done well. We've experienced unexpected event this nine years. Every time something happens, we make a disccussion about them and make an effort to solve themt.We understand that we need to improve our international exchange by refernce to the efforts with NIT and NIT, Other Colleges.

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ICT-ENHANCED, ACTIVE AND COLLABORATIVE LEARNING OF ENTREPRENEURSHIP USING WEB-BASED TOOL AND COMPUTER SIMULATION GAME

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Abstract

The paper shares the experiences of the authors in introducing computer simulations for active learning and in using web-based tool as a collaborative teaching and learning environment for students and lecturers in entrepreneurship module. ICT (Information Communication Technology) in the forms of web-based tool as well as a computer simulation game are being used to facilitate core learning activities that would otherwise be difficult or impossible in the teaching and learning of 90-hour core module 'Entrepreneurship Project'. The targeted students are the final year students from the Diploma in Business Informatics in the School of IT, Nanyang Polytechnic who read entrepreneurship project as a prescribed elective module. 'SimVenture' is the simulation game being used in the module as an active learning platform where students can safely apply what they have learnt and gain valuable experiences that would otherwise be difficult or impossible without the technology. The simulation game mimics real-life situation with interaction component that allows the students to practice and safely apply what they have learnt. Simple interaction with computer may help student acquire basic skills, but to progress further, it will require greater levels of interaction and collaboration among the students and between students and the subject expert – the lecturer. Ultimately, to master a skill, the learner needs to apply that skill in a real-life situation. The entrepreneurship project module also leverages on a web-based tool for venture creation and business development known as 'Canvanizer'. It is an online collaborative tool where students can visualise their business model using business model canvas. The web-based tool provides a collaborative learning environment where students can interact and collaborate to brainstorm for business ideas, justify the feasibility of their business model and outline the potential market opportunity. The collaborative tool also allows the lecturer to track the students' progress to provide timely feedback on their work and learning.

Keywords: *ICT-enhanced learning, computer simulation game, technology integration, active learning, collaborative learning, entrepreneurship*

Introduction

The instructional challenge for the teaching and learning of Entrepreneurship is the limited real-life environment where students can safely apply what they have learnt in class to validate and reinforce their concept and knowledge of the subject concerned. This is where simulation of venture creation can be useful in providing an active learning environment to allow students to have experiences that they could not have in a real-life situation by applying their knowledge and skills in a safe and realistic environment without the hazards of what real financial world would have entailed. The use of a collaborative tool in the teaching of entrepreneurship will facilitate students to interact with each other and with the lecturer. It also allows lecturer to track the students' progress to provide timely feedback on their work and learning.

Literature Review and Pedagogy

The goal of entrepreneurship education is for students to develop entrepreneurial mindsets and entrepreneurial capabilities which can lead to entrepreneurship effectiveness (Quality Assurance Agency for Higher

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Education, 2012). While the traditional teaching and learning of entrepreneurship typically uses lectures, exams, case studies and business plan, Neck and Greene proposed a new paradigm for teaching and learning of entrepreneurship that goes beyond mere talking, knowing and understanding but embraces using, applying and acting where practice becomes more important (Neck and Greene, 2011). This new approach requires continuous practice of do-learn and not the traditional approach of learn-do. This practice approach may be manifested in the form of simulation game where learners play and experience starting a business before learning the portfolio of techniques of entrepreneurship.

Accordingly to the Longman Dictionary of Contemporary English, the noun 'simulation' means the activity of producing conditions which are similar to real ones, especially in order to test something, or the conditions that are produced. The Oxford Advanced Learner's Dictionary defines the verb 'simulate' as create particular conditions that exist in real life using computers, models, etc., usually for study or training purposes. These definitions emphasize replication of conditions as realistically as possible for various purposes including that of training.

Simulation has been suggested as an innovative pedagogy for the teaching and learning of business concepts (Aldrich, 2003). It has been widely used in the training of business subjects such as accounting (Springer & Borthick, 2004), supply chain management (Sparling, 2002) and strategic management (Mitchell, 2004). Simulation provides an active learning environment to allow students to have experiences that they could not have in a real-life situation. Active learning is anything that involves students in doing things and thinking about the things they are doing (Bonwell and Eison, 1991). Simulation is an active learning strategy that offers students participation through activities and interactions.

There are studies that indicate students preferring simulation to other learning strategy because simulation allows students to actively participate and feel more engaged in learning (Massey and Warblow, 2005). Simulation is centred on students with instructor playing the role of facilitator of learning. Studies have shown that in simulation, students become active learners and demonstrate greater self-motivation and self-direction (Jeffries, 2005).

Simulation is a fundamental shift in education that bridges the gap between textbook oriented classrooms and skills learned on the job (Aldrich, 2006). Simulation is an effective delivery of blended learning approach where the key premise of integrating simulation is that it supports the educational process and offers new potential for learning (Ravert, 2002). Blended learning can be categorised into three types: Enabling Blends, Enhancing Blends, and Transformative Blends (Graham, 2006). For enabling blends, the primary focus is on addressing the issues of access and convenience as well as providing similar learning experiences. Enhancing blends allow for incremental changes to the pedagogy or improved productivity, with additional or supplementary online resources. In contrast, the scope of transforming blends is large and it leverages on affordances of environment to improve pedagogy and moves towards active learning. Blended learning can be transformative when we use ICT (Information Communication Technology) in the form of computer simulation to facilitate learning activities that would be difficult or impossible to do without it. Computer simulations is thus a form of transformative blend that move beyond the passive information transmission approach to active learning that facilitates active learners' construction of knowledge. Interactive simulation game coupled with collaborative tool will allow students to interact, collaborate and safely apply what they have learnt to attain higher level proficiency in the subject concerned.

This improved pedagogy of leveraging computer simulation augmented with collaborative tool in teaching and learning is significant to polytechnic education in Singapore where a mastery of higher level knowledge and skill will require a platform where learners can safely apply what they have learnt.

Methods

To investigate the effectiveness of using computer simulator game for active learning and web-based tool for collaborative learning for the teaching of entrepreneurship, the authors had evaluated various start-ups simulation games and web-based collaborative tools before settling for 'SimVenture' and 'Canvaniser' respectively. SimVenture is a computer simulation game that allows learners to discover for themselves by making decisions and dealing with consequences on how to create and run a business without fear of real financial failure. It provides simulations that mimic real-life situation and the interaction component allows students to practice and safely apply what they have learnt. It is based on best-practice for business start-ups, covering areas on marketing, operations, finance and organisation. The simulation game runs in a cycle of 3 simulated years, about 8 hours of game play, to facilitate students' construction of entrepreneurship knowledge and encouraging higher-order thinking skills in term of judgement, critical thinking and problem solving. The use of collaborative tool in the form of Canvaniser will further engaged student to allow greater levels of interaction and collaboration among the students, and between students and lecturer who is the subject expert. Canvaniser is a web-based *Business Model Canvas* where it outlines several prescriptions which form the building blocks for business activities and it reflects systematically on the business model to allow start-ups to map each of its elements to its business components. The components of the canvas,

which can be color-coded, include: key partners, key activities, value proposition, customer relationship, customer segment, key resource, distribution channel, cost structure and revenue stream. Students are require to brainstorm for business ideas, differentiate their business, justify the feasibility of their business model, outline the potential market opportunity, all of which are higher-order thinking tasks which are important components of active learning. SimVenture as a form of active learning simulation and Canvaniser as a form of collaborative learning platform are the two main ingredients of a transformative blended learning approach in students' construction of knowledge in entrepreneurship.

The Entrepreneurship Project module is a 90-hour prescribed elective module for the year 3 (final year) student of Diploma in Business Informatics in School of Information Technology, Nanyang Polytechnic. The module learning outcomes are that at the end of the module, students will be able to discover business opportunity, exploit information technology, take calculated risks and experiment novel methods or ideals. To investigate the effectiveness of ICT-enhanced learning using Canvaniser and SimVenture, the authors identified the 40 students from the two entrepreneurship classes of academic year 2015 semester 1 as experimental group, with the corresponding 2014 semester 1 as control group for measurement of learning effectiveness and students' satisfaction. These two groups of students have similar GPA (Grade Point Average) prior to taking this entrepreenurship module. Students from the experimental group will undergo a 'do-learn-think' approach where they will first play the for entrepreneurship simulation game from week 3 to 6 during their practical lessons. After which they will have to do a reflection on the learning points and observations made on the game play. At the end of the semester, students will have to do a group presentation with the submission of business plan using Canvaniser.

Measurements

The measuring metrics of 'Learning Effectiveness' and 'Student Satisfaction' are primarily used to evaluate the level of success of implementing computer simulation and web-based collaboration tool for the teaching and learning of entrepreneurship by comparing and contrasting the learning outcomes of the control group vis-à-vis the experimental group. For learning effectiveness we will be looking at the following facets of measurement between experimental group and control group:

- Passing rate, to measure the students' performance in meeting the module learning outcomes
- Mean score, in the form of effect size of the mean to measure the magnitude of difference in results between the two group

For the measurement of student satisfaction level on using the simulation game and web-collaboration tool for learning, the authors will be collecting student feedback via the following ways:

- Survey questionnaires, on a four-points Likert scale)
- Focus group discussion

In addition, the authors will examine the module learning outcomes through classroom observations and coupled with focus group discussion. The learning outcomes, coupled with the investigation on learning effectiveness and students' satisfaction, will provide useful research data to empower lecturers to continuously improve on best practices in active learning and collaborative learning in the area of entrepreneurship.

Results and Discussion

As the lesson of experimental group is still ongoing at the time of this writing, the authors are unable to provide the final results of the measurement but to discuss on the interim (mid-semester) students results and feedback to appraise the level of success of implementing computer simulation game and web-based collaboration tool for the teaching and learning of entrepreneurship.

Improved Learning Effectiveness

The learning effectiveness is based on the mid-semester in-course assessment results of the students which constitute 30% of the total score. The authors compared the mean score between the control and experimental groups with the result depicted in chart 1 below.

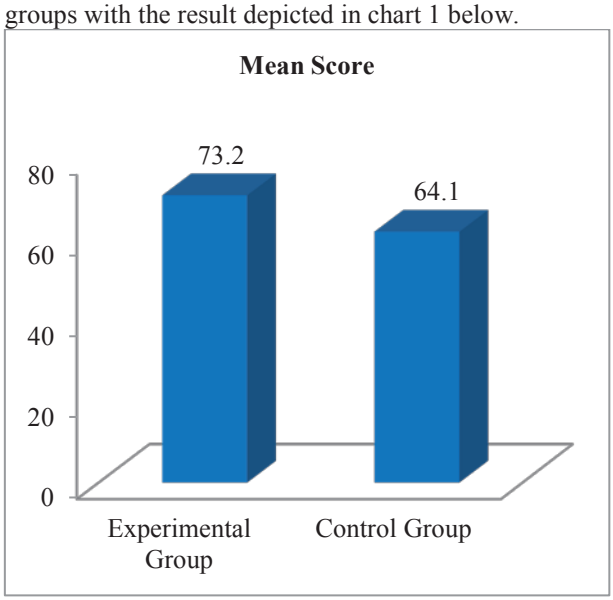


***Chart 1**: Comparing students' mid-semester mean score*

From Chart 1, we can see that the simulation game and web-based collaboration tool provided students with a more effective learning platform than traditional one without the ICT tools, with experimental group achieving a mean score of 73.2 marks over control

group of 64.1 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 0.8238, indicating a large effect on the use of computer simulation game and web-based collaboration tool in the improvement of mean score. The improvement in mean score can be attributed to the learning effectiveness in the use of computer simulation game and web-based tool for active and collaborative learning in entrepreneurship project module. The learning effectiveness was reinforced with the mid-semester survey questionnaires asking students in experimental group if they have had a better understanding of the module with the help of the game and tool. As seen in Chart 2, an overwhleming 92.4% students gave an affirmative answer. Informal feedback from students has it that SimVenture is engaging and helped them to have a better understanding on what it takes to become an entrepreneur. Students also appreciate the use of Canvaniser where the lecturer gives timely feedback and comment on their progress of business plan.

Through classroom observations and feedback from lecturers, the authors gathered that there is an increased in interest and motivation level for the experimental group of students in class. In addition, students in the experimental group demonstrated higher level of entrepreneurial mindset (e.g. personal confidence & resilience, tolerance of uncertainty & risk), entrepreneurial capability (e.g. opportunity recognition, decision making supported by critical analysis and judgement) and entrepreneurial effectiveness (e.g. implement enterprising ideas, identify and approach target market). This further established the improvement in learning effectiveness and the attainment of the module learning outcomes.

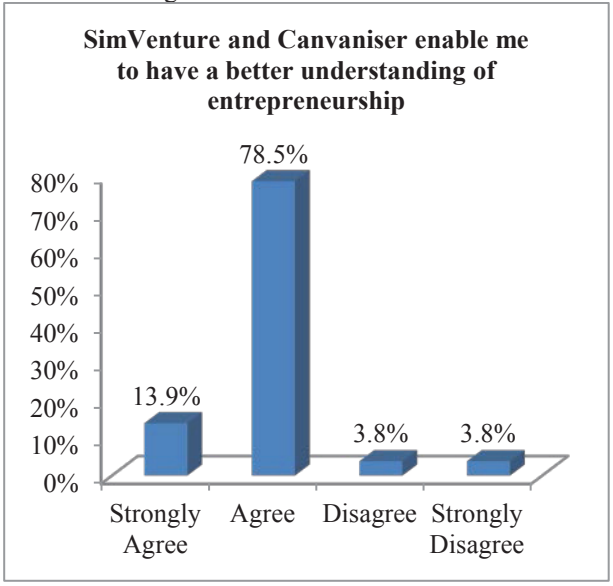


***Chart 2**: Student feedback on the learning effectivenesss*

Increased Student Satisfaction

The level of student satisfaction on the use of game and tool is based on the interim student feedback collected from the experimental group after the mid-semester break in the form of survey questionnaires. The survey result is depicted in Chart 3 below.

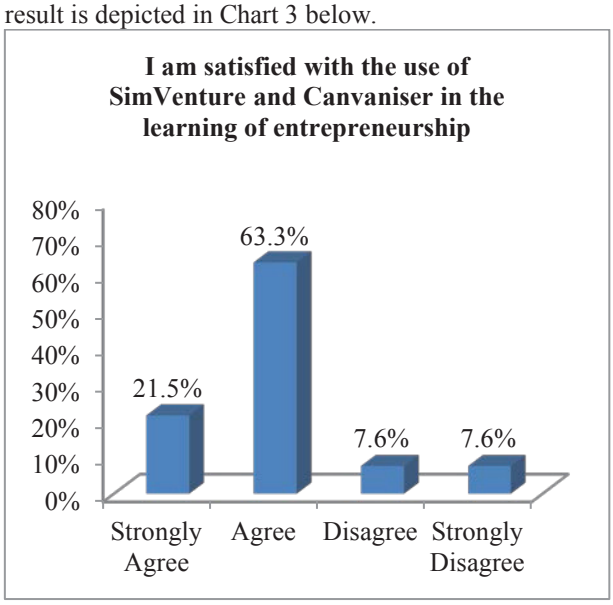


***Chart 3**: Student satisfaction on the use of simulation game and web-based collaboration tool*

The results of the student satisfaction feedback survey reinforced the authors' belief on the use of computer simulation game and web-based collaboration tool for higher student satisfaction. 84.8% of the students surveyed found the use of the simulator game and collaboration platform particularly satisfying as a learning tool for the entrepreneurship project module. In addition, the authors observed the improvement in student attendance rate as well as student engagement during the 6 weeks when the students are playing the entrepreneurship simulation game during practical lessons.

Conclusions

One of the emphases of polytechnic education in Singapore is the application of concept and knowledge in real-world environment. However, there are occasions when it is impractical and impossible to use real-world environment because of the financial risk involved and the lack of fund. The traditional way of teaching entrepreneurship using textbook and case studies in classroom does not provide students the opportunity to apply what they have learnt in class to real-life situations. In such case, the help of ICT in the form of web-based collaboration tool and computer simulation game that mimic real-life in venture creation can address the aforementioned and allow the polytechnic students to collaborate and safely apply what they have learnt in class. The students' feedback and interim results validate the learning effectiveness of computer simulation game and web-based collaboration tool for the teaching of entrepreneurship. Not only the module learning outcomes were achieved, the satisfaction level of the students was improved with the

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aforementioned ICT-enhanced, active and collaborative learning tools.

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Topic 4

Educational Models and Approaches

（教育モデルと実践）

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DEEPENING SKILLS-BASED LEARNING THROUGH WORKPLACE PRACTICUM: A CASE STUDY

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Abstract

To achieve skills mastery requires excellence through knowledge, application and experience, especially pertinent for clinical skills, where one needs to couple motor skills expertise with flexibility accumulated through experiences. Workplace practicum thus bridges the theory-practice gap. This pilot study reports the mastery learning of audiology clinical skills of students. It was to examine whether the students' performances relate to their conception of learning and the interactions with workplace professionals. Overall, students reported this mastery learning model helped them gain a better understanding of the subject, enhanced their clinical skills and increased their confidence as practicing audiometrists. The instructor also assessed that these students to have achieved the learning outcomes in accordance to the workplace standards.

Keywords: *clinical, conception, learning, practicum, skills-based*

Introduction

In the Applied Study in Polytechnics and ITE Review (ASPIRE), Singapore, in looking at enhancing career prospects for Polytechnic and Institute of Technical Education (ITE) graduates, recommendations by the Committee include to provide deeper skills, work-relevant training for students (Ministry of Education, 2014). A SkillsFuture Council was also formed to enable the nation to attain the mastery of skills. To achieve skills mastery is not just by having the right paper qualifications, but to strive towards excellence through knowledge, application and experience (SkillsFuture Council, 2014).

Particularly for clinical skills, where unlike knowledge-led subjects, rote learning alone may not maximize the learning outcomes. To practice clinically, one needs to integrate the motor skills expertise with some flexibility which can only be accumulated through experiences. Research has also shown (Marton, 1993; Prosser and Trigwell, 1999; van Rossum and Schenk, 1984) that one factor influencing learning outcomes is the students' conception of learning, which is correlated to the learning approaches, "surface" or "deep". On this note, Griffiths and Guile (2001) highlighted the role of workplace practicum to bridge the gap between theory and practice, to achieve deep conception of learning and maximize the motor skills expertise development.

By directly engaging with the industry professionals, these career-ready skills learned in the classroom can be reinforced as the learner would be observing and practicing in a job situation. These workplace professionals, playing the role of supervisors by providing timely feedbacks and assessments, enhance the learning process too.

Purpose

This paper thus reports the pilot study on the mastery learning of audiology clinical skills, of final year students from the Diploma in Biomedical Informatics and Engineering, Temasek Polytechnic. They were students of the elective subject Audiometry and Hearing Devices (AudioHD). As these students were exposed to a mastery learning program, including the workplace practicum; this study examines the effect of mastery learning in relation to the students' conception of learning, inferred from their voluntary survey responses. As Ramsden (2003) has outlined, students' perception of teaching, the assessment process, and the clarity of goals play a part in orientating them to take on the different learning approach; to inform the future learning-teaching approaches to this clinical skills-based subject, this study also investigates the learning outcomes in relation to the interactions with the workplace professionals.

Method

A total of 41 students were enrolled in this unit of study. A practicing audiologist, Mr Steven Lee Lock Hey, from the Changi General Hospital, Singapore, was engaged as the workplace instructor and also the assessor of their clinical skills, to infuse in the subject the industrial/clinical elements which academic staff cannot duplicate.

Curriculum: The subject was designed to enable students to experience, as close to industrial environment and real world scenario as possible.

Students studied the properties of sound, the physiology of hearing and the causes of hearing impairment. The final aims were to enable them to acquire the mastery of assessing hearing impairment, the pure tone assessment (PTA); and provide health care advice in the technologies available to remediate hearing loss.

During Mr Steven Lee's lectures, he shared his insight and experiences on the conduct of Pure Tone Audiometry (PTA) with our students. For the entire cohort, the students continued to polish their skills through self-directed learning by practicing the PTA using the Ultimate Hearing Test Simulator software at their own time. During the process of practicing, students may refer to their notes as well as instructional video recordings of Mr Steven Lee's for self-evaluation and improvement. Simultaneously, they were to practice PTA with their peers and receive peer appraisal. At the end of the learning process, students were expected to do an unedited recording of their best PTA session they conducted on their peers.

Assessment: The video submission above served as a self-assessment as well as peer-assessment for students to evaluate their mastery level. Their skills will be also be reviewed and appraised by the tutor. Students were also assessed on their ability to perform a real-time PTA in the form of a lab test. Again their mastery level was evaluated based on an assessment rubric pitched against the workplace standards.

Workplace professional feedback: To investigate if the learning outcomes and the mastery were achieved more effectively through engagement with the workplace professional, the students from both classes were assessed by the same audiologist, for their PTA. However due to his clinical load, one class of students, group 2, was unable able to receive direct and constant practical guidance from Mr Steven Lee. The other privileged group of students conducted PTA on their peers in an actual acoustic hearing test booth and real audiometer, with Mr Steven Lee sitting in during the sessions. At the end of each session, students would receive feedback from him on their performance and area of improvements.

Survey: The 41 students were administered an electronic questionnaire (eSurvey, https://esurvey.tp.edu .sg/eSurvey/), which they could voluntarily complete after their unit of study. A 4-point Likert type items were used. These questionnaire items were pertaining to the perception of the roles of laboratory lessons, lecture videos and industry professional as the instructor; and also assessed the student conceptions of learning and the perception of their Mastery. The responses to these questions helped to inform our future delivery of the subject, on the mastery learning models and how high-level forms of thinking can be promoted.

Table 1. Questionnaire

Question
1. The laboratory lessons provide me with hands-on experience to understand the subject better. Strongly Agree Agree Disagree Strongly Disagree
2. The free-access laboratories are available before lab tests, etc. Strongly Agree Agree Disagree Strongly Disagree
3. I have reviewed the instructional/lecture videos for the subject. Strongly Agree Agree Disagree Strongly Disagree
4. I find that reviewing the instructional/lecture video recordings benefitted my learning. Strongly Agree Agree Disagree Strongly Disagree
5. The teaching and clinical experiences sharing by the audiologist had been beneficial to my learning. Strongly Agree Agree Disagree Strongly Disagree Describe how these sessions had benefitted you and how it can be improved.
6. Compared to other subjects, you find AudioHD is run more stimulating to your learning and hands-on skills development. Strongly Agree Agree Disagree Strongly Disagree
7. You feel confident and ready to take on a job in Audiometry, even with minimal on-the job training. Strongly Agree Agree Disagree Strongly Disagree
8. If the opportunity arises and there is a vacancy for this line of work, you will consider taking on the job. Strongly Agree Agree Disagree Strongly Disagree

Results and Discussion

We define a degree of mastery in the student if his or her proficiency of this subject attained at least a 'B' grade (70%). The overall subject marks of these 41 students were put to a Anderson-Darling normality test and it was reported a normal distribution adequately described this set of data. We performed a 2-sample t test on these two groups of students, group 1 which undergone the workplace practicum with Mr Steven Lee guiding them and providing critique on their skills, with the other group 2 without this priviledge. There is a significant difference, at 95% confidence level, in their mean subject mark between these two groups, with mean of group 1 higher than mean of group 2 ($p=0.036$). This result implies the importance of workplace practicum in mastery learning. Apart from workplace practicum, we will also discuss how additional practice, self-regulation, learning with technology, find their significance in this mastery program.

Mastery learning with additional practice and self-regulation (questionnaire items 1 to 4): Students found that with hands-on experience allowed them to understand the subject better (item 1: 92% Strongly Agree and Agree (SA&A), item 2: 86% SA&A). It is also found allowing the students to self regulate their learning such as in the form of reviewing recorded videos has benefitted their mastery learning. (item 3: 83% SA&A, item 4: 86% SA&A). In alignment with the mastery learning theory (Bloom, 1981), where students require different durations of study to attain the same mastery level, allowing students to study at their own pace and provide them with the after-class facilities to perform repetitions to perfect their clinical skills enhanced their attainment of mastery.

Mastery learning with technology: In the mastery learning program of AudioHD, authentic assessment of the clinical tone assessment skills was made possible with technology. It has been defined the technology-enhanced simulation as an ″educational tool or device with which the learner physically interacts to mimic an spect of clinical for the purpose of teaching and assessment.″ (Cook 2013). As described in earlier section, the students got to use the Ultimate Hearing Test Simulator software which simulates an environment with virtual hearing impaired clients, inplaced with real clients. In this simulator, it was programmed 20 virtual clients of various conditions; and the students needed to go through the virtual simulation at their own pace, anytime, anywhere. They got to practice their skills to their own satisfaction. With the results they obtained from each exercise, they would need to discuss with their peers and collaboratively receive continuous feedback or critique from tutors to improve on their techniques.

As for project work, students rotated the roles of an audiometrist (whose job was to interact with and conduct hearing tests on patients, and evaluate their conditions, including to ethically recomend solutions), and patients. Each pair of students would record videos of themselves in getting each procedural step of using the audiometers done correctly. Using the video recording once again helped in providing constant feedback from their peers, as they could review the recordings, by replaying each step. These collaborative feedback have helped each student to understand where they have missed out and have done wrongly.

As Bloom (1985) has recommended, learning is influenced by opportunity and effort. These AudioHD students were able to re-visit their strengths and weaknesses through recordings and remedify. By repetitively re-doing each clinical step correctly, these forms of learning practices have more significant impact on student performance than any other variable, including student background and prior achievement (t test performed on their cumulative aggregate score (CGPA) indicated no significant difference between these two groups). One of most important element is our students learned that making mistakes was a part of the learning process of any mastery skills and that this process is to be valued as is the motivation to improve learning.

Mastery learning with workplace practicum (questionnaire items 5 to 8): Students found that with interventions from the industry professional, an audiologist, on their clinical PTA skills, helped in their learning and degree of mastery (item 5: 89% SA&A). Their comments were generally favourable:

″He talked based on his experiences...So we can have an idea of what could happened. ″

″He allowed us to know why it is done that way...″

″He has explained the principles with realistic examples and made different approaches to make us understand the subject.″

″He demonstrated to us on how to use the equipments properly. ″

The instructional guide provided by the practicing audiologist had also stimulated and benefitted them (item 6: 94% SA&A). Their confidence in taking on the clinical role has also been boosted (item 7: 91% SA&A). In comparision with previous years, this cohort has been reported to respond to the audiometric technician openings more actively, concensus with their voluntary response (item 8: 91% SA&A).

Säljö (1979) has classified the learning conceptions into five categories with the last two as: (d) the abstraction of meaning; and (e) an interpretative process aimed at the understanding of reality. We can relate these two conceptions as deep learning; and the students had adopted this conception through interactions and interventions from the workplace professional. With group 1 having constant feedback and critique from the expert having the domain knowledge, their skills were significantly improved as compared to the other group as the domain expert, Mr Steven Lee, is able to point out the mistakes and how to fix and optimise them.

Compared to other audiometry courses like the basic industrial audiometry course which is a part time course at our polytechnic, this course is set at a more advanced level. Students have to learn how to perform clinical masking which involves a higher level of understanding of theoretical concepts and a more rigourous practicuum. The students have performed well with guidance and should they choose to embark on a career

as an audiometrist, they would only require minimal on-the-job training to work independently.

Conclusion

We report an integration of mastery learning strategies, from opportunities for additional practice and self-regulation, interactions and interventions in the form of workplace practicum, to technology-enhanced simulator; provides greater benefits for students adopting the deep learning approach and acquiring a high degree of mastery for clinical skills. Given the shift of emphasis to defined objectives or goals from the conventional defined learning time, students with different abilities were able to attain same mastery. Inevitably mastery learning will take longer than non-mastery learning, as displayed in the form of constant feedback to guide, correct and reinforce. These findings are able to guide the design and enhancement of the mastery learning models for clinical skills for AudioHD and other skills-based subjects. It is also found that mastery learning models are also able to encourage learners to confidently apply their deep skills in their future job with shortened on-the-job training.

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REGIONAL CONTRIBUTION OF NIT FUKUSHIMA COLLEGE IN THE FIELDS OF DESASTER PREVENTION AND MITIGATION, RENEWABLE ENERGY AND NUCLEAR SAFETY, AFTER THE GREAT EAST JAPAN EARTHQUAKE AND FUKUSHIMA DAIICHI NPP ACCIDENT

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Abstract

NIT Fukushima College is conducting a program to assist the recovery from damages caused by the 2011 Great East Japan Earthquake. One of the targets of the program is to enforce the engineering activity in the fields of renewable energy, disaster mitigation and nuclear safety, since they are recognized to be crucial engineering subjects for the future of Fukushima prefecture. The activities are not limited to the inside of the college, but widely extended to the public. Such as the assistance to the public education in those subjects from primary education to lifelong one at the community centers is also involved. As to the renewable energy (RE) technology, the college students and outside participants are to be taught what RE is, how to utilize them. Smart grid technology is also included in the theme, because the technology is very important for the utilization of RE. The real scale smart grid experimental system consisted of two photovoltaic generation systems with other RE generations was installed and used for research, education and demonstration. When Fukushima–Daiichi Nuclear Power Plant Accident happened, after the tsunami caused by the earthquake, a large number of residents around the NPP have passed days in anxiety. To reduce the anxiety, talks on the effects of radiation on human body are under way for students and school teachers in elementary and junior high school, for workers involved in decontamination work, and for local community residents in lifelong learning, in addition to the lectures on radiation safety, reactor physics and radiation detection experiments for the college students. As to the disaster prevention and mitigation, efforts have been made to raise young students who can contribute their study for the establishment of measures against not only earthquakes and tsunami, but also flood and soil avalanche. It was clarified what kinds of past plans were effective or not from the points of views of disaster prevention and mitigation, learning from such past tsunami disasters as the Showa-Sanriku Tsunami in 1933 and so on. Such research results will play an important role to improve the present plans of the recovery projects.

Keywords: *the 2011 Great East Japan Earthquake, recovery program, renewable energy, disaster prevention and mitigation, nuclear safety*

Introduction

The 2011 Great East Japan Earthquake brought catastrophic disasters to Japan, especially to the Tohoku district. Since then, many programs have been deployed for the recovery. NIT Fukushima College made an educational plan to raise not only students but also residents suitable for the purpose in the region. The five year long plan to open special courses was approved by the Ministry of education, culture, sports, science and technology of Japan. Five new professors and five additional students joined in the course. Even though this is the final year to conclude the plan, the purpose has not been attained yet. The effort should be continued in any ways.

Here are described the steps made so far in the three fields, the RE technology, the disaster prevention and mitigation and the nuclear safety engineering.

Activities on the renewable energy technology

The government of Fukushima made a decision to realize the RE utilization by 2040, of which amount is equivalent to the total energy consumption in the prefecture. Considering the present status that about 20% of energy is provided by the RE, mainly by the hydro power, the target seems not to be the easy one.

Although the increase of photovoltaic and wind turbine generation is quite enormous in the region, the industry and human power is not sufficient for the attainment. So the progressive build-up of education scheme in this field was urgent. In the special course described above the curricula in this theme consist of renewable electricity generation, energy conversion engineering and electric transmission and distribution system engineering. Those are key technologies to be learned. Since outputs of renewable energy sources, such as photovoltaic and wind turbines generations are quite unstable and the fluctuation in amplitude is fairy large. As a result, the study on the countermeasure against the instability which may be caused with the introduction of RE's in the great scale is thought essential.

As to the citizen educational effort outside of the college, a few day course would be prepared open to public. In 2013, forty participants learned about wind turbine engineering. The subjects consisted of the principles of wind turbine, fundamental technologies, the floating type large scale wind turbines in the ocean as a typical example and problems with the grid connection. The lectures were welcome to the participants, even though some fundamental knowledge was required. When the course was finished, certificates of completion were issued to the participants. The themes were photo voltaic generation in 2014, and the utilization technology of RE's in 2015. The number of the participants were around forty, and most of them replied to the questionnaires circulated after the lectures amiable. This program will be continued this year.

Smart grid technology is also included in the theme, because the technology is very important for the utilization of RE. An experimental system shown in Fig.1 was installed in NIT Fukushima College and has been being used for research, education and demonstration. (Higuchi, N. et al. 2014)

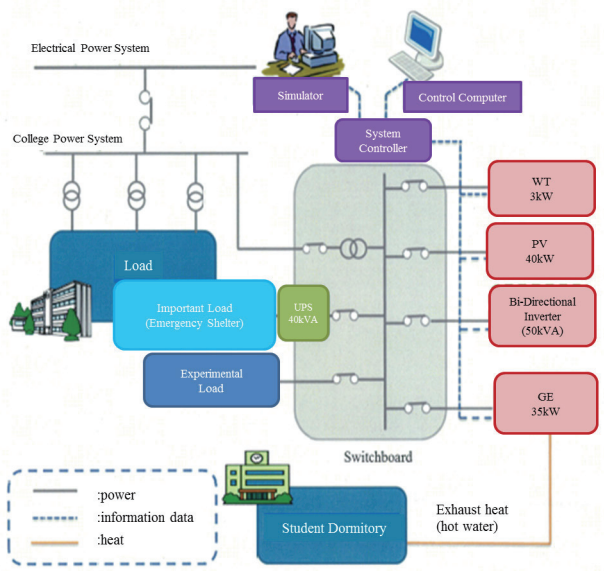


Fig.1 Structure of the real scale smart grid experimental system

The system is designed and produced to realize the following three main purposes.

(1) An experimental facility for students to understand to connect distributed generators to the grid: namely, planning, operation and maintenance of the smart grid.

(2) To continue to supply electric power to the college buildings even during the grid failures (disaster resistive).

(3) Demonstration and promotion to introduce a similar micro-grid like power supply system to schools, hospitals, and such emergency offices as police offices and fire stations, etc.

The system mainly consists of the distributed generation systems, uninterruptible power supply system (UPS), a bi-directional inverter for batteries, and a supervisory control system, etc. The distributed generators include a 35kW gas engine co-generation system, a 3kW wind power generation system and a 40kW solar power generation system. In normal operation, the whole electricity from the distributed generators is supplied to the load in the college. Exhausted heat from the gas-engine co-generation system is used to supply hot water to the student dormitory.

A reverse power flow to the power system is not allowed because the power from the distributed generators is so small compared with the total load of the college. The operation of the distributed generators under a fault state of the utility system is not allowed, and the reverse power flow protective relay and a under power detection relay are installed for this purpose. The protective relaying scheme is followed to the Japanese grid-code. Namely, a fault in the utility power system is detected through the protective relaying system.

When a black-out occurs in the utility power system, the system mode can automatically shift to the islanded operation mode to supply electricity to an important load of the main building through uninterrupted power supply system. The frequency and voltage of the islanded system are controlled through the CVCF inverter of the gas-engine co-generation system. An experimental load connection panel (switch-board) is also facilitated in the system so as to examine such load control apparatus as smart meters, etc.

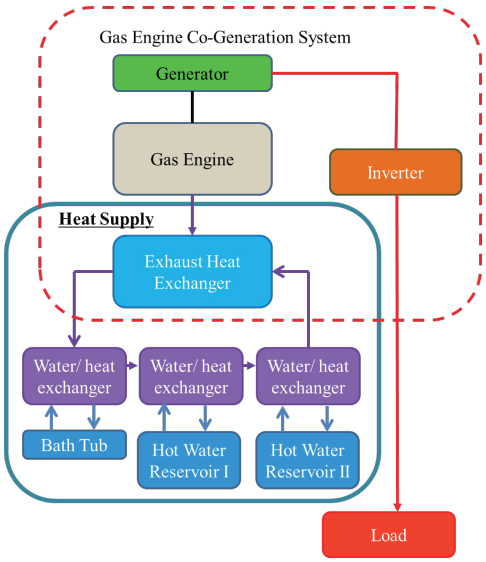


Fig.2 Exhausted heat supply system

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Fig.2 shows an exhausted heat recovery system. The system has 3 heat exchangers and each of them supplies heat to 2 hot water reservoirs and a bathtub in the student dormitory. The operation of the heat-collection system is controlled by the pre-determined schedule to improve the total efficiency. In this system, in spring and autumn, the optimal operation hours are 8 hours per day. The rated heat recovery ratio is 51%, and the rated collected heat is 52.5kW.

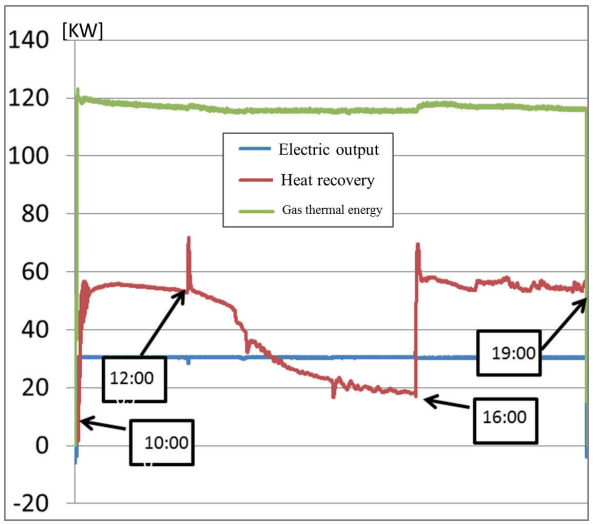


Fig.3 Operational example of gas-engine co-generation system

An operational result of gas-engine co-generation system for some winter day is shown in Fig.3. Green line shows the gas consumption of the co-generation system, blue line shows the electric power generation, and the brown line shows the exhausted heat recovery. The peaks of the brown line mean switching timing of three heat exchangers.

This system is the 'real scale' one, so the simulator has been used for experiments performed by students. It offers wide scale of variation in the system constants, such as wind turbines of corresponding capacity of the photovoltaic, 40kW to investigate the characteristic of the cooperation.

Demonstrations of the system were performed to guests many times to show the feasibility in both of the emergency and ordinary conditions.

The efforts will be continued this year.

Activities on the disaster prevention and mitigation

Education and research in NIT Fukushima College in the field of disaster mitigation, is undertaken to contribute to the Reconstruction Human Resources Development Program after the Great East Japan Earthquake and the tsunami.

In the teaching, prevention measures against damages resulted from natural disasters such as earthquake, tsunami, flood and landslide are lectured from the view point of town construction planning. In the Great Earthquake, collapse of banks by the tsunami took a heavy toll of human lives, therefore such software approach as information transmission and evacuation plan of residents is recognized to be also important. It is expected that they who have attended the lecture will be able to make a good judgement, for instance, in administrative work on prevention of damage by disasters, when they encounter with disasters in the future, applying their knowledge.

In the research, the reconstruction plan after showa-sanriku tsunami in 1933 is being reviewed how it is reasonable or not, from the view point of the experience of the great earth quake. The governments of the areas suffered from the showa-sanriku tsunami made reconstruction plans, independently. They included construction of tide embankment, plantation of trees to protect the shoreline, relocation to elevated ground, and level raising of urban district. These tasks are very similar to the restoration plans after the great earthquake. Therefore the review of the former plan, such as, what were carried out, what were effective or not, will contribute to the evaluation the present plans to be realized soon.

The research was focused on the effects of the relocation to elevated ground and the level raising of urban district. In the Showa plan, relocation to elevated ground was chosen in the area where the height of the tsunami was over ten meters. And in the area of the lower tsunami height, level raising scheme was selected. In both cases, the final ground levels were designed higher than the tsunami levels in 1896 and 1933.



(a) An example of the relocated area before 3.11



(b)An example of the relocated area, inside the red contour, after 3.11 (the area did not suffer any damages)

Fig.4. An example showing the effect of the relocation before and after the 3.11 earthquake

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(a)An example of the embanked area before 3.11



(b) An example of the embanked area after 3.11. The area inside the red contour was embanked based on the experiences in 1896 and 1933, which was washed away.
Fig.5 An example showing the effect of the embankment before and after the 3.11 earthquake

The results of the reviews concerning to the damages by the great tsunami obtained so far showed meaningful data. Five relocated areas and three embanked areas involved in the Showa plan were chosen for the review, and it was clarified that the relocated areas were quite safe. On the contrary, almost of all of the houses in the three embanked areas were washed away, accompanied with enormous damages.

It can be concluded that the relocation was quite effective as a countermeasure against to the tsunami. However, the design of evacuation plan to the safer area, for example, will be essential to decrease the damages.

Concerning to the embanking plan, it is not good enough to design the level based on the experiences in the past disasters. Various measures, such as, construction of refuge buildings high enough against tsunami and arranging the evacuation route to safer places in the restoration plan under the consideration at present from the points of views for much safer situation.

Activities on the nuclear safety engineering

People living in Hamadori district in Fukushima prefecture, as well as common Japanese people, don't have basic knowledge on radiation and radioactivity. They have become restless in their daily life, after Fukushima Daiichi Nuclear Accident.

A course of learning as a part of the Program for Nuclear Safety Engineering includes "Introduction to Radiation Safety", "Radiation Engineering", "Reactor Engineering", "Nuclear Safety Engineering" and "Experiment on radiation detection". Several research activities on the reactor decommissioning technology have been also carried out. The other part of the Program includes talks for such students as elementary school and junior high school and their teachers and parents, for workers for decontamination as well as general public who are interested in lifelong learning. We actively carried out educational programs and community forums in order to support smaller business and to contribute to the community. Among of these activities, the talks for primary education and several researches on the reactor decommissioning are introduced in the following.

Most of the talks at elementary and junior high schools are not serial ones and the time available is limited, therefore the contents are designed to keep continuity with science education at the schools. Also, experience to look at the trace of alpha-particle with a Langsdorf's high temperature diffusion type cloud chamber is used. It acts as a powerful tool to attract and inspire imaginations of boys and girls. About three hundred students experienced the "cloud chamber experiment" at one time in a junior-high school in Koriyama Fukushima in July 2015 (Fig. 6).



Fig. 6 "Cloud chamber experiment" at Koriyama-daiichi junior high school (About three hundred students experienced the "experiment" at one time.)

Effects of heating on the strengths of the components of during the Fukushima-daiichi accidents are important for the safety for the decommissioning process. The effects of heating to elevated temperatures on the concrete for reactor buildings and steels for the containment vessels/reactor core have been examined experimentally. Numerical analysis on the temperature history has been also conducted.

Strength of the concrete is rather sensitive to heating comparing with other structural materials of the light water reactors. Heating to temperatures above 500 degree Celsius exhibited the degradation of the strength of the concrete specimens. Heating to 1000 degree Celsius further reduced the strength.

Strengths and microstructures of the low alloy steels and austenitic stainless steels have been examined before and after the heating. Some of the specimens have been also irradiated with ion-accelerators. The specimens were annealed to estimate the effect of heating on the microstructure and the strength of the core-internal materials and pressure vessel steels.

One of the most important issues is the treatment of highly radioactive wastewater generated in the process of cooling of the damaged reactor core. Zeolite particles are used to eliminate radioactive Cesium nuclides and other radioactive species in the coolant. The zeolite particles bearing radioactive species are placed in interim storage container. The deterioration of the containers may be accelerated by decay heat, so thermal conductivity of the packed zeolite particles was measured; temperature distribution in the container was estimated (Yamagishi, I. et al., 2014). To discuss the process of heat transfer, packed alumina particles is also examined. The results are utilized to evaluate the method of the storage.

Most of these researches (except for the Zeolite pebble-bed) have been conducted in a MEXT funded research program on the decommissioning (*Haishisochitou Kibannkennkyuu Jinnzaiikusei* program; Programs for the basic researches and education for the reactor decommissioning). The program also contains the researches on the public and risk communications by NIT Fukushima College, and miniaturization studies of the gamma-ray detectors by Toyama College and Nagoya university.

Conclusions

The program on Regional Rehabilitation for Safer and More Secure Society in Fukushima has been being carried out in NIT Fukushima College, concentrated in the three fields, the RE technology, disaster prevention and mitigation and nuclear safety. The activities are coverimg education for students and citizens and researches on each mission.

We would like to admit that the task has been succesful so far, but it should be continued in any ways.

Acknowledgements

The authors would like to thank Dr. Koichi Nara, the former President of NIT Fukushima College for the designing the Concept of the project.

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DEVELOPMENT OF AN ENGLISH-BASED "INTRO TO ELECTRONIC CIRCUITS" LAB COURSE FOR NIT THIRD-YEAR ELECTRONIC SYSTEMS ENGINEERING STUDENTS

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Abstract

With the push that NIT has had to cultivate Global Engineers, stress on ramping up English Education at NIT has followed. However, there is a significant difference between the content of the English taught in the English Classroom and the English that the young engineer will use in his or her specific field in their future workplace or research laboratory. Thus, the English-based "Fundamentals of Electronic Circuits Laboratory" course was implemented for third year Electronic Systems Engineering students at NIT, Kagawa College, Takuma Campus (NIT, KC-Takuma). The third-year course begins with simple analogue electronic components and circuits and takes the students through to digital microcontrollers and physical computing. All educational materials including lab manuals and lab worksheets are in English. All instruction is also given in English. To encourage the students to use English during class they are required to ask all questions in English as well. As an effort to encourage motivation in the class, students are also given some "ownership" of learning in the form of a final project. Students were given the freedom to decide what electronic system they are going to design and build and were allowed to present their design to the rest of the class. Although presenting the material in English at times required additional time to repeat or explain, all of the units in the course were completed within the time allotted for the lab for the school year. It was evident that students understood much of the English as they were able to complete all laboratory tasks. In conclusion, there may be other courses at NIT that could be taught entirely in English that would positively affect student's English ability and comfort level using English without affecting the acquisition of the concepts presented in the course.

Keywords: *Active learning, English in the content area, Engineering education*

Introduction

With the recent emergence of the Globalization of everything, communicating with people from all over the world has become common place. Our present global economy has become the driving force in pushing various fields of study and industries including entertainment to go global. English has become the main medium of communication.

It is technology that has made this possible, technology that has come from engineers' research from all over the world. To continue moving forward, engineers in every field necessary for sustainability are going to have to continue to innovate to accommodate our changing world.

It will be engineers with the ability to communicate and conduct research collaborations in English with other engineers from across the globe that will make it possible to create the innovations that we need to help support and propel our planetary society forward.

To empower the students with the skills to do this, NIT, KC-Takuma has begun putting resources into stepping up English education at the school by hiring native teachers to teach the Oral Communications classes, tutor students for regional and national speech contests and for running after school English programs (Figure 1).



Figure 1. Native English Oral Communications Teacher

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However well implemented, the efforts fall short in one area. The English content covered in the Oral Communications classes and speech content rarely covers the English used in the engineering content area.

To address this short coming, the Department of Electronic Systems Engineering at NIT, KC-Takuma has begun migrating its course content to be conducted in English, of which the first to be completed was the third year 3ES "Fundamentals of Electronic Circuits Laboratory" course.



Figure 2. Native English Engineering Content Instructor

Course Materials

To help facilitate the English curriculum migration for the 3ES "Fundamentals of Electronic Circuits Laboratory", a native English speaking engineering instructor (Figure 2) joined the department to conduct the class and interact with students in English. In addition, one additional part-time native English teacher was asked to join the class, as well.

In collaboration with the existing faculty, development of the course migration began 3 years ago in 2012.

Development began with creating all English hand-outs and course materials from various educational material sources with content mapped to the current curriculum objectives and aimed at producing learning outcomes that matched the original curriculum with the addition of learning English in the content area and improving English oral communication skill objectives.

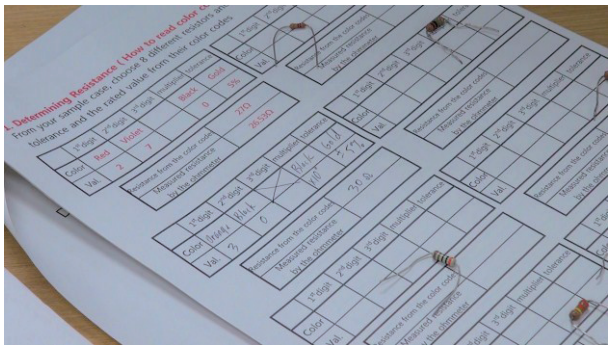


Figure 3. Electronic Circuits Course Content in English

The hand-outs, consisting of lab manuals and worksheet packets, were created from various sources on-line and Arduino based tutorials released under the creative commons license. The lab manuals explained the background information and objectives of the lab exercises and the worksheet packets were for students to record their laboratory exercise data.

All new, comprehensive lab project kits (Figure 4) were assembled as part of the new courseware as well. Every laboratory project kit included all the necessary components and tools for the course laboratory project tasks as well as a few extra components for use in their final laboratory project.



Figure 4. New Laboratory Project Kit.

Initially, supplemental videos were also created for the students but as videos are not as interactive; it was decided that it would be more beneficial to use the existing content to make PowerPoint slide presentations for use in the laboratory to make the laboratory project objective orientations more engaging.

The PowerPoint presentations were specifically designed to give a solid audio/visual mnemonic aid to help students create meaningful audio/visual/word connections for the vocabulary of the concepts, components and equipment used in the laboratory.

Methods

As for methods implemented for the third year "Fundamentals of Electronic Circuits Laboratory"; to satisfy the condition of total immersion English, the class was primarily taught in English with little Japanese used during instruction. To be classified as an immersive class, generally speaking, a class has to be conducted more than 50% in English.

At the beginning of each lesson unit a short orientation and guidance session was given for the students. This was given in English and the unit project experiment and objectives were covered. The orientation and guidance session was given accompanied by the PowerPoint content prepared for each of the units.

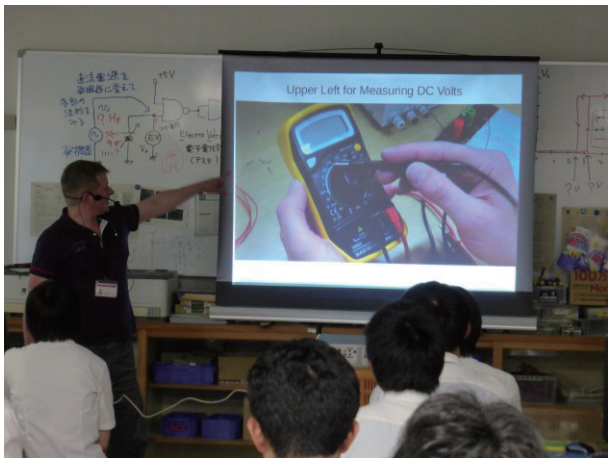


Figure 5. Orientation and Guidance Session in English

After the short orientation and guidance session (Figure 5) was finished, students were given time to start the project laboratory exercises. The exercises were grouped by one topic/objective per page. When the students completed all of the objectives on the page, they were to consult one of the laboratory instructors to check their work and confirm their progress onto the next topic/objective page. If the students work checked out, the laboratory instructor stamped a personal seal next to the tasks completed on the topic/objective page and they were allowed to move on to the next task. The tasks were designed with a gradual increasing level of difficulty. This was also used to confirm retention of knowledge and concepts acquired during class room lecture. If students were having difficulty with the task at hand they were encouraged to ask the instructors in English for assistance.

To encourage students to put more effort in class, students were also given "Ownership" of their learning path by having the choice to choose their own final microcontroller project and presenting it to the class in English. Students were encouraged to use any or all of the components they learned about during the laboratory exercises as well as any of the extra available parts to create the electronic system of their own design.

Results and Discussion

Although the class was taught primarily in English, at times when students had difficulty understanding, it took additional time to explain multiple times and on rare instances Japanese was used to explain. However, the ratio of Japanese to English instruction was well below any ratio that would drop the English instruction time below the 50 percent required for immersion class status. The additional time required for repeated explanation also did not cut sugnificantly into students discovery learning time in the laboratory as all students were able to complete tasks comfortably by the required deadlines. It is felt that due to this ample time to complete the tasks, the students didn't feel that the conversation in English came as a burden. On the contrary, it resulted in the generation of more student motivation to ask and answer questions in English to and from the teachers. In addition, some students enjoyed the chance to chat with the teachers in English.

Introduction of native English teachers in the Electronic Circuits Lab and changes to curriculum have effectively increased student-teacher interaction in English and students learned English specifically related to Electrical Systems Engineering (Figure 6).



Figure 6. Student-Teacher Interaction in English

Evidence of increased communication could be seen in the fact that all of the students were able to complete the tasks for each unit and that as the course progressed, students were less aprehensive about approaching the instructors and trying to communicate their questions in English.

The seal/task system also proved to be an effective measure of formative assessment mid unit and assured that the students grasped all of the new concepts as well as retained the concepts from the previous lessons. This was also an acurate measure for predicting student success rate for completing the next unit.

Although there were some basic teacher centered components to the lessons such as the laboratory project objective orientations, the majority of the laboratory time was discovery based, especially during the final projects/tasks of each unit. Students demonstrated characteristics of "synthesis" from Bloom's taxonomy, self-motivation and autonomous learning.

Conclusions

It seems that giving students "ownership" of their own learning paths increases their self motivation and autonomous learning and may have an overall positive influence on their academic and personal growth.

In conclusion, there may be other courses at NIT that could be taught entirely in English that would positively affect student's English ability and comfort level using English without affecting the acquisition of the concepts presented in the course. General Education courses such as Mathematics and Physics that directly support concepts in the engineering content area seem to be ideal candidates for migration to English immersion courses. Courses currently under migration development include 2nd year C Programming and 4th year Robotics Engineering. Further study may confirm to what extent English immersion can be applied to what other content areas.

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TETRAPOD EDUCATIONAL MODEL OF CREATIVITY DEVELOPMENT

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Abstract

In 2008, we started the education of intellectual property (to 160 students, belonging to Mechanical, Electrical, Intelligent System and Chemical Engineering), that included general things on intellectual property, patent search using IPDL (Industrial Property Digital Library), the way how to write the patent specification and so on. In 2009, we started application to the patent contest by INPIT (National Center of Industrial Property Information and Training), JPAA (Japan Patent Attorneys Association), Patent Office and MEXT (Ministry of Education, Culture, Sports, Science and Technology). From 2012, we started the class, "Training on intellectual property" for the advanced course students.

From 2009, our students started the applicants to patent contest, however, for the first 2 years, we took no special award. Therefore, we reflected our class and considered the strategy, tetrapod education model of intellectual property, which is composed from Coaching, Super memory, creativity by invention theory and co-creativity by facilitation skill. As a result, in these three years, we got three objectives for special support and two of them were awarded by INPIT. Much more, our college took the newly founded award by MEXT. Tetrapod education model gave us a certain amount of fruits, we guess.

Keywords: Tetrapod education model of creativity development, Coaching, Super memory, TRIZ, Facilitation

Introduction

According to the pro-patent doctrine, Japan Cabinet, Prime minister, Koizumi founded Intellectual Property Strategy Headquarter in 2003 and MEXT (Ministry of Education, Culture, Sports, Science and Technology) started the education on intellectual property[1)]. That is why our college started the education from 2008 and our college founded the special committee for the education as 6 academia members group. However, we had not the specialists for the intellectual property at the beginning and that is why we began to study it, together. At first, we relied on the specialists, for example, chartered patent agents or layers on the intellectual property.

Back

In 2008, we had 7 classes to 160 students as 100minutes long tuition (50minutes x 2). That included general things on intellectual property, patent search using IPDL (Industrial Property Digital Library), the way how to write the patent specification and so on. In 2009, we started application to the patent contest by INPIT (National Center of Industrial Property Information and Training), JPAA (Japan Patent Attorneys Association), Patent Office and MEXT. From 2012, we started the class, "Training on intellectual property" for the advanced course students.

Methods

Patent Contest[1)]

This contest was started from 2002 and held by INPIT, JPAA, Patent Office and MEXT. The purpose of this contest is activating the understanding of the intellectual property system for high school, college and university students. In case of judged as the objectives for special supports, the applicant students would get special benefits, for example, help by the attorneys with free and submitting their application of patent with free and if that could be judged as a patent, the registration fee should be free. Much more, the right of the obtained patent should belong to the students themselves.

Generally, about 300~400 applicants are submitted to the contest and about 20 applicants are selected as the special support objects, every year.

From 2009, our students started the applicants, however, for the first 2 years, we took no special support. Therefore, we reflected our tuition and considered the strategy.

On reflection, we almost threw things at students on the submission of patent contest. There was not much Q&A or discussion on the content of the applications. Therefore, we adopted next strategy, below.

Coaching[2)]

Implantation of academic members' idea to students is not invention by themselves. We would like to make students think independently and spontaneously. One of communication skills, coaching would support "thinking through by themselves". That is why our 6 academic members studied it and took the coaching license in 2012.

Coaching is the support skill for burying the gap between the actual condition and the ideal goal. Generally, there are 3 main skills, listening carefully, acknowledgement and questioning. In this way, students would "think through" and usually take "some awakening" from dialogues and Q & A between academic members and students or students themselves.

Super memory skill[3)]

At first, we thought, creativity was the combination of much knowledge and the unification. Therefore, getting much knowledge easily is effective to producing creative idea, we thought. That was why we

took lessons about super memory skill. We have two type of memory system, one is the short term memory and the other is the long term memory. Usually, we try to input too many things into the short term memory. However, this way of memorization is not effective because the short term memory doesn't have much memory space. This super memory skill is utilizing the long term memory. More concretely, there could be 20 objects (No.1, No.2, No.3…No.20), that we would like to memory. In case of "image combination method", we create images composed from No.1 and No.2, No.2 and No.3, No.3 and No.4…… In these cases, we create ridiculous, impressive or interesting image between two objects (see Figure1.), that we would like to memory. In other words, we create chain between No.1 and No.2, No.2 and No.3, No.3 and No.4…… In this way, we are able to memory a lot of things in order.

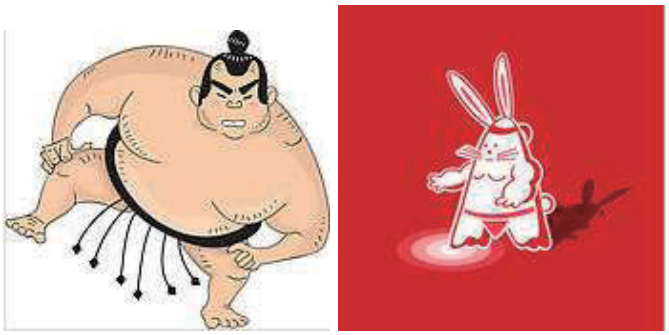


Figure1. Example of ridiculous image:
Fighting between a sumou wrestler and a huge rabit

Here is the super memory seminar results toward 19 students in our college. This seminar was held from 1 p.m. to 12(next day's noon) including homework. Before and after, their subjective score to their memory ability was greatly changed (see Figure 2.). Roughly speaking, their score became from 40/100 to 80/100 (twice).

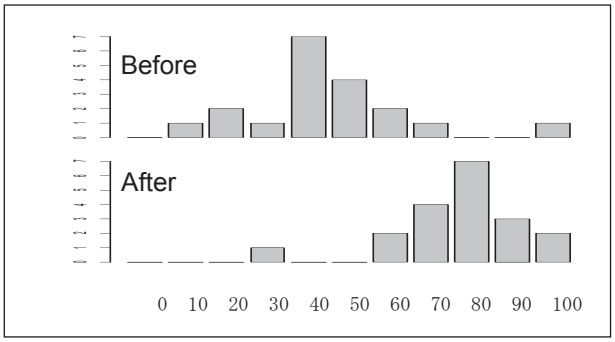


Figure 2. subjective scores before and after joining the super memory seminar
Vertical axis:frequencies,
Horizontal axis: scores

We had a questionnaire to every student and most of them answered, "I am surprised by my memory ability ", or "I got confidence of my memorization", "I am shocked and motioned by this seminar"….. We got favorable comments from them. As a result, we thought that this super memory skill was playing the role of lifting up students' confidence or self-affirmation level. In a sense, this effect could be more important than memorizing many things.

TRIZ (invention theory) [4)]

Genrich Altsuller (patent judge in Russia) established the invention theory, what we call, TRIZ. He searched and investigated 2,400 thousand patents and found 40 principles of invention. In case of problem solving, we usually face with the various type of contradiction. He shaped contradiction matrix for such problems. That is to say, depending on the contradiction factors, suitable invention principle would be introduced to us using TRIZ.

Facilitation[5,6)]

The application to the patent contest by students are created by 4 members from mechanical, electrical, intelligent system and chemical department in respectively. That is why the co-creation skill should be needed. Therefore, we studied Facilitation skill (Coach Approach Facilitation, CAF). This Facilitation skill is characterized by the human power (the ability of accepting diversity of value judgment), skill of listening carefully, and acknowledgement.

We studied these 4 skills or theory and gradually passed down to students in recent years.

Results

In 2011, our students' application was for the first time selected as one of the objects for special support in the field of college and, much more, their offer took the award as "Boosting on the reconstruction of the earthquake disaster" award. This award was founded in 2011 and our students got the award with the grope of Tokushima University. And the award winners were 4 applicants of 344 proposals. In 2013, our students' applications were selected as two of the objects for special support in the field of College and University in respectively.

Still more, their offer (in the field of University) took the award as "Boosting on the reconstruction of the earthquake disaster" award, again (see Photo1). And the award winners were 4 applicants of 377 proposals. Additionally, our college was also awarded by MEXT as "Chief of the bureau on science and technology and



Photo 1. Awards ceremony with certificates of commendation

the policy" award because our college's education on intellectual property promoted the content level of students' applicants. This award was newly founded in 2013.

Conclusion

We took some repeatable results in the patent contest using our education model (Figure 3).

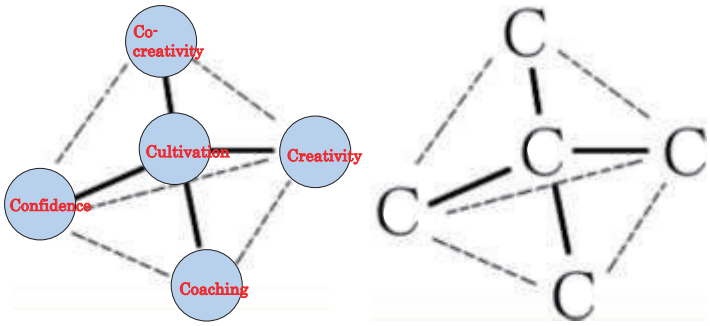


Figure 3. Tetrapod (Diamond) Educational Model of Creativity development

"Lifting up confidence level of students and supporting their "thinking through" by coaching skill, generating synergetic effect by team members (Coach approach Facilitation) and utilizing the theory of invention, these 4 items would produce powerful effect to our students' invention level, we guess. Much more, inputting Cultivation into the center of 4C (Confidence, Coaching,

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Creativity and Co-creativity), this could be the structure of tetrapod, and in other words, diamond.

Finally, In 2015, 10th and 11th of January, we had the seminar on the "Super memory and its Application to Intellectual property Education", at Philippines Normal University for students and teachers (totally, 43 participants) with the aid of Allen A. Espinosa, Rebecca Corpuz Nueva Espana, Ph.D. and Zenaida Quezada Reyes, Ph.D.etal. All the participants and me enjoyed together. This seminar could be a kind of empowerment and entertainment.

Acknowledgements

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THE "JIZAKE PROJECT": ADVANCE SCIENCE "MONOZUKURI" EDUCATION AND TRAINING THROUGH TRIPARTITE COLLABORATION, PRODUCT DEVELOPMENT, AND PARTICIPATION IN LOCAL AREA REVITALIZATION

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Abstract

We hereby report the temporary result of our ongoing project, namely the "JIZAKE Project", which two main aims are (1) to motivate and educate students about applied bioscience through active participation in biotechnological research during the development process, and (2) to develop a commercial brand of sake specific to Hidaka County in Wakayama as a form of social contribution. This project was commenced successfully in 2014 through a three-partite social-collaboration among the industry (Nate Brewing Co. in Kainan City, Wakayama), the local government of Wakayama Prefecture, and the academia (participating KOSEN and university professors and students).

Keywords: *Sake, Yeast, Social, Collaboration, Food Science, Graduation Project*

Introduction

Experimental bench work besides classroom lectures are very important to increase student comprehension and motivation when educating students in a technical or engineering school such as polytechnical college or KOSEN. The Ministry of Education, Culture, Sports, Science and Technology of Japan (MEXT) has been encouraging the implementation of "Monozukuri Education", i.e. an education including hands-on experience for students. As a place of higher learning in engineering and technology, KOSEN has been actively implementing Monozukuri Education, which we call the "Active Learning". The Department of Material Science at the National Institute of Technology, Wakayama College (NIT-WC; WAKOSEN) emphasize on direct hands-on education thus students to learn not only scientific basics, but also the direct applicative aspects engineering.

Along the line of the Monozukuri Education philosophy, we initiated the "JIZAKE Project" at our college, the WAKOSEN. "Jizake" is a Japanese word for "local sake". In Japan, local sake is loosely and arbitrarily defined as sake brewed locally using local raw materials and/or brewing yeast, completely or partially, during its production. WAKOSEN is located in the Gobo-Hidaka area in Wakayama Prefecture in Southwest Japan. Thus, the main aim of this project is to produce a local sake (JIZAKE) using yeast isolated from Gobo-Hidaka area, and rice also produced locally in this area. This project is a three-partite social-collaboration among WAKOSEN, the industry (Nate Brewing Co. in Kainan City, Wakayama), and the local government of Wakayama Prefecture. Through this project, some participating students of WAKOSEN had a chance to experience almost every aspect of sake brewery and production, including involvements in the isolation and identification process of local yeast strains, to the distribution and marketing of the produced jizake.

Among the Japanese sake, junmaishu is a type of sake made by fermenting only rice, by koji, with no subsequent addition of alcohol, sugar, or any other non-rice additional material (Kazuoka, 2015). The Japanese people regularly consume this type of sake not only as casual alcohol beverage, but also during traditional festivities and life ceremonies. Therefore one of the aims our JIZAKE Project is to produce sake with dry and clear taste, which is popular among the Japanese consumers.

In order to do so, in this project, we isolated and cultured strains of *Saccharomyces cerevisiae* yeast from a famous, 1300-years-old local temple (the Dojoji Temple) in Gobo-Hidaka area. After we micro-brewed (microvinification) junmaishu sake with the isolated yeast strain, we conducted analyses to measure the chemical components affecting the taste and fragrance of the resulting sake. Our results showed that we successfully collected, identified, isolated, and cultured

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a local yeast strain useful to produce a jizake with desirable taste and fragrance, as indicated by the results of our chemical analyses.

Materials and Methods

1. *Isolation of yeast strain*:

Yeast isolation was carried out in the Dojoji Temple what is the famous temple in Hidaka. Samples were taken from sakura flowers, honeybee and soil, etc. These samples were added to koji extracted medium and cultivated at 30 °C until spontaneous fermentation. The yeast single colonies were prepared by five times spread culture on YPD plate (5% yeast extract, 5% peptone, 10% glucose, 20% agar) at 30 °C for 3 days.

2. *Sequence identification and phylogenetic analysis*:

Colony PCRs was conducted for the whole nine isolated strains (arbitrarily named Yeast1–Yeast7, Yamanaka1, and Yamanaka8 strains) using standard protocol, to amplify the genomic ITS1 region. We used commercially available ITS1 PCR primers for yeast strain identification (BEX Co. Ltd.) for the PCR reactions. DNA sequencing of PCR products were outsourced to Eurofins Genomics KK. We obtained roughly about 400 bp for each sequence.

Initially, BLASTn analyses were conducted to quickly identify the yeasts. Then, additional 46 yeast ITS1 sequences (2 outgroup and 44 ingroup sequences) were then downloaded from GenBank for further phylogenetic analyses. We loosely referred to suggestions and results of Kazuoka (2015), Montrocher et al (1998), and Salichos&Rokas (2013), to choose appropriate ingroup and outgroup OTUs for the phylogenetic analysis. Sequence data were aligned using the online version of MAFFT ver. 7 (http://mafft.cbrc.jp/alignment/server/; Katoh&Standley, 2013) with L-INS-i setting. We used the online version of GBlocks ver. 0.91b, (Talavera&Castresana, 2007; http://molevol.cmima.csic.es/castresana/Gblocks_server.html) to do post-alignment sequence editing. Maximum likelihood phylogenetic analysis was conducted on RAxMLGUI ver.1.3 (Silvestro&Michalak, 2012), using the GTRGAMMA model with 1000 rapid bootstrap replications.

3. *Yeast strain used for sake brewery*:

Yeast1 were re-named as “Ma2”, and Yamanaka8 as “Ma2P”. Yeast1 (Ma2) was used in subsequent sake brewery process.

4. *AlcoMate analysis*:

The isolated cells cultured on 1 mL koji extracted medium in test tubes at 40 °C. The fermented ethanol concentration was measured by AlcoMate AL-2 (Woodson, Co., Ltd.) for each 24 hours.

5. *Microvinification (Small Batch Brewing)*:

The sake was made in order to measurement of following some including chemicals. The Hatsuzoe (first rice addition) was done by adding 141.2 G steamed rice (65% ground), 67 G koji, 158 mL water, 0.53 mL Lactic Acid and Yeast starter (strain K7 or strain Yeast1(Ma2) and Odori (mixing each days) was carried out for three days. The Nakazoe (second rice addition: 225 G steamed rice, 54 G koji and 263 mL Water) and the final rice addition (Tomezoe) (390 G steamed rice, 82 G koji and 503 mL Water) at 22th day. And stopped fermentation of filtered sake with Hiire (pasteurization) at 60 °C for 15 minutes.

6. *Chemical analysis*:

Volatile fragrance compounds were adsorbed on Mono Trap (GL science Inc.) at 60 °C for 30 minutes, and extracted to clean water with sonication for 5 minutes. Extracted chemicals were analyzed by GC/MS 7890A MS: JOEL JMS-QI050GC (Agilent Technologies Inc.). The initial temperature was 40 °C for 10 minutes holding time, rising to 200 °C at a rate of 10 °C/min. Organic acids were measured by HPLC with Shim-pack SCR-102H. Mobile phase 1 was prepared as 5 mM p-toluenesulfonic acid and mobile phase 2 was composed of 5 mM p-toluenesulfonic acid, 100 μM EDTA and 20 mM Bis-Tris solution. The analysis flow rate was 0.8 mL/min at 40 °C.

Results

1. *Yeast strain isolation and identification*

After the selection process, we obtained nine strains of yeast, which we arbitrarily named Yeast1–Yeast7, Yamanaka1, and Yamanaka8. Genomic ITS1 sequence is commonly used for yeast identification (Goto, 2009), and we therefore sequenced the ITS1 of the nine isolated strains. BLASTn analyses on the ITS1 sequences indicated that eight of the isolated strains (Yeast1–Yeast7, Yamanaka1) were Saccharomyces cerevisiae with low e-values and high sequence similarities (above 99%) (Data not shown). Meanwhile, Yamanaka8 was identified as *Kluyveromyces lactis* through BLASTn analysis, also indicated by low e-values and above 99% sequence similarities.

We obtained a sufficiently resolved phylogenetic tree for the yeasts, supporting our BLAST results (Fig. 1A). Yeast1–Yeast7 and Yamanaka1 strains were placed among *Saccharomyces cerevicieae* with strong bootstrap support (BS; 87%). Yeast1 to Yeast6 were grouped into one strongly supported monophyletic group (Bootstrap support: 82%), and the group then formed another monophyletic group with Yeast7, although weakly supported (less than 39%). The Yeast1–7 clade formed a monophyletic clade with Yamanaka1 and *S. cerevisiae* strains CBS382, CBS5378, Wu-Y2, and KADOYA1, albeit weakly supported. Yamanaka8 was confidently placed among the Kluyveromyces (BS: 100%), showing a highly supported affinity (BS: 86%) with *Kluyveromyces lactis* strain UCD698. We also conducted visual inspection of each strain by optical microscope with 100X magnification (Fig 1B).

2. *Ethanol, Fragrance and Organic Acids Analysis*

The fermented ethanol concentrations by all isolated yeast strains were increased to 6 % in 4 days. Finally, train K7 and strain Yeast1 (Ma2) show 15.5 % and 11.95 % ethanol concentration on small batch brewing test, respectively (Table 1). We detected presence of 1-butanol 3-methyl acetate and phenylethyl alcohol in the fermentation produce by Yeast1 (Ma2) (Table 2). These compounds are known to give rose-like ginjo fragrance

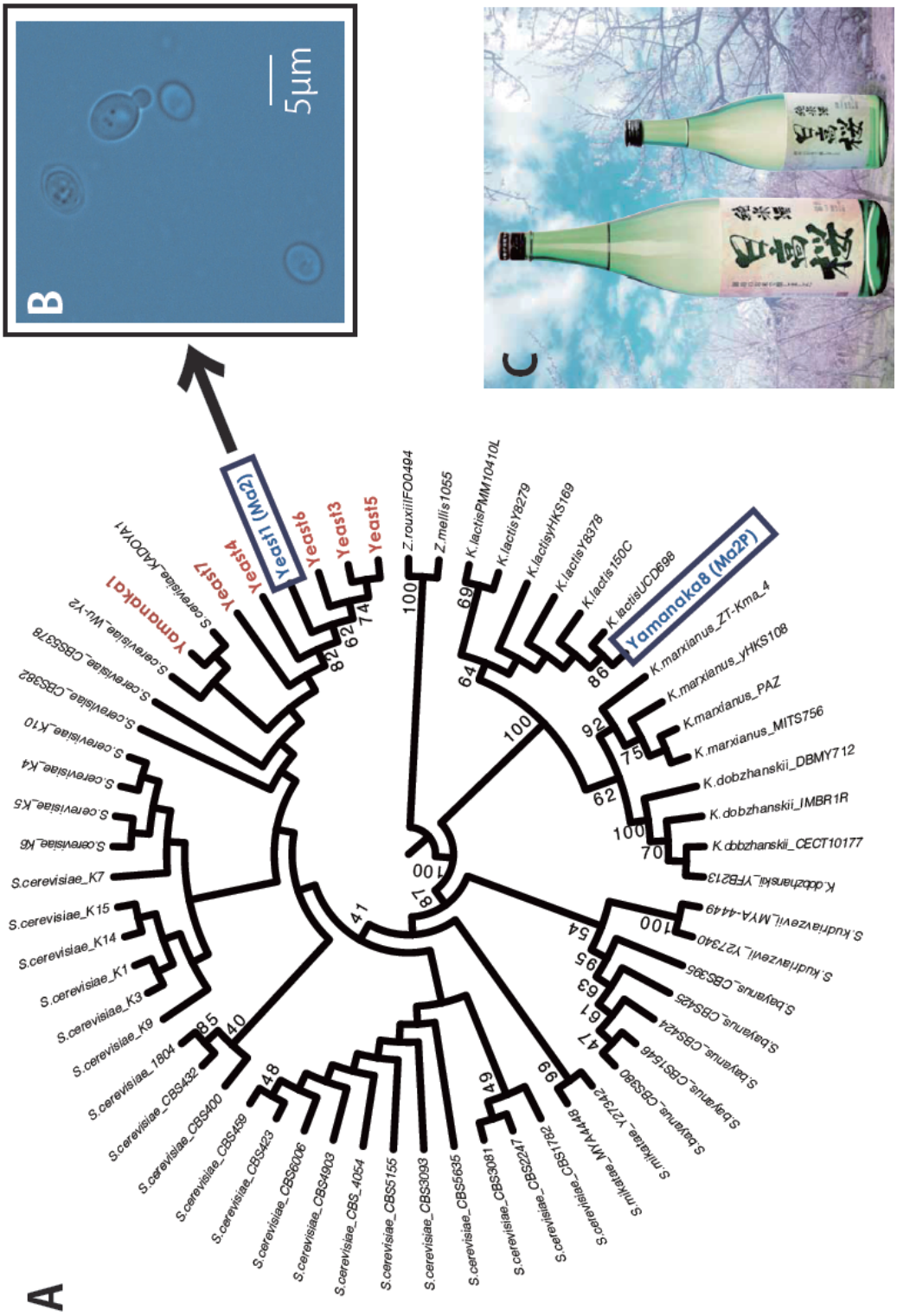


Figure 1. Identification of the locally isolated yeast strains in this study. (A) Maximum likelihood phylogenetic tree of the yeast strains analyzed in this study. We sequenced sample from one colony each of the nine distinct cultures of the environmental samples we obtained from the local temple in Hidaka City (Dojoji Temple; Sample names = Yeast1–7, Yamanaka1, Yamanaka8). Genus name abbreviation: Z = *Zygosaccharomyces*; K = *Kluyveromyces*; S = *Saccharomyces*. Numbers adjacent to the nodes are bootstrap support values (%). Only bootstrap support values above 39% are shown. (B) Microscopic photograph of the Yeast1 (Ma2) strain. Scale bar = 5μm. (C) The "prototype" sake, HIDAKAZAKURA, which was brewed using the common Japanese sake yeast (the K7 strain) in order to prepare the mill for commercial-scale brewery of BOCHI-BOCHI (jizake brewed using the Yeast1 (Ma2) strain, which was extensively analyzed in this study). For more detailed explanation, see the main article.

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in sake. On the other hand, strain K7 produced isoamyl acetate (banana-like ginjo fragrance), phenetyl acetate, and phenylethyl alcohol (rose-like ginjo fragrance). Dry and clear taste originates in the presence of organic acids. Our analysis indicated increased presences of citric acid, pyruvic acid, and lactic acid on strain the produce of Yeast1 (Ma2). In total, the concentrations of seven out of 10 (7/10) organic acids tested in our analysis were increased (Table 1). Therefore, our results strongly indicate that the sake produce of Yeast1 (Ma2) most likely has a dry and clear taste, with rose-like ginjo fragrance.

Table 1. GC/MS analysis for fermented ethanol and organic acids.

Chemicals		Yeast strain	
		K7	Yeast1 (Ma2)
Ethanol	%	15.5	12.0
Phosphoric acid	conc./ppm	255.90	366.39
	r.t/min	15.18	15.18
Citric acid	conc./ppm	74.81	103.43
	r.t/min	16.12	16.12
Pyruvic acid	conc./ppm	131.55	340.77
	r.t/min	16.89	16.91
Malic acid	conc./ppm	229.26	315.68
	r.t/min	18.14	18.15
Succinic acid	conc./ppm	483.06	364.06
	r.t/min	21.17	21.17
Lactic acid	conc./ppm	969.72	1575.57
	r.t/min	22.19	22.20
Formic acid	conc./ppm	1.09	1.67
	r.t/min	23.61	23.55
Acetic acid	conc./ppm	133.52	29.30
	r.t/min	25.76	25.77
Pyroglutamic acid	conc./ppm	55.27	65.58
	r.t/min	29.56	29.45

Table 2. HPLC analysis of volatile fragrance chemicals.

Chemicals		Yeast strain	
		K7	Yeast1 (Ma2)
1-Butanol, 3-methyl, acetate	%		6.74
(basic sake)	homology		992
Isoamil acetate	%	3.72	
(ginjo, rose)	homology	985	
Phenylethyl alcohol	%	85.52	71.9
(ginjo, rose)	homology	985	949
Phenetyl acetate	%	6.76	
(ginjo, rose)	homology	974	

Discussion

In this report, we presented the result of our effort to produce local sake (JIZAKE) conducted through a tripartite collaboration among the local academia-industry-government. As part of the effort of doing so, we conducted a biotechnology/food science research and analyses. We succeeded in isolating sake-fermenting yeast collected from a local temple, and subsequent analyses indicated that the sake produced by the yeast has desirable properties: a sake with fruity fragrance, and dry and clear taste. Interestingly, phylogenetic analysis indicated that the local yeast we isolated is not monophyletic with the conventionally used strains of yeast (the Kyokai strains) when producing traditional sake. Further detailed molecular genetic analyses will be needed to further elucidate this aspect of the yeast characteristics.

The bigger picture presented in this report is also about the commencement of the JIZAKE project with multiple social aims: research, education, tripartite collaborations among local academia-industry-government, a production of local sake, and ultimately, the revitalization of the Gobo-Hidaka area. At present, in order to prepare the commercial production of the JIZAKE brewed using the yeast strain isolated from the local Dojoji temple, we conducted a preliminary brewing to produce "prototype" sake using the K7 yeast strain. The "prototype" sake, named "HIDAKAZAKURA" (=The Sakura of Hidaka; Fig. 1C), is now being sold in local liquor stores. All of these preparations (microvinification and the produced sake's taste and fragrance analyses by WAKOSEN, the prototype HIDAKAZAKURA sake production by Nate Brewing Co., market testing by selling HIDAKAZAKURA by Maruni Co., etc.) were done to prepare the next step of our JIZAKE project: We aim to commercially produce a local junmaishu (informally and temporarily called "BOCHI-BOCHI", which means "relaxed and step-by-step", indicating a nuance of a slow-life), fermented using the Yeast1 (Ma2) strain yeast, which were isolated from the local Dojoji Temple in Gobo-Hidaka area.

60 bottles of the prototype sake HIDAKAZAKURA sold out on its first selling day, indicating the enthusiasm of local customers in Gobo-Hidaka for the production of a local jizake. Marketing-wise, we plan to produce up to 1000 bottles of BOCHI-BOCHI at the first mass-production step of the jizake. Our project presented here, which were carried out through an active and close-knit collaboration among the academia, industry, and local government, has multiple positive effects: (1) Student hands-on learning experience about product research and development, (2) The establishment of active collaboration among the academia (WAKOSEN), local industry, and the local government of the Gobo-Hidaka area and Wakayama Prefecture, (3) Local product and business development that will hopefully further develop into a bigger scale business, and thus assisting the revitalization and rejuvenation efforts of the Gobo-Hidaka area.

Conclusions

We conducted basic biotechnological research for product development, called the "JIZAKE Project" was initiated by faculties of WAKOSEN, and was later conducted through the commencement of a three-partite collaboration also involving the industry and local government. Specifically, we started by isolating an original local *Saccharomyces cerevisiae* yeast strain from Dojoji Temple, which identity was confirmed by the variable ITS DNA sequence analysis. Our subsequent tests of this strain showed that the strain is capable to biosynthesize ethanol in 3 days *in vitro* (ca. 3 mL), and 7 days as small plant scale system (ca. 5 L).

Further analyses of the resulting trial sake, detected the presence of some organic acids for giving dry taste. Our GC/MS analysis also detected the presence of esters, giving the sake its fruity "Ginjo" fragrance.

At present, we are still conducting extra analyses for license registration in order to mass-produce sake using this particular strain. Simultaniously, in order to test our system to mass-produce commercial sake, we mass-brewed a prototype sake (named "HIDAKAZAKURA" by using a local, standard K7 yeast strain. HIDAKAZAKURA is now on sale at local liquor stores in the Gobo-Hidaka area. As the next step, we are preparing to commercially produce a local junmaishu (informally and temporarily called "BOCHI-BOCHI"), fermented using the Yeast1 (Ma2) strain yeast, which were isolated from the local Dojoji Temple in Gobo-Hidaka area.

This project is also well aligned with the "Monozukuri Education" philosophy being encouraged by MEXT. Students participating in this project were able to experience the intricate process of RND (research and development) of a product, and thus giving the students hands-on experience of "Monozukuri" (=product development).

Acknowledgements

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LEARNING OF BUSINESS PROCESSES & APPLICATION: AN INDUSTRY-READY APPROACH

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Abstract

Business processes are key to many organizations and the use of Enterprise Resource Planning (ERP) applications has been identified by many as a critical factor to attain competitive advantage. The learning of business processes however, can be challenging especially to students who do not have the relevant industry experiences. With the paradigm shift to have institutions create learning rather than provide instructions, there is a need to develop a learning framework that make use of appropriate teaching pedagogy, to deliver the concepts in business processes and at the same time provide relevant hands on experience on an ERP application. A Learning Framework is developed based on the studies from Biggs (1978), Dunbar and Mackaway (2011) is applied into the Learning of Business Processes. The objective is to provide concepts in business processes, together with relevant hands on experience on an ERP application. In addition to content knowledge, students will also develop industry ready skills that are sought after by employers. For the Learning Framework to be impactful, the teaching and learning approaches adopted in the framework has to be integrated into the curriculum, and this will also include the use of industry-standard software to simulated real-world environment, as well as changes to the physical setup of the classroom. These changes to the physical learning environment are neccessary so that students can experience the "real-world" with the confines and safety of the classroom. This paper will examine how the Learning Framework has developed and implemented in two modules which allowed students to experience more authentic learning which will develop them to be industry-ready professionals.

Keywords: *Business Processes, Learning Framework, Industry Ready, Integrated Curriculum, Learner Centered Learning*

Introduction

The study of business processes has been the emphasis of many organizations. Organizations are constantly on the lookout for improvements in their processes to gain competitive advantage over their competitors. These processes are usually cross functional or even spanning across organizations which make it difficult to manage. Organizations often leverage on Enterprise Resource Planning (ERP) applications to increase the efficiency and effectiveness of their operations.

The teaching of business processes and applications can be challenging as content knowledge is not sufficient for students to grasp the essence of the topic. In order for students to fully experience ERP, they will need to have both the content knowledge and the practical know-how that can only be developed in real world environment. The nature of this topic lends itself well to learning approaches that allows for both acquisition of knowledge and an immediate application of that content.

There is a need to develop a learning framework that make use of appropriate teaching and learning pedagogy to deliver the concepts in business processes and at the same time provide relevant hands on experience on an Enterprise Resource Planning application, for the students from the Diploma in Financial Informatics (FI) course at Ngee Ann Polytechnic.

Literature Review

There is abundant literature that discuss how learning takes place among students. Learning is important to students as this is how they acquire knowledge and skills. With the acquired knowledge and skills, students will be equipped for future roles in their workplace. The General Model of Student Learning by Biggs (1978), shares that presage factors exist before a student enters into a learning environment. There are two types of presage factors. The first presage factor is more personal, which includes students' knowledge on the subject matter, their learning ability, values and attitude towards learning. The second presage factor is more situational, which are often linked to the amount of time available, the structure of the course and the difficultly level of the subject matter. These presage factors will influence how the learning process takes place, with an effect on the performance at the end of the cycle.

In a similar presentation by Robyn Wright Dunbar of Stanford University, she shared that besides prior

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knowledge, students also need effective organizing schemes, timely constructive feedback and multiple representations of information in their learning journey. Learning takes place in a cycle. The Inquiry Based Learning Model which Dunbar developed consists of four key stages - Engage, Explore, Explain and Apply. The model indicates that students need to be ***Engaged*** before learning can take place. They will then be able to think critically, ask insightful questions and have the ability to ***Explore*** deeper into the subject matter. With the provided scaffoldings and concepts, students will be able to ***Explain*** how things work. Finally, they can ***Apply*** all that they have learnt into a real world issue.

Mackaway et al. (2011) developed the Learning through Participation framework which includes experiential learning, work-integrated learning and cooperative education. This framework introduces many benefits to students, such as employability, ability to integrate theory in the real work, students' motivation and eagerness to learn more with a possibility of having a career in the area.

Based on the General Model of Student Learning by Biggs (1978) and The Inquiry Based Learning Model by Dunbar, a synthesized Learning Framework has been developed by the teaching team for the Diploma in FI course as shown in Figure 1. The teaching team also leveraged on the belief that learning takes place through participation (Mackaway, 2011), and designed the learning experiences within the framework to be engaging and participative.

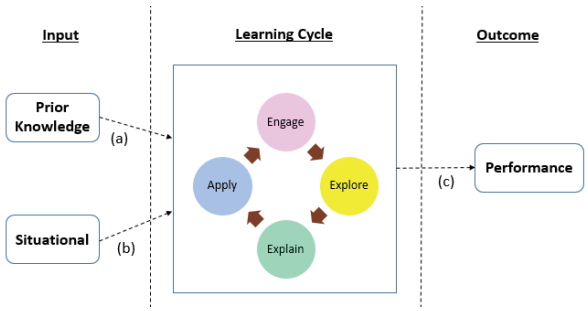


Figure 1: A Learning Framework from Literatures

This Learning Framework consists of two preceding inputs that can influence the students' learning journey (a, b) and an outcome (c) to be achieved. To provide students with an enriching and effective learning experience, the learning cycle will be based on Dunbar's Inquiry Based Learning model. The outcome of this framework is performance.

Application of the Learning Framework

This Learning Framework (in Figure 1) is applied into the Diploma in FI course at Ngee Ann Polytechnic. This course aims to train future IT-savvy techno-strategists who have an understanding of the technologies and information and are able to design, integrate and manage business processes and applications. The learning of business processes is part of the curriculum in their diploma as graduates need to understand existing business processes of an organization and apply IT knowledge to help organizations be efficient and effective.

By infusing the learning of business processes into the Learning Framework from Figure 1, a new framework for the learning of business processes is developed. The Learning Framework for Business Processes is shown in Figure 2.

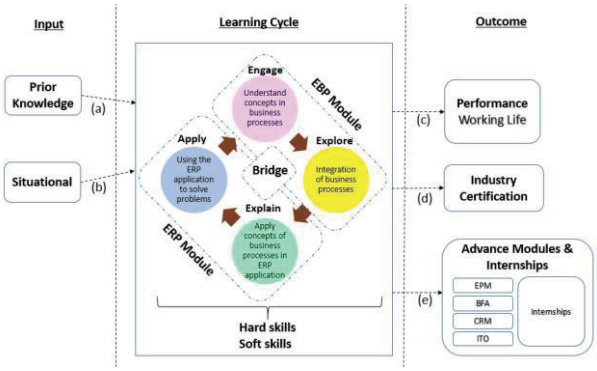


Figure 2: The Learning Framework for Business Processes

Input: Prior Knowledge

Many students at the Diploma level do not have much industry experience. Their knowledge on business processes is often based on their past experiences in part time jobs. These are typically short-termed vacation jobs and students are not likely to have developed a strong understanding of how activities within an organization are integrated with each other. This implies that students have little prior knowledge (a) in the Learning Framework for Business Processes from Figure 2.

Input: Situational

The classes which the students are enrolled in are compulsory and the usual method of delivery is discussion based. Students are often asked to get together in teams to discuss on possible solutions to solve problems. The difficulty level of the subject matter varies from student to student, but the amount of time given to each student to complete their Diploma is also predetermined. This forms the situational input (b) of the Learning Framework for Business Processes in Figure 2.

Learning Cycle

The learning of business processes for the Diploma in FI course is covered in two modules – **Enterprise Business Processes (EBP)** and **Enterprise Resource Planning (ERP)**. These are second year modules in the course. The curriculum aims to provide students with an understanding of the complexity of business processes, expose them to an enterprise level application through hands on experiences and training them in the soft skills that employers are looking for.

In the EBP module, the focus will be on key knowledge in business process to answer the question of ***why*** business processes are used in organizations while the ERP module will focus on ***how*** concepts in business

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processes can be applied onto an application to help businesses solve problems and gain competitive advantages. These modules are taken in a sequential manner.

Learning Cycle: Engage & Explore in EBP

The first two stages of the learning cycle will be covered in the EBP module. Students are ***Engaged*** in the subject matter via in-class activities and hands on exercises where they will be able to acquire basic concepts of the different processes in organizations. Topics covered in this module include an Introduction to Enterprise Business Processes and processes ranging from Fulfillment to Financial Accounting. Students will get to learn about the activities in each process and how these activities are associated with the roles and responsibilities of individuals in an organization.

The second part of the EBP module will attempt to illustrate the integration of business processes via the use of a simulation game in an assignment. Students will get a chance to ***Explore*** these concepts and put their knowledge into practice through a simulation game. Not only will the students experience delays and lead time, they will have to work as a team to make worthy decisions so that their team can win the game.

Learning Cycle: Engage & Explore using ERP Simulation Game

The ERP Simulation Game (ERPSim) is an innovative approach to teach business concepts on the SAP application. This simulation game is an anchor activity for the EBP module that allows students to explore theoretical concepts learnt using practical and realistic scenarios. This software is developed by ERPSim Lab at HEC Montreal as detailed in Léger (2011). The software is made available to institutes of higher learning as part of the SAP University Alliance Program. The simulation game mimics a business environment of an organization in which business activities operates.

Students operate a simulated real life business operations on the application, each taking up different roles. The application simulates a make-to-stock manufacturing supply chain where buyers and sellers' market responds and behaves just as it would in the real world setting in every quarter. The team will have to operate the full business cycle: plan procurement, production and fulfillment to experience the value of up and down stream information flows. Figure 3 shows the decision making process by students during the ERPSim Game. Students are required to document the entire process as part of their submission for the assignment in the EBP module.



Figure 3: Decision making process during ERPSim Game

Learning Cycle: Explain & Apply in ERP

In the next module ERP, students will get to ***Explain*** how these concepts learnt in EBP can be applied to an industry standard application, SAP. Students have to complete hands on SAP exercises that are created to guide students in their application of business processes knowledge in SAP. At the end of these exercises, students should have developed sufficient confidence to operate the SAP application and have the ability to analyze and explain the results.

The final stage of the learning framework is to consolidate their knowledge in business process and ***Apply*** them into an integrated assignment on the SAP application. This assignment will also involve solving an industry problem individually.

Learning Cycle: Explain & Apply using an Integrated Assignment

To conclude their Learning Framework for Business Processes experience, the students are asked to ***Apply*** their knowledge into an integrated assignment. This cornerstone project will require students to use the business process concepts acquired in the EBP module and apply them into the use of the SAP application at the end of the ERP module to sum up the entire learning journey. The assignment is designed for students to work both in groups and individually on the SAP application. They are required to work on complex business scenarios and demonstrate how the SAP application can be applied in these scenarios. The assignment covers end-to-end topics from fulfilment to management accounting.

To test the students' ability to handle problem solving skills, each student is given a set of business problems to solve, using the SAP application. Students are given a week to solve these problems before making a presentation to their class. They are required to present their analysis of the problems, their solutions and a demonstration on the SAP application to solve these problems.

Students complete their final assignment by applying knowledge acquired through the Learning Framework for Business Processes. This assignment requires students to utilize some of the important skill sets that will benefit them.

Outcome: Performance

The outcomes of the learning of business processes can be seen in the areas of content knowledge and skills and the development of industry-ready professional skills.

The first outcome (c) (in Figure 2), which the Learning Framework for Business Processes intends to achieve is for graduating students to be able to apply what they have learnt into their jobs. Students had indicated that the training on business processes they had received during their course of study had allowed them to be more confident in using other enterprise applications. Students who had graduated from the diploma had given feedback that the training they received in school in the two modules had helped them secured job placements.

Outcome: Industry Certifications

Another outcome (d) (in Figure 2) of the Learning Framework for Business Processes is the number of students who can qualify for certification such as the SAP TERP10 (Training Enterprise Resource Planning in 10-Day) certification, which is typically taken by working professionals with a few years of working experiences. . Students who have done well in both the EBP and ERP modules are encouraged to take up the certification. This certification is administered by an industry partner and thus is not a requirement of the Diploma course. The teaching team do see an increased in the number of students who are interested in this certification.

Outcome: Advance Modules & Internships

The knowledge acquired by students can be applied to advanced modules subsequently or concurrently in their course. The third outcome (e) (in Figure 2) of this method of learning is that students are able to develop professional skills that would be useful when they take on industry projects for their internships.

Internship is a compulsory module for all graduating students. These professional skills are also "soft skills" which employers are looking for. Some of the key soft skills develop are the ability to integrate the knowledge of business process concepts, analyze data that are available to make decisions, working in groups to ensure a cohesive integration of ideas within the group through effective communication, ability to process multiple tasks under time constraint and troubleshooting skills. This will deepen their ability in systems thinking among many others to make them more confident learners. Being trained to be industry-ready allows students to take on real work projects easily.

The knowledge acquired in the learning of business processes will increase the confidence level of students moving on to more advanced modules, to work on other enterprise level applications in modules such as Enterprise Project Management (EPM), Banking and Financial Applications (BFA), Customer Relationship Management (CRM), IT Outsourcing (ITO) etc. Students have commented that the learning of the modules is difficult but it builds up their foundation for subsequent modules – "*SAP is a very complex system, learning SAP before taking other modules that use different software allows me to pick up the modules so much quicker.*" "*SAP enables us to familiarize with business applications. We can now easily pick up other system like the Salesforce.*"

Resources to support the Learning Framework: Teaching Tools and Facilities

To ensure continuity of the Learning Framework for Business Processes between the modules, the teaching team needs to ensure strong alignment between the two modules so that reference can be made easier between them. Factors that support the Learning Framework include :

- Create synergies among the teaching team members
- Use of the same teaching materials that are aligned to industry for the real-world reference
- Make purposeful use of teaching spaces for engagement

Synery among the teaching team members

The teaching of the two modules under one Learning Framework requires much alignment between the teaching team members, and in this case, the teaching team for both modules are the same. This will ensure that teaching team members have a very clear understanding of the obejctives of each module, teach concepts to different depths of understanding required by each module, ensure consistency in the terminology used, and are able to make reference to prior knowledge learnt in EBP during the ERP module. The synergy between the teaching team members and the modules plays an important role in the learning of the students.

Use of the same teaching materials that is aligned to industry for the real-world references

The teaching materials adopted for both the EBP and ERP modules are aligned with industry standards and requirements. For example, SAP which is the market leader in enterprise software and software-related services, is used in the teaching of business processes. The teaching team has also adopted materials from the SAP University Alliance Program as part of SAP experience which provides students with in-depth, hands on experience with the SAP application and solutions through peer hosting centers. Besides this, the SAP University Alliance Program provides an ecosystem for lecturers and tutors from participating institutions to share and exchange knowledge in teaching pedagogy specific to the use of the SAP application.

In order to complete the activities from the SAP University Alliance Program, students will not only need to apply business process knowledge acquired, but also the logic and flow of activities predefined in the SAP application. Activities designed include hands on exercises on the SAP application and the mapping of business processes. This SAP experience provides students with a much needed industry experience and will help their professional skills for their future work in the industry. Figure 4 shows examples of the teaching

material developed by the teaching team, which are adapted from the SAP University Alliance Program.

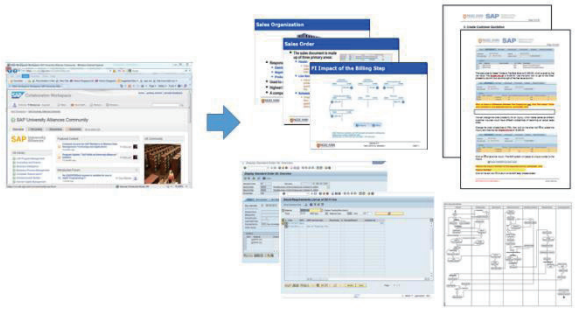


Figure 4: Examples of teaching materials adapted from the SAP University Alliance Program

Purposeful use of teaching spaces for engagement

The traditional classroom is designed for teacher-centered learning, which is not designed to facilitate participation from students. The traditional classroom, which typically has a fixed projector with screen and a fixed whiteboard, limits the type of engagement students can have. In order to allow for a more engaging learning experience, students must be able to tap on their prior knowledge easily, to be able to view multiple representations of their information and to be able to receive timely feedback for learning. To do so, the physical learning space must be designed for this interaction to take place.

In the Learning Framework for Business Processes, the teaching team designed the "Financial Informatics Lab" (as shown in Figure 5) to create more "learning spaces" for students to engage and participate in the learning process. In this lab, three projection screens with three separate projectors are installed. Together with a larger size whiteboard, students are able to review materials from three different sources separately at the same time. The advantage of such a setup is that it makes it easier for students to refer to notes that were covered earlier and to build on this prior knowledge with a new set of knowledge. Tutors do not need to toggle between screens which can be distracting for the students. This setup also allows for up to three sets of answers to be shared among the students. Students get the present their findings and solutions with feedback from peers and tutors received immediately. Students also get to compare their answers against what their peers have come up with. This provides an avenue for active learning.



Figure 5: The Financial Informatics Lab setup for the Learning of Business Processes

Effectiveness of Learning Framework

In order to have a better understanding of the impact of the Learning Framework for Business Processes for the students, surveys are conducted at the end of each module to find out if the intended outcome of the Learning Framework in the development of industry relevant knowledge and professional skills are achieved. The first survey is done online after the students complete their EBP module, which involved the use of the ERPSim Game, where the focus is on "Engage and Explore". The results of the 2013 survey show that:

- 89% of the students indicated that ERPSim Game makes the class more interesting.
- 91% of the students indicated that ERPSim Game allows them to experience collaboration with team members.
- 82% of the students indicated that ERPSim Game provides an experience of real world integration of processes across different functions in an organization.
- 79% of the students indicated that through the use of ERPSim Game, it has aroused their interest to learn more about business processes.

The survey also asks the students to rate their understanding of business process concepts learnt before and after the simulation game. In the 2013 survey, 80% of the students felt more confident about business processes after ERPSim as compared to 6% before the game.

A second survey is conducted with the same group of students after they complete the Enterprise Resource Planning (ERP) module where the students are expected to be able to demonstrate their learning in all four areas of Engage, Explore, Explain and Apply. The result of the 2013 survey show the following:

- All students indicate that the Learning Framework to break up the focus in EBP and ERP is useful.
- All students agreed that the Integrated Assignment has allowed them to consolidate what they have learnt in EBP and ERP.
- 90% of the students agree that the problem solving approach taken is challenging and fun.

Students also commented that the Learning Framework for Business Processes allowed for them to be more engaged in the learning even though the learning process was difficult - "*The experience was a memorable one. Although the assignment was the toughest that I had*

ever experience, it has shape me to take on greater challenge. Furthermore, it was the assignment which really put our knowledge to the test and taught us about time management. It was a memorable and challenging experience, especially for the ERP assignment. ERP assignment was extremely hectic, because it was very challenging."

95% of the students surveyed agree the knowledge acquired through the Learning Framework for Business Processes has made it easier for them to pick up new tools (e.g. Salesforce.com) in more advanced modules during their course of study or during internships on this.

In addition to the positive feedback from students on the Learning Framework for Business Processes, students' performance had also shown improvements. One indicator of such improvement is the increased number of students who are qualified to be invited to take part SAP TERP10 (Training Enterprise Resource Planning in 10-Day) certification for which only students who do well in both of these modules are be invited to participate.

There has been positive feedback from tutors who have taught these modules that through the use of the Learning Framework for Business Processes, learning has been more structured and students are more well prepared for the industry. Feedback from industrial partners, who have taken these students for internships is also positive. Students exhibited good knowledge and understanding of processes and are able to value add to the job requirements. Some students are offered employment straight after their internship.

Conclusion

In conclusion, the development of the Learning Framework for Business Processes is an innovative approach used to create an authentic learning experiences for students that develops students in both hard content knowledge and skills as well as soft skills. Students get to learn about business processes through activities and simulation games which engage them with the content knowledge. Together with choice of suitable and appropriate teaching resources and material that are closely aligned to the industry, students who have undertaken these two modules are now more industry-ready than before.

This approach has been impactful to students as evidenced by the student comments & reflections. The teaching team has also received instances of positive feedback from tutors and industry partners.

Moving forward, the Learning Framework for Business Processes can also be applied to other subject areas which are of industry demand for students.

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FLIPPING THE ENGINEERING MATHEMATICS CLASSROOM

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Abstract

As technology becomes ubiquitous in our lives and information becomes readily available via channels other than the classroom, the practice of face-to-face (f2f) lectures becomes less relevant in educational settings. Educators are more aware of the deficiencies of such lectures and are trying to shift towards instructional strategies that will encourage student engagement and active learning. One of these strategies is the Flipped Classroom pedagogy. The essence of this pedagogy is to move direct instruction online and out of classroom, creating space to promote discourse and problem-solving in the classroom. In effect, it requires a rethink of when resources to support learners should be provided. In Singapore Polytechnic, the School of Mathematics and Science "flipped" an entire engineering mathematics module and piloted it on selected diploma courses. Lesson packages were developed and deployed via the polytechnic's learning management system. Each of these packages consisted of short online video lectures, lesson plan, in-class activities, class quiz and tutorial problem sets. Students are tasked to view pre-assigned online video lectures weekly before attending tutorial sessions. In the classroom, they checked their understanding through quizzes, discussed and collaborated on activities with their peers, and worked on the tutorial problems. For evaluation, data was collected in the forms of student surveys, student interviews, lecturer perceptions and assessment score analysis. The summative assessment scores did not consistently show significant differences between the "flipped" and the "non-flipped" groups. However there was a significant increase in mean scores of student perceptions of mathematics lessons that serve to measure student engagement and self-directed learning attitudes after 15 weeks of "flipping". Both student and lecturer interviews revealed that the new pedagogy is a welcomed change to how mathematics lessons are conducted. With the reasonably positive findings, the school intends to extend the pedagogy to more mathematics modules. Future directions of the project can include exploration of ways to effectively evaluate the pedagogy and sharing the experience to help other schools and institutions adopt this pedagogical model.

Keywords: *Flipped Classroom, Engineering Mathematics, Polytechnic, Student Engagement, Evaluation*

Introduction

The official definition of Flipped Learning is that it is a "pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides the students as they apply concepts and engage creatively with the subject matter." (Flipped Learning Network, 2014). It is believed that what goes on in a lecture or direct instruction usually involves cognitive processes that are lower in Bloom's Taxonomy such as Remembering and these are processes that students can handle on their own. The more challenging cognitive processes such as Applying and Evaluating should be done in the classroom, so that students can have access to resources and help in the forms of teacher and peer support (Honeycutt & Garett, 2013). The essence of the Flipped Classroom pedagogical model is a reconsideration of the provision of support to students when they need it most (Te@chthought, 2014).

In 2013, largely motivated by the need to better engage today's learners through the use of Edutech, MS submitted a proposal to "flip" an entire engineering mathematics module. It was decided to "flip" all 15 weeks of the module because it was believed by the team that students' learning habits take time to change and partial "flipping" and reverting to traditional mode midway will not provide sufficient allowance for that change. An engineering mathematics year 2 module was chosen because of the higher level of maturity of year 2 students. Mathematics is also a subject matter that is epistemologically suitable for this pedagogy. There are many procedures and techniques in mathematics that require progressive demonstration by the instructor and these demonstrations can be done via videos. Students often struggle in solving mathematics problems on their own and having the instructor around whilst they are doing so can be an effective reallocation of learning support. In fact, many mathematics educators have flipped their classes all over the world and there is vast experience for the project team to learn from.

In particular, the selected module contains content that is new to students and yet a large part of it is procedural and process-driven, characteristics which the team felt lent the module well to the new pedagogy.

For the pilot run, only the diploma courses DASE, DES and DEB will undergo the new pedagogy. These 3 courses were selected because they constituted a comfortable student group size for the pilot. They are also relatively more motivated to try a new way of learning.

Developmental Phase

A project team comprising of 6 lecturers was then established. The team first redrafted the teaching schedule from the existing one and demarcated 12 weeks of lesson packages to be developed. Each member had to develop between 1 to 3 packages each consisting of 4 to 8 video lectures, detailed lesson plan, class quiz, tutorial problem set, in-class activities and even teaching aids or props. The assessment scheme was also modified as seen in the Table 1 below.

Table 1 : Assessment Scheme of Non-Flipped Classroom and Flipped Classroom Modes

Assessment Components	**Non-Flipped Classroom**	**Flipped Classroom**
Test	25%	25%
Exam	50%	50%
E-learning Quiz	3%	3%
Participation Mark	5%	10% (for tutorial solving and for participation in group activities)
Assignment	7%	N.A.
Online Quiz	5%+5%	N.A.
Weekly Class Quizzes	N.A.	12%

The weekly class quizzes as well as the participation mark were meant as extrinsic motivation to encourage students to complete the pre-class learning activities i.e. the video lecture watching and to participate actively in class subsequently. At the same time, the class quizzes were intended to provide formative feedback to the students and the lecturer on the level of understanding of the learners after watching the video lectures. The outcomes of these quizzes provide information to the lecturer on how they should adjust their subsequent teaching strategies in order to enhance students' strengths or bridge their learning gaps (Hattie, 2012). The provision of such timely and appropriate feedback is a powerful tool to enhance learning, with an effect size of 0.75 (Hattie, 2012).

The in-class activities were included to get students to practise their teamwork and communication skills as well as to provide students insight to how mathematics is applied in real life and to encourage them to construct their knowledge of the formulae and theorems introduced. It was a challenging task crafting these activities as they had to be scoped to fit into the class hours and at the same time to remain relevant to the mathematics content and the diploma domain knowledge.

Video lectures were developed for every week's lessons. The developer would decide what content is cognitively simple enough for novices to learn on their own and what is too challenging and needs to be resolved in class. The former would be included in the video lectures that were recorded using the Camtasia software whilst the latter were brought back to class as problems or activities to be solved with peers and teacher. Video lectures were intentionally chunked to 10 to 15 minute blocks with MCQ quizzes embedded. These quizzes served to promote self-assessment as students could assess own understanding as they progressed. If they realized that they had not fully grasped the concepts introduced, they could take remedial actions such as re-watching the particular segment or seek help from peers or lecturer. The ability to assess their own work and understanding has been found to lead to students taking greater responsibility of their learning and thus moving towards cultivating a sense of intrinsic motivation and personal control (Barron et al., 2008).

After the lesson packages were developed, the next challenge was to find a suitable way to disseminate them to students (videos) and lecturers (lesson materials). After going through a process of evaluation, the team decided that the best platform will be the existing institutional learning management system BlackBoard (BB) site with video lectures uploaded via the module content area.

Implementation Phase

When term started, students were told that all f2f lectures will be replaced by video lectures that they could access via BB site. They were also informed about the class quizzes that would precede the tutorial sessions and the repercussions of not viewing the video lectures before attending class.

When students returned to class for tutorial lessons, they were administered a weekly quiz to be completed within 15 minutes. Each quiz assessed materials that had been presented in the video lectures. Course notes were also checked for annotations as those were indications that students had viewed the video lectures. Thereafter, students had to solve assigned tutorial problem sets and collaborated to work on group activities. The role of the lecturer became one of a facilitator, in which he or she will provide guidance, scaffolding and clarify doubts. Feedback from students led the teaching team to set up 1-hour consultation slots during which students could access a lecturer teaching the module to answer questions from the video lectures. The above described went on for all 12 teaching weeks.

Various forms of feedback were gathered from students and lecturers to refine and improve the Flipped Classroom model before it was implemented again in the second semester.

Evaluation Phase

As Flipped Classroom is a major shift in pedagogical approach, it is vital that data is collected and analyzed to ensure learning outcomes were not negatively impacted upon.

The evaluation process was carried out by

1. Statistically compare the MST and Exam scores of the Flipped groups and the comparable Traditional groups
2. Surveying students on their perceptions of the mathematics lessons conducted
3. Surveying students on how the engagement levels and self-directed learning attitudes have changed before and after 15 weeks of Flipped Classroom model
4. Interviewing selected students and lecturers

Statistical comparison of MST and Exam scores

A comparison group comprising students who did not go through the Flipped Classroom model was selected based on their grades in a prior mathematics module. Chi-square test was first used to check that the comparison group had similar mathematics ability as the treatment (flipped classroom) group. Below in Table 2 are the outcomes of the analysis.

Table 2: Comparison of test and examination scores

Sem	Assessment	Mean of Flipped Classes	Mean of Non Flipped Classes	Conclusions
1	Test	80.8	73.9	Flipped was significantly higher (p-value = 1%)
	Exam	69.6	62.2	Flipped was significantly higher (p-value = 0.5%)
2	Test	72.3	72.7	No sig difference
	Exam	71.8	70.0	No sig difference

As can be seen from the table above, the "flipped" groups performed on par as the "non-flipped" groups and even outperformed them in semester 1.

Surveying students on their perceptions of Flipped Classroom model

Students were also surveyed on their perceptions of the Flipped Classroom model. They were asked 5 free-response questions.

- What were your feelings about how the mathematics module was run?
- To you what were the main advantages of how the mathematics module was run?
- To you what were the main disadvantages or difficulties in the way the mathematics module was run?
- How could we improve on how the mathematics module was run?
- Did you use the video lectures to revise for MST or exam?

In semester 1, 80% of the students spoke positively of the Flipped Classroom experience. The remaining 20% either did not like the experience or were neutral about it. In semester 2, 80% of the students spoke positively whereas 2% of them did not like it. The remaining 18% were neutral about it or made comments about the lecturers rather than about the module experience.

Students made positive comments such as "good", "fun", "awesome", "excited to learn", "organised and structured" and "engaging". They liked that the videos could be replayed, that they could work at their own pace and preferred time, and that the lessons were well organized and efficient. They had opportunities to clear their doubts in class. However, there was also feedback that they were unable to clarify their doubts while watching the video lectures as there was no lecturer available then. This is despite the teaching team allocating 1-hour consultation slots for them to do so. A check with the teaching team revealed that no student had approached any lecturer during that consultation time.

Generally, the model was well-received by the students.

Surveying students on change in engagement levels and self-directed learning attitudes

Since one of the aims of the Flipped Classroom was to inculcate self-directed learning attitude in students and to better engage them in the mathematics classroom, a self-reporting survey was administered before and after the 15 weeks of "flipped" lessons to measure if there has been any changes in both items. Students had to rate on a Likert scale of 1 to 5, their agreement on 20 statements that aim to measure both engagement and self-directed learning attitude. The same survey was also administered to students who underwent the traditional mode in 2014/2015 Semester 2 to assess if there are any differences between the 2 groups. The results are seen in Tables 3 and 4 below.

Table 3: Pre and Post Survey Scores for Flipped groups

Statement	**Flipped Classroom 2014/2015 Sem 1**		**Flipped Classroom 2014/2015 Sem 2**	
	Pre	Post	Pre	Post
1. I look forward to attending math class	3.70	4.28	3.60	4.27*
2. I get to learn a lot in math class	3.69	4.35	3.76	4.30*
3. I can relate the mathematics that I learnt to real world situations	3.07	3.61	2.96	3.47*
4. I work hard during math class	3.94	4.29	3.67	4.04*
5. I ask questions and answer questions during math class	3.69	4.18	3.36	3.89*
6. I work with other students to solve assigned tasks during math class	3.77	4.32	3.68	4.28*
7. I am focused on my tasks during math class	3.90	4.22	3.73	4.07*
8. I enjoy the tasks and activities during math class	3.52	4.13	3.52	4.17*
9. If I am assigned work to do before turning up for math class, I will do the work	3.78	3.99	3.83	4.13*
10. I check my work while doing it	3.81	3.95	3.70	3.98*
11. I am aware of my own learning when doing mathematics tasks	3.70	4.11	3.85	4.07*
12. I seek help when in doubt	4.10	4.46	3.90	4.31*
13. I keep track of my performance in math	3.69	4.01	3.85	3.95
14. I am able to locate relevant resources to enhance learning	3.31	3.89	3.47	3.66
15. I know when I need to learn more about the topic	3.81	4.04	3.83	4.03
16. I analyze mistakes made in solving tutorial problems	3.72	4.24	3.85	4.10*
17. I review my learning after completing each topic	3.46	3.75	3.19	3.77*
18. I identify important concepts learnt in mathematics class	3.64	4.06	3.80	3.99*
19. I learn from feedback from others	3.68	4.02	3.64	3.98*
20. I am able to identify my own learning needs	3.86	4.14	3.80	4.11*

Table 4: Pre and Post Survey Scores for Non-Flipped groups

Statement	**Non-Flipped Classroom 2014/2015 Sem 2 (survey was only administered to non-flipped groups in semester 2)**	
	Pre	Post
1. I look forward to attending math class	3.60	3.84*
2. I get to learn a lot in math class	3.76	3.98*
3. I can relate the mathematics that I learnt to real world situations	3.09	3.45*
4. I work hard during math class	3.74	3.77
5. I ask questions and answer questions during math class	3.50	3.62
6. I work with other students to solve assigned tasks during math class	3.76	3.86
7. I am focused on my tasks during math class	3.79	3.79
8. I enjoy the tasks and activities during math class	3.51	3.65
9. If I am assigned work to do before turning up for math class, I will do the work	3.65	3.69

10. I check my work while doing it	3.72	3.83
11. I am aware of my own learning when doing mathematics tasks	3.77	3.90
12. I seek help when in doubt	3.94	4.06
13. I keep track of my performance in math	3.54	3.82*
14. I am able to locate relevant resources to enhance learning	3.37	3.74*
15. I know when I need to learn more about the topic	3.74	3.90
16. I analyze mistakes made in solving tutorial problems	3.70	3.91*
17. I review my learning after completing each topic	3.37	3.63*
18. I identify important concepts learnt in mathematics class	3.66	3.72
19. I learn from feedback from others	3.63	3.70
20. I am able to identify my own learning needs	3.78	3.77

Based on independent t-tests conducted on the average scores, amongst the students who had their mathematics lessons "flipped", there were significant increases from the beginning of the semester to the end of the semester in both semesters in almost all 20 statements (those that displayed significant increases are marked with asterisks). Students became more engaged in the lessons and were more self-driven in their learning. Comparatively, the classes that went through the traditional mode of instruction did not see as many significant improvements in their perceptions of mathematics lessons at the end of the semester (those that displayed significant increases are marked with asterisks).

Student and lecturer interviews

A set of interview questions were designed for this purpose. Students were selected for semi-structured interviews in order to gain more qualitative insights.

All the students interviewed spoke positively of the Flipped Classroom experience. Most of them liked the fact that they were able to learn at their own pace and time and could clarify doubts in f2f tutorial lessons. They commented that in large group lectures, they would often lose focus or lose track of what the lecturer was saying and would be too shy to ask questions thereafter. With videos, however, they could rewind and pause and forward, according to their abilities. As they watched the video lectures, there were times when they wished they had someone to ask questions to when they could not understand certain concepts. They would then rewind and re-watch and very often could figure out themselves eventually. This is in fact a powerful metacognitive ability that the Flipped Classroom model hopes to instill in learners. The students were also appreciative of the fact that the easier content was delivered via video lectures while the tougher parts were taught in class. Most liked the self-assessment component via the embedded quizzes in the videos.

The class activities were a welcoming change to the take-home assignments as the activities were guided and completed in class whereas take-home assignments were to be done during outside class hours and were often not guided. However, a few interviewees felt the activities did not make a difference to their learning as they were not being tested in tests or examinations. These interviewees commented that instead of conducting activities, tutorial sessions can be shortened and the focus should be on tutorial problem solving, as these will definitely be assessed. An interesting point to note is that such interviewees tend to be the better students, and also tend to be more assessment-driven.

Students had the view that technical subjects such as mathematics and digital electronics could benefit from such a pedagogical approach but would not want for all modules to be "flipped". They elaborated that workload will become too heavy if they have to watch video lectures for all modules in a semester. They also feel that some subject matter may not be suitable for "flipping" as they tend to be more "open-ended". The interviews also uncovered interesting variations of how students approached video lecture viewing as part of the pre-class activity. Some would diligently watch the videos a few days before lesson time and would watch a few times until there is full comprehension. Most would only watch one day before class time. Some watched the entire set of videos from start to finish while others will only view the solutions of the examples. This variation speaks of the ability of the video lectures in meeting the diverse learning capabilities of our students, something which f2f lectures will not be able to afford.

Lecturers teaching the module were also asked their perceptions of the new way of conducting the mathematics lessons. This is what lecturer X had to say.

"*Students are able to take charge of their individual learning pace ..promotes learner independence and accountability. In the f2f lessons, students are able to practise what they have learnt from the video lectures and the peer interaction in classroom activities definitely value-adds to each individual in their experience in solving tutorial questions.*

I am able to focus and spend more time on students with slower learning curves."

Lecturer Y noticed that there was greater interaction between students and teacher and that he was better able to identify and respond to the learning needs of his students. He elaborated that

"*there is better student engagement as class activities were conducted which deepen/pique the students' interest in the topics. By putting lectures online, it enables students to pace their own learning. The onus is now on students to acquire their own learning and self-direct their learning needs while we become the coaches/facilitators*".

And finally lecturer Z admitted that she started off feeling apprehensive about the new pedagogy and students did not take to it well in the beginning. However, she went on to say that

"*..as time goes by, the weaker students appeared to cope well with this mode of learning and grew confident enough to teach the more capable peers.. the students also grew to like this mode of learning as it is more efficient and flexible…I realise that this mode of learning empowers students to take ownership of their own learning."*

Refinement process

The team continued to refine the lesson packages throughout the year. Videos that were unclear were re-recorded. Activities that needed more scaffolding were redesigned. Quizzes that were too difficult for content presented on videos were simplified. Lesson plans were tweaked to better engage students and manage the time. Feedback forms and a whatsapp chat group were set up to gather feedback from the teaching team and to allow sharing of classroom experiences.

Challenges

Along the way, the team was presented with many challenges. Initially, students did not adapt well to the new way of learning mathematics and at week 1, only 50% of the students had watched the video lectures. Even at week 3, some students were still watching the wrong videos, despite numerous reminders from the lecturers. Despite all these, the lecturers persevered and things improved after the first term.

There were also issues with timetabling requirements. The first lecture had to be timetabled before tutorial sessions as the students had to be briefed about the video lectures before they could watch them and prepare for tutorials. This requirement was difficult to fulfill especially with many other timetabling constraints presented to the affected academic schools. It took some negotiation and compromise before the issues could be resolved. However, when the Flipped Classroom model gets fully rolled out to the entire module next academic year, this requirement can no longer be met. The teaching team will need to find ways to work around it.

There was also skepticism amongst other lecturers whether this new approach will be detrimental to students' learning. Some were concerned that unmotivated students will suffer from this mode of learning mathematics as they will almost never be prepared (by watching video lectures) for tutorial sessions. The team conducted numerous sharing sessions and answered many queries, mostly based on experience gained from teaching the flipped classes, to allay these concerns. It is hoped that from all the sharing of experience, other lecturers will come to adapt to the model and take the step to try it out themselves. In addition, the model adopted by MS had many structures put in place to ensure the large majority of students will be sufficiently motivated to view the videos (weekly quizzes, marks awarded for note annotations, class participation mark, communication channels with students). However, as with any pedagogy, there will always be some students who will not do anything for school. That fact is equally applicable to Flipped Classroom.

Conclusions and Future Plans

Motivated by the reasonably good pilot results and as Singapore Polytechnic heads towards greater use of Edutech in its teaching and learning, this project, in which only one module is "flipped", has evolved into a 3-year roadmap that lays out the plans of MS to flip a large number of its core engineering mathematics modules. Two other development teams are currently developing lesson packages for another 2 modules. By the end of the 3-year journey, the school targets that a good proportion of students who read MS modules would have benefitted from the Flipped Classroom experience. Going forward, the team hopes to not only design the flipped classroom model for MS modules, but also share its experience in doing so with other schools.

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THE NIT NAGANO COLLEGE INTERNSHIP-ABROAD PROGRAM

— A Case Study —

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Abstract

From 2014, the National Institute of Technology (NIT), Nagano College began offering an internship-abroad program to the advanced course students. Six students, three sent to Thailand and three to Taiwan, interned at local Japanese-affiliated factories for about three months. Although the entire project required more than six months for planning and implementation, it was a worthwhile internship experience for the students. This program was made possible with support from companies and universities in the hosting countries, and also that of a Japanese university among others. Student scholarships were provided by the Japan Student Services Organization (JASSO).

Every year, NIT-Nagano sends fourth-year students on very short one or two week exchanges to foreign countries. It is a valuable experience because students encounter many unexpected happenings in totally different cultures, and must overcome problems with the explicit or implicit support and guidance of their foreign hosts. The experience surely gives them a level of self-confidence which would be impossible to gain within Japan. However, as we often see in the newspapers these days, many Japanese students are reluctant to participate in such international programs. Only after they have had such an experience do they realize just how precious it was.

The college intends to continue providing students international exchange and internship opportunities in order to raise their global awareness and to inspire them to develop long-term relationships with foreign people throughout their careers.

In this paper, we have outlined the steps which we believe are necessary to develop an international internship program, such as: building relationships with host organizations, arranging internships with appropriate companies, and finding safe and suitable housing. Visa procedures, crisis (emergency) response systems and funding are other issues to consider. At any rate, the long-term goals of the students must be given top priority throughout the developmental process.

Keywords: *internship, visa, insurance, financial support, culture*

1. Program Objectives

Although NIT Nagano College has had a fourteen week domestic internship program since founding the

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Advanced Course in 2003, 2014 was the first year to send students abroad for internships.

A Companion for the Internship states the objectives of the internship program as follows:

> "Long term internship outside campus is burdensome for both the students and the companies. It is especially so for the students since the living conditions as well as relationships with people around them are quite different from those to which they are accustomed. However, (the college believes) it is an invaluable learning experience, which cannot be replicated within the campus. The students have opportunities to develop and brush up their engineering sense through such experiences among experienced engineers, and they have chances to grow emotionally and mentally."[1)]

Acting on one of the annual Advanced-Course educational improvements targets for 2014, the college promoted an internship-abroad program "in order to nurture the students' knowledge and ability in global communication." [2)] The target coincides with the NIT administrative policies emphasizing the education of highly competent global engineers.

2. Overview of the program

Table 1 provides an overview of the 2014 Internship abroad program at Nagano College.

Table 1. 2014 Internship Abroad Program at Nagano College

Total Days	Country	Internship at university	Duration	Number of students	Internship at factory
90	Taiwan	United University (9/1~9/30)	10/1 ~ 11/16	2	Taiwan Mimaki
				1	Taiwan Orion Industry
114	Thailand	Thai-Nichi Institute of Technology (9/8~9/29)	9/30~ 12/23	2	Ingress Automotive
				1	Nidec Copal Thailand

The two country programs had some similarities. First, students spent the first month at educational institutions with which Nagano College has exchange agreements, and then they spent their remaining time at Japanese-affiliated factories. Second, students in both country programs received scholarships from the Japan Student Services Organization (JASSO).

So, even though there was no earned income from the hosting companies, students had little or no financial burden for travel and accommodations. The Thai program was unique in that it required student visas, which were secured through the efforts of our Thai educational partner. This partner also provided students opportunities to explore the culture and environment.

3. Schedule of the program

Table 2 outlines the program schedule, including pre- and post-internship activities, especially those for the Thai program.

Table 2. Schedule of 2014 Program (in chronological order)

Month	Events	Remarks
5~7	Search for hosting companies	Via Nagaoka University of Technology
7	Prepare Passports and other documents	
8	Apply for student visas	Thai Embassy in Tokyo
	Prepare for the trip	Insurance, Reservation of flight, etc.
9	Visit hosting companies	Support by Nagaoka University of Technology, Thai-Nichi Institute of Technology
	Lease apartments for interns	
11	Extend visas	Support by Thai-Nichi Institute of Technology
12	Submit various documents	College requirement and others

A Nagano College professor visited students twice during the internship; once at the beginning of the program and then again after they moved to the factories.

4. Issues that need further consideration

4.1 Hosting companies

Finding hosting companies for any internship program is a big challenge because interns inevitably burden company staff who must both train and care for students and perform their regular duties. Fortunately, Nagaoka University of Technology provided great assistance and guidance in finding excellent Thai companies, and Nagano College's Industry-Academics Exchange member companies provided invaluable assistance in finding such Taiwanese hosts. At present, it may be easy to find willing Japanese affiliated companies or factories in some Asian countries; however, it is much more difficult to develop and maintain good relationships with these entities to ensure a continuation of the internship program.

4.2 Visas

Many Asian countries don't require special visas for Japanese interns who will stay three months or less, and receive no financial compensation. However, situations and conditions vary by government and internship program, so it is important to constantly monitor and confirm such conditions regularly. In the case of the Thai program, interns were required to apply for student visas and, fortunately, acquired them without any problems.

4.3 Accommodations

The cost of accommodations is one of the major financial burdens facing interns despite the fact that meals and other goods are relatively inexpensive compared to those items in Japan. This year, two interns in Thailand agreed to share an apartment in order to reduce their housing costs. Additionally, it is often quite difficult for students to read and understand contracts written in a foreign language, so it is critical that they receive assistance from the people in the host country.

4.4 Living environments

Finding a safe and comfortable living environment is an important objective for any person who wishes to stay in a foreign country. It is especially important for Japanese students who grow up in relatively safe and sheltered environments.

4.5 Budget and Financial support (JASSO scholarship)

As mentioned before, the costs of round-trip flights to the host country and living expenses should always be considered from the planning stage. Of course, it costs money for domestic internships, but living in a foreign country requires additional funds for unexpected living expenses. As such, it is desirable for students to have internships in countries where the costs of living are relatively cheaper than those in Japan. Pairing two interns together is highly recommended to save money on accommodations and transportation and also to increase the level of safety.

4.6 Health care

There is little disagreement to the assertion that an educational institution must give its highest priority to students' health and safety. In fact, at the beginning of the program, our college established a safety net which included broad travel insurance coverage for the college and the students, and which also designated first and second emergency contact persons. Although the insurance premiums were rather expensive (¥70,000 per student and ¥21,000 for the college for four months in Thailand), we gladly paid them given the importance of the program.

Thanks to the insurance, a student in Thailand, who was suffering from a chronic illness, was able to visit a doctor several times, which probably allowed him to continue his internship. Another student was treated for minor injuries he had sustained during his job in a workshop. Without insurance coverage, these students would have been forced to pay expensive medical bills. It is important to understand that getting the right kind of insurance requires a lot of research into the specific types of work each intern will be asked to do. Any tasks considered even slightly dangerous can cause insurance premiums to increase dramatically.

4.7 Evaluation

During the internship program, students were asked to submit monthly reports via email. At the end of the program, each student was required to submit two final reports; one to their hosting company and the other to the college. We also asked the hosting companies to evaluate the students. Based on the feedback, the college made final assessments for the twelve-credit course, similar to the procedure used for the domestic internship program. This assessment system was adopted because of the prohibitively expensive prospect of assessing students at their overseas hosting companies.

4.8 Other issues

Thorough preparation for the internship is highly recommended because the more one prepares before going to a host country, the easier the cultural adjustment and the more fruitful the internship experience becomes. Such preparation of course, includes researching the host company, but also includes such things as learning about the host country's culture, religion, language, geography, and climate. Knowing about their hosts helps the student build respect for the culture of the host country, and smooths the way for their first contacts.

5. Students' reflections and opinions

* "I was bewildered a little at first by circumstances where Japanese is not understood; however, with much help from

the people there, I was able to have a valuable experience. I was able to learn a lot of things about the people and culture. I felt strongly that I needed to study English more because most of our communication was through English despite the fact that it is a foreign language for both interns and hosts."

* "We had a chance to have dinner with one of our college's graduates who is stationed there. We learned a lot about the difficulties and joys of working in a foreign country, which was a very good experience."

* "This experience lowered my apprehension about living in a foreign country, which I had thought was extremely high."

* "The first month I spent at a Thai university helped me very much to communicate with the Thai people. I was first able to communicate in English with Thai-Nichi university students. Then they taught me some useful Thai language. So the system was quite helpful for me."

* "This was my first experience living in a foreign country, which gave me daily stimuli. I believe doing this kind of internship, including all the preparation, is very valuable for us before we start working."

6. Evaluation of the program and prospects

Is the program worth continuing for the students as well as for the college? Yes, definitely, because all the six participating students expressed their excitement and satisfaction at having discovered a new level of self-confidence. Both the students and the college were able to achieve our respective objectives.

Of course there are many uncertainties, both for the students and for the college, but as we gain experience, it will be easier to anticipate challenges and to take necessary precautions.

It is desirable to have a professor or an officer stationed in the target country as an emergency first-contact person. Some universities already have such personnel in place in a number of countries and are energetically maintaining and even expanding long term internship programs. If the National Institute of Technology could appoint such persons in host countries, it could be quite beneficial to the entire NIT Colleges throughout Japan.

Finally, to insure the continuity of the new internship programs, it is important to constantly look for ways to eliminate any bureaucratic or financial barriers for all stakeholders

Acknowledgements

We would like to express our sincere gratitude to all the institutions which made this program possible: Nagaoka University of Technology, United University (Taiwan), Tai-Nichi Institute of Technology (Thailand), Taiwan Mimaki, Taiwan Orion Industry, Nidec Copal Thailand, Ingress Automotive Thailand, and the Japan Student Services Organization (JASSO).

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A PRACTICE OF DEEP LEARNING ABOUT MATHEMATICS USING KNOT THEORY

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Abstract

In this study, we have supplementary lessons and open classes with teaching assistants. Moreover we consider a practice of *high-level* active learning in which we use knot theory as a teaching material so that teaching assistants can also learn mathematics deeply.

The supplementary lessons, the first grade students joined had two courses, that is, basic and advanced one. The upper-class students who were highly motivated played a central role as teachers, on the other hand, we participated 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 by improvement of presentation skills and deepening understanding.

In the open classes held for junior high school students at Kurume College in 2013 and 2014, one of the authors explained an introduction to "*knot theory*" which is an important field in topology, and had the above upper-class students to be assistants. The results of the questionnaire distributed to the students told us that their polite instruction was highly evaluated.

In knot theory, it is important to consider whether a knot can be unknotted or not, and whether two knots are same or not. One of the authors focused on classifying three knots: a trivial knot, a trefoil knot and a figure eight knot by using the tricolorability, the number of p-colorings and the Goeritz invariant. Throughout the learning, the upper-class students obtained the deep learning about set and proposition, congruence and deformation of a matrix which are relevant to the above invariants.

In presentation of the above research, they announced that they studied the tricolorability, the number of p-colorings and the Goeritz invariant by themselves, and checked that these were knot invariants. Moreover they reported that they had succeeded in classifying a trefoil knot, a figure eight knot and a 6_1 knot using the number of p-colorings and the Goeritz invariant.

We mainly describe the effort of high-level active learning using knot theory in this paper.

Keywords: *Supplementary lesson, Open class, Knot theory, Active learning*

§1. Introduction

Active learning is defined in Collins (2003) as "The process of having students engage in some activity that forces them to reflect upon ideas and how they are using those ideas. Requiring students to regularly assess their own degree of understanding and skill at handling concepts or problems in a particular discipline. The attainment of knowledge by participating or contributing.The process of keeping students mentally, and often physically, active in their learning through activities that involve them in gathering information, thinking, and problem solving".

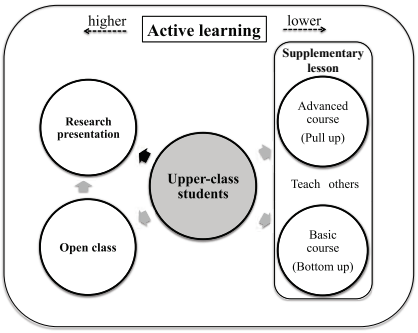
The main purpose of this work is to help our students acquire the skills for learning by themselves, unifying knowledge and giving presentation in the class. Moreover we had the upper-class students help us in *low-level* active learning: supplementary lessons and open classes so that they can connect experience to their research and presentation (see Figure 1).

Knot theory is an interesting field in Topology. It is easy for beginners to understand it since it is not necessary to know its background well and there are various teaching materials of knots in which they can learn visually (e.g., Kawauchi & Yanagimoto, 2012; Miyaji, Sakai & Nakabo, 2013). On the other hand, knot theory is associated with various fields, such as DNA in biology and QFT in physics, which correspond to the relevant feature. Therefore we think that knot theory is suitable for our students who study the technological field. In particular, we gave three research themes for

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three upper-class students respectively: tricolorability, the number of p-colorings (Lickorish, 1997) obtained by considering congruence modulo p and Goeritz invariant which is a non-negative integer sequence obtained by the deformation of the elementary row operation of integral square matrices. They can learn mathematics deeply because congruence and matrices are the learning contents which they understand in the ordinary classes and in the supplementary lessons.

This paper is composed of six parts. Section 1 is the introduction, which includes the background of the investigation. In Section 2, we introduce examples of knots and define knot invariant. In Section 3, 4 and 5, we define some knot invariants: tricolorability, number of p-colorings and Goeritz invariant, and introduce its calculation results which the upper-class students obtained. Finally in Section 6, we describe conclusion of this effort and the future challenges.



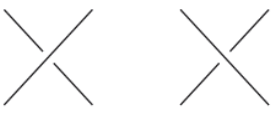
[Figure 1: Active learning]

§2. Knot and its invariant

First we define a knot and a knot diagram, and give some examples.

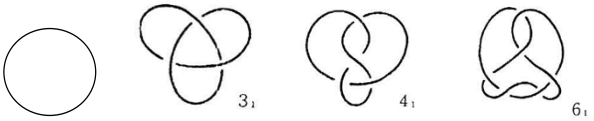
Definition 2.1. A *knot* is an embedding of a circle in 3-dimensional Euclidean space R^3.

Definition 2.2. Let us consider the projection of a knot onto a plane. A small change in the direction of projection will ensure that it is one-to-one except at the double points, called crossing. The projection which is distinguished between the over-strand and the under-strand at each crossing is called *knot diagram* (Figure 2).



[Figure 2: Knot diagram]

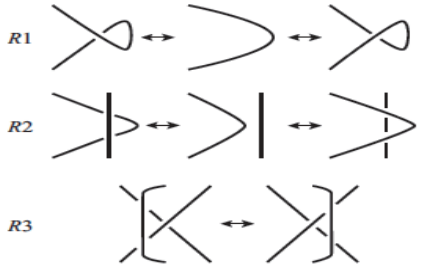
Example 2.3. Knot diagrams shown in the Figure 3 are called a trivial knot, a trefoil knot (or 3_1 knot), a figure eight knot (or 4_1 knot) and a 6_1 knot respectively.



[Figure 3: Example of knots]

Next we define some deformations of a knot diagram and a knot invariant, or a value which is independent of the deformations.

Definition 2.4. The following deformations R_1, R_2 and R_3 in the knot diagrams are called Reidemeister move.



[Figure 4: Reidemeister move]

If two knot diagrams can be moved each other by repeating Reidemeister moves finite times, they are defined to be the *same* knots. Moreover a value which is defined for each knot and is independent of Reidemeister moves is called *knot invariant*.

We define some knot invariants in Section 3, 4 and 5 to check whether a knot can be unknotted or not, and whether two knots are same or not.

§3. Tricolorability and its calculation results

The definition of tricolorability is given as follows:

Definition 3.1. A knot is *tricolorable* if each strand of the knot diagram can be colored one of three colors, subject to the following rules:

1. At least two colors must be used in the knot diagram, and
2. At each crossing, the three incident strands are either all the same color or all different colors.

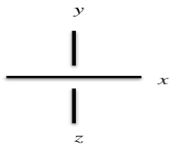
Then it is well known that the following statement holds.

Theorem 3.2. Tricolorability is independent of Reidemeister moves, i.e., it is a knot invariant.

Example 3.3. A trivial knot is not tricolorable because it has a knot diagram which does not satisfy the condition 1 in Definition 3.1.

Remark 3.4. (1) The converse of Theorem 3.2 does not hold because the figure eight knot is not tricolorable.
(2) Considering the contraposition of Example 3.3, we see that a knot is not unknotted if it is tricolorable.

Remark 3.5. We may denote three colors by three integers 1, 2 and 3. If each of x, y and z denotes one of the three integers, as in Figure 5, then the condition 2 in Definition 3.1 has an alternative description as $2x \equiv y + z \ (mod\ 3)$ by using congruence modulo 3.



[Figure 5: Crossing condition]

One of the upper-class students studied tricolorability and checked that it was a knot invariant. The calculation result about four knots given in Figure 3 is as follows:

[Table 1: Tricolorability of knots]

Knots	Tricolorability
Trivial knot	Not tricolorable
Trefoil knot	Tricolorable
Figure eight knot	Not tricolorable
6_1 knot	Not tricolorable

She obtained that the trefoil knot was unknotted using Remark 3.4 (2) and it was impossible to consider whether the figure eight knot and the 6_1 knot can be unknotted or not, and whether they are same or not using tricolorability because of Remark 3.4 (1).

§4. Number of *p*-colorings and its calculation results

Using the description in Remark 3.5, a generalization of tricolorability which is called *p*-colorability is given as follows:

Definition 4.1. A knot is *p-colorable* if each arc of the knot diagram can be labeled by the one of integers: 1, 2,…, p, subject to the following rules:

1. At least two integers must be used in the knot diagram, and
2. For each triple of integers $x, y, z \in \{0, 1, \cdots, p-1\}$ at a crossing as in Figure 5, they satisfy the condition: $2x \equiv y + z \ (mod\ p)$. (This condition is called *crossing condition* at the crossing.)

Next let us define a number which is obtained from Definition 4.1.

Definition 4.2. We say that a knot diagram is *p-colored* if each arc of the knot diagram is labeled by one of the numbers 1, 2, ⋯, p in such a way that at each crossing the labels satisfy the condition 2 in Definition 4.1. The number of *p*-colored knot diagrams for a knot K is called *the number of p-colorings of K*.

Theorem 4.3. The number of *p*-colorings is independent of Reidemeister moves, i.e., it is a knot invariant.

Example 4.4. The number of *p*-colorings of a trivial knot is *p*.

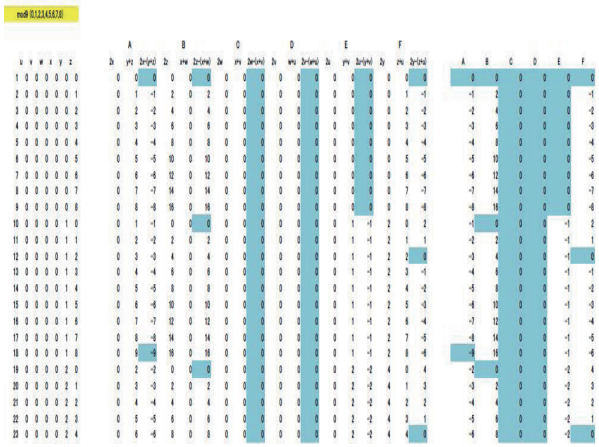
Remark 4.5. (1) The converse of Theorem 4.3 does not hold.

(2) Considering the contraposition of Example 4.3, we see that a knot is non-trivial if the number of *p*-colorings is not *p*.

Remark 4.6. If the crossing number of a knot diagram is n, then it needs to choose (x, y, z) which satisfies the crossing condition out of np^3 ways in order to calculate the number of *p*-coloring.

One of the upper-class students studied the number of *p*-colorings and checked that it was a knot invariant. Moreover she made a program so that (x, y, z) satisfied the crossing condition for each crossing using Excel software (see Table 2).

[Table 2: A part of crossing condition mod 9]



The calculation result about four knots given in Figure 3 is as follows:

[Table 3: Number of p-colorings of knots]

Knots	Number of p-colorings	p=2	p=3	p=4	p=5	p=9
Trivial knot		2	3	4	5	
Trefoil knot		2	9	4	5	27
Figure eight knot		2	3	4	25	
6_1 knot		2	9	4	5	81

She succeeded in classifying a trivial knot, a trefoil knot, a figure eight knot and a 6_1 knot from the above Table 2. In fact, she obtained the following results.

- A trefoil knot, a figure eight knot and a 6_1 knot are not unknotted by considering the number of 3-colorings, 5-colorings and 3-colorings respectively.
- A trefoil knot and a figure eight knot are not the same by considering the number of 3-colorings.
- A figure eight knot and a 6_1 knot are not the same by considering the number of 3-colorings.
- A trefoil knot and a 6_1 knot are not the same by considering the number of 9-colorings

Remark 4.6. These results mean that four knots as above are different.

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§5. Goeritz invariant and its calculation result

Let D be a diagram of a knot K. Then D devides a plane into finitely many domains $D_1, D_2, \ldots, D_n$, one of which is unbounded, say D_n. We classify these domains into two classes, black and white in such a way that no domains of the same color have edges in common. For convenience, we assume that D_n is a black domain. Now we define an index $\varepsilon = +1$ or -1 of a crossing point of D according to Figure 6.



[Figure 6: Index of crossing point]

Here, a shaded area indicates a black domain and the orientation of K is irrelevant. Let $\{W_1, W_2, \ldots, W_{m+1}\}$ be the set of all white domains. Using these white domains, we define an $(m+1)\times(m+1)$ integer symmetric matrix $A = (a_{ij})$, $1 \le i, j \le m+1$ as follws:

Definition 5.1.

$$a_{ij} = \begin{cases} \sum \epsilon & (\text{for } i \neq j) \\ -\sum_{j=1,\ i\neq j}^{m+1} a_{ij} & (\text{for } i = 1, 2, \cdots, m+1), \end{cases}$$

where the summation $\sum \varepsilon$ runs over all crossing points of D that are common to W_i and W_j. This matrix A is called Goeritz matrix of a knot K.

Let an irreducible Goeritz matrix A_1 be a minor matrix of A that results from A by removing an arbitrary row and an arbitrary column. Goeritz invariant of a knot is given by deforming the irreducible Goeritz matrix using the following transformations. Let M and N be two integral matrices.

Elementary transformations
(a) Interchange two rows (resp. two columns).
(b) Multiply a row (resp. a column) by -1.
(c) Add a row (resp. column) to another one multiplied by an integer.
(d) If we have $M = (1) \oplus N$ or $N = (1) \oplus M$, then change M (or N) to N (or M).

Definition 5.2. Using the above operation, any integral matrix, especially, the irreducible Goeritz matrix A_1 can be deformed into a unique diagonal integral matrix: $(k_1)\oplus(k_2)\oplus\cdots\oplus(k_d)$ which satisfies the following condition (i) and (ii). Then the non-negative integral sequence $(k_1, k_2, \cdots, k_d)$ is called Goeritz invariant of a knot K.

(i): If $d = 1$, then $k_1 \ge 0$.
(ii): If $d \ge 2$, then $k_i \ge 0$, $k_i \neq 1$ $(1 \le i \le d)$ and
$k_{i+1} = mk_i$ $(1 \le i \le d\text{-}1$; m: integer)

Example 5.3. Since a trivial knot is regarded as the following figure (Figure 7), we have its two Goeritz matrices (1) and $\begin{pmatrix} 1 & -1 \\ -1 & 1 \end{pmatrix}$. So the Goeritz invariant of a trivial knot is (1).



[Figure 7: Trivial knot]

Theorem 5.4. The Goeritz invariant is a knot invariant.

Remark 5.5. (1) It is well known that the converse of Theorem 5.4 does not hold.
(2) Considering the contraposition of the conclusion in Example 5.3, we see that a knot is non-trivial if the Goeritz invariant is not (1).

One of the upper-class students studied Goeritz invariant and checked that it was a knot invariant. The calculation result of Goeritz matrices and Goeritz invariant about four knots given in Figure 3 is as follows:

[Table 4: Goeritz invariant of knots]

Knots	Goeritz matrices	Goeritz invariant
Trivial knot	$\begin{pmatrix} 1 & -1 \\ -1 & 1 \end{pmatrix}$, (1)	(1)
Trefoil knot	$\begin{pmatrix} 3 & -3 \\ -3 & 3 \end{pmatrix}$, $\begin{pmatrix} 2 & -1 & -1 \\ -1 & 2 & -1 \\ -1 & -1 & 2 \end{pmatrix}$	(3)
Figure eight knot	$\begin{pmatrix} 3 & -2 & -1 \\ -2 & 3 & -1 \\ -1 & -1 & 2 \end{pmatrix}$, $\begin{pmatrix} -2 & 1 & 1 \\ 1 & -3 & 2 \\ 1 & 2 & -3 \end{pmatrix}$	(5)
6_1 knot	$\begin{pmatrix} 3 & -2 & 0 & 0 & -1 \\ -2 & 3 & -1 & 0 & 0 \\ 0 & -1 & 2 & -1 & 0 \\ 0 & 0 & -1 & 2 & -1 \\ -1 & 0 & 0 & -1 & 2 \end{pmatrix}$, $\begin{pmatrix} 5 & 1 & 4 \\ 1 & 2 & 1 \\ 4 & 1 & 5 \end{pmatrix}$	(9)

She succeeded in classifying a trivial knot, a trefoil knot, a figure eight knot and a 6_1 knot from the above table 3. In particular, she obtained that these four knots were different.

§6. Conclusion of this effort and a future subject

We had the following comments about our practice from the upper-class students.

- It was interesting that whether a knot can be unknotted or not using congruence.
- I made a calculation of congruence using Excel software, but it was tough because of its complexity. So I want to find an easier calculation method in the future.
- I could understand that various mathematical methods decided whether a knot can be unknotted or not without deforming knots by hand.

- I want to study knot theory and calculate various knots and links in the future.
- I was interested in knot theory because I found that it was relevant to DNA in biology.

Knot theory is one of the fields of current mathematics. Using teaching materials concerning knot theory, the authors tried to have students pay attention to relevance of the theory and be motivated to learn (Kawashima, Sakai & Tanaka, 2014). The trial of this time is aimed that students notice knot theory is closely related with various contents of mathematics and understand them deeply, paying attention to cautions and relevance.

The questionnaire showed good results. As is in the comment, we think that themes which are relevant to their field such as DNA in biology were well received.

Though the original guidance plan was to help students calculate knot invariants of a trefoil knot and a figure eight knot using the number of p-colorings and Goeritz invariant respectively, the upper-class students have studied knot theory enthusiastically, and at last they have succeeded in calculating more complicated knot; 6_1 knot. They presented these results at a symposium held in 2015. Their presentations were brief and to the point. In addition, they all got an extremely high score on the national mathematics test, the unified National Institute of Technology examinations for the third-year students. This means that they had a good grounding in mathematics through this trial including the supplementary lessons and an open class. From the above, this trial can be regarded as a positive one.

Now we introduce the following three teaching materials so that we can help students' research and presentation in the future. The first is classification of knots using the number of p-colorings. As mentioned in Section 4, a student calculated the number of coloring of various knots since she could make a program on Excel software. However this method is extremely complex according to her comment. On the other hand, it is possible to calculate them efficiently using elementary transformations of matrix. For example, if K is a trefoil knot, then the crossing condition about mod p is given as follows:

$$\begin{cases} x + y - 2z \equiv 0 \\ x - 2y + z \equiv 0 \\ -2x + y + z \equiv 0 \end{cases}$$

Using elementary transformations except multiplication of a column, we have the following deformation.

$$\begin{pmatrix} 1 & 1-2 \\ 1-2 & 1 \\ -2 & 1 & 1 \end{pmatrix} \sim \begin{pmatrix} 1 & 1- & 2 \\ 0 & -3 & 3 \\ 0 & 0 & 0 \end{pmatrix}$$

If $p \neq 3m$ $(m: natural\ number)$, then we have that

$$x \equiv y \equiv z\ (mod\ p).$$

So the number of p-coloring is p.

If $p = 3m$, then we have that

$$x + y - 2z \equiv 0\ (mod\ 3) \Leftrightarrow x \equiv 2y + 2z\ (mod\ 3).$$

So the number of 3-coloring is $3 \times 3 = 9$.

We may help students calculate the number of coloring of knots using this method.

The second is a classification of knots using the determinant of a Goeritz matrix. Since this method is not only a tool to classify a trefoil knot, a figure eight knot and a 6_1 knot but also suitable for an application of linear algebra (eigenvectors and eigenvalues, etc), it may be valuable for students who aim at engineers. Moreover, this teaching material is good for students to know the usefulness of matices easily since the invariant is simply calculated, compared with the other very effective knot invariants.

The third is "*L-S category*" (Cornea, Lupton, Operea & Tanre, 2003; Miyaji & Sakai, 2013) in homotopy theory. It is an invariant for various figures and can be understood relatively easily since we can learn it visually as knot theory, and need to have little preliminary knowledge on it. Then this theme would be interesting for students. For example, the L-S category of a torus and a Klein bottle are both two. There is a *fibrewise* version of the L-S category and it is known to have a possibly different value from the ordinary L-S category. As a simple example, a torus has the value two as its ordinary L-S category, but one as its fibrewise version (Cornea, Lupton, Operea & Tanre, 2003). Using the property of the fibrewise A_∞-structure, one of the authors gives that the fibrewise L-S category of the Klein bottle has the value two (Sakai, 2010). In addition, it is known that the fibrewise L-S category is related to "topological complexity", a field of research involved in the motion planning of robot arms (Iwase & Sakai, 2010).

Appendix

We had the following comments about the supplementary lessons from the first grade students.

- The upper-class students were very kind and helped my understanding during the lessons.
- The explanations by the upper-class students were easy to understand for me and I want to take lessons again.
- I found the lessons were 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.

These results clearly mean that the supplementary lessons were very useful to not only the upper-class students but also the first grade students. In addition, we obtain that the supplementary lessons by the upper-class students are more effective than ones by teachers (Kawashima, Sakai & Matsuda, 2014). We will describe the details of the supplementary lessons including the most recent study in some other time.

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MULTI-DISCIPLINARY TEACHING FOR PROTOTYPE DESIGN AND START-UPS: THE OULU APPLAB CASE

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Abstract

This paper summarizes the LAB studies program established at the Oulu University of Applied Sciences in Finland and specifically outlines outcomes from one of the recent LABs - APPLAB. The LAB model is based on pedagogical approaches such as self-regulated learning, problem-based learning, and entrepreneurship education. It is presented as an example of how innovative prototype design and business-university connections support multi-disciplinary teams of students and professionals to build prototypes and start-ups. One of the key features of this permanent pre-incubator program is that LAB studies bring together fully integrated multi-professional groups of students from diverse fields to work on prototype product design in a range of technology-related fields. Based on participant responses from pre- and post-program surveys, the APPLAB program supported participants' knowledge of and interest in entrepreneurship and skills development associated with start-ups. The success of APPLAB and other similar LAB programs is leading to the expansion of this type of studies within the university and supporting greater business and university collaboration in the Oulu region and internationally.

Keywords: *LAB model, pre-incubator, prototype design, start-ups, multi-disciplinary*

Introduction

The LAB studio model was established in 2012 at the Oulu University of Applied Sciences (OUAS) in Finland. This model was first put into practice as a program to support the training of new professionals for the gaming industry (Oulu Game LAB) (Heikkinen, 2014). APPLAB was a multi-disciplinary, post-secondary education program offered in 2015 with the target to develop skilled professionals, self-directive teams and product prototypes in the industry fields of health technology, energy and environment and automotive software. The 4-month APPLAB program was offered in Oulu, Finland between February and June 2015. In total, 39 ICT professionals entered the program as a re-training experience.

Overall, APPLAB and the LAB studio model of education can be described as a pre-incubator (Wirsing et al, 2002; Rajaniemi, Niinikoski & Kokko, 2005). Not unlike other pre-incubator models (Rajaniemi, Niinikoski & Kokko, 2005; Voisey, Jones & Thomas, 2013), APPLAB creates opportunities for university students to work on new product design that can lead directly to their ownership over the ideas and to the possible establishment of viable start-up businesses. And yet, one of the key distinguishing features of Oulu LAB studies is that the LAB model brings together fully integrated multi-professional groups of students and professionals from diverse fields to work on prototype product design from a range of fields including engineering, design, business and ICT.

Increasingly entrepreneurship is being taught at the higher education level (Potter, 2008). In relation to the teaching of entrepreneurship, it is suggested that the concepts of the reflective practitioner and self-regulated learning (SRL) can be used to describe an approach to learning that supports the development of entrepreneurial competencies. With respect to the reflective practitioner, Schön (1983) describes a process of reflective practice or *knowing- and reflecting-in-action.* This notion is a critical component of the LAB studio model since teaching and learning takes place through work on real world problems (Schön, 1985).

Self-regulated learning represents a key concept in connection to effective schooling as suggested by Winne (1995) who states that it "has become a pivotal construct in contemporary accounts of effective academic learning" (173). Furthermore, self-regulated learning represents a foundation pedagogical approach used in the design and delivery of the APPLAB program. More specifically, the SRL process outlined by Zimmerman, Bonner and Kovach (1996) as a cyclic model including "self-evaluation and monitoring; goal setting and strategic planning; strategy implementation and monitoring; and strategic outcome monitoring" (11) was integrated with a design thinking approach to support the concept design and development of ICT product prototypes.

Methods

During the APPLAB program, data were collected through an internal, online questionnaire distributed to APPLAB participants at the beginning (n=31) and the conclusion of the program (n=24). This questionnaire included 10 questions focusing on the participants' perspective and experience with interprofessional learning and entrepreneurship. Additionally, a second online questionnaire (n=24) including 29 questions was distributed to participants at the end of the program through the APPLAB program sponsor – the Finnish Ministry of Employment and Economy. Results from this sponsor survey have been provided to the APPLAB team and are used to highlight participant satisfaction with various aspects of the program design and delivery.

Results

At the conclusion of the APPLAB program, six teams had been formed each with a prototype developed in a target industry - health technology (3), energy and environment (1), education technology (1) and automotive software (1). These teams ranged in size from four to eight individuals. While no team had established a start-up as of July 2015, four teams had communicated their intent to seek start-up funds and continue prototype development.

With respect to development of participants' entrepreneurship competencies and technology-related skills, a series of questions were asked within the participant survey with responses ranging along a Likert-scale from 1 (total disagreement) to 6 (total agreement). Development of key knowledge and awareness relating to participants' interest in being an entrepreneur was noted. For example, when asked if a career as an entrepreneur was attractive, agreement increased with an average score rising between the pre-survey (3.38) and the post-survey (3,77). Similarly, agreement increased when respondents were asked if they would like to start their own firm if they had the opportunity and resources (average response pre-survey 3,83; post-survey 3,97).

Survey responses further suggest that participants were gaining skills and knowledge necessary to establish their own start-up as observed in a significant increase in respondents' agreement when asked if they knew about the necessary practical details to start a firm (pre-survey 2,87; post-survey 3,71). Also of note, respondents' level of agreement slightly increased (pre-survey 3,23; post-survey 3,42) when asked whether a new start-up venture would have a high probability of succeeding if they were to initiate one. These results suggest that participants were gaining a better understanding of the nature of start-up work and gaining confidence as a result of taking part in the program.

With respect to the overall program training experience, 63% of the sponsor survey respondents stated that the program was 'very good' or 'excellent' as an overall training experience.

Conclusions

Since 2012, the Oulu LAB studio model has demonstrated strong results by offering training to ICT professionals and students as well as supporting the development of new start-ups. The APPLAB represents a recent evolution of the LAB studio model by offering training specifically for technology related fields such as health technology, energy and environment and automotive software. Participants show a high level of satisfaction with the training offered and suggest that the training model effectively supports their knowledge of and skills relating to entrepreneurship.

In conclusion, the successful outcomes of APPLAB and other LABs at the Oulu University of Applied Sciences is leading to the expansion of these studies within the university and supporting greater business and university collaboration in the Oulu region and internationally. While the data presented in this paper reflects a preliminary assessment based on participant perceptions, further research should be conducted to assess the long-term development of individuals, teams and prototypes supported within the LAB.

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A Trial on Teaching Machine Learning Technology in National Institute of Technology, Kushiro College

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Abstract

Machine learning is one of the field of artificial intelligence. It is the promised way to make smart and intelligent computer systems. Nowadays, it is widely utilized in many applications, so the graduated engineers from National Institute of Technology are desired to equip appropriate knowledge in order to apply the technology into a variety of smart device making fields. While, the training of the technology requires much more fundamental classes such as linear algebra, probability, statistics, multivariate analysis, programming language and software development techniques. However, it is difficult to keep the students' interest in this field and the shortage of the time is also severe due to the five or seven years curriculum of the National Institute of Technology which should include and start from a high school part. Therefore, a good way to attract such young students' interest is strongly needed. In National Institute of Technology, Kushiro College, the subjects related to the machine learning technology are taught in the combination of the department of Information Engineering and the Advanced Course of Electronic and Information Systems Engineering. Mainly, the fundamental knowledge is given through the probability and statistics, C programming language and Java programming language, pattern recognition, multivariate analysis and reinforcement learning classroom lectures, and the applications of the technology are achieved as graduate thesis studies in laboratories. In the fundamental classroom lectures, some active learning style methodology are utilized, such as collecting and discussing students' idea, drawing taught concepts as figures, making their ideas as computer software. In the application stage, students apply their knowledge into real world problem according to their own interests, such as image recognition, SNS message classification, virtual robot control, reversi game, and so on. Some students who had graduated the Advanced Course of Electronic and Information Systems Engineering could present and/or publish their papers in English that are related to machine learning technology.

Keywords: *machine learning, artificial intelligence, pattern recognition, multivariate analysis, reinforcement learning, C programming language, Java programming language, active learning*

Introduction

Machine learning is one of the field of artificial intelligence. It is the promised way to make smart and intelligent computer systems. Nowadays, it is widely utilized in many applications, so the graduated engineers from National Institute of Technology are desired to equip appropriate knowledge in order to apply the technology into a variety of smart device making fields.

Machine learning technology has rapidly became one of the biggest presences in the information science and information engineering filed in the first ten years of the twenty first century. We have been trying to teach the machine learning technology as the subject of “Artificial Intelligence” in National Institute of Technology, Kushiro College since the final year of the last century. We have been trying to explain the difficult subject by comparing the computers as humans in the real world so as to be easily understandable for the young students of National Institute of Technology.

The term of “Artificial Intelligence” already has a half century history, and nowadays it widely spreads and consists the basis of every information engineering technology. Thus, it now has somewhat ambiguous feeling and meaning without more supplemental or specific words. So, almost all subjects in National Institute of Technology, Kushiro College can be seen as a facet of “Artificial Intelligence”.

Considered such a situation, as “Artificial Intelligence” subject in National Institute of Technology, Kushiro College, we are mainly teaching “learning from examples” technology especially in the Artificial Intelligence field. We think of computing algorithms of inducing generic rules from the given past examples, data, instances, experience and evidences. Such a technology is called “Pattern Recognition” in the traditional words and in the traditional information engineering.

In this paper, we introduce our teaching subjects of machine learning, mainly pattern recognition, in National Institute of Technology, Kushiro College. Some past graduate thesis themes on machine learning

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and pattern recognition are also introduced. International papers presented by our students or ex-students are also introduced.

Definition and Example of Pattern Recognition

Let us consider a problem to make a classifier under n training patterns in m-dimensional Euclidean space. Then, a sample is given by $\boldsymbol{x}=(x_1, x_2, \ldots, x_m)$ and a training patterns z^n is, with the class label set $Y=\{1, 2, \ldots, c\}$, denoted by $z^n=(\boldsymbol{x}, y)^n=\{(\boldsymbol{x}_1, y_1), (\boldsymbol{x}_2, y_2), \ldots, (\boldsymbol{x}_n, y_n)\}$. The classifier constructed based on the training patterns is expected to classify unknown patterns, e.g., the pattern without class label, same as the training patterns.

For example, Tenmoto and Kudo(2008) proposed a histogram approach for feature selection and classification. In the method, the axes are divided into equally-spaced intervals, while the division numbers differ among the axes. The main difference from the similar approach is that feature selection is embedded in the model selection criterion. As a result, this criterion brings feature selection for a small number of training samples and convergence to the optimal Bayes error for a large number of training samples. In Tenmoto and Kudo(2014), we applied the proposed method to an image classification problem in which local image features and bag of visual words model are used for obtaining feature vectors. Through experiments, we confirmed that the proposed method can successfully select important visual words with additional small errors.

An example of pattern recognition is shown in Figure 1 and Figure 2. Figure 1 shows the decision boundary as bold lines. Figure 2 shows the concept of image classification.

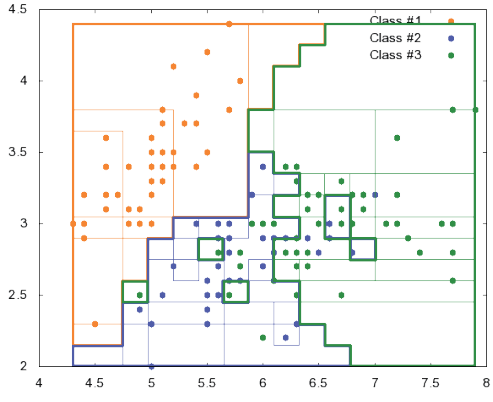


Figure 1: Example of classifier in pattern recognition.

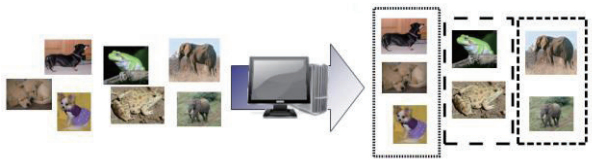


Figure 2: Example of image classification. Each image is cited from Caltech 256 image database.

Fundamental Classroom Lecture Subjects

We are thinking that the graduated engineers from National Institute of Technology are desired to equip appropriate knowledge about machine learning in order to apply the technology into a variety of smart device making fields.

At first, in order to analyse much more big data, the required basic knowledge is probability and statistics. The students of the department of information engineering in National Institute of Technology, Kushiro College, have to attend the classroom lecture on probability and statistics in the 3rd grade year.

In addition, in order to handle much more data simultaneously, the students need to remember linear algebra calculation knowledge such as vectors and matrices. This is achieved in the mathematics classroom lectures in the 2nd, 3rd and 4th grade years.

Of course, it is not useful only with knowledge of theory. So the students have to have implementation techniques of the algorithms on the computers and making software technology and carrying out techniques of experiments on real world datasets.

As a programming language, we are teaching Scheme as a functional programming language in the 2nd grade year, C as a procedure type programming language in the 3rd grade year, and Java as an object-oriented programming language in the 4th grade year. We think that we also have unique system in the programming language teaching steps as this.

After attending such a fundamental classroom lecture subjects, the students proceed to the “Artificial Intelligence” subject in the 5th grade year. The detail of the subject is explained in the next section.

In National Institute of Technology, Kushiro College, the machine learning technology related subjects are taught in the combination of the department of Information Engineering and the Advanced Course of Electronic and Information Systems Engineering. Therefore, multivariate analysis and reinforcement learning classes are taught in the advanced course, in addition to probability and statistics, linear algebra, programming languages mentioned above.

Pattern Recognition Subject in the 5th Grade

In this section, we introduce our subject of pattern recognition in the 5th grade in National College of Technology, Kushiro College. We open the subject in the 1st semester and perform two unit hours once in a week in fifteen weeks.

We feel that keeping the students' interest in this field is difficult and the shortage of the time is also severe due to the five or seven years curriculum of the National Institute of Technology which should start from the high school part. Therefore, a good way to attract such young students' interest is strongly needed. So, in this subject, some active learning style methodology are utilized, such as collecting/discussing students' ideas, drawing taught concepts as figures, making their idea as computer software. We introduce such a methodology in the list below.

[Placement test report]
Theme: Linear Algebra, Probability and Statistics, C Programming Language
Contents: The students are required to solve some basic linear algebra problems, such as vector and matrix operations. In addition, the students are required to solve some basic problems on Bayes' theorem and normal distributions in probability and statistics. The students are also required to make some basic programs on C programming language, such as calculating summation of data, finding minimum value in an array, making them as functions, and so on. Finally, the students are required to consider an example of pattern recognition.

[1st week]
Theme: Syllabus Explanation, Introduction of Pattern Recognition, Position of Pattern Recognition in Artificial Intelligence, Applications of Pattern Recognition, Required Basic Knowledge
Active Learning / Practice: Consideration of how to classify Iris flowers
Contents: The famous Iris flower classification dataset are shown to the students. The dataset consists of three classes and four features. Each student presents his idea of how to classify the three flowers by using the four features, and discuss their ideas.

[2nd week]
Theme: Definition of Pattern Recognition, Pattern Recognition System, Feature, Feature Vector, Observation Space vs. Feature Space
Active Learning / Practice: Drawing the observation space and feature space.
Contents: The students are required to draw the conceptual figure of the relationship between the observation space and the feature space for Iris flower dataset in the 1st week. In addition, the students are required to draw the conceptual figure for his/her original example in the placement test report.

[3rd week]
Theme: Variation of Feature Vectors, Prototypes as Representative Vectors, Formalization of Nearest Neighbour Method, Disadvantages of Nearest Neighbour Method, Decision Boundary of Nearest Neighbour Method
Active Learning / Practice: Implementation of nearest neighbour method in C programming language
Contents: The students are required to consider two C programming language functions on the paper. The first one is for calculating the distance between two patterns represented in feature vectors. The second one is for finding the nearest pattern, called nearest neighbour, among the training patterns from the unknown pattern. The students are also required to draw decision boundary of the nearest neighbour method on two dimensional feature space with his/her original artificial dataset and discuss its validity.

[4th week and 5th week]
Theme / Active Learning / Practice: Implementation of Nearest Neighbour Method on C Programming Language
Contents: The C programming language framework of nearest neighbour method is shown to the students. The framework is produced by the teacher (the author). The students need to complete the missing parts of the program source code. The students are required to plot two dimensional artificial dataset, by using a plotting software, and decision boundary calculated by the completed program. An example is shown in Figure 3. They should discuss about the difference between the computer's result and the hand-written boundary drawn the 3rd week by themselves.

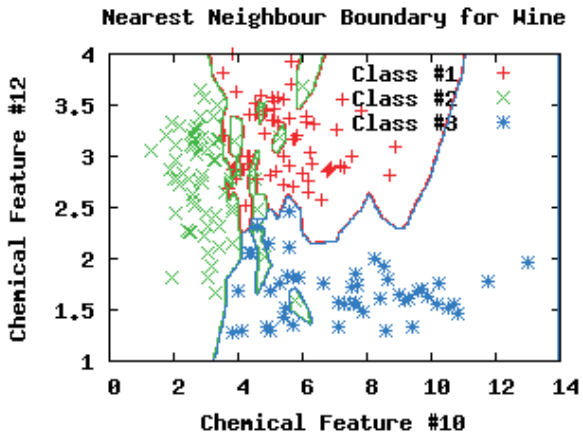


Figure 3: Example of nearest neighbour decision boundary.

[6th week]
Theme: Linear Discriminant Function, Feature Space vs. Weight Space, Resolution Area in Weight Space
Active Learning / Practice: Drawing the weight space and finding the result point for decision boundary
Contents: Simple one dimensional artificial dataset are shown to the students. The students are required to draw weight space for the dataset and need to determine a result point in the weight space for decision boundary. The students are also required to compute back the result point in the weight space into the decision boundary in the feature space.

[7th week]
Theme: Learning Algorithm of Perceptron as Linear Discriminant Function
Active Learning / Practice: Drawing the transitions of the weights in Perceptron
Contents: Three initial points in the weight space are shown to the students. The students are required to calculate and draw the transitions from the initial points to the result points according the learning algorithm of Perceptron. An example is shown in Figure 4. They should discuss the validity.

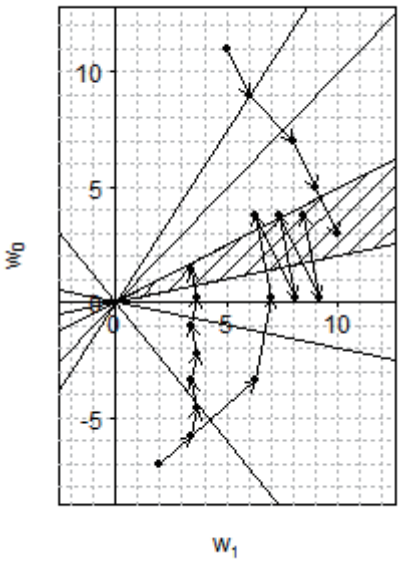


Figure 4: Example of transition of the weight in Perceptron learning algorithm.

[8th week]
Theme: Convergence Theorem of Perceptron, Advantages and Disadvantages of Perceptron, Basic Idea of Neural Network as Piecewise Linear Classifier
Active Learning / Practice: Drawing the conceptual figure of Perceptron learning algorithm.
Contents: The students are required to draw a conceptual figure of Perceptron learning algorithm. By this practice, the students can understand the detail theory/logic of the steps in the transition in the 7th week.

[9th week]
Theme: (Middle Term Examination Test)
Active Learning / Practice: (Nothing)

[10th week]
Theme / Active Learning / Practice: Implementation of Perceptron Learning Algorithm on C programming Language
Contents: The C programming language framework of Perceptron is shown to the students. The framework is produced by the teacher (the author). The students need to complete the missing parts of the program source code. They should confirm the hand-written transitions drawn in the 7th week by comparing it with computer's calculated results. In addition, the students are required to plot two dimensional artificial dataset and decision boundary calculated by the completed program. By this practice, the students can understand the algorithm can be applied to higher dimensional dataset.

[11th week]
Theme: Bayes Classification Rule, Multivariate Normal Distribution, Mean Vector, Covariance Matrix
Active Learning / Practice: Calculation of mean vector and covariance matrix for multivariate normal distribution
Contents: The students are required to remember the calculation formulae of the mean, variance and covariance for univariate dataset. Then, the students are required to compose them into mean vector and covariance matrix. By this practice, the students can see that the mean vector and covariance matrix can be calculated directly in vector forms, not in components.

[12th week]
Theme: Bayes Quadratic Discriminant Function, Mahalanobis Distance, Bayes Linear Discriminant Function, Decision Boundary of Bayes Classification Rule
Active Learning / Practice: Analysing the dependency of calculation, drawing multivariate normal distribution PDF(Probability Density Function), quadratic and linear decision boundary
Contents: The students are required to decompose the calculation dependency on the Bayes' quadratic classifier. In addition, the students are required to draw two dimensional multivariate normal distributions PDFs, quadratic and linear decision boundary. Examples are show in Figure 5 and Figure 6. Of course, the students need to show the quadratic and linear property of the decision boundary by formulae transformation calculation.

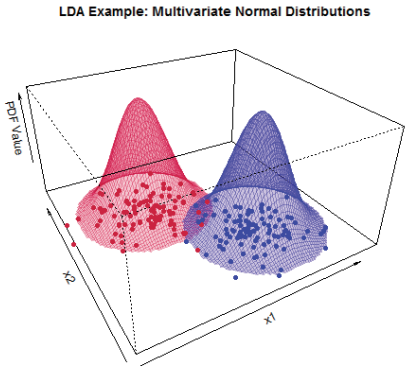


Figure 5: An Example of Multivariate Normal Distribution PDFs.

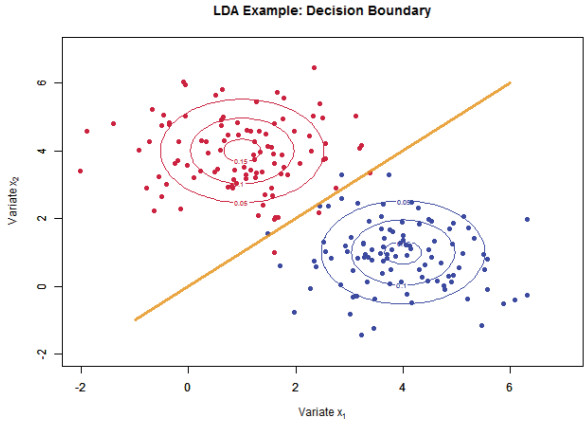


Figure 6: An example of decision boundary of Bayes' linear classifier.

[13th week]
Theme: Parametric Learning vs. Nonparametric Learning, Estimation of Parameters of Probabilistic Distribution, Maximum Likelihood Method
Active Learning / Practice: Drawing the concept figure of likelihood on normal distribution PDF, estimating the parameters of normal distribution
Contents: The students are required to draw a conceptual figure of likelihood. They should draw three different normal distribution PDFs for a certain univariate dataset and show the difference of the likelihoods of the three PDFs. The students are also required to estimate (calculate) the best parameter value for normal distribution PDF by using maximum likelihood method.

[14th week]
Theme: Disadvantage of Bayes Quadratic Classifier, Bayes Mixture Classifier, Classification as Supervised Learning vs. Clustering as Unsupervised Learning
Active Learning / Practice: Clustering by k-means method
Contents: Two dimensional artificial dataset with three clusters are shown to the students. The students are required to calculate (find) clusters according to the k-means clustering algorithm. They should discuss about the validity.

[15th week]
Theme: Number of Features vs. Number of Patterns (Curse of Dimensionality), Determination of Hyperparameter values (Estimation of Error Rate of Classifiers)
Active Learning / Practice: The students are required to draw two conceptual figure of "Curse of Dimensionality". The first one is the figure of many points on the linear plane, and the second one is the figure for showing separation of points by plane is easy in sparse case. By this practice, the students can understand much more points as the training patterns than the features are recommended to have a high performance classifier.

[16th week]
Theme: (Final Examination Test)
Active Learning / Practice: (Nothing)

Graduate Thesis Studies in the 5th Grade

In this section, we introduce some of our graduate thesis study themes related to the machine learning in the 5th grade in National College of Technology, Kushiro College.

As mentioned above, mainly the fundamental knowledge is given through the classroom lectures, and the applications of the machine learning technology are achieved as graduate thesis studies in laboratories in the 5th grade.

In this application stage, the students apply their knowledge into real world problem according to their own interests, such as image recognition, virtual robot control, reversi game, and so on.

Here, we show three subfields in the graduate thesis study themes.

[Statistical Pattern Recognition Fundamental Field]
In this subfield, we are trying to build algorithms for analysing big dataset and finding generic rules, typical patterns, from the dataset.

[Statistical Pattern Recognition Applications Field]
In this subfield, we are trying to apply the fundamental algorithms onto real world problems, such as image recognition, text classification (natural language processing), and web (SNS message) classification.

[Reinforcement Learning Field]
In this subfield, we are trying to build algorithms for finding action policies and obtaining artificial languages for virtual robots, called agents.

Presented Papers in English by Students

Some students who belongs to or had graduated our department of Information Engineering and the Advanced Course of Electronic and Information Systems Engineering could present and/or publish papers in English related to machine learning technology.

Here, we show the papers according to the subfields mentioned above. All of these papers are presented by the students or ex-students of National Institute of Technology, Kushiro College.

[Statistical Pattern Recognition Fundamental Field]
Saito and Tenmoto(2014) had tried to develop an algorithm for constructing highly interpretable classification rule based on Linear SVM (Support Vector Machine). Usually, the classification rule produced by SVM cannot be interpretable for general users, e.g., non-researcher, non-developer persons. In this paper, Saito and Tenmoto proposed an algorithm for constructing tree style classifier like as decision tree by using SVM as a component classifier. This work was presented in the 4th International Symposium on Technology for Sustainability held in Taipei, Taiwan.

[Statistical Pattern Recognition Applications Field]
Kanda, Kudo and Tenmoto(2009) had tried to develop an algorithm for hierarchical and overlapping clustering of retrieved web pages. Usual clustering algorithms produce completely separate clusters, while the proposed method produces nonoverlapping clusters by finding maximally extended subsets of patterns. This work was presented in the 17th International Conference on Intelligent Information Systems in Krakow, Poland, and published as technical paper in Recent Advances in Intelligent Information Systems.

[Reinforcement Learning Field]
Kasai, Tenmoto and Kamiya(2008) had tried to develop learning algorithm of communication codes in multi-agent reinforcement learning problem. In the proposed method, two hunter agents learns communication codes

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by themselves in order to improve their performance to catch the pray. The proposed method can be thought as very unique study in obtaining artificial language by computers. This work was presented in the IEEE Conference on Soft Computing in Industrial Applications in Muroran, Japan.

In addition, Noro, Tenmoto and Kamiya(2014) had tried to develop the extension of the above work. They developed signal learning algorithm with messages by using reinforcement learning. This work was presented in the 18th International Conference on Knowledge-Based and Intelligent Information & Engineering Systems in Gdynia, Poland, and published as technical paper in Procedia Computer Science.

Results and Discussion

In order to fit our subjects into up-to-date machine learning technology, we have to brush up and extend the contents of the subjects. Especially, we think handling of "Deep Learning" as an extension of neural network is necessary. It should be achieved as soon as possible.

More interesting and impressive graduate thesis themes are required as applications of the technology in order to catch the attention of the students.

Conclusions

Some students who belongs to or had graduated our department of Information Engineering and the Advanced Course of Electronic and Information Systems Engineering could present and/or publish papers in English related to machine learning technology. They could build their fundamental knowledge by attending the classroom lectures such as probability, statistics, programming language, pattern recognition, multivariate analysis and reinforcement learning. We hope more and more students succeed in this field in the future.

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IMPLEMENTING FLIPPED CLASSROOM FOR A FUNDAMENTAL ENGINEERING SUBJECT

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Abstract

Low attendance rates, students learning at different pace, students coming unprepared for class with homework left undone were some of the problems we were facing in our classes. These problems resulted in lecturers like us ending up doing most of the work, such as solving or answering the problems assigned as homework, explaining concepts at a slower pace and sometimes repeating the explanations to help students who needed more time to process their thoughts. This resulted in lesser student engagement and class participation, an environment which typifies a teacher-centered classroom. All these problems prompted us to try a different mode of instruction - the flipped classroom. The flipped classroom is a form of blended learning where there is a shift from a teacher-centered approach to one that is student-centered. It is a method of teaching where the place and sequence of homework and classwork are flipped.

A pilot run on flipped classroom for two fundamental subjects was carried out for a selected group of first year Engineering students. In this pilot run, all our lecture materials were converted into interactive e-learning modules with video lectures. Students were required to complete these modules prior to the face-to-face sessions. To encourage deep learning and reflection, students were required to complete summary sheets as they watched the videos. During the face-to-face sessions, students spent more time in solving problems and group discussions.

A survey was conducted to gather students' feedback on the new method of learning. Majority of the respondents found the flipped classroom more engaging than traditional classroom. An independent panel also interviewed a group of students to get feedback about the flipped classroom approach. The interviewees gave positive and encouraging feedback regarding the flipped classroom.

While flipped classroom does not address all problems related to teaching and learning, we believe that it is a good model for creating an environment that is learner-centered.

Keywords: *flipped classroom, e-learning, student-centered, active learning, feedback, interactive*

Introduction

In the School of Engineering, most of the subjects are usually carried out in three modes: lecture, tutorial, laboratory. In the lecture sessions, the teacher takes center stage with the students passively receiving information. Prior to the tutorial sessions, students are expected to complete a set of homework so as to enable them to actively participate in the class discussions. The tutorials are also meant to give the students an avenue to reinforce what was learnt in the lecture. This method, at a glance, seems to encourage active learning; however, several reasons hinder this from happening. Guided by a teaching schedule, lecturers are expected to complete a prescribed set of topics within a lecture session. Grappling with shortage of classroom time, lecturers tend to resort to a one-way mode of teaching which inhibits them from employing different active learning strategies in class. This is compounded with various problems such as classroom management issues, declining attendance rates in lectures, and different learning pace of students. This gave little chance for students to clarify their doubts leaving them not being able to do their homework. This resulted in some of the tutors re-teaching the concepts to the students.

While lecturers are facing these difficulties, our students, on the other hand, demand for more help in their learning. Every semester, surveys on lecturers‟ effective teaching are conducted among students. Some of the comments that are repeatedly aired by students include requests for more examples and practice questions, slower pace of teaching and extra lesson time or one-on-one consultation.

The Flipped Classroom

The flipped classroom approach is often attributed to Jonathan Bergmann and Aaron Sams, Chemistry teachers at Woodland Park High School in Woodland Park, Colorado. These teachers encountered problems in finding time to reteach students who missed lessons. This prompted them to create recordings of their lessons but they noticed that the videos were being accessed not only by those who missed lessons but also by those who did not. The videos became useful in reinforcing what

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the students learned in the classroom (Tucker, 2012). Leveraging on this, the two teachers were able to redesign the use of class time by introducing activities which promoted active learning. They flipped their classrooms.

Flipped classroom is more commonly known as the reversal of the sequence of elements which occur in traditional classrooms. Traditionally, classwork is done before homework is given to students. In the flipped classroom, students learn content prior to coming to class. This now serves as their homework which is followed by the classwork. However, there is more to flipped classroom than just offering online videos and doing work in class. It involves a more personalized training for the students where the teacher can spend more contact time with each student. The teacher is now a facilitator rather than someone who teaches the content. The flipped classroom creates an environment where students are accountable for their learning and are engaged in their learning (Bergmann, Overmyer & Willie, 2013).

Due to its advantages, flipped classroom approach is gaining its hold in more classrooms. An online survey among 2358 educators was conducted by the Flipped Learning Network and Sophia in February 2014. Their findings show that this pedagogical approach is becoming more prevalent in classrooms and teachers have found it to be effective. Some of the findings are (Sophia & Flipped Learning Network, 2014):

- The number of teachers having a flipped lesson increased from 48% in 2012 to 78% in 2014.
- 96% of the teachers surveyed would recommend the method to their colleagues.
- About 90% of the teachers have seen a change in how the students are engaged in their lessons.
- According to 71% of the respondents, there is an improvement of the students‟ grades. This is an increase from 67% in 2012.

There have been several studies that have highlighted the benefits of flipped classroom. Some of the benefits are increased student-teacher interactions and improvement in student behavior and attitudes towards learning (Flumerfelt & Green, 2013; Goodwin & Miller, 2013; Stone 2012). There have been several studies recently that have shown that flipped classroom approach promotes active learning (Aronson, Arfstrom & Tam, 2013; Pierce & Fox, 2012; Roehl, Reddy & Shannon, 2013). In our Engineering school, there has been a push to encourage active learning strategies. Before embarking on this approach we also looked at implementation of flipped classroom in Engineering settings. A study conducted by Papadopoulos, Santiago-Román & Portela (2010), showed that students in the electrical engineering class progressed faster and were able to learn the subject in greater depth as a result of the flipped classroom. In another example, students in a Digital Engineering course at the California State University found that this approach promoted deep learning and understanding of the real world design process in engineering (Warter-Perez & Dong, 2012). At the Pennsylvania State University, the flipped classroom approach was implemented in one of the subjects in the department of Civil Engineering. It was observed that students were more open to taking responsibility for their learning. A study revealed that the pedagogical approach developed the students to become self-directed learners (Laman, Brannon & Mena, 2012).

Being aware of the effectiveness and advantages of flipped classroom, we adopted this pedagogical approach to encourage active learning in our classes.

Methods

The flipped classroom approach is often perceived as moving the passive lecture component outside of class. For our case, we decided to make both out-of-class and in-class activities engaging and interactive.

Online Videos: Although the internet is proliferated with video resources and information similar to our subject contents, we opted to create our own e-learning modules to ensure that they met our needs. We examined the subject content to determine which information should be included in the videos and which may be left out. We had to avoid the creation of lengthy videos to prevent learners from getting bored and eventually losing interest in learning.

Since one of our priorities was to create engaging e-learning videos, we used various pedagogical methods in presenting the information. Some static diagrams were replaced with animations and simulations to help students understand them better. Concepts were explained through the use of analogies and story-telling. We included videos of students taking part in role plays to have variations in how concepts were taught. Real life applications of certain concepts were included so that students could appreciate what they were learning. In order to connect with the students and to overcome the problem of students feeling isolated in online environment, we embedded videos of the lecturer explaining the concepts in all slides of the e-leaning modules.

To engage students and help them with their learning, we embedded different types of quizzes in different parts of our e-learning modules. Using the authoring tool Articulate Storyline allowed the easy creation of different types of quizzes. Moving the materials online gave us the flexibility to design materials which encouraged differentiated instructions. We were aware that some students had background knowledge on some of the subject content. These students were given the choice to either skip the related e-lectures or to take a quiz to test their knowledge on those concepts before proceeding to learn the content. In cases where students could not answer the questions, they were directed back to the e-lecture for that particular topic. Interactivity was also achieved by the non-linear sequencing of the contents. In this format the students were given the freedom to explore topics in any sequence.

One of the challenges in the flipped classroom is getting the students to watch the online videos prior to the face-to-face sessions. To address this, we

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encouraged active learning by requiring students to take notes (summary sheets) or complete worksheets while viewing the e-lectures. Relevant tasks were assigned to students and they were required to post their submissions on Padlet, an online virtual bulletin board.

In-Class Activities: The subjects selected for the pilot run consist of five credit units which is equivalent to five contact hours per week. Of these, three hours are used to cover the theory; i.e. lectures and tutorials, and two hours are for hands-on sessions in the laboratory. Since the teaching of content was moved out of class, the number of contact hours was reduced by one; i.e. two hours for theory and two hours for the hands-on session.

The two-hour face-to-face session always started with a debrief where the lecturer highlighted the key points discussed in the online modules. Although the lecturer led the discussions, students were encouraged to participate by asking them to contribute key learning points derived from the online modules.

Short diagnostic quizzes were used, not only to help students check how much they understood but also for the lecturer to identify the students‟ learning needs. The diagnostic quiz consisted of a set of easy questions, to check students‟ understanding of the basic concepts, and more difficult questions to check their higher level of understanding. For each answer, the students had to indicate their level of confidence. Based on the results, the lecturers were able identify common gaps in the students‟ understanding and correct misconceptions, if any. A follow-up short quiz was given to the students to check if their doubts had been clarified. A variation to this was to allow students to discuss in groups and help each other in clarifying doubts.

After the student‟s doubts were clarified, bulk of the class time was spent on problem solving where students applied the concepts that they had learnt. Problems of different difficulty levels were given to students. While the students solved the problems, the lecturer went around to monitor their progress and to provide guidance. This approach enabled the lecturer to immediately identify the difficulties of students and to give feedback on their work. Doing this allowed lecturers to cater to individual student‟s learning pace. Students were encouraged to work in groups when discussing the more difficult problems.

To manage classroom activities, lecturers were given lesson plans, but they were also given the autonomy and flexibility to allow minor changes in the activities if the lecturer observed that more was needed to address students‟ difficulties.

Survey and interviews: A mixed method approach was adopted for this study. A survey and semi-structured interview was carried out to collect data. A total of 117 students participated in an electronic survey which was conducted to gather feedback regarding the online videos and in-class activities. A 4-point Likert scale was used in the survey. There were 17 items that assessed students‟ general perceptions on flipped classroom. The respondents were also asked to answer an open-ended question to elaborate on why they preferred flipped classroom over the traditional method of teaching (item 18).

Table 1. Survey questions

Questions
1. The online modules helped me understand the topics.
2. The examples in the online modules helped me understand the topics.
3. The online modules motivated me to complete the learning activities (videos quizzes tasks lecture notes/handbook etc.).
4. The online modules helped me learn at my own pace.
5. Completing the online modules helped me with the in-class activities.
6. The summary of the online modules done in class helped me clarify my understanding of the topics.
7. I tried to relate what I learned online to what I did in class.
8. I found the in-class activities engaging.
9. The in-class activities increased my confidence on the topics learnt.
10. The in-class problem solving activities helped me apply what I learned online.
11. I watch the e-learning videos on time (i.e. prior to the face to face sessions).
12. Describe the amount of effort you have been putting into learning this subject OUTSIDE CLASSTIME.
13. Describe your level of confidence on your ability to solve problems AFTER watching the video but BEFORE coming to class.
14. Describe the amount of effort you have been putting into learning this subject during your time IN CLASS.
15. How confident do you feel about the topic/subject AFTER watching the video and AFTER attending class?
16. Flipped learning made me view learning as a more active process.
17. Overall, the flipped classroom is more engaging than traditional classroom (i.e. online modules instead of face-to-face lectures).
18. The reason for my response to the above question no. 18 is…

Results and Discussion

Feedback from Students: Both the survey and interviews yielded very positive results. There were high „agree‟ and „strongly agree‟ ratings for all categories.

Noticeably the ratings for those who found the e-learning videos helpful in their learning were very high. The respondents do agree that by completing the online videos and coming prepared to class, they could participate in the in-class activities. These findings are summarized in Figure 1.

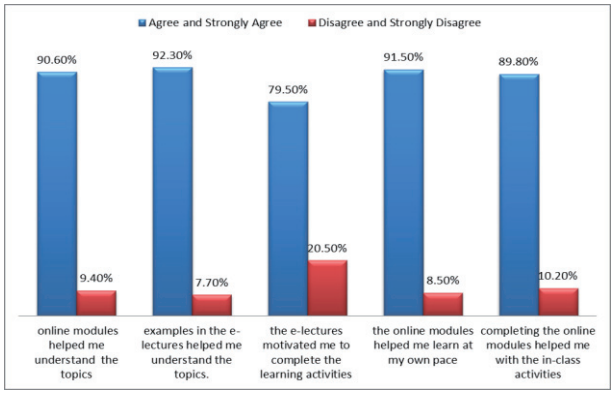


Figure 1: Feedback related to on-line modules

The data in Figure 2 shows that students find the in-class activities engaging. These activities also helped them boost their confidence in the concepts learnt. The points included in the survey are characteristic of expected outcomes of the in-class activities. The data shows that we have achieved these expected outcomes.

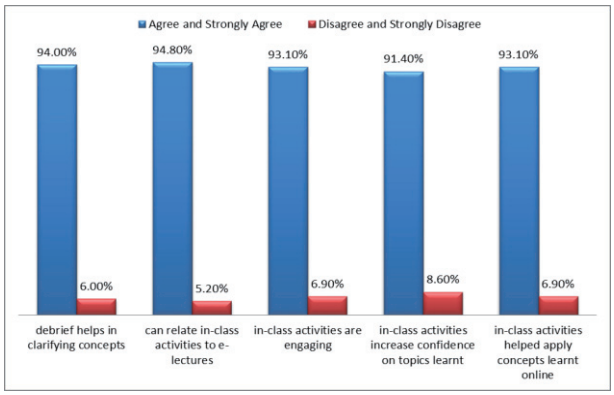


Figure 2: Feedback related to in-class activities

As mentioned earlier, we spent majority of the class time on problem solving and peer or group discussions. Through the survey, we tried to find out if the in-class activities helped in improving their understanding of the concepts. It does not come as a surprise that their confidence level did go up after the in-class activities. A summary of these findings is shown in Figure 3.

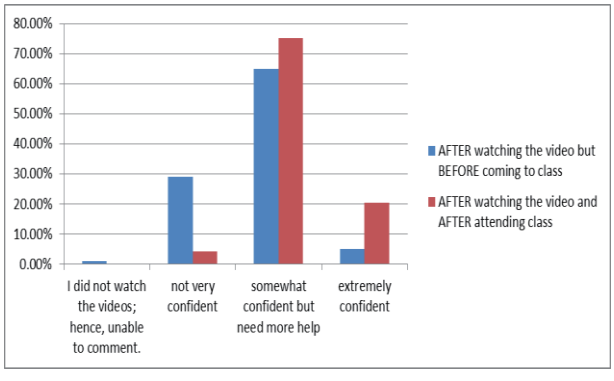


Figure 3: Students' confidence level before and after in-class activities

Based on the survey, 89.7% agree or strongly agree that flipped classroom made them view learning as a more active process.

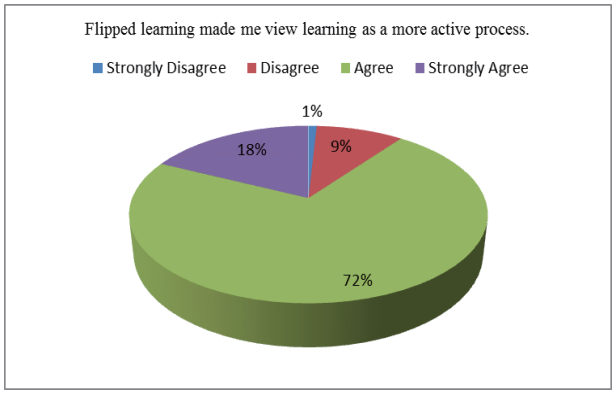


Figure 4: Feedback on student perception of learning as an active process

78.7% of the respondents found the flipped classroom more engaging than traditional classroom.

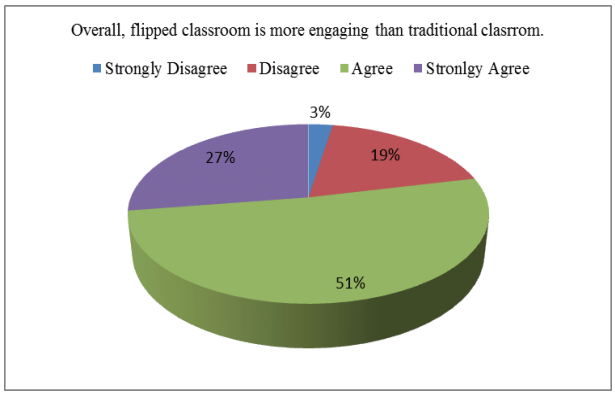


Figure 5: Feedback on flipped classroom being more engaging than traditional classroom

In the same survey, students acknowledged that the e-lectures helped them learn at their own pace. It was mentioned that they could go back to any topic at any time that they have difficulties. They felt that the flipped classroom approach gave them more time to do activities or work together in class which helped them in better understanding the topics learnt. A few students also appreciated the fact that the lecturers were able to focus on them more effectively and that allowed them to clarify their doubts easily. One student commented, "The flipped classroom helped me to understand the topics in my own pace and style. I am not pressured to instantly understand the topic as it would in a normal classroom setting. Other than that, it gives me freedom to use other online resources to enforce my understanding. When in class, it is more like enforcing and polishing our understanding of the topic. Overall, I really benefitted a lot from the flipped classroom experience. "

Aside from the survey, an independent panel interviewed a group of students who were in the first pilot run of the flipped classroom. The interviewees

found the flipped classroom was a good option as compared to fully online or traditional classroom teaching. Learning at their own pace was one of the plus points cited while some of them felt that preparing at home helped create more time for more complex problem solving. One of them said, "The flipped classroom will overtake normal traditional lectures in the future to come. It is interactive and engaging for students as we discuss problems we face while learning the subject at home. I personally learn more effectively in flipped classroom than traditional classroom."

Feedback from Staff: Lecturers shared that, in this pedagogical approach, they could better monitor individual student‟s progress and give feedback to individual students. One lecturer shared that the flipped classroom approach provided timely and direct diagnostic and formative feedback on the student learning. In addition, the flipped classroom encouraged students to be more open to working and discussing with peers. Posing questions which require higher-level outcomes naturally geared them to discuss in groups or in pairs.

Flipped classroom has its own share of challenges. Student accountability is one of the main challenges that is often encountered. When students come unprepared for class, it is difficult for them to participate in the class activities. We found that students were initially resistant to doing work at home but this gradually improved over the weeks. The varied learning pace of students also posed a challenge to tutor‟s classroom management. We provided differentiated instructions by giving additional problems to the fast learners and extending guidance to those who need them more.

Despite these challenges, lecturers found the flipped classroom approach a rewarding experience. We observed the flipped classroom encouraged independent learning and students taking ownership of their learning.

Student Performance: The statistics below show the encouraging results of the performance of students who were involved in the pilot run of the flipped classroom.

Table 2: Term test results of students in the first pilot run

	AY2013/2014 October	AY2014/2015 October
Grade	Term Test	Term Test
A (Excellent)	7.50%	26.50%
F (Fail)	30.20%	16.30%

Table 3: Term test results of students in the second pilot run

	AY2014/2015 April	AY2015/2016 April
Grade	Term Test	Term Test
A (Excellent)	7.80%	9.80%
F (Fail)	23.50%	9.10%

Conclusion

The flipped classroom is a strategy that could address common problems faced by both educators and students. Our findings were encouraging as it revealed that this approach helped in enhancing students‟ learning. We also observed that students picked up vital skills such as independent learning, ability to identify their learning gaps and work collaboratively to solve problems. Much time and effort is required in designing and developing materials and activities for both the e-learning component and in-class activities. However, like in other student-centered approaches, it is worth the effort.

With the positive results obtained in our pilot run, we hope to see a more prevalent use of the flipped classroom in suitable engineering subjects in our school.

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THE ROLE OF A NEW FORM OF ART IN EDUCATION IN CONTEMPORARY MEXICO: ANALYSIS OF TWO ARTWORKS MADE IN SALAMANCA

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Abstract

Salamanca is the second most polluted city in our country. The municipality has organized events to enhance the citizens' consciousness about the milieu we live in. One of these activities is the Environmental Fair, which has invited, since 2009, local artists to create artworks that involve high school students. This is why we planned for the 2010 fair's edition two art pieces: Key messages and Mice.

Joseph Beuys (1972) thought education was not only provided at school and tried to include people in reflection and creative activities in a project called social plastic. He also established the extended concept of art according to which "every man is an artist". Ever since, other art forms, engaged to the social creation, have been agreed. Relational art, a group of artistic practices that develop from human interactions and their social context, was proposed by Nicolas Bourriaud in 2006. This year (2015) our theoretical concept has been set as art of the human space experience, which recognizes the works of art that debate on the living of our space and its link to the relationships we hold.

The result of the students' participation in Key messages and Mice is their reflection about pollution, which records are the messages written by using keys physically (and that could had also been written digitally using the same keys with a lower ecological footprint) and the out-of-order electronic devices (mice) placed near a fridge door (as a metaphor that relates biological and electronic mice as a plague at different times). Both pieces have impacted the students by making them more aware of our relationship among ourselves and with the environment. Finally, the result of analysing these two artworks is the acknowledgement that art can play an important role in the high school education in our context nowadays.

Keywords: art, education, Mexico, pollution, participation, high school.

Introduction

This work is structured in four sections. The first one is Materials and Methods or pedagogy. In it we introduce the city of Salamanca, one of its concerns (pollution) and the actions taken by the government to make it decrease and improve the citizens' consciousness on our environment. One of those initiatives is mentioned as well as our participation through art. We also specify the materials or mental contribution that the artist and the students involved had to take to develop the artworks. The four methods used to organise the project are also mentioned in this part.

The second section is called results and discussion. We mention two basic figures as precedents of a new form of art we conceived, Joseph Beuys and Nicolas Bourriaud. The objectives of the two pieces are stated and some evidences of the results obtained are shown.

The third section of the work is named conclusions. We mention some traits of the creations we presented and the effects they had on the students' learning. The final outcome of our project is revealed as a materialisation of the building and learning processes that were held before.

Materials and Methods or pedagogy

The city we live in, Salamanca, Mexico, is located in the industrial heart of our province, Guanajuato. Many factories have established there since 1950, when a petroleum processing plant arrived. Ever since, the amount of pollution has grown until becoming the second most polluted city in Mexico. The government is worried about this issue and has made important efforts to decrease the pollution by making the factories fulfil the environmental responsibility laws. It has also organized events to enhance the citizens' awareness on the milieu we live in. One of these activities is the Salamanca Environmental Fair. The Environmental Education Department has brought together for this event, since 2009, high schools, local artists and waste disposal and recycling enterprises. We had the chance to be one of the invited artists to the fair between 2009 and 2011. For the 2010 edition of the fair, we planned two artworks: *Key messages* and *Mice*.

Since both oeuvres depended not only on the artist's work, but on the students' participation, each piece needed these agents to provide something, a physical or a mental contribution.

For *Key messages* we supplied a set of 26 reused plastic bowls, each one labelled with a letter of the English alphabet. Each vessel contained some keys, taken from computer keyboards, corresponding to the labels. The containers were set over some tables and an ad was included to communicate the instructions for the students to complete the piece: "Write a key message". Students invited to participate didn't need to take with them any extra material for the development of this creation. They just needed to have in mind their own life experiences and previous knowledge. It wasn't mandatory, but they could additionally take their smartphone or camera to register their input toward this oeuvre, which is, as we may notice, the only way to keep a record on what was built since one of the main features of this artwork was being ephemeral. Figure 1.



Figure 1. Students registering a word written using keys

In the case of *Mice*, we presented a reused refrigerator door and an instruction poster which read: "Place your mouse in the fridge". Students were previously asked to take a broken mouse (electronic device) to the fair. This call was made as a part of a collecting campaign organised by the City Environment Department, in an effort to gather some recyclable products, such as keyboards, wires, mice, piles, paperboard or plastic items and ink cartridges. As in *Key messages*, students had to provide some reflexion on the metaphor led by the artist. They could take pictures of the individual object they left or of the complete arrangement, which was more interesting since collaborative creation was intended to be encouraged and revalued.

All the physical materials used to build *Key messages* and *Mice* were given, at the end of the event, to the City Environment Department to be placed at the right enterprise so they could be properly recycled. This is why both artworks have a temporary nature.

Concerning the methodology, four methods were used to structure this proposal. The deductive method was taken up to study similar projects in other provinces of Mexico as an antecedent. The synthesis method was applied to relate different types of artworks into a conductive line. The historic method was useful to analyse the evolution of art forms through time until reaching the *art of the human space experience*. Finally, the comparative method was helpful to point at the similarities and differences among the perspectives of diverse artists.

Results and Discussion

After researching alike works of Mexican artists, connecting them, revealing their similarities and differences and exploring theoretical origins, we created a couple of artworks that belong to a new form of art that we have identified (2015) as *art of the human space experience*.

The precedents of this new artistic way of expression date back to 1972 when German artist Joseph Beuys joined the documenta, one of the most important art exhibits in the world. What he presented weren't objects, but a social project of which he was the spokesman and listener. One of the main axes of his plan was education. He considered that it was basic, but that it could be produced beyond the school. According to Beuys, a simple chat with someone else could be an educative event. That's why he devoted a long time of his life trying to help people develop their creative skills and reflection. He called his project "social plastic" and as a part of it he proposed the "extended concept of art", which changed the way art was understood until then, because it established that everyone is an artist.

Later, in 2006, curator Nicolas Bourriaud defined art in terms of the human relationships through a concept called "relational art" which he outlined as a group of artistic practices that develop from human interactions and their social context. This author considers the departing point of relational art is the bond spectator-spectator and that its objective is the link spectator-work of art.

The thought of Beuys and Bourriaud, mainly, guided our research to create the idea of *art of the human space experience* that can be defined as a set of artistic practices which main topic or creation matter is the living of the space we share. An essential feature of this kind of art is the bond between the deterioration of the human relationships and the impoverishment of the experience of the space we have built. From our investigation, we have found that there isn't a single type of *art of the human space experience*, but many, each one associated to a kind of human relationship weakening. We have distinguished five of these rapports, not expecting to find them all, but to characterise some of them: manipulation, automation, identity lack, invisibility and fugacity. Each oeuvre can belong to more than one category, however, each one fits basically in one group. Both pieces presented at the Salamanca Environmental Fair in 2010 match the set of creations that reflect on invisibility. In this context, this idea is understood as immaterial because a space can be invisible to a person independently of its appearance. Besides, invisibility is assumed as individual because only the people who have had a particular experience are able to see a certain space.

The objective of *Key messages* and *Mice* was, thus, to rethink how not recycling out-of-order electronic devices is an invisible fact that can affect our experience of the human space. In *Key messages* students were invited to finish the work of the artist by writing any message they wanted. Through this simple exercise they were expected to analyse the way messages written digitally don´t have the same effect on the environment than if they are written in other support, such as printed messages or even written by using keys physically. Besides, they were expected to examine how they can give a second chance to materials to create something by collaborating with other people (the artist and/or his/her partners) and which can have a positive outcome on our milieu. In other words, students were envisaged to develop their awareness of the relationship towards the environment and among themselves.

It is hard to quantify the results of our intervention. We might know the number of people who participated, but there is no way to know objectively if students achieved to develop the consciousness we are referring to. From this perspective, the only tangible result we have are the records of some of the products that arose from our teamwork and some pictures of the students while writing. Figures 2 through 8.



Figure 2. Students choosing keys.



Figure 3. “Mimi ♥”



Figure 4. “Take care”



Figure 5. Students writing key messages.



Figure 6. Gerai and J*Luis”

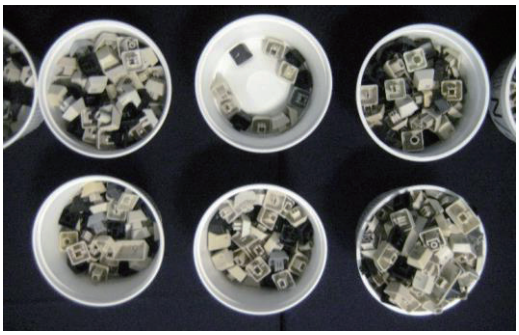


Figure 7. Bowls with keys.



Figure 8. "Thank you"

In *Mice*, students were invited to finish the work of the artist by leaving a broken mouse in a reused refrigerator door. At first sight this artwork doesn't make much sense, but it encloses a metaphor that ties biologic and electronic mice as a plague at different times. Students were thought again to reflect on recycling through collaboration as a way to show commitment towards our environment and the community we live in.

The effect of *Mice* on the students' development of awareness regarding human and environmental relationships isn´t any easier to calculate. We can count the number of mice to know how many students participated, but there isn't a way to know accurately the outcome on the people's consciousness. The accounts of the product that resulted from our collaborative work are shown next. Figures 8 through 11.



Figure 9. *Mice* (overview)



Figure 10. *Mice* (detail)



Figure 11. *Mice* (detail)

Conclusions

The pieces shown at the 2010 Salamanca Environmental Fair allowed us to point at a special characteristic of art: its capacity to educate. Learning is possible, just as Beuys defended, beyond the school limits and art is likely to be created anywhere and by anyone. Some people think, even nowadays, that only who have received a formal instruction on art deserve to be called artists and that they are the only ones who have the right to create. The truth is, more than forty years ago, art began an important evolution. We must recognise that we all have the capacity to create within each one of us and that everything we build is valuable because it was made by a person.

Another function of art that must be highlighted is its faculty to produce thinking in the spectators, who were actually collaborators in this case. Students reflected on what they saw, but most importantly, on what they made. They also learned from what they created by themselves, but in particular, as Bouriaud indicates,

from what they built together, from the bonds to other people and to their surroundings.

Key messages and *Mice* generated an experience for the students. The fact that electronic devices pollute was revealed by providing the students with a chance to make something new from items that many times remain invisible. Through collaborative creation we got some ephemeral products that resulted attractive to students, but that also helped them think on recycling as an important action.

Education in Mexico is different than it was before since it is now conveyed through activities different than those that took place in a traditional class and within learning ambiences diverse from the classroom. We consider this project, inscribed in a new form of art that we have named *art of the human space experience* contributed to the students' growth, not only academically but in a human way. Our final outcome were two finished artworks that somehow embodied the creation and learning processes achieved by the students. Both pieces were dismantled at the end of the fair so that every material could be recycled.

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MODULE RE-DESIGN FOR HOLISTIC APPROACH TO TEACHING CHEMICAL PROCESS SAFETY

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Abstract

This paper shares the experience from the Diploma in Chemical Engineering (DCHE) from Singapore Polytechnic (SP) in revamping its Year 3 core module entitled *Plant Safety and Loss Prevention.* The module is often perceived by students to be dry and boring, and assessments are often a test of memory work on factual information. The traditional approach to teaching chemical process safety is via "Learning from Accidents" where case studies are used for classroom discussion during which useful lessons are drawn through analysis of root causes of the world's major industrial incidents involving chemical plants. The availability of the Internet and general proliferation of mobile devices made this traditional approach ineffective as students can readily go to Google and obtain model answers to questions posed in these case studies. Through a self-evaluation process based on the 12 Standards contained in the CDIO Framework (http://www.cdio.org), we came up with an innovative framework to teaching the module, based on application of risk management strategies to the entire lifecycle of a given chemical plant, where appropriate safety measures can be implemented to address the chemical and process hazards present. We firstly summarize the teaching of chemical process safety in the DCHE curriculum, identifying the shortcomings of the current teaching approach. Secondly, we outline the work done to re-design the module, justifying the retention of the use of case studies as the pedagogy of choice, but modified the way these cases are used in the "Learning from Accidents" approach. We then share the learning outcomes of the revised module, and explain how we teach chemical process safety in the new approach. This involves scaffolding students' thinking in relation to the lessons learned from the Bhopal Gas Tragedy, other selected cases, and one that we designed using dynamic simulation. Lastly, we share some learning points and plans to move forward.

Keywords: *chemical engineering, chemical process safety, CDIO, module re-design, case study*

Introduction

Chemical and process safety is an important component in chemical engineering education. It is a requirement from professional bodies that accredit chemical engineering programs such as the Institution of Chemical Engineering (IChemE), UK. However, the teaching of safety to chemical engineering students needs improvement (Louvar & Hendershot, 2003). The subject is taught in essentially all chemical engineering programs. A major challenge in the teaching of chemical process safety is that students often cannot readily identify with the safety issues as they lacked the relevant real-world experiences in the chemical processing industries. Chemical process safety is unlike other core chemical engineering subjects such as fluid mechanics, heat and mass transfer, separation processes and reaction kinetics which has strong design components requiring significant theoretical underpinning knowledge and involved mathematical calculations using various formulas. Issues in chemical process safety, as well as the proposed solution, on the other hand, are often sounded common sense in hindsight, and laden with many factual information. Students typically found the traditional lectures boring and hence only engage in surface learning. Teaching of HAZOP (hazard and operability) is particularly troublesome, as students' lack of actual working experience in chemical plant means that they are not able to effectively consider plausible undesirable consequences resulting from a process plant upset (Cheah, 2010).

The challenge further deepens as today's chemical plants become more integrated, where operational upset in one process unit can have consequences elsewhere in another different process unit. The level of risk has increased in the chemical processing industries (Kidam, et al, 2013). There must be greater integration of chemical process safety with other core subjects in chemical engineering as well as research programs (Mann, et al, 1999). There are three ways of incorporating chemical process safety into the chemical engineering curriculum: (1) a course or courses devoted to process safety, (2) integration of chemical process safety into existing courses and (3) a combination of the two approaches. Pintar (1999) gave detailed discussions on the relative merits of each approaches.

Chemical Process Safety in DCHE Curriculum

The Diploma in Chemical Engineering (DCHE) is a 3-year program, offered in Singapore Polytechnic (SP). The diploma is accredited by the IChemE, UK; which specifically requires that safety topics be adequately integrated in key categories of the curriculum, namely: (a) core chemical engineering, (b) engineering practice, and (c) design and design practice. In DCHE, we used the third approach in the teaching of chemical process safety, i.e. with a dedicated module as well as integration into other core modules throughout the diploma's three year curriculum. More specifically, we employ the following strategies:

- A 60-hour Year 3 core module entitled *Plant Safety and Loss Prevention* that is compulsory for all 120 students. Based on fully in-course assessment, this module has no final examinations. It also does not have any practical activities in the laboratories. This module covers many safety topics, ranging from hazard identification, risk assessment, plant safety systems, chemical safety data sheets, fire and explosions, safe work practices, etc; often in isolation from each other. We also spent a small portion of curriculum hours on a teaching approach widely known as "Learning from Accidents" in the safety literature; where case studies that present students with the real accidents involving major chemical plants that have occurred that have resulted in either death, injury or at least property loss, are used for classroom discussion. Examples of such case studies are the Bhopal Gas Leak Disaster, Flixborough Explosion, and Piper Alpha Accident. The objective is to draw out useful lessons through analysis of the root causes of these accidents that can be used to prevent future accidents.
- Integration of safety into all laboratory activities that support the learning of key chemical engineering concepts and principles in core modules: there is an explicit section on hazard identification and safety precautions, and where students are assessed on the ability to identify hidden hazards, and link the selection of appropriate personal protective equipment to these hazards. Students are assessed on their ability to do this, before they are permitted to continue with the laboratory activities. Students are also evaluated for their safety consciousness throughout the entire duration of the activities. as well as proper house-keeping at the conclusion of each activity
- Integration of safe practices into students' Final Year Projects (FYPs). All students are required to attend a risk assessment workshop. The students then conduct a risk assessment on the FYP that they plan to work on, together with their project supervisors and technical support officers from the laboratory where their FYP is located.

This paper focus on the first approach, which had several shortcomings in the way it is currently taught; making it ripe for a complete revamp. The various safety topics in the module are not explicitly connected to the case studies used in "Learning from Accidents"; and all assessments in the module are pretty much conducted topic-by-topic, with hardly any in-depth linkage back to the case studies. Assessments for this module also tend to test mostly memory work, rather than critical analysis. Besides HAZOP, there is also lack of integration with other Year 3 core modules such as *Chemical Reaction Engineering* and *Plant Design, Economics and Sustainable Development*, In the former students learnt about chemical reaction kinetics and the application in designing chemical reactors, and are also required to operate simple reactors in the laboratory; but had no coverage on chemical reaction runaway, one of the most common hazards encountered in the operation of chemical reactors. In the later, students are required to complete a design of a chemical process plant using computer modelling, and prepare the necessary process piping and instrumentation diagram. Students are expected to make the connections between these modules for themselves; and often this do not happen.

The opportunity to revamp the *Plant Safety and Loss Prevention* module arises from the rationalization of the course structure, where the module was shifted from Year 2 to Year 3 for its "integrative" nature (Cheah and Koh, 2013). This move is very appropriate, as it allows the use of safety topics to integrate the core modules taught in the first two years of study. It also challenge us to design learning tasks that can engage students in critical and creative thinking in relation to chemical process safety, given their lack of practical real-world experience, and the immense amount of background information that is needed to provide the right context to develop deep learning.

Methodology

For the re-designed module, we decided to retain the use of case studies as the pedagogy of choice and to design the entire module around case studies, with enhanced focus using the "Learning from Accidents" approach. Shallcross (2013) argued that case studies had been identified by many educators as an effective method to teach chemical process safety. He also reported on an alternative approach in which groups of students prepare presentations for delivery to the class, each group looking at a different case study. This approach, it is claimed, not only allows students to learn more deeply about one specific case study but it also helps to improve their communication skills. Saleh and Pendley (2012) presented an example whereby the entire subject on chemical engineering safety relies in part on the use of case studies. In all these instances, the most common method of using case studies in promoting student learning is to present selected cases in lectures taking time to highlight key points and the chain of events that led to the disasters. The key learning points are then presented. However, we felt that such approach is not effective, because these 'high-profile' incidents are already very well documented, and students only need to go to Google to look for model answers. As noted by Pitt (2012): "The official 'lessons

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learned' can be pasted in or even memorized for the exam but not applied elsewhere."

The innovation in our approach derives from the insight we gained when we carried out a self-evaluation of the current module based on the CDIO Standards. The details of our approach are covered elsewhere (Cheah and Lee, 2015) and in this paper we only focused on the key outcomes of this effort. Most importantly, we noted that a typical chemical plant can be viewed as a major chemical product or system that went through the same four processes of conceiving, designing, implementing and operating embodied in the CDIO Framework. Applying Standard 1 "CDIO as Context" to this module leads to the new approach to re-design the *Plant Safety and Loss Prevention* based on hazard identification and risk management around the lifecycle of a chemical plant; as shown in Figure 1.

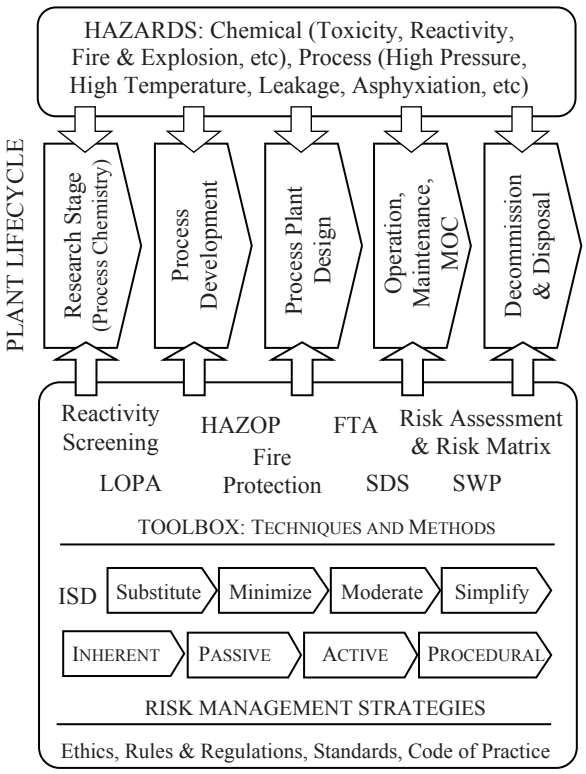


Figure 1. Integrated Approach to Teaching Chemical Process Safety. (List of abbreviations: MOC = Management of Change, LOPA = Layers of Protection Analysis, HAZOP = Hazard & Operability, FTA = Fault Tree Analysis, SDS = Safety Data Sheet, SWP = Safe Work Practices, ISD = Inherently Safer Design)

It had been cautioned that despite the wealth of information from so many accident investigation reports, the transfer of such "Learning from Accidents" had not been satisfactory (Sinclair, 2013). We hope that using the framework in Figure 1, we can better prepare our students in their learning about chemical process safety and apply the lessons learnt in a more effective manner to contribute to accident prevention in the workplace.

The non-technical key features of Figure 1 relevant to this work are briefly explained. The top-most box shows the types of hazards under consideration for chemical engineering, broadly classified as "chemical" and "process" hazards respectively. The middle section shows a typical plant lifecycle (adapted from CCPS, 2009). The large box at the bottom are the key topics relevant to loss prevention in the chemical process industries; broadly grouped as legal requirements, risk management strategies and risk management toolbox.

In this model, we specifically link risk management strategies such as inherently safer design (ISD) to the different phases of the chemical plant's lifecycle. Due to the myriad of techniques and methods available and the limited time for the module, our toolbox is confined to the tools and techniques most pertinent in the field of chemical engineering, in particular HAZOP and LOPA (layers of protection analysis), with special emphasis on Safety Instrumented Systems (SIS) and Pressure Relief Systems. With the “Learning from Accidents” approach, we then select suitable case studies of major accidents and guide students through these case analysis by firstly identifying the stage of the plant’s lifecycle, to identify which risk management principles had been violated, the hazards involved, followed by application of proper safety measures available from the toolbox. With this approach, we hope to encourage our students to think critically and creatively from first principles and not rely on following codes, standards and rules (Lee, 1999).

Another outcome of our module review worth noting is CDIO Standard 6 Engineering Workspaces. At first glance, it would appear that this standard is not applicable to the *Plant Safety and Loss Prevention* module, since it does not have any practical components. In applying this standard in our module review, we extend the interpretation of workspaces beyond that of physical locations to include virtual environments such as those afforded by dynamic simulation (Figure 2).

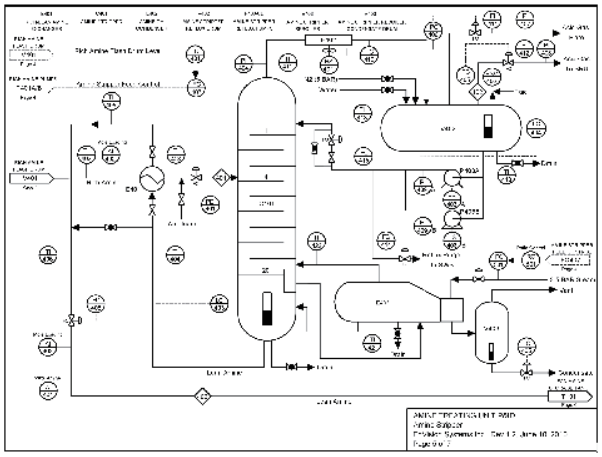


Figure 2. Sample Dynamic Simulation Model showing part of the Amine Treating Unit (ATU) from EnVision

With this, we can scaffold students' learning to build up their understanding of typical chemical process operations, and how to respond to process upsets and

various equipment malfunctions. This involves getting them to think critically (e.g., analyzing, comparing and contrasting, making inferences and interpretations, evaluating) in completing various simulation exercises; which is not possible in the academic settings, and risky in an actual chemical plants. They are asked specific questions to cue these main types of thinking (e.g., what inferences and interpretations can be made from the data presented; what is the best option to solving this problem given the inferences and interpretation being made).

The last CDIO Standard of interest is Standard 8 Active Learning; as it challenges us to look for innovative ways to engage students in studying this module. We decided to adopt flipped learning (also used synonymously with flipped classroom) coupled with peer instruction. Our experience is beyond the scope of this paper and will be shared elsewhere at a later date.

Summary of Programme Implementation

The 60-hour module is completely revamped in terms of its learning outcomes, module contents, and mode of delivery and approaches to student engagement. It is delivered in blocks of 2-hour Lecture and 2-hour Tutorial, for a total of 4 hours per week (hpw), for a total of 15 weeks in a semester. Time required of students for flipped learning is not included in the total module hour. The re-designed module has the following learning outcomes representing higher-order applications:

1. Apply application of loss prevention principles to key stages of a process plant life cycle
2. Explain key terminologies of process hazards and risks
3. Apply layer of protection analysis on a process system
4. Apply hazard analysis techniques for qualitative (such as HAZOP) and quantitative (such as HAZAN) risk assessment
4. Apply fire and explosion prevention and protection principles to chemical design and operation
5. Apply safe work practices according to industrial standards and regulations
6. Examine the ethical and responsibility issues the responsibility and ethical issues in the management of process safety

We use the Bhopal Gas Tragedy as the "anchor" case to illustrate how application of various risk management strategies can be used to avoid the use of dangerous chemical, or to properly assess the risk involve, or to provide more reliable safeguards, etc; as shown in Table 1.

The time freed up with flipped learning allows us to introduce more cases that were originally possible with the earlier curriculum. Where appropriate, we supplement the classroom activities with other case studies, mostly available from the U.S. Chemical Safety and Investigation Board (CSB); but also from YouTube videos and animations from reputable sources such as SIS vendors. We also develop our own case study based on the Amine Treating Unit (ATU) dynamic simulation model available from EnVision Systems. The learning tasks more or less parallel that of the Bhopal case and are used during tutorials (as well as parts of the module in-course assessments) to evaluate how well students are able to apply these concepts. Using dynamic simulation, students can learn how the relevant safety system in the plant is activated when a hazardous condition is detected, and how the hazard is contained.

Table 1. Learning from Accidents using Bhopal Case

Wk	Safety Topic	Bhopal Case
1	Plant lifecycle Risk Manage	Background information
2	Process Chemistry: Inherently safer synthesis	Alternative pathway that avoids using the lethal chemical MIC
3	LOPA: Safety Instrumented System	Insufficient redundancy, inadequate design
4	LOPA: Pressure Relief System	Relief scenarios, wrong sizing of relief valve
5	Risk Matrix, Swiss Cheese	History of past accidents, multiple failures
6	Hazard Analysis: HAZOP	Application to MIC Storage Tank
12	Fault Tree Analysis	Causes of MIC leakage, lack of training
15	Safe Work Practices	Positive isolation, Safety Data Sheet for MIC
17	Summary	Ethics re-visited
Note: No lesson for Mid-semester test week (Week 8), and term break (Weeks 9-11).		

As shown in Table 1, we frequently re-visit the Bhopal case, as the weeks progressed when a new topic is covered. For example, on week 4, students learnt about pressure relief systems (PRS) and they are asked to evaluate various scenarios where an equipment over-pressure may occur. In another example, where students learned about various process disturbances and equipment malfunctions in the ATU in week 5, then revisited the Bhopal accident on week 6, to reinforce and extend their learning through linking how such an incident could have been prevented had a proper HAZOP is conducted. The students are also required to apply HAZOP to other cases, such as the BP Texas Refinery Gas Explosion.

We map out the entire 15-week lesson plan for the module, carefully converting factual information of the cases and theories on the safety topics into online versions for flipped learning. A sample 3-week lesson plan is shown in Table 2.

During later lessons, especially after Week 12, by which we had sufficiently covered various aspects of chemical process safety using Bhopal, ATU and other cases in particular the BP Texas Refinery Gas Explosion, we started introducing additional cases and at appropriate situations, assess students on their ability to relate current case with previous cases covered so as

to apply lessons learnt from previous cases to the case at hand. We conclude the module with an analysis of the ethical issues embedded in the Bhopal case, and then comparing and contrasting these with a case study based on the video "Incident at Morales"

Table 2 Sample Lesson Plan for Weeks 2-4

	Week 2	Week 3	Week 4
Learning Outcomes	Understand the Application and Management of Loss Prevention in Chemical Plants	Understand Basic Components in Safety Management	Understand Basic Components in Safety Management
Flipped Learning Topics	Principles of Loss Prevention Inherently safer process + video Management of change Bhopal video, with specific attention of above concepts	Layer of Protection Analysis (LOPA) Safety Instrumented Systems (SIS) See also link to web page ATU: Process Description	Pressure Relief Systems (PRS), see also link to web page CSB Video: BP Texas refinery explosion Visit W318 Gas Absorption Pilot Plant & line trace
Classroom Activities (2 hpw)	Clarify Bhopal Case Use Bhopal Case and discuss concepts Loss Prevention Principles & Inherently Safer Design, Management of Change	LOPA and SIS as examples of Concepts of Loss Prevention LOPA and SIS in Bhopal Case Readiness Check on ATU Process Description (Q&A)	Analysis of scenarios and sizing of relief valve in Bhopal – not sized for scenario of runaway reaction; sized for vapour only, not V-L flow CSB Video: BP Texas refinery explosion
Tutorial Activities (2 hpw)	Intro (pre-ATU) to Gas treating: ISD in solvent selection Apply inherent safety concepts to Piper Alpha	Worked examples on LOPA/SIS from existing materials ATU Case Study: Analyze LOPA, alarms, SIS	Analysis of W318 Gas Absorption Pilot Plant relief scenarios ATU Case Study: Relief scenarios (including worst-case of vapour blow-through)

As for the design of learning tasks, we strive to attain curriculum alignment (Biggs, 2003) for all the activities introduced in the module. In particular, we are looking for evidence whereby students can identify stages in the chemical process plant whereby appropriate risk management strategies can be applied, using the safety measures appropriate for the hazard identified. This is illustrated with three examples below.

Example 1: BP Texas Refinery Explosion

In this activity, which is carried out in Week 4, the students are required to watch the CSB Video as part of flipped learning. They had learnt about elements of LOPA earlier in Week 3 when analyzing the Bhopal case. Students then had to generate and evaluate possible ways to improve the safety in the BP plant using suitable elements of LOPA.

Example 2: Fire & Explosion at Formosa Plastics

In this activity, which is carried out in Week 13, the CSB Video is watched and analyzed in class, where students identify issues highlighted and organize them under different stages of the plant's lifecycle covered in Week 1. Students are expected to be able to retrieve the proper Safety Data Sheets relevant to this case, having learnt about usage of Safety Data Sheets in Bhopal in earlier lessons. They also need to implement a proper containment measure to mitigate the situation in the plant which is missing in the original design.

Example 3: Learning from Accidents - Valero

In this activity, which is carried out in Week 14, the lecturer play the CSB Video "Fire from Ice – Valero LPG Explosion" in class, and students are asked to answer a series of questions at appropriate points when the video is paused. The questions are listed below.

Q1. What is the financial loss of the incident?
Q2. In terms of separation processes, what unit operation is the Propane Deasphalting Unit?
Q3. What are the properties of propane relevant to this situation?
Q4. What type of fire is this known as? How is it different from that in Feyzin?
Q5. What would be the inherently safer way to deal with the problem of the dead leg?
Q6. Name an example of freeze-protection that can be used.
Q7. What can you recall from the Formosa fire example in handling the fuel source?
Q8. What is fireproofing and why is it useful?
Q9. Back to lesson on inherently safer design – what is the lesson learnt here?
Q10. Feyzin re-visited – what are the lessons learnt that can be applied to this case?

Students are expected to use the knowledge gained from earlier lessons, where inherently safer design, use of Safety Data Sheets, LOPA, etc; are employed, past accidents (namely Formosa Plastics and Feyzin), in the detailed analysis of this case.

We initially thought that the Bhopal Gas Tragedy, given the high profile attention that it continues to attract even to this day, and the apparent abundance of information available on the Internet, will be a relatively straight-forward case that we can adopt for our module re-design work. We soon realized that there were limited technical details in all the available resources that match the learning outcomes we strive to achieve. As a result, we wrote our own background information pack for Bhopal, and reference it throughout the weeks as we explore different safety topics as shown in Table 1. Adapting other past accidents into the module for discussions are more straight-forward. The challenge

here is in going through the vast CSB Database to select the case best meet the desired learning outcomes.

The challenge in "Learning from Accidents" is to understand how one can apply the lessons to one's own processes, even though the process or technology used is different from that involved in another accident from which the lessons are derived from (Hendershot, 2014). The revamp effort is only part of the holistic approach to teaching of chemical process safety. Although it is the biggest part, it is not complete without the other 2 approaches mentioned earlier: that of learning about safety via laboratories activities that simulate real-world practice, and final year projects. As can be seen from Figure 1, the module *Plant Safety and Loss Prevention* focused on the technical aspects of safety management in the chemical process industries. To achieve a truly holistic approach, we will also need to leverage on the laboratory activities to develop other aspects on safety management such as safety culture, which is important element in reducing future re-occurrence of accidents (Capelle, 2013).

Conclusions

As noted by Knegtering & Pasman (2009), in response to the complexity of today's chemical plants, there is a need for a new approach to learn from past incidents. We believe the new approach presented in this paper will better engage students in learning about chemical process safety from past accidents. The re-designed *Plant Safety and Loss Prevention* module was introduced to Year 3 students for the first time in April 2015. At the time of this writing, the teaching of this module is still on-going. We planned to survey the students for their learning experience for this re-designed module, to identify areas where they faced challenges, and formulate action plans to address them as part of continual improvement.

Acknowledgement

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Attempt of PBL to Solve Regional Problems

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Abstract

Our PBL is based on the problems that local community is struggling with now. Our goal is that students offer the ideas of solving them with technologies through group learning. We expect that the student will get three abilities, (1) the independence and cooperation of students in the school program, (2) the ability of surviving in future world, (3) the ability to think about the future from the perspective of the regional, national, and world. We make a repot of the present situation on this paper.

Keywords: *PBL, local community, active learning, ICT*

Introduction: purpose of PBL

Kochi has struggled with various problems which has appeared in the age of structural changes of post-industrial era. Because of aging population and declining birth-rate, the productive age population is declining. Kochi is in great trouble. In other words, there are a lot of needs. For example, development of the primary products with additional value, solving the labour shortage issue especially in construction industry and care works, the countermeasures for the large-scale earthquake, building of the efficient care service system for the aged, constructing information system and security and so on.

Our Learning is based on these problems and the projects to offer the ideas of solving them with technologies. It is our goal that students think and express the ideas about the local area, namely "homeland", and technology by themselves. We expect that the student will get three abilities, (1) the independence and cooperation of students in the school program, (2) the ability of surviving in future world, (3) the ability to think about the future from the perspective of the local, national and global.

Unique points of this attempt

We have two unique points. First, this attempt is based on integration of arts and sciences. The teachers cooperate across the disciplines. Mainly, teachers of social sciences give guidance to students. And some teachers (as experts of technology) of engineering often come to the classroom and give advices to them about technology and natural science. Students hereby could combine some intellectual frameworks to proceed with the project. It is unique point of this attempt. Second, students experience international communication "casually". They will make blog or Homepage in English.

Learning environment

This learning held in the "active learning room" (Figure 1). It has 45 movable desks and chairs, and iPad-mini. Each student can use it to research. The home page is made for this learning with iPad-mini or PC and shows students links to governmental and prefectural policies etc. on the homepage.



Figure 1 Active Learning Room

Method and schedule

The participants are in the third grade of four classes (departments). The number of each class is 44 at most, total 172. They belong to one of four departments in NIT, Kochi College and usually study mechatronics, electrical engineering, information science, materials science and civil-engineering.

Our PBL continues for a year, that is, started in April in this year and will end in March in 2016. Each class hold once a week (50 minutes) and 30 hours in total. We use an active learning that incorporates the group work. They make small groups (about 4-6 people), for promoting the research and proposals.

This PBL consist of six stages.
(1) Learning of the basic issue (8 weeks)

Back

Students learned the basic issue about structural changes of post-industrial era and situation of local areas in contemporary Japan. And they read and understood basic local policies or economical and social statistics of Japan and Kochi. They confirmed what they had learned in first half-year midterm examination.

(2) Lectures on technology (1 week)

After first examination, teachers of each department came to classroom and lectured in contemporary technology (Figure 2). There were seven themes; robotics, energy technology, information security, material science, biotechnology, civil-engineering, architecture. Student chose one theme that they interested in.

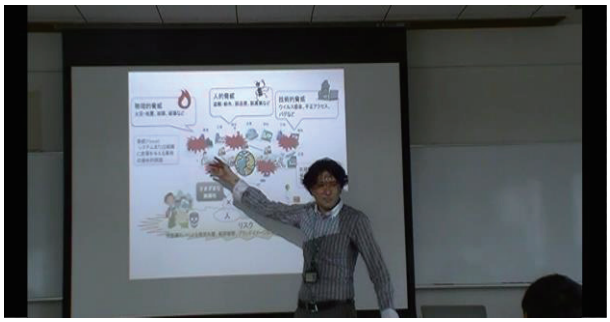


Figure 2: Lecture of experts

(3) Theme setting and making groups (6 weeks)

Each student tried to find out his or her theme in two weeks by him- or herself at first. It is common framework to find out the field of technology that should solve above-mentioned local problems. Then the groups were made. Everyone showed their own theme to the group members. Now they are devising one (integrated) theme for their group work. Not only teacher in charge (first author) but also various teachers including second and third authors give advices to students about theme stetting.

(4) Research and making of presentation materials (summer vacation and 6 weeks)

Students research the situation of technology and local problems that they devise. They have to gather three types of information about their theme. 1. General information: The basic information that anyone gets through Internet or the books, 2. Inherent information: Information, document and the statistics which are available from the field, 3. Information of experience: Information which is provided by an interview with the persons and organization concerned.

Then they analyze the information and make presentation materials. And they launch a blog, which will publish the results of their investigation. Teachers as experts periodically check the blog, and give advices in the comments section for providing guidance.

(5) Presentation (3 weeks and outside the school)

Presentation will be held 10 minutes for each group in the classroom. It is evaluated by mutual assessment of students. And students make a presentation outside the school, for example in the 37th. Cultural Festival of NIT in Sikoku in December, cultural event in Centre of Industry-Academia-Government Collaboration in Kochi (CoCoPla).

(6) Self-reflection and international communication (6 weeks)

This is very important stage for this learning. Students make their own portfolio through the learning. Based on it, they reflect the work by themselves and drew up a proposal paper. It will be presented on the Internet. We will tell the parents, local people and the experts in and outside the school about what students obtained. Furthermore students make blog in English. We will participate in OECD-project "Innovation School Network 2030". We would like to let the experts abroad know the outcomes of students in this project. We expect that all give students advice or encouragement.

Way of performance assessment

We use three ways of performance assessment; (1) mutual assessment of students, (2) self assessment of students, and (3) four-time examinations. Mutual assessment is mainly used in the presentation. Self assessment is included in the examinations. Teachers evaluate not only what they learned but also to what extent they can look after themselves and their groups.

Achievements at this moment and provisional conclusion

Students have discussed about theme with their all heart. And now they are in the 4th stage. Each group made a theme (Figure 3 and 4).

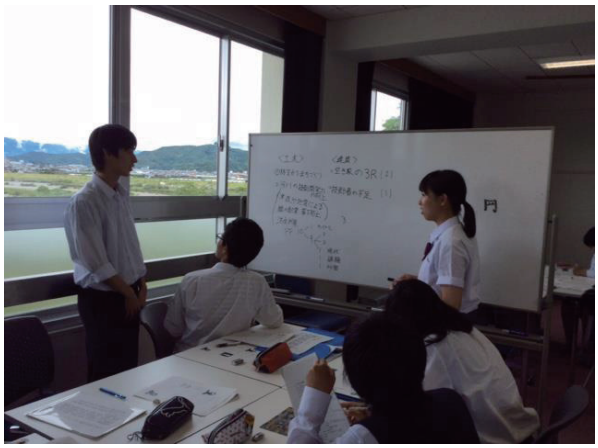


Figure 3: Group Discussion (1)

Back



Figure 4: Group Discussion (2)

24 themes are all out. Students have found out the five major regional issues (Figure 5).

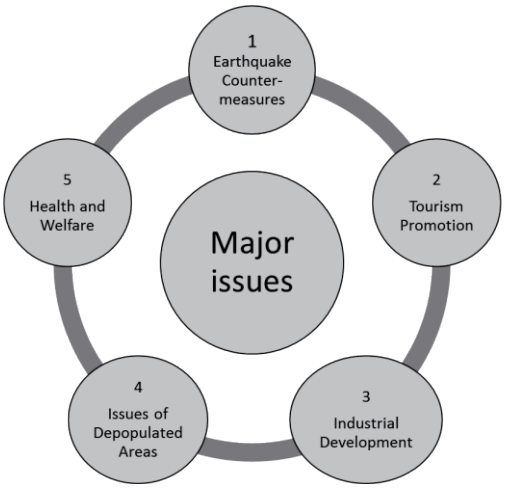


Figure 5: Five issues, that students found out.

The following (Figure 6 and 7) are the details about theme 1 and 3. (Abbreviations in the figures show the departments; M: mechatronics, E: electrical engineering and information science, C: materials science, Z: civil-engineering and architecture. Number after Abb. shows number of group.)

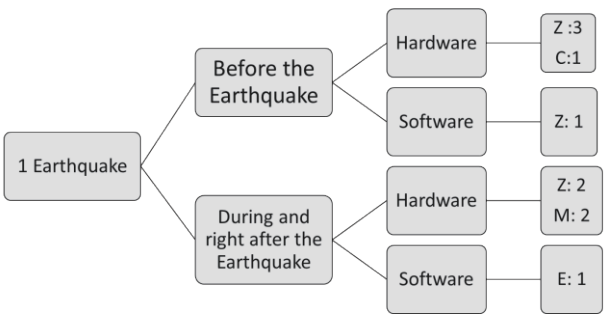


Figure 6: Themes of Groups about the earthquake countermeasure

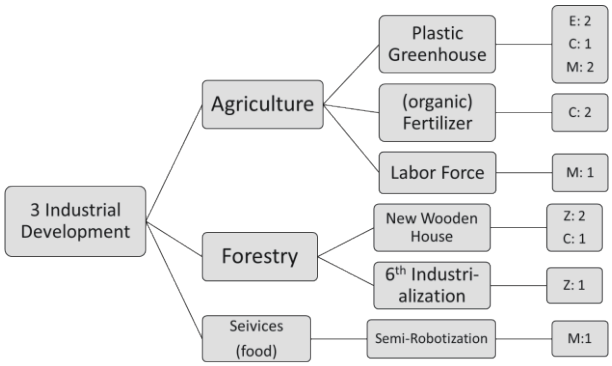


Figure 7: Themes of Groups about industrial development.

It is very interesting that students begin to make interdisciplinary communication. Students asked teachers for advises when they worked with the theme. 3 groups asked the teachers of other department without connection of club or extracurricular activities.

And we showed them all themes and the relationship map of groups like figure 5, 6 and 7. They can compare and cooperate each other. They are curious as to how groups of other departments cope with the same theme.

We mentioned the three aims of this PBL above. Especially the "independence and cooperation of students" grow among students. We have to go to next two aims. Information gathering is one of the largest issue in this regard. Student must and will find the information for their own work by themselves. There is no "the right answer" like a usual tests. We believe that it is the ability of surviving. We hope to report their whole achievement in the next time.

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Regional Promotion of Ideas and Innovation -An Examination of the Design-a-Roomba Contest-

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Abstract

The aim of this article is to introduce a robot idea contest, which is part of National Institute of Technology, Kagawa College's regional cooperation activities and designed to revitalize local communities and help people in the community to become more familiar with robots. The NIT, KC, has conducted many activities with Mitoyo City. This robot idea contest focuses on the "Roomba" platform which is the most popular robotic cleaner. This idea was brought about by receiving total cooperation from Sales On Demand Corporation (SODC) who is the sole licensed distributor of the "Roomba" in Japan. NIT, KC and SODC have a common goal of boosting the local area economy with robot technology. This contest was designed to be an educational effort to encourage students to generate their own ideas. Therefore, the contest accommodated any kind of ideas about the Roomba. Thus, the contest had three different categories for entries. The categories included a "New Roomba", which was for creating new functions for existing Roomba model, the "Dream Roomba", which was for designing a totally new Roomba and the "Mitoyo Roomba", which was based on Roomba designs specifically for use in and around Mitoyo City. To present them, students submitted their ideas in the form of 1 page Power-point proposals. During their idea brainstorming process, students were given a lesson on slide design, balance of colour, basics of chromatics and other tips for making their presentation eye-catching and concise.

The contest received a total of 98 idea submissions. NIT, KC and SODC developed exhibitions for displaying the ideas. The exhibitions were held at three places in Mitoyo City, as well as four places in Takamatsu City. Additionally, these exhibitions got local media coverage and received favourable comments from visitors. From the results, it could be concluded that the activity was successful as a regional improvement, educational effort and activity that generated awareness and promotion of robot technology.

Keywords: *Idea contest, Regional cooperation activity, Roomba, Robotics engineering*

Introduction

This Design-a-Roomba Contest was designed to revitalize local communities and familiarize the community people with robots. The National Institute of Technology, Kagawa College has conducted many activities with Mitoyo City, located in Kagawa Prefecture. This contest is part of our regional cooperation activities.

This robot idea contest settled on the "Roomba" platform which is the most popular robotic cleaner. This idea was brought about by receiving total cooperation from Sales On Demand Corporation (SODC) who is a sole distributor of the "Roomba" in Japan. NIT, Kagawa College and SODC had a common goal of boosting the local area awareness about robot technology.

This contest was designed to be an educational effort to encouraging local students to generate their own creative ideas. Therefore, the contest tolerated any kind of idea based on the Roomba to promote generation of ideas. They needed to submit their ideas in the form of one page proposals presenting their ideas with single page submissions. The students were given lessons on design, balance of color, basics of chromatics and tips for making the presentation.

After the submission, NIT, KC and SODC developed exhibitions for the ideas at eight sites around the area. The exhibitions were held in three places in Mitoyo City, including city center and city hall, five places in other cities including the largest commercial establishment in Takamatsu city, Takamatsu Center Library, a central branch of a Bank and JR station and Takamatsu Airport. Additionally, this exhibition got local media exposure and many favourable comments from visitors.

In this paper, our regional promotion activity, which was the "Design-a-Roomba Contest", is introduced as one success example of regional cooperation activities. First, some history of regional cooperation activities of NIT, KC is described. Next, what lead to the cooperation between SODC and NIT, KC is described.

Finally, an outline of the contest and exhibition of the contest are explained.

History of Regional Cooperation with Mitoyo City and Background of Cooperation with SODC and NIT, KC

NIT, KC has coordinated many activities with Mitoyo City. Especially with the author's laboratory, NIT, KC has carried out various activity to promote Mitoyo City where it is a small and local city in Kagawa prefecture. Here, how this cooperation has been realized is described as a success example of regional cooperation.

The author's laboratory in NIT, KC have carried out collaborations on Awashima Island, a small island near NIT, KC Takuma Campus, PR jobs in Ikebukuro City, Tokyo since 2009 in coordination with Mitoyo City and residents of Awashima. The PR job brought good results every year, therefore this activity has been able to keep running in the face of a declining budget. Through this activity, great deal of cooperation was elicited from the people who have visited and stayed or lived on Awashima Island. The authors built a coalition with a superintendent of sales in one of the world's largest news service company through this activity.

In 2012, a ladybug Roomba was developed as a new project for this exhibition as shown in Figure 2. The ladybug was made of a Roomba and a handmade cover that was made by an artist who lived on Awashima and has participated in the activity every year. Irrespective of age or sex, many visitors thought of the ladybug as pretty and enjoyed playing with it. With that in mind, the participant began considering about holding some event having to do with the Roomba.



Figure 1 Awashima Island PR activity in Ikebukuro City



Figure 2 Ladybug Roomba at the Awashima Island PR activity

In 2014, the news service held a news photo exhibition on Awashima for two months and two weeks. It was the residents of Awashima Island that prepared for the exhibition. As part of other regional cooperation activities, the author's laboratory has participated in volunteer work such as traffic control and guidance for one month. This volunteer activity was remarkably helpful for tourists. Therefore, Kagawa University began participation in this activity and the author's laboratory turned over the organizational role to the university. The author's laboratory, the news service and residents of Awashima enhanced their relationship thorough this activity and gathered enough momentum to hold the proposed Roomba event.

After the photo exhibition, SODC and NIT, KC met through the contact personnel's good offices and introduced SODC to the author. The authors started to seek a way to promote the robot product and local city at the same time. The authors planned and realized the Design-a-Roomba Contest.

From the result of this sequence of the events, it can be confirmed that regional cooperation activities hold the possibility for growth. The important thing is to increase the number of members who participate and promote the activity. Volunteer activities might be difficult to keep doing because some faculty members and students might feel that they can get little benefit. Thus, the coordinator must be able to show benefit for both students and faculty members. For students who have not participated in the activities many times and live in a local city like those of NIT, KC, to participate in some events held in the big city can be of great benefit. Also, to meet and talk with persons on the outside can be a great experience for them. For faculty members, to meet and cultivate new relationships with others on the outside and gain new opportunities for future research or activities that can be a new and representative project, they will also gain the possibility to get financing for their research.

Outline of Design-a-Roomba Contest

In this section, an outline and the rules of the idea contest are described. The categories of the contest

included a ”New Roomba”, which was for creating new functions for existing Roomba models, the “Dream Roomba”, which was for designing a totally new Roomba and the “Mitoyo Roomba”, which was based on Roomba designs specifically for use in and around Mitoyo City. The students could submit their ideas to any category they like. As shown in Figure 3, template files were provided to make their proposals. The students needed to decide and write the theme for their idea on the form. The students were also allowed to write sentences and draw figures to explain their ideas. Lastly, a form for the trigger of the inspiration at the bottom of the paper should be filled out.



Figure 3 Template for the idea contest

First, students brainstormed creative ideas and wrote down or made some rough sketch as shown in Figure 4. Then, they made their own proposal using the notes or the sketch. During their idea brainstorming and organizing process, students were given a lesson on slide design, balance of color, basics of chromatics and other tips for making their presentation eye-catching and concise as shown in Figure 5.

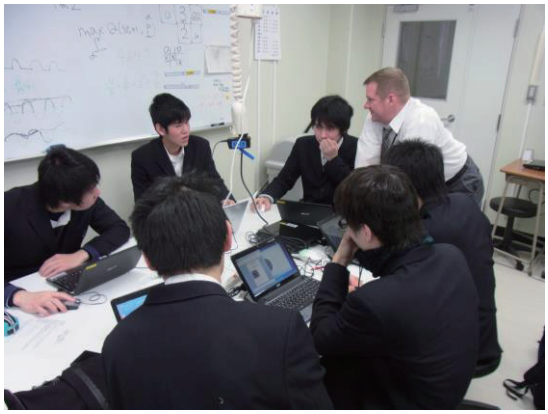


Figure 4 Brainstorming Session



Figure 5 Lesson of Slide Design, Color Balance and tips for making presentations

After these sessions, the students submitted their own idea within 2 weeks. As the result, the contest received 98 submissions.

Award Winner of the Design-a-Roomba Contest

The contest received many well thought out ideas. Three award winners were featured as representatives of the applicants here. The awards were the “iRobot Award”, “Mitoyo City Mayor Award” and “Collaborative Education Center of Emerging Technology Award”.

The theme of the iRobot Award winner was a “Dream Roomba for Seabed Cleaning” as shown in Figure 6. The idea proposed that the Roomba detect garbage on the ocean floor and collect the garbage. The student who conceived of the idea came up with it when he saw garbage while fishing. The judges of the iRobot award evaluated that the idea focused on environmental reclamation by picking up the garbage that might contribute to pollution of the ocean.

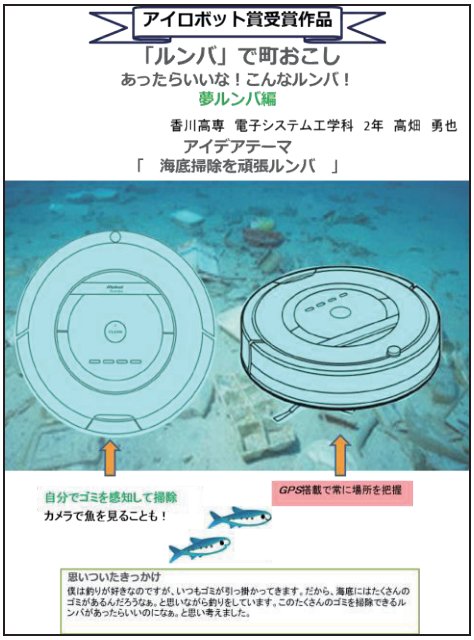


Figure 6 iRobot Award Winner

The theme of the Mitoyo City Mayor Award winner was a “New Roomba for Rice Cultivation” as shown in Figure 7. The idea proposed that the Roomba help farmers plant and harvest rice using two arms attached to the body of Roomba. The student who conceived of this idea assumed that the Roomba should be bigger than the normal Roomba for the bigger scope of work. The student came up with this idea because Roomba can memorize the tractor path in the rice paddy. The judges of the Mitoyo City Mayor award gave their evaluation based on that the idea focused on rice cultivation which is one of the main agricultural businesses in Mitoyo City.

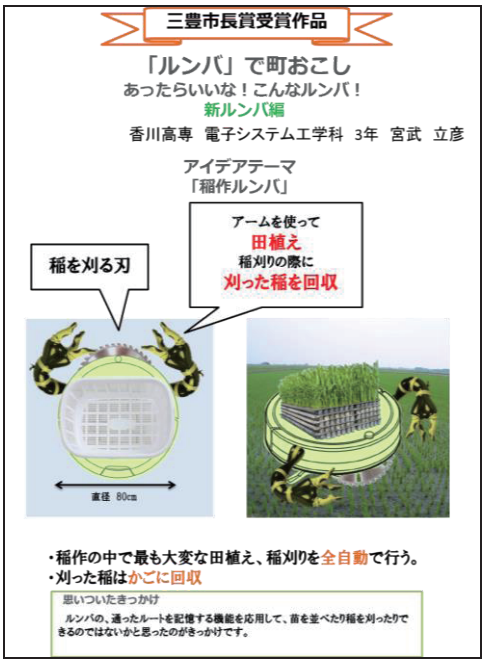


Figure 7 Mitoyo City Mayor Award Winner

The theme of the Collaborative Education Center of Emerging Technology Award winner was a “New Roomba for Timely Administering of Medication to Patients”, as shown in Figure 8. The idea proposed that the Roomba helps people who need to regularly take prescribed medication and is also in need of nursing assistance care. The new Roomba is assumed to be much smaller than the standard Roomba because the new Roomba would operate on a desk or counter. The new Roomba picks up the medication at a scheduled time from the base station and deposits them on the desk for the patient. In addition, the new Roomba checks whether the person has taken the drug or not and logs the administration of the medications. The student came up with this idea when she considers the burden of health care workers. The judges for the Collaborative Education Center of Emerging Technology award evaluated that the idea focused on supporting persons who need to supervise the elderly who are on a medication regiment.

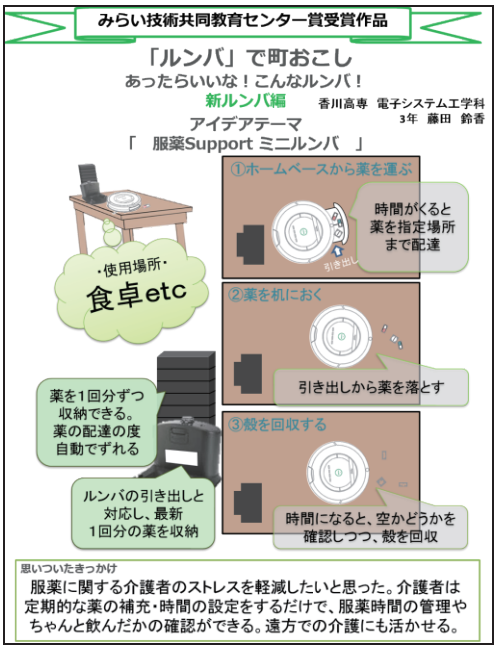


Figure 8 Collaborative Education Center of Emerging Technology Award Winner

Exhibition of Design-a-Roomba Contest

To demonstrate the student’s well thought out ideas to the public, all of the presentations were displayed at the exhibitions. A total of 8 exhibitions were held in Kagawa prefecture. The three sites in Mitoyo City were City Center and City Hall, five sites in another cities including the largest commercial establishment in Takamatsu City, Takamatsu Center Library, a central branch of a Bank, JR Takamatsu Station and Takamatsu Airport. From 20 to 60 presentations were displayed in each of the places. From the efforts of SODC, signboards that showed the title of the contest and panels that explained the intent and purpose of the contest were made and displayed. Especially, at Takamatsu Center Library, the authors made various cards to introduce books related to robots, making presentations, methods to generate ideas and electronic circuits as shown in Figure 10.

These exhibitions got local media exposure and many favourable comments from visitors.



Figure 9 Exhibit Site at Takamatsu Airport

Back



Figure 10 Exhibit Site at Takamatsu Center Library

Future Work

SODC and NIT, KC have the next Design-a-Roomba Contest in contemplation. The next contest will advertise for ideas to all regional colleges of NIT. The theme will be “Robots that Address Regional Problems”. Many regions will have both unique and also universally shared problems. NIT has a national network, thus if the contest can be realized, many kinds of ideas to solve social, ecological, and economical problems can be generated and shared.

Conclusions

In this paper, the Design-a-Roomba Contest was introduced as a successful example of regional cooperative activity. The contest was designed to revitalize local communities and familiarize the community people with the potential that robots may provide in the near future. SODC the sole distributor of Roomba and NIT, KC has a common goal of boosting the local area with robot technology potential and awarenes. This contest was also designed to be an educational effort to encourage the students to generate their own ideas.

After the submission, NIT, KC and SODC developed exhibits in eight sites in Kagawa prefecture. The exhibits were displayed at three places in Mitoyo City, and five places in other cities. As as a result, the exhibition got local media exposure and many favourable comments from visitors. Additionally, SODC and NIT, KC have the next Design-a-Roomba Contest in contemplation.

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FUTURE HEI OF ENGINEERING INNOVATION

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Abstract

Turku University of Applied Sciences has prepared a new strategy to 2025. The new strategy has four strategic programs. One of those is building a new future higher education institute of engineering innovation. The basis of this new institute of engineering innovation is our pedagogical model called innovation pedagogy. Innovation pedagogy integrates entrepreneurship, applied research and development, and internalization with education and working life. In engineering education innovation pedagogy is implemented with the CDIO approach. Both innovation pedagogy and CDIO are not new to our university rather we have been working with them many years. For example our university joined the CDIO initiative in 2007. We have been active in pedagogical development and continuous improvement, but with the new strategy we want to take our university into next level. We are aiming at excellence in action. Our goal emphasizes international professional excellence. Our success will be measured with the generated innovations and entrepreneurship. The new future higher education institute of engineering innovation has four fields of operation in focus: maritime cluster, circular economy, sales and digitalization. The development of these themes will be implemented through four areas of improvement. These areas are new structures, new teacher, new learner, and new culture. New structure aims at more flexibility in learning and increase of project based learning. New teacher means transforming teacher profession from pure expert to more coach-like profession without losing strong expertise. New learner means strengthening intrinsic motivation for learning and enabling individual learning paths. The previous three requires changes in the learning and teaching culture. Our strategic goal means also raising the level of studying and requiring more from all members of our community. The strategy implementation will start in June 2015. This paper describes the background of the strategic choices and shows the implementation plans of the various aspects of the strategy. The paper will provide fresh ideas for engineering education development from the perspective of an experienced CDIO university.

Keywords: *innovation pedagogy, CDIO, new engineer, new culture, new teacher, strategy*

Introduction

Turku University of Applied Sciences is a multidisciplinary university located in southwest Finland (www.tuas.fi). We have almost 10000 students and offer over 30 different bachelor and over 15 different master programs. We identify ourselves as an entrepreneurial university. An entrepreneurial university seeks to innovate how it operates and functions in its business constantly (Clark, 1998). Shattock (2010) shares this idea when saying *successful universities will always seek to improve their performance in teaching and research.* As part of this continuous improvement we launched new strategy formulation process in autumn 2014. The new strategy was targeted to year 2025. The objective of creating a new strategy was to achieve and sustain the success of an entrepreneurial university.

The strategy formulation process had following phases:

1. Where we want to be in the future?
2. Internal discussions
3. Management workshops
4. Planning of strategic programs
5. Finalizing the strategy
6. Implementation startup.

The first phase included over 70 interviews with industry and regional stakeholders. In addition, most available national and regional strategies and future reports were studied. Furthermore, a web questionnaire was opened for public to participate to the discussion of the future of our university. The goal of this first phase was to identify important strategic aspects and to create a preliminary strategic plan for our university. The second phase focused on internal discussion of the preliminary strategic plan. Discussions were held with all faculties, employee and student representatives in order to engage the community to the strategic plans and get their contribution to the plans too. In the third phase management workshops were held to formulate strategic plan, first strategic programs and preliminary key performance indicators. Fourth phase focused on the strategic programs and the concrete actions within them. Finally, the strategy was formulated in a presentable format and it was officially published. After the official launch strategic programs are further designed, key

performance indicators are taken into program and personal level, and personnel are challenged to initiate concrete proposals to the strategic programs.

The new strategy of Turku University of Applied Sciences has four key strategic programs: 1) Future higher education institute of engineering innovation, 2) Wellbeing development, 3) Innovation pedagogy learning continuum and 4) Inspiring community. Each programs is led by one of the deans. This paper focuses especially on the first strategic program, future higher education institute of engineering innovation. We describe the background of the strategic choices and show the implementation plans of the various aspects of the strategy. Furthermore the paper will provide fresh ideas for engineering education development from the perspective of an experienced CDIO university. The strategy implementation has started in June 2015.

Excellence in action

The leading theme in our strategy is *Excellence in action*. Our goal emphasizes international professional excellence. Our success will be measured with the generated innovations and entrepreneurship. We have been active in pedagogical development and continuous improvement, but with the new strategy we want to take our university into next level.

Our education is based on innovation pedagogy (Kettunen, 2011). In engineering education 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. For example our university joined the CDIO initiative in 2007. Still, this strategy is our first that truly combines the strengths of both. Actually innovation pedagogy and CDIO complement each other well (J. 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 strategic program of future higher education institute of engineering innovation has four fields of operation in focus: maritime cluster, circular economy, sales and digitalization. These focus areas are well rationalized. Maritime cluster is one of the major industrial sector in Turku and it has strong connections to our university operations. Circular economy is clearly newer theme, but it is recognized in the current program of Finnish government stating an objective that in ten year time Finland is a pioneer in circular economy among others (Prime Minister's office, 2015). Sales is essential part of getting engineering products succeed, but still sales has not been natural part of engineering education. Our strategy establishes role of sales education in engineering. Digitalization is emphasized in the current program of Finnish government too (Prime Minister's office, 2015). In addition, the importance of digital skills are stated in the European Commission (2013) 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).

Building engineering excellence in action requires multiple new minds to understand and solve problems and to create and innovate. As Goldberg and Somerville write a whole new engineer needs to extend and build six minds: analytical, design, linguistic, people, body and mindful. (Goldberg & Somerville, 2014) The figure 1 below summaries the foundation of the future higher education institute of engineering innovation in Turku University of Applied Sciences.

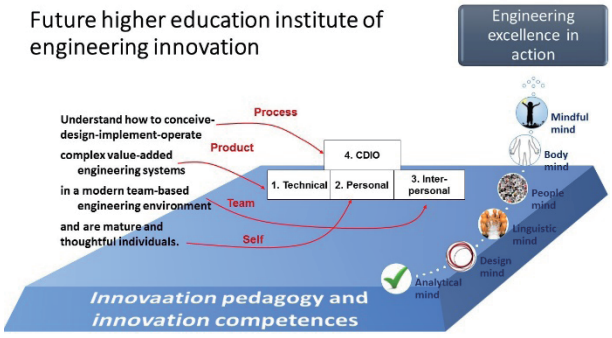


Figure 1. Future higher education institute of engineering innovation.

Building the future higher education institute of engineering innovation

Building of the future higher education institute of engineering innovation will be done through four areas of improvement. These areas are

- new structures
- new teacher
- new learner
- new culture.

New structures

New structures aim at more flexibility in learning and increase of project based learning. These new structures deal strongly with the curriculum and implementing learning and teaching. Reforming curriculum can be rewarding since curriculum change can create positive environment for promoting strategic plans (Kandiko & Blackmore, 2012). This is a question of reforming

engineering education which according to Crawley et al. (2014) is best addressed on a department or program level. This way common expectations for faculty performance and student responsibility for learning can be set and maintained (E. Crawley, et al., 2014).

First degree programmes have already volunteered to reform their curriculum. Among them are Chemical and materials engineering and Business information systems programmes for example. General principles of our curricula reform include following (J. Kontio, 2014): a) curricula is based on relative large modules, b) study year is divided in five periods (9 weeks, 7 weeks, 9 weeks, 7 weeks and 7 weeks), c) introduction to – courses in first semester, d) multi-disciplinary innovation project (15 credits) in third year of studies, e) elective modules in the beginning of second and third year (15 credits each). These general principles have been further discussed and project based learning will be further emphasized. Our goal is to have large project modules in every study year. Confederation of Finnish industries (2011) share this ideology in their report stating that at best learning is done in projects where students grasps information through phenomena and problems. Introducing project based learning we create integrated learning experiences and provide broader competencies, encourage creativity and entrepreneurial attitudes that are all seen important structures of contemporary curriculum (E. Crawley, et al., 2014; Göran et al., 2015).

Flexibility is another key term in new structures. As mentioned earlier we have already a lot of flexibility in our curricula, but what we can still increase is learning pathways within our university as well as between institutions just like the recent report about Finnish higher education suggests (Göran, et al., 2015). While increasing flexibility we must take care of study counselling, mentoring and guidance (Kandiko & Blackmore, 2012). We should provide lifelong learning opportunities for students of all ages who, for career and life-style reasons, seek to re-enter the education system, including those who already hold a Bachelor's or Master's degree (Göran, et al., 2015). Therefore we have started discussion with universities to provide new learning pathways for our Bachelors to Master studies in science universities. Furthermore we are developing our own Master programs to better answer the needs of the working life. Master programs in university of applied sciences require minimum of three year working experience after the Bachelor degree. We have identified two main interests of the possible students: leadership focused programs and technological focused programs. Leadership focused programs will provide skills and knowledge on leadership and management and aim at helping the students to take the next step in their career. Technological focused programs on the other hand focus on certain technological field and aim at deepening the skills and knowledge on the specific field. These programs are constantly open for new students whereas the leadership focused programs are open only on certain application period. Technological focused programs will be strongly connected to our research groups and a student will become member of a research group while studying.

New teacher

New teacher means transforming teacher profession from pure expert to more coach-like profession without losing strong expertise. We should move from teaching to guiding of learning (Eskola-Kronqvist, Mäki-Hakola, Mäntylä, & Nikander, 2015). Our teachers will become coaches and facilitators that lead and guide the learning experiences. There must happen a shift from contact hours and lecturing to new ways of teaching and learning, which many of our personnel we have been doing already. Still, there is room for stronger shift into this new direction. We will move to more learning-focused education and while doing so current faculty must be supported in their personal development and use of teaching and learning techniques (E. Crawley, et al., 2014).

Although we have had innovation pedagogy around for some years already it still needs to be discussed and our personnel needs to be trained for it. Innovation pedagogy learning continuum is one of the strategic programs of our new strategy. One central action in this strategic program is to arrange personnel trainings in innovation pedagogy. In addition to the innovation pedagogy concepts and models we have identified the need for strengthening personnel skills in modern ICT-tools that can support teaching and learning. This strong need of teachers' skills in ICT, virtual teaching and learning is acknowledged nationally too (Eskola-Kronqvist, et al., 2015; Prime Minister's office, 2015). For this we have been building an ICT tools testing and learning environment for our personnel together with Microsoft. This will be opened in autumn 2015 and after that we will start training sessions for personnel.

In addition to the pedagogical skills we must make sure that our personnel's skills and competences in engineering and their own expertise area are up-to-date and relevant. The change process requires strengthening the competence of faculty in engineering skills (E. Crawley, et al., 2014). We must not leave our personnel alone here rather we need to support this transition. One solution that has been planned is working life periods for our personnel. There are plans that every faculty member has a working life period within a certain timeframe. This period can be for example three months or even longer. We have some experiences on this kind of activities in part of our university (E. Kontio, Lakanmaa, & Kontio, 2015; J. Kontio & Suni, 2008), but now we want to enlarge it to the whole university. The main goal of this is not only to provide updated working life experience to our personnel rather also strengthen our connections to the industry and provide information to the industry on our operations and possible co-operation opportunities.

In addition to supporting our personnel in their engineering skills we are also planning to introduce a system of visiting professional professor. A visiting professional professor is a recognized expert in his own field working in industry or in higher education. As a university of applied science we are strongly emphasizing the professional expertise – relevance to real working life and industry. He/she will be hired for

our university for a predefined period and he/she will work according to mutually agreed plan. This plan can include various tasks in teaching and in research and development. The visiting professional professor system can be used to complement certain expertise field or it can be used to introduce new expertise fields. During this autumn we need to identify the first expertise fields for visiting professional professors and also identify possible candidates. At the same time we need to solve the practical matters relating to the hiring of a visiting professional professor. Probably large amount of the visiting professional professors will come abroad from our partner universities. This ideology fits well with the recent report (Göran, et al., 2015) stating that Finnish higher education and research are in great need of strengthened internationalization.

The activities presented in this new teacher section are well supported in the CDIO approach too. Standards 9 and 10 deal with faculty skills in engineering and in teaching and learning (CDIO, 2014b).

New learner

New learner means strengthening intrinsic motivation for learning and enabling individual learning paths. Strengthening intrinsic motivation is important because when intrinsic motivation is enhanced students are more motivated and inspired to the subject they are working on (Goldberg & Somerville, 2014). Goldberg and Somerville (2014) give several ways to support intrinsic motivation:

- Autonomy: student can make meaningful choices on their education
- Purpose: student do things that matter to their peers and to the world at large
- Mastery: student experience feeling of being able, effective and doing well.

The listed ways are relevant when we define our curriculum activities. It is essential that we have these elements in balance. We have to provide enough autonomy, but at the same time students must have the sense of mastery. Similarly the projects and activities have to have a purpose. Earlier we have already experienced that intrinsic motivation is affected with these factors. A good example is our innovation project that has been very successful and interesting project module. However, there are still too much teaching and learning where extrinsic motivation has a major role. Reforming this is not a simple question rather it deals with the curriculum structures, teacher's pedagogical skills and also students' abilities. Our new structures and new teacher areas of improvement have to keep these requirements of new learner in mind too. For example enabling individual learning paths is an area where these areas of improvement overlap. Individual learning path is also a direct answer to autonomy thus intrinsic motivation.

Another thing that has been discussed here is renewing our entrance examination system. We think that the current system does not support us to get those students who truly have the intrinsic motivation for their field of study. We would like to have an entrance examination that is more like the actual studying and thus prepares the students the way learning will take place. A big challenge here is that the entrance examinations are national and changing our exam to something else means that it is has to be managed by us alone.

New culture

The previous three areas of improvement require changes in the learning and teaching culture. Effective learning depends heavily on the interaction of faculty and students. Typically it is a question of attitudes such as cooperativeness, goodwill and openness. In other words this is a question of cultural change. (Blackmore & Kandiko, 2012; E. Crawley, et al., 2014) Our strategic goal aiming at *Excellence in action* means also raising the level of studying and requiring more from all members of our community. It is not a matter of fixing something that is broken, but improving something that is vital to our future technological education (E. Crawley, et al., 2014). We can do better!

Shattock (2010) has written that successful strategic management is highly dependent on a supportive institutional culture. CDIO approach is also calling for a new cultural framework or environment because it is the context that supports learning (E. Crawley, et al., 2014). As a higher education institute we need to react and transform ourselves to the changes in the external environment. The external environment demands a change in the culture of engineering education – engineering education must change to survive in a world of ubiquitous information and accelerating technological advances (Goldberg & Somerville, 2014).

Creating a new culture is not an easy task. Clark (1998) has presented five general change pathways for universities. First, the strengthened steering core is needed because the complexity of universities has increased and the pace of change has accelerated. Second, the expanded developmental periphery refers to the need to reach across the old university boundaries, link with outside organizations and groups and build outreach structures such as research centers. Third, the diversified funding base becomes essential when the governmental funding base is hardly increasing. Fourth, the stimulated academic heartland emphasizes the need to achieve changes in the departmental level and turn them to entrepreneurial units reaching outside with new programs and relationship and promoting new income sources. Fifth, the integrated entrepreneurial culture refers to the work culture that embraces change and creates ground for new practices and innovations. Our new strategy seems to emphasize most of the pathways – only the third pathway is not emphasized in the strategy. Reason for that is in the recent years and the changes in the national funding model thus forcing us to focus those issues already earlier. Altogether these pathways all deal with culture – the way our university operates and what we see relevant to us. The importance of culture and required change can be summarized in a citation from a book by Goldberg and Sommerville (2015): *If we are going to trust students, if students are going to have the*

courage to take risks and learn from failure, if we're going to move from competitive framing of education to a collaborative one, if we are going to develop students' openness and willingness to reflect, and if we hope to make the learning of engineering joyful instead of painful, we will need to change not just the curriculum. We need to create a new culture of engineering education!

Discussion

Our strategy is very well aligned with the recent reports on higher education in Finland and the new governmental program. According to Göran et al. (2015) one of the key objectives of the Finnish higher education system is to enhance sustainable economic growth, employment and competitiveness. Similarly, the economy and employment in Finland can be restored to growth only through entrepreneurship and work (Prime Minister's office, 2015) and economic function of higher education, and its role in meeting the skill needs of the changing labor market, is seen as central to Finland's future (Göran, et al., 2015). Our strategy is easily understood and it has clear strategic programs that guide our strategy implementation. However, a key question in the future is how we can maintain the new way and not to be drawn back to the old ways of doing and working. In Graham's (2012) study this was identified as one major challenge. She identified several activities that can support lasting change. Many of these can be identified in our strategy process such as communicating the new strategy clearly and engaging the university community to the strategy process.

A report by Confederation of Finnish Industries (2011) encourages us to focus on two things throughout the educational system to obtain change: educating skills alongside information and doing together instead of stressing individual performances. Our strategy process seems to fulfill these: skills and information are going alongside in our curriculum and we are emphasizing inspiring community as one of our strategic programs.

The foundation elements of the future higher education institute of engineering innovation – innovation pedagogy and CDIO – provide strong and recognized foundation to our strategy. CDIO initiative has over 120 universities worldwide and innovation pedagogy has been successful in research and development funding calls in European Union.

The four areas of improvement are moving on all the time. First concrete co-operation agreements have been negotiated in Mechanical engineering to formulate learning pathways from Bachelor to Master studies and negotiations will continue after summer with other fields. Similarly first new master students will enter our research groups in autumn. The new teacher area of improvement is accelerating pedagogical transition in our university. Pedagogical education is already part of our formal teacher qualifications in university of applied sciences, but we will promote and urge on introducing active, innovative and student-focused learning. Visiting professional professor is an interesting concept that we look forward to succeed too. It might be a possibility for professors in countries where so-called sabbatical years are in use. Maybe one challenging part in improvement is the the new learner. The is general consensus on the need to change the entrance examination, but so far no sustainable solution have been found. Finally, the need for cultural change is agreed, but future will show how we manage implementing it and also how our stakeholder approve it. We must be patient and be careful not to go back to the old way of working.

During the autumn 2015 we will finalize the strategic programs and key performance indicators. In addition, the key performance indicators are taken into program and personal level, and personnel are challenged to initiate concrete proposals to the strategic programs. There is some financial incentives available too since the strategy implementation is supported with additional funding. Similarly as Blackmore and Kandiko (2012) conclude the idea is that through strategic resource allocation broader collaboration and wider change across the institution can be achieved.

Conclusions

This paper has described the strategy process of Turku University of Applied Sciences and one of the strategic programs namely the future higher education institute of engineering innovation. The paper has shown the key elements of this strategic program. It has given detailed information on the implementation plans of the strategic program. Furthermore we have hopefully been able to provide some fresh ideas for engineering education development. However, we must remember that development activities are always connected with the context and structures of the higher education system in specific country. Therefore our plans are maybe not transferrable to other institutes as such, but we are sure that they have given some ideas of possible development activities.

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Immediate Post Lecture Formative Assessment Using Google Form

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Abstract

This research aims to investigate students' perception on using their mobile devices to complete Immediate Post Lecture Formative Assessment (IPLFA). A preliminary study of this new method of teaching was conducted to assess its usefulness. Eleven survey questions were administered to 80 year 1 Pharmaceutical Sciences students taking the basic pharmaceutics module.

A typical lecture with IPLFA:

1. IPLFA is administered at the end of the lecture;

2. Students input their answer using their mobile devices;

3. They are given about 5-10 minutes to submit the answers;

Five percent of the final result is assigned for a total of 13 IPLFAs so as to encourage participation. Discussion is allowed while they are doing IPLFA so as to enhance learning. When all students submit the answers, the instructor will go through the summary of response and elaborate questions that are poorly answered. The questions in IPLFA were not lifted up and asked in future tests.

Their perceived usefulness and acceptance level of having IPLFA after 8 lectures was measured. Based on 28 males and 52 females, more than 96 % agreed that IPLFA reinforced the knowledge learnt in the topic. More than 93.5% agreed that IPLFA helped them to understand the topic better. The test results between students with IPLFA (current batch) and students without IPLFA (previous batch) were compared using an independent T test. There is a significant improvement of 3.53/50 marks in their test.

Compared to MCQ questions asked during lectures using power point, IPLFA gives instructors a sense of students' understanding of the topic. With IPLFA, all students regardless of whether they are reserve or outspoken, have equal chances to answer the questions and get immediate feedback from their instructor. Students will also know how well the others perform for the same question through the summary of response. That served a very good gauge in self-improvement and evaluation.

Hence, IPLFA allows students to assess their understanding immediately after lectures and serve as a useful tool for revision.

Keywords: *Student response system, SRS, immediate feedback, electronic feedback, formative assessment*

Introduction

Most of the lectures conducted in the polytechnic cater to a large group of students, ranging from 40 to 300. Unlike in the tutorial, it is difficult for lecturers to assess what is being taught in a mass lecture. Since feedback is not readily available, students usually have to grabble with any misconceptions they may have and clarify them during the tutorial.

Feedback improves students' learning and provides a useful connection between the teacher and student (Cohen, 1985; Burning, Schraw, & Ronning, 1999; King & Young, 2002). Effective feedback is usually obtained through two avenues, namely: verification and elaboration. There are several ways to acquire verification and elaboration in the classroom. They are written feedback, verbal feedback and peer group feedback (Merrill, 1987). These feedbacks can be achieved by conducting tutorials and doing project. However, students generally favour immediate feedback delivery methods and are more eager in their assessment of the technique and believe it helps in learning (Smith & Wight, 1988).

If students are able to provide an immediate response when the lecturer raises a question to assess students' understanding, the teaching and learning during lectures will be immensely improved. It is with this aim that the Student Response System (SRS) was developed in late 1980s to support communication and interactivity in classes (Beatty, 2004). The first SRS was created in 1976 which is a permanently mounted hard-wired system (Abrahamson A. , 1998).

SRS allows the lecturer to post questions during lecture and receive immediate feedback. A summary of all the responses is presented for both lecturer and students to view. It is a communication system which allows teacher to gather and study large amounts of data and examine whether learning has taken place (Conoley, 2005).

The traditional SRS generally includes a receiver for teachers, a collection of keypads (clickers or transmitters) for students and a dedicated software system. Since the students use their keypads instead of raising their hands to answer, the individual responses remain confidential while overview of the result can be seen from the screen. This allows the teacher to review the answers with the students in an instant.

Several studies showed that such systems have the potential to facilitate several classroom developments such as participation (Defrense, Gerace, Leonard, Mestre, & Wenk, 1996), cognitive involvement (Draper & Brown, 2004; Arnesen , Sivertsen Korpas, Hennissen, & Birger Stav, 2013) and self-evaluation (Boyle & Nicole, 2003; Stuart, Brown, & Draper, 2004). Moreover, research by Dangel and Wang in 2008 shows that that teachers and students perceive SRS to be useful (Dangel & Wang, 2008).

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Despite of the benefits, the cost of implementing SRS is huge due to the commercial interests and expensive support system which includes the appropriate software and keypads.

A mobile computing based SRS system will provide a cost effective solution by utilizing widely available mobile devices or wireless tablets, so that student may give their feedback through online questionnaires and voting system. Presently, with the advance in technology, most students possess either a smartphone or tablet. Leveraging on the well-established wireless network in Nanyang Polytechnic, a 'modified' version of the SRS with the use of 'Google Form' is experimented in this study.

Web based student response technology

Google Forms by Google® is a web based control interface that can act as a tool to administer surveys and collect information in an easy and streamlined manner. Responses will automatically be sent to google spreadsheet. This allows the lecturer to analyze or collate individual response if necessary. The overall percentage of response can be viewed in a pie chart. The percentage of each individual option can also be shown. This allows the lecturer to evaluate which aspect of the lecture requires more clarification or a revisit.

The aim of using immediate post lecture formative assessment by Google Form (also known as IPLFA) is to assess the students' understanding of the lecture. IPLFA consists of five multiple choice questions (MCQ) which aim to assess students' knowledge, understanding and ability to apply the concept learnt in the lecture (Anderson et al, 2001). In order to encourage students' participation, the result obtained by the student for IPLFA would contribute 5% of the total semestral marks for the module.

A typical lecture with IPLFA has the following structure:

1. IPLFA is administered at the end of the lecture;
2. Students are given about 5-10 minutes to input their answers using their own mobile device;
3. IPLFA ends when the number of submitted response tallies with the number of students in the lecture.
4. The lecturer goes through a summary of student responses.
5. The lecturer explains the various alternatives and highlights the correct option.
6. If most students are unable to select the correct answers in particular question, the lecturer would revise the topic during tutorial or the next lecture.

Methods

Target participants

The target participants consist of 80 Year students from the Diploma in Pharmaceutical Sciences who are taking the module, CL1821 Basic Pharmaceutics. These students are chosen because this is the first time they were learning in a large group lecture setting and open to a different teaching and learning approach. Furthermore, being in a new environment, some may be too shy to seek the necessary clarifications to aid their understanding.

Procedure

IPLFA was administered to 80 Year 1 students enrolled in CL1821 Basic Pharmaceutics for 8 weeks. The students were asked to answer a series of 11 questions at the end of their lecture on week 8.

The eleven survey questions were used to assess:

1. The perceived usefulness of IPLFA by the students in their understanding and revision of lectures,
2. The appropriateness in using Google Form to administer IPLFA, and
3. The acceptance level of students to have IPLFA in other lectures.

Test questions from previous year were used in the current test in week 11 to assess their understanding of the topics taught in the first 8 weeks. This does not affect validity as there was no student repeating this module and test questions are not made available to students. Using questions from previous tests enabled us to compare the participants the performance of students who are studying the same content with and without IPLFA.

IPLFA is then continued to be conducted until the end of week 17 before the examinations so as to include exam result in the correlation study between 2 batches of students with and without IPLFA. A qualitative question "Do you think IPLFA useful to you? Please elaborate." is asked in the last IPLFA so as to capture qualitative response from students.

Statistical method used for analysis

Percentage is used to calculate the perceived usefulness for IPLFA, the appropriateness in using Google Form and acceptance level of conducting IPLFA in other lectures.

Unpaired T test is used to assess the test result between two different batches with and without IPLFA. Pearson's liner regression is used to calculate the correlation among the students' score of IPLFA and perception of IPLFA as well as exam result and test result.

Result

Result on the test result between the student with IPLFA and without IPLFA

There were a total of 12 students admitted into the Diploma in Pharmaceutical Sciences programme through the Polytechnic Foundation Programme in the current batch. This group of students is not involved in this study as they were not part of the O level intake. They were admitted into programme via an alternative route unlike the majority of the students who were admitted into the school based on their O level results. The data was collected from test results which have a maximum of 50 marks from the current students who had IPLFA (Treatment group) and the 86 students from the previous batch who did not have IPLFA (Comparison group). Based on the results in the table 1, there are differences between the mean score of two groups.

Based on the score for Levene's test for equality of variances in table 3, $p>0.05$, the variability between the two groups of students is not significantly different. It means equal variance assumed between treatment and comparison group.

From the result in t-Test, the group with IPLFA scored 34.485/50 and the group without IPLFA scored 30.953/50; $t(152) = 3.368$, $p=0.01$. Hence, the null hypothesis of "There is no difference between student

with IPLFA and without IPLFA on their test result" is rejected.

Result of perceive usefulness of IPLFA

Table 3 shows the survey results of the 11 questions conducted in week 8. There are a total of 80 students with 28 males and 52 females. These eleven questions were further categorized to answer a few main questions; question 1 and 2 addressed the engagement and efficiency of IPLFA; question 3 and 10 assessed the appropriateness of the time allocated for IPLFA; question number 4, 5, 6 and 9 checked the usefulness of IPLFA in understanding and revising of the lecture; question 7 measured whether Google Form is a good instrument to administer IPLFA.

Table 1: *The statistics between students with IPLFA and without IPLFA*

	Student	N	Mean	Std. Deviation	Std. Error Mean
result	1	68	34.485	5.7724	0.7
	2	86	30.953	6.9577	0.7503

Table 2: *Independent samples test between students with IPLFA and without IPLFA*

		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
result	Equal variances assumed	1.843	0.177	3.368	152	0.001	3.5318	1.0486	1.46	5.6036
	Equal variances not assumed			3.442	151.628	0.001	3.5318	1.0261	1.5045	5.5591

Table 3: *Survey result*

		Strongly Agree	Agree	Disagree	Strongly Disagree
1	IPLFA is administered efficiently.	35%	61%	4%	0%
2	It is engaging to have IPLFA in Lecture.	30%	65%	4%	1%
3	It is time consuming to do IPLFA.	5%	23%	59%	13%
4	IPLFA helps me to understand the topic better.	25%	68%	6%	0%
5	IPLFA reinforces my knowledge about the topic taught.	27%	70%	4%	0%
6	IPLFA helps me to do revision on the topic.	18%	67%	15%	0%
7	Google Form is an appropriate tool to conduct IPLFA.	33%	63%	3%	1%
8	IPLFA should be used in all lectures.	20%	52%	24%	4%
9	IPLFA helps me to realise the misconceptions I may have immediately.	19%	67%	13%	1%
10	The time given to complete IPLFA is enough.	16%	79%	5%	0%
11	The use of IPLFA makes me stay focus during lecture.	16%	53%	29%	1%

Question 8 measured the acceptance of IPLFA being applies in other lectures; question 11 evaluated whether the use of IPLFA will make them stay alert during lecture.

The results in Table 3 provided evidence that the students had a good impression of IPLFA, receiving more than 95% positive response for question 1 and 2. Students also commented that the time used to administer was appropriate. Students also found that IPLFA was useful in understanding and reinforcing concepts learnt; as well as realization of misconception and revision of the topic. The percentage of positive response measuring those aspects (survey question number 4, 5, 6 and 9) ranged from 85% to 97%.

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Result on qualitative question about IPLFA

In the last IPLFA (IPLFA in Week 16), the question, "Do you think IPLFA is useful to you? Please elaborate." was asked. 75% of the students answered 'Yes' and only 3.8% of the students answered 'No'. 7.5% of the students gave "I don't know" or "I am not sure" and there was a 13.8% unresponsive rate.

From the 75% of students who gave positive responses, some mentioned that IPLFA helps them to do revision by summarising the lecture into 5 key questions and some gave feedback that IPLFA helps them to familiarise with the phrasing and format of the questions in the exam; some students said that IPLFA was a good way to recap what they have learnt in the lecture and some of them believed that IPLFA helped them to understand the lectures better.

There were 3 students who answered "No". Two of them wrote that they would prefer to have IPLFA in tutorials and the 3rd student mentioned that she couldn't recollect the questions and answers after IPLFA.

Correlation study between the perception, the score of IPLFA, test result and exam result.

Table 4 shows the result of a Pearson correlation between the survey questions with IPLFA score, test and exam result. Almost all questions show positive correlation with IPLFA score and test result except question 3 which is a negatively phrased question.

Only question 1, 2, 5 and 6 are statistically significant with IPLFA score. With r(cv) = 0.224 for df=75, there is probably a positive liner relationship between positive reception of IPLFA and score of IPLFA.

The r score between the score of IPLFA and test as well as exam is significantly different from zero when $p<0.05$. Hence, there is a probably a positive linear relationship between the score of IPLFA and test and exam result.

Table 4: *Correlation table between the survey items, score of IPLFA, test result and exam result*

		IPFLA	Test	Exam
Q1	Pearson Correlation	.276*	0.042	0.013
	Sig. (2-tailed)	0.014	0.71	0.911
	N	79	79	79
Q2	Pearson Correlation	.238*	0.088	-0.089
	Sig. (2-tailed)	0.034	0.439	0.431
	N	80	80	80
Q3	Pearson Correlation	-0.098	-0.182	-0.026
	Sig. (2-tailed)	0.387	0.106	0.816
	N	80	80	80
Q4	Pearson Correlation	0.145	0.192	0.173
	Sig. (2-tailed)	0.203	0.09	0.126
	N	79	79	79
Q5	Pearson Correlation	.275*	0.171	0.209
	Sig. (2-tailed)	0.014	0.129	0.063
	N	80	80	80
Q6	Pearson Correlation	.321**	0.006	-0.035
	Sig. (2-tailed)	0.004	0.96	0.76
	N	80	80	80
Q7	Pearson Correlation	0.175	0.044	0.044
	Sig. (2-tailed)	0.12	0.697	0.696
	N	80	80	80
Q8	Pearson Correlation	0.204	0.08	-0.037
	Sig. (2-tailed)	0.069	0.481	0.743
	N	80	80	80
Q9	Pearson Correlation	0.074	0.064	0.018
	Sig. (2-tailed)	0.512	0.573	0.871
	N	80	80	80
Q10	Pearson Correlation	0.198	0.085	0.012
	Sig. (2-tailed)	0.079	0.453	0.915
	N	80	80	80
Q11	Pearson Correlation	0.218	0.076	0.01
	Sig. (2-tailed)	0.052	0.501	0.931
	N	80	80	80
IPFLA	Pearson Correlation	1	.293**	.245*
	Sig. (2-tailed)		0.008	0.029
	N	80	80	80
Test	Pearson Correlation	.293**	1	.701**
	Sig. (2-tailed)	0.008		0
	N	80	80	80
Exam	Pearson Correlation	.245*	.701**	1
	Sig. (2-tailed)	0.029	0	
	N	80	80	80

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Discussion

Significant differences were observed in students' test results with IPLFA and without IPLFA. This showed that IPLFA improves students' results. This corresponds with many experimental studies where classes with SRS scored significantly higher in test and examination than classes who were exposed to only traditional lecture formats (Kaleta & Joosten, 2007; Kennedy & Cutts, 2005; Raey, Li, & Bao, 2008). Though the students involved in this study with and without IPLFA are not from the same batch, their polytechnic entry points was similar across the two batches and identical test paper was used for both batches.

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As shown in the result on survey questions, all of the positively phrased questions in the survey scored 69% and higher. Some of the questions on "helping students to do revision and understanding the lecture better" scored more than 85% and this suggests that students find IPLFA helpful them. It is further supported by the result in the qualitative response by the students. The IPLFA, which included 5 key questions at the end of the lectures, served its purpose in students' perception.

The students also found that IPLFA is engaging which is similar to the finding in other studies about Student Response System (SRS) (Bergtrom , 2006; Draper & Brown, 2004; Caldwell, 2007; Preszler, Dawe, Shuster, & Shuster, 2007). The research mentioned, also suggests students involved in SRS are more focused in class. However, only 69% of students found that IPLFA helps them stay focused during the lecture. This could be because the nature of IPLFA is very different from the traditional SRS conducted in other studies. Other studies use SRS as a form of formative feedback during class. IPLFA only ask the questions at the end of the lecture and hence it may not serve the same purpose of keeping students through the lesson.

Only 72% students agree that IPLFA should be used in all lectures. Though students recognise the importance of revision being conducted after each topic, there are other factors that affect their willingness of IPLFA being conducted in other lectures. There are some possible reasons as suggested in other studies which includes: "too much effort is required by student when using SRS (Tree & Jackson, 2007)", "students want to remain anonymous (Abrahamson L. , 2006)" and "students feel bad when receiving negative feedback (Carnaghan & Webb, 2007)". A further investigation and research can be done in this area to better understand students' reservation to have IPLFA for all lectures.

It was interesting that 2 students out of 3 found that IPLFA is not useful because they would like IPLFA to be conducted during the tutorial time. They did not deny the usefulness of IPLFA but they preferred it to be done after they had revised their lecture content. This showed that the appropriateness of the timing of the IPLFA can vary with students' perception of self-efficacy.

The result in the correlation study suggested that students with positive perception about IPLFA will score better in IPLFA. This in particular is true for students who perceive IPLFA as a tool to reinforce the knowledge learnt and for revision. Those reasons correspond to the core objectives of using IPLFA.

The score of IPLFA also statistically correlate with the test and exam results. The purpose of IPLFA is to give immediate response and clarify misconceptions.

The students will know their misconception immediately once the lecturer goes through the questions after everyone has submitted their answer. This offers feedback to both lecturer and the students on how well the concepts are understood (Bergtrom , 2006).Since answers are marked electronically and automatically, feedback on overall performance of the right answers can be achieved quickly (Kay, 2009). This enhances learning and understanding between the lecturer and the students.

Evaluation and Reflection

IPLFA appears to be an easy and hassle free way of revising and collecting immediate feedback. However, I faced some difficulties during the research. These difficulties can be classified under two categories.

The first category is technology-based challenges. The primary difficulty faced was that some students did not have the device to go online. Secondly, in week 13, Google Form did not show students' response after the student submitted the answers. The problems mentioned are also problems faced by other SRS researches (El-Rady, 2006; Siau, Sheng, & Nah, 2006).

The first difficulty was overcome by making mobile devices available for loan to students. In week 13, lecturers went through the answers without the summary of response.

The second category is human based challenges; Students found it difficult to adapt to a new way of submitting feedback during lectures and found that it was very troublesome to login online to answer questions.

However, by third week, the students were familiar with IPLFA and they were more receptive to answer the questions. Most of them submitted their answers faster than expected. The other challenge in this category is to craft five meaningful and representative summary questions for the lecture (Beatty, 2004). The way to overcome this was to be familiar with the content of lecture and be focused on the important point.

Due to the limitation of time and resources, this research can only include the comparison of test results of the current batch (with IPLFA) to the previous batch (without IPLFA) of students. Another research should be conducted in a lecture which has two runs in the same semester with a large cohort of students, with the students from one lecture group using IPLFA and the other lecture group serves as a control. In this way, the effectiveness of using IPLFA for their learning as well as test and exam score can be shown in a fairer manner.

Three students answered that IPLFA is not useful to them in the qualitative question that was asked at the end of the semester. Two of the three students mentioned that IPLFA will be more useful if it was conducted in the tutorial. Hence, another study can be done to use IPLFA as a pre-tutorial test. This will enable tutors to know the students' level of understanding before the tutorial and then cater the tutorial to the students' ability to maximise learning and understanding of the topics. This research can be easily conducted as a quasi-experiment with modules having a lot of tutorial classes.

An encouraging result obtained in this research shows that students who score better and have a better perception about IPLFA seem to score better in tests and exams.

However, more than 30% of students did not want IPLFA to be conducted in other lectures. Hence, a focus group or interview can be done with the students who indicate their unwillingness to extend the use of IPLFA to other lectures to ascertain the reason.

IPLFA seems to be useful in testing the student and serving as a revision after the lecture. Since results can be provided immediately, the instructor is able to explain if there is anything that students do not understand. It is recommended that further research is done in different disciplines and different academic level of students to assess the usefulness of IPLFA.

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Framework Construction of Regional Cooperative Off-campus Curriculum Studies

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Abstract

The industrial technical society has highly developed in recent years and its complication, compounding and upgrading have been accelerated. The level of talented people demanded from the industrial technical society has become higher and higher. Moreover, the qualitative conversion and organization of new educational systems are required to prevent a decline in the scholastic ability of new students in the field of engineering education. The knowledge acquirement of advanced specific field is one of the ways to educate technical experts, which satisfies a social need. Furthermore, the development of creative technical experts is necessary who can find the optimal solution then solve the problems under the given condition. Hence, we carried out the framework construction which develops curriculum studies to satisfy social needs for technical experts. Practice for pragmatic design engineering was designed by three characteristic educational policies. First, it is the subject of regional cooperation type. Students pick up regional problems from the viewpoint of public interest and then solve these problems. Second, as for group organization, consideration is performed to balance performance of each group in terms of the following two point:

1) **Configure by students who studies in the different specialized fields**
2) **Contemplate academic ability equilibration of students in group configuration**

Third, cooperative understanding and awareness raising of the roles are aimed at to promote teamwork through lodging in the activity area. We did not regulate student grade to participate in technical cooperation type volunteer activities. Due to this qualification, a lot of students participate and perform the technical guidance including several graduates. We conducted a survey of motivation changes before and after the participation about their activities. The results of a conducted survey indicate that both experiments affect their volition increase. They also feel a sense of accomplishment and fulfillment with their activities. These activities must be dealt with independently and actively by themselves compared to passive lecture type classes. Moreover, we are considering that what their co-operation achievements of the group can benefit to the region by looking for regional problems and then solving the problems have a good influence on their volition improvement.

Keywords: *Engineering Design, Off-Campus, Regional Alliance, Evaluation Rubric, Problem Based Learning, Curriculum Studies*

1. Introduction

The industrial technical society has highly developed in recent years and its complication, compounding and upgrading have been accelerated. The level of talented people demanded from the industrial technical society has become higher and higher. In addition, the development of engineering technology has been required from international society. Whereas the number of applicants for Japanese engineering institutions of higher education tend to decline due to the low birth rate and flight from science. Thus, the qualitative conversion and organization of new educational systems are required to prevent a decline in the scholastic ability of new students in the field of engineering education.

The knowledge acquirement of advanced specific field is one of the ways to educate technical experts, which satisfies a social need. Furthermore, the development of creative technical experts is necessary who can find the optimal solution then solve the problems under the given condition. Therefore, we carried out the framework construction which develops regional cooperative off-campus curriculum to create their engineering design ability. In particularly, we focused on making them understand why they must achieve an educational target by providing opportunities which enhance consciousness in terms of regional communities.

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2. Framework of Curriculum

Table 1 shows the comparison of studying styles. Value reached learning, so-called a passive lecture type of ordinary classes, causes that leaders become authoritative and participants become passive. In contrast, value-creative learning which is based on fieldwork, so-called participation experience type, causes that leaders become mutual and more active attitude is required to participants. Each students can learn different various contents and the objective to be achieved is wide in the value-reached learning.

Figure 1 shows the creative system subject and its outline in each grade in our school. The students take basic educational classes in lower grades in our school and graduation research which is based on regional problems is provided as the grade goes up. Moreover, many opportunities have been established as off-campus learning, e.g. internship and cooperative education (CO-OP) practice. Especially we have introduced the following programs afresh based on regional cooperation in recent years.

1) Practice for pragmatic design engineering which aims to find out regional problems then provides solutions for the public by applying engineering approach technique. This class is held for the first grade of advanced course students(Sato, Shishido, Hoga, and Onodera, 2014, Shishido, Sato, Hoga, and Motohashi, 2014).
2) Technical cooperation type volunteer activity which requires the participants' technical ability and then they repair home electrical appliances and any other demanded works as the off-campus training(Shishido and Onodera, 2012).

Table 1 Comparison of studying styles

	Position of teaching	Position of learning	Communication method	Learning content	Evaluation
Passive lecture type	Authoritative	Passive	One-way	Knowledge Concept	Subjective
Participation experience type	Mutual	Active	Interactive	Attitude Value	objective

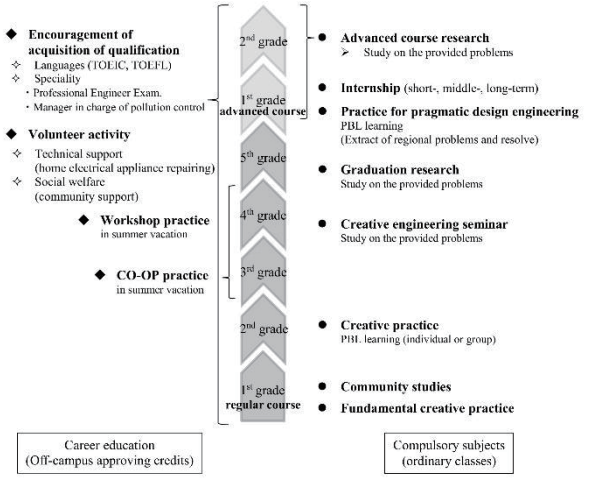


Figure 1 Creative system subject and its outline in each grade in our school

2-1. Practice for pragmatic design engineering

2-1-1. Procedure of class

This class is a project style practice for solving problems which they discover by themselves. The class of this kind is characterized as a manufacturing practice for solving needs of community, cooperative education among industries, universities, and governments, creative practice for making creativity richer and improving their teamwork. Especially, this class was differentiated from passive lecture type subject. The objective of this class is shown as following three points.

1) Regional cooperation type education
2) Interdisciplinary education
3) Training camp type experience education

The objective of first point, "regional cooperation type education", is to solve the region-specific problems in terms of public interests and region-contribution. The second point, "Interdisciplinary education" is constructed by the students from different majors. Thus, all students were distinguished without deviation, who belonged to mechanical, electrical and electronic, control and information and biological engineering departments. The third point, "Training camp type experience education", means off-campus training. We have performed training camp as a field survey and practical activity twice in order to make students act actively and educate their individual position and motivation in the group, in addition, understanding of the value to cooperate. We have also provided opportunities with students to have them absorb various regional information in real time by inviting a consultant engineer lecturer.

2-1-2. Action area and its characteristics

Tobishima is an isolated island located 39km northwest from Sakata, Yamagata, Japan, in the Sea of Japan, where we have performed this activity. The fisheries industry and sightseeing are the basic industries in Tobishima. Transportation from Sakata to Tobishima is inconvenient because liners operate only once or twice a day and sometimes they cannot telephone by cellphones. In particular, the operation of liner depends on weather and there is a case where the transference of freight and people cannot be performed. On the occasion of requiring first-aid cure, they must request a heliambulance to limited hospital in Honshu. The heavy aging population combined with the diminishing number of children is also characteristics of this area. The average age of living people in Tobishima is over 68 years old and the ratio of over 65 years old to population exceed 67% as of 2015.

2-1-3.Groups organization and the method of student evaluation

We considered the equilibration of academic ability by using the class order of a graduate examination in the last school year when we organized groups.

Figure 2 shows the procedure of the class. It was performed over 90 hours and the contents were divided as follows;

1) Advanced preliminary survey
2) Fieldwork (training camp type field survey and fieldwork)
3) Lecture from the exterior professional and discussion
4) Proposal for general public

Table 2 shows the evaluation method. We utilize this table and more than 60 points are required to pass.

2-2. Technical cooperation type volunteer activity

This volunteer activity is organized as off-campus learning effort by applicants who are elected in public offering on-campus. Tobishima is an island with a population of 290 people and having many problems, such as inconvenient transportation access and acceleration of the aging population combined with the diminishing number of children. Thus, these problems also affect in a daily life of insular. This volunteer activity is composed of repairing broken home electrical appliances for free and contribute our industrial research seeds. This activity has been performed for 5 years.

Figure 3 shows the timetable of activities. A leader and teachers discuss and then appoint for the leader in next fiscal year. We seek applications on-campus and conclude a number of participants by an interview. All students are qualified to apply for this activities. Thus, students from the second grade of regular course to the second grade in advanced engineering course of each department join and several graduates also participate and perform the technical guidance. After that, we organize each group in consideration of balance of each grade. The purpose of this activity is to repair home electrical appliances, but also forecast a demand of insular for our activities in terms of our experience in past fiscal year. In addition, those of groups must discuss, e.g. issues of the insular of life, then act efficiently in the point of view of public interest by themselves.

We work out the classified advertisement and show this activity around Tobishima by way of local government in May. In order to survey the state of Tobishima, a necessary number of students including the elected leader and group leaders visit there in June. Then they discuss activities and investigate a number and kind of products which are required to repair. They specify the components which are broken down as much as possible. After coming back to school, they obtain those of components and consumption articles before revisiting Tobishima. They design and manufacture components in the case of manufacturing and on-site installation. After completing preliminary preparation, they perform practice through the training camp of four days and three nights in August.

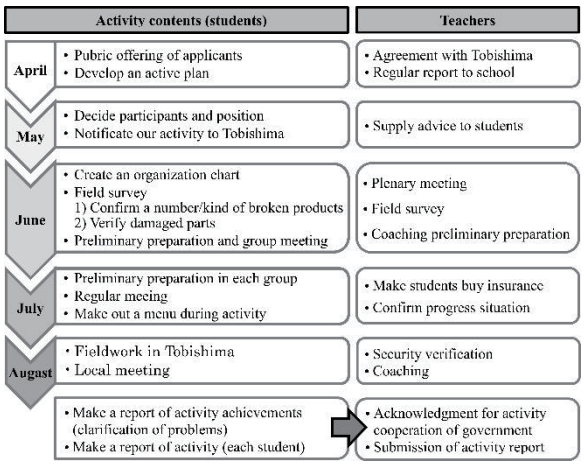


Figure 2 Procedure of the class

3. Results and achievements of activities

3-1. Practice for pragmatic design engineering

The practice for pragmatic design engineering has been performed three times. In the first and second years, improvement proposals and regional conservation activities were carried out for the effective utilization of the park in Sagae-city, which is symbolized by cherry trees and azaleas. A challenge at this time is "conservation and activation in the park facility use".

On the other hand, the activities were carried out in Tobishima from last year. The challenge is development and proposal of "self-support possible housing equipment which does not rely on the lifeline". Along this theme, field survey was conducted by each group divided into five. After the continuous discussions, each issue was set.

Table 2 Evaluation method

Evaluation method	Evaluation rate [%]	Remark
Evaluation of relevant people (proposal to public exhibition)	40	Evaluation of groups
Evaluation of the teachers in charge (interim presentation, proposal)	25	
Practical report	25	Evaluation of individual
Attitude of activities	10	

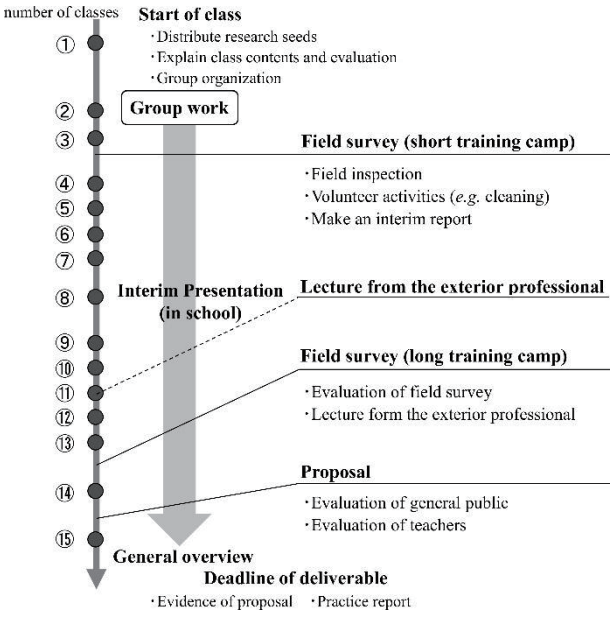


Figure 3 Timetable of activities

Table 3 Challenges and self-evaluation which each group worked on

Group number	Challenges of each Group	Overview of initiatives	Self assessment
1	Purification of drinking water by seawater distillation	The driftwoods which are washed ashore on the coast are used. Sea water is distilled using them and drinking water is ensured.	• 24.6% of distilled water was obtained from seawater. • Element concentration value is low as drinking water.
2	Solar cooker	The cooking equipment utilizing sunlight energy was developed.	• In order to obtain the quantity of light needed for cooking, it is required to construct the system of considerable scale. • Increasing the system scale, environmental resistance becomes trade-off for the weather conditions. • It depends on the weather conditions.
3	Rocket mass heater	The driftwoods which are washed ashore on the coast are used. Using of heat equipment which don't rely on lifeline was consider.	• High temperature of 250 ℃ was obtained. • It is expected to be applied to winter snowmelt. • To use fire, consideration of safety is required.
4	Daily life water ensuring system	Daily life water was ensured by the hybrid type device carried out filtration and distillation of sea water and rainwater.	• In order to ensure the distilled water, the large-scale plant is required. • System ensuring water and rainwater is required.
5	Food preservation method in a vacuum	To achieve the long-term storage of foods, simple container was degassed and foods were stored. ・ Ph ・ Nonvolatile amine ・ K value ・ Volatile basic nitrogen	• The vacuum container was created using the bicycle pump. It can vacuum to 0.2 atm. • Bag-shape is better than Bottle-shape for using widely.

Questionnaire item	Evaluation (1～5)
1) Did you attend this class aspiringly?	4.3
2) Did you understand the contents?	4.35
3) Did you obtain improvement of idea, ability, knowledge and technology?	4.43
4) Was syllabus showed specifically about goals and plans of class?	4.09
5) Was syllabus showed specifically about performance evaluation criteria and the evaluation methods?	4.22
6) Did you feel the enthusiasm of the teachers?	4.35
7) Did you understand about the way of thinking?	4.04
8) Did you feel the communication which is not a one-sided teaching of teachers?	4.09
9) Was the class prepared well by teachers?	4.0
10) Was the speech of teachers easy to hear?	4.52
11) Were writing on blackboard and handout easy to read?	4.26
12) Did you feel that teachers considered to keep the classroom of the good environment ?	4.22
13) Do you think this class is good in case of comprehensive assessment?	4.17

Figure 4 Results of class questionnaire

Table 3 shows the challenges and self-evaluation which each group worked on. About regional deployment of each group proposal, a model house was prepared. Performance evaluation of the prototype had been planned by attaching to the model house. However, it is a problem that evaluation of assuming ordinary life is insufficient by time constraints and location conditions from school.

As the overall learning outcomes, there were some learning outcomes educational effects. For example, one is awareness of the students themselves. They could recognize again "armchair theory" through the difficulty of practical ideas. In addition, importance of teamwork and cooperation was learned. Relative to problem solving beyond own specialized field, the discussion of problem solving was repeated through brainstorming. Also, many of the experimental and prototype were examined quickly by applying the waste around us.

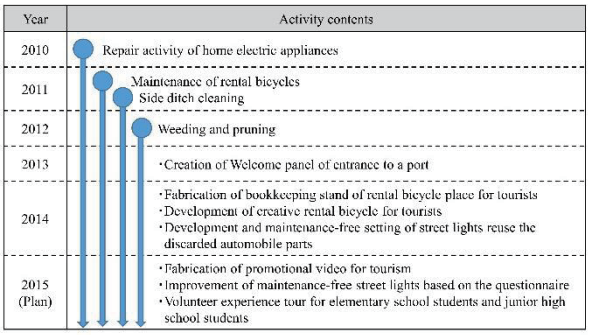


Figure 5 Activity results of each fiscal year

Figure 4 shows results of class questionnaire. About awareness of individual students, it can be analyzed by class questionnaire. "Do you think this class is good in case of comprehensive assessment?" This item is relatively high and 4.17 (n = 23). The following comments tion." Many students feel the freshness for subject which is greatly different from the conventional lecture-based learning. In addition, it is necessary to make the meal during the camp activities on their own. Therefore, they must be conscious of the group unit under the situation where personal negligent would bother their groups in all of the activities. By such opportunities, students cooperate with each other in the restricted life. It is considered that the value of this experience is great for students.

3-2. Technical cooperation type volunteer activities

Figure 5 shows activity results of each fiscal year. In last year's achievement, maintenance of rental bicycles which tourists can use for free was carried out in addition to repairing of home electric appliances. Other than technology which eliminates or reduces the inconvenience in island life.

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Repair of fan heaters

Repair of air-conditioners

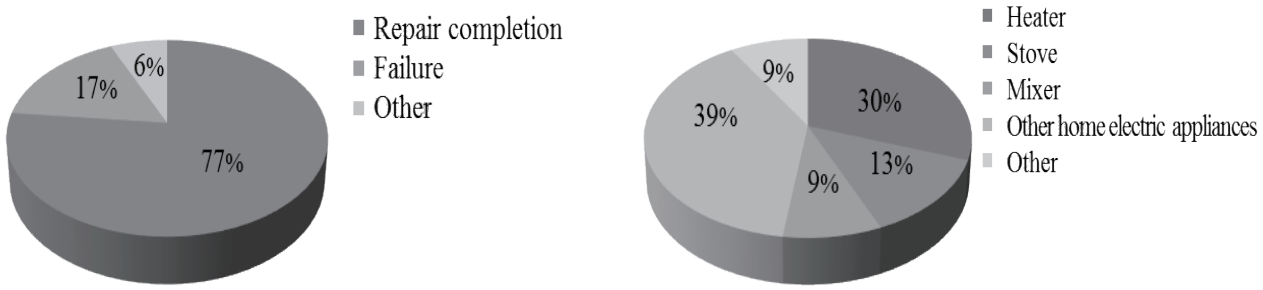
Maintenance of rental bicycles

Street lights reuse the discarded automobile parts (Setting scene)

Street lights reuse the discarded automobile parts (Lighting at night)

Side ditch cleaning

Figure 6 Activities scenes



a) Repair achievements of home electric appliances (total 30)

b) Breadown of home electric appliances

Figure 7 Breakdown of home electric appliances which were requested for repair and repair completion achievements

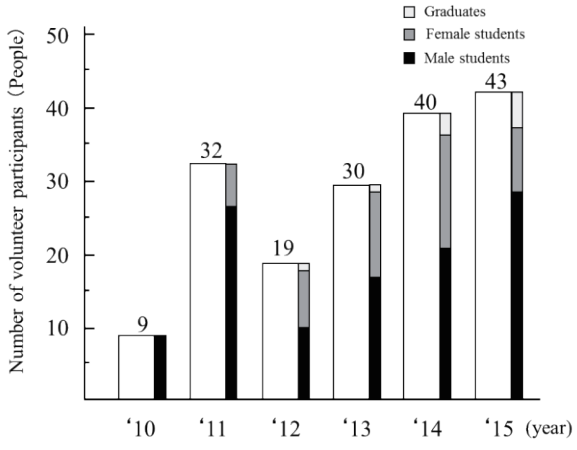
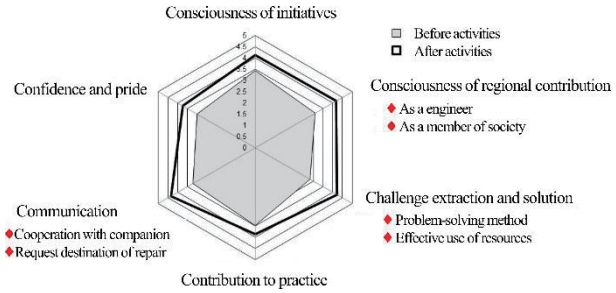


Figure 8 Number of participants and activities achievement so far

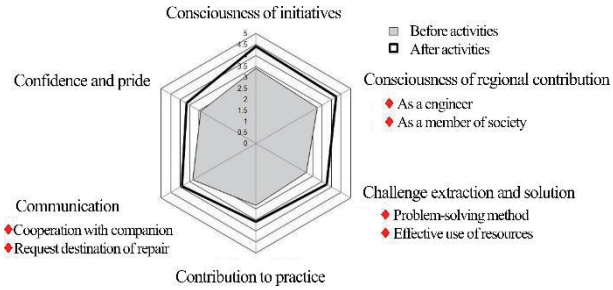
Figure 6 shows activities scenes. Repair of home electric appliances was performed in pairs and senior students teach junior students. If specific of failure part or repair cannot progress, the problem solving is advanced by advice of teachers. The breakdown of home electric appliances which were requested for repair and repair completion achievements is shown in Figure 7.

Figure 8 shows the number of participants and activities achievement so far. This activity has taken the form without a limit on the grade of participants. In terms of this form, students in the second grade of regular course to the ones in the second grade in advanced engineering course of each department have participated. Especially, participants of female students have increased.

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a) Practice for pragmatic design engineering



b) Technical cooperation type volunteer activity

Figure 9 Motivation changes of the participating students before and after the participation

4. Discussion

We conducted a survey of motivation changes before and after the participation about practice for pragmatic design engineering and technical cooperation type volunteer activities. After that, the results were quantitatively analyzed.

Figure 9 shows motivation changes of the participating students before and after the participation. Motivation to the subjects is increased in both attempts, and students are feeling a sense of fulfillment and a sense of accomplishment for the initiatives. On the other hand, students are feeling their technical skill shortage. Especially, the breakthrough of problems which requires skills beyond own specialized field is achieved by cooperation and collaboration. Therefore, we are keenly aware of the importance of teamwork to fulfill the goal achievement. These activities must be dealt with independently and actively by themselves compared to passive lecture type classes. Moreover, we are considering that what their co-operation achievements of the group can benefit to the region by looking for regional problems on their own and then solving the problems, which has a good influence on their volition improvement.

5. Conclusion

Response of awareness and a sense of fulfillment to the subjects was felt from students who work on problem solving through regional cooperation, interdisciplinary department and the camp experience. At the same time, the degree of freedom of the setting the challenges becomes large and the class time of initiatives is insufficient. For efforts to the problem, setting of the just good level challenges where it is required to tackle over the multi-year and time management. In addition, the need for autonomy and communication skills was understood through the interaction with the regional community. Response of growth toward the student problem solving is felt.

In the future, based on the variety of issues obtained by these efforts, the growth and close regional cooperation as a student engineer should be promoted. We want to pursue the activity results for achieving effective horizontal development to the region.

Acknowledgements

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AN IMPROVED APPROACH OF EXPERIMENT PROGRAM BASED ON ENGINEERING DESIGN METHOD

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Abstract

In this paper, we present that experimental program approaches are tried for advanced course students to enhance their motivations and performances to solve and/or overcome their faced subjects. The class program of engineering experiment is provided one of project-based learning (PjBL). Also, team-based learning (TBL) is a form of group-based student centred to achieve group working process. TBL provides opportunities to students to learn course contents as well as to develop various professional and generic skills, such as problem finding and solving and interpersonal skills. One of the key issues on our program is that team members consist of different major courses, such as mechanical engineering, electronic engineering, information engineering, and biological resources engineering.

This paper considers the importance of practical work in an engineering environment and then discusses the student feedback.

Keywords: *Engineering design, Engineering education, PBL, Experiment program, Generic skills*

Introduction

One of the aims of engineering education are for students to develop and integrate engineering knowledge, skills, understanding, and experience, however, it is difficult to educate them in technical skills through classroom lectures. Based on these fundamental intentions, many teachers and instructors pay an attention about engineering design education. Therefore, many universities and/or colleges tried to adapt their curricula for engineering design [1-3].

According to educational research, student-centred active learning has been effective to achieve deeper conceptual learning than traditional learning since the group-based learning, such as problem-based learning (PBL), project-based learning (PjBL) [4].

Team-based learning (TBL) is a form of group-based student centred to achieve group working process. R. M O'Connell reported that the strategy of group work is an effective in the TBL-taught courses [5].

This report presents that PjBL and TBL methods are effective to carry out as one approach to connect fundamental knowledge and practical training of formation for different major students. In this paper, it is suggested how to approach of our experiment program to take into engineering design. This study indicated that it is effective and attractive to give some opportunities and to practical training, such as consent, responsibility, presentation, and creative ability thorough group-work project.

Project Requirements and Management

Project Contents and Definition

Our program is adapted PjBL and TBL methods. There are 5 key points: (1) How to give a subject, (2) How to define problems, (3) How to plan their schedule, (4) How to share their group information, and (5) How to implement and operate their subject. The first step in the design process is the problem definition.

The project topics normally changes each year. In our program, one of the cooperated companies provides their information and problems to students. The students think and recognize company's problems as a customer and/or guest. Then, students shared their problems and made three groups for overcoming defined problems. The second step is to think how to overcome their subjects and problems. And then students make a plan and schedule to create "Objectives". In group discussion of this step, the teachers focused on: (a) control their each role in a group, (b) appropriate prospect of their plan, (c) agreement of the plan, and (d) advice technical support for realization. The sharing their information each other in their group are one of the key issues to analysis and solve their defined problems for the

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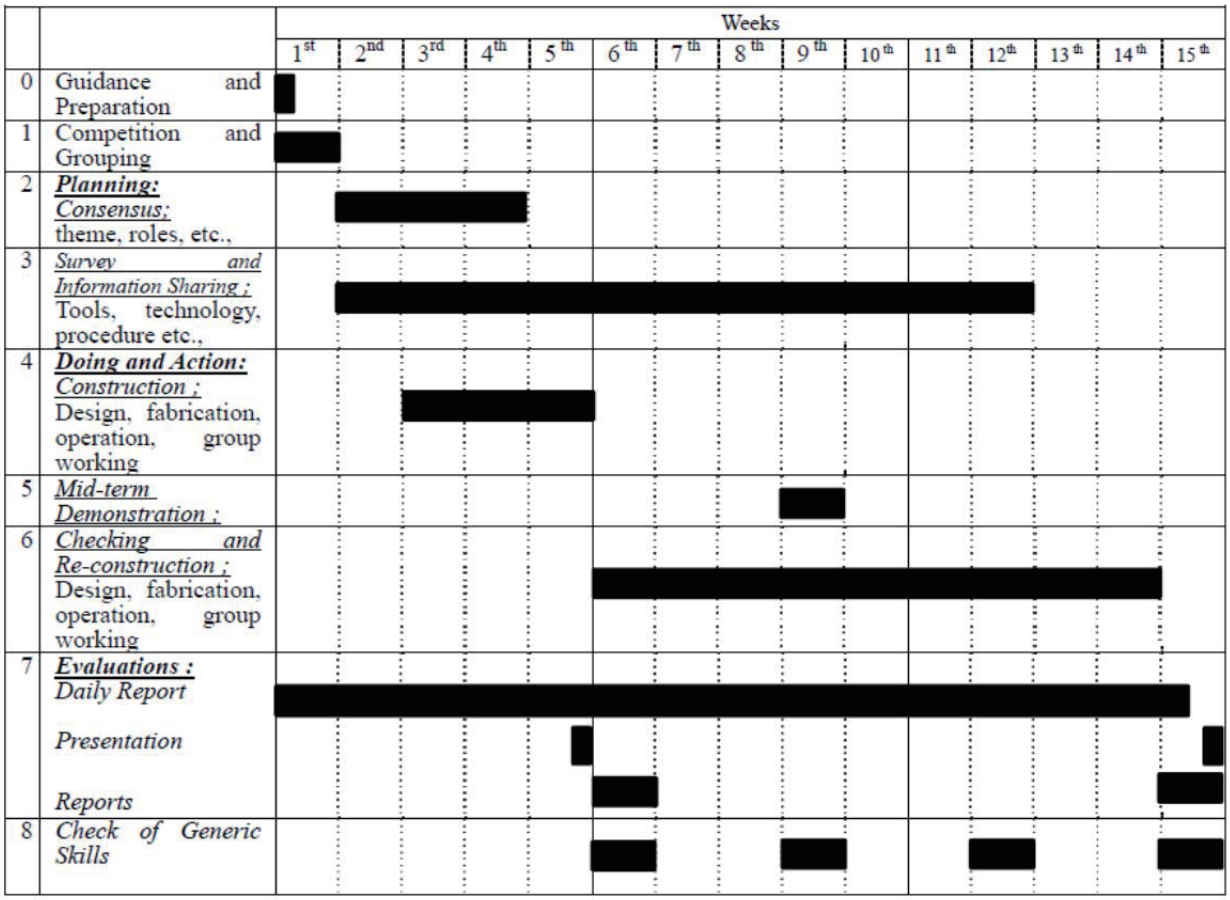


Figure 1 Program contents and time line schedule.

subjects. To overcome their problems, students must make communication and survey their specified technology. After discussion, students design and plan for create and realize their "Objectives". The final step is to perform and create their "Objects" to solve their determined problems.

To check their progress of the subject work, students submitted their planning sheets and made a presentation for disclose their work during practical work. And then, teachers feedback key points, such as responsibility and contribution themselves in a group, sharing information and appropriate planning.

Planning and Time Schedule

Figure 1 shows activities and timeline schedule. To find out and set theme, guidance and field trip is held before starting semester. And then, each presents their idea and concept what they want to fabricate "Object" which is required from company's problem. The aim of this presentation process is to competition their ideas. After presentation, students make a group for achievement of their idea which is consensus each other.

Each team have a discussion and decision to achieve their concept, such as theme, role, plan and schedule. First step, students do and act their self-role based on their plan. To check team progress of team's plan, the group presentation and demonstration held in the mid-term of semester. The aim of this presentation is helpful and effective to re-consider and improve previous plans.

Each team fabricates an "Object and Tools" based on their technical skills and knowledge which they learned in the past curriculum. During program progress, every student survey some required information and share them.

Final step, teachers required presentation and report. Also, to evaluate their satisfaction and motivation, self-evaluation was carried out. The self-evaluation could indicate the motivation changes of students through this experiment program.

Program Procedure and Process Check

In guidance, students visit a company to see and interview their situation. And then, each student summarized.

Guidance and pre-competition

Students reconfirmed the technologies that they learned and practiced in each course. After guidance of this program, they identified problems as a visitor of the cooperated companies. Figure 2 shows the photograph of field work to the company in order to survey its circumstance. Students took a walk in the park and get an introduction and information. Students think and recognize company's problems as a customer and/or guest. At preparations stage, students made a competition of each idea, such as subjects, problems and solution plan. Students selected a theme among the proposed plans, and made team members to achieve



Figure 2 Look around in a park

their subject and purpose. As a result, the number of teams was three which means three themes were agreed and accepted in this year program.

Group work and Mutual and Self check

Students shared their problems and information in each group member. The second step is to think how to overcome their subjects and problems. And then, they made a plan and schedule to create "Objects". Table 1 shows three experiment themes. Group A proposed "Proposal of a course guide system of the fairy using AR" whose concept is to give a point to watch. Group B proposed "Development of a quiz system of fruits" whose concept is that a customer can get knowledge of fruit while enjoying it. Group C proposed "Examination of method to offer fruit juice amusingly" whose concept is that a customer can buy fruit juice while enjoying it. Students use skills of each field in order to construct a system. The presentation was carried out in order to show a solution method of subject in a group as shown in Figure 3.

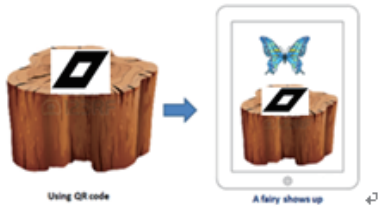
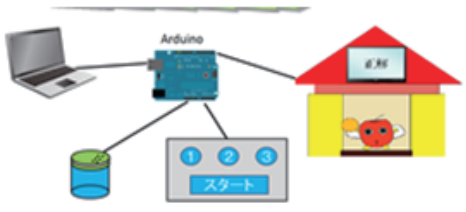
In this experiment program, one of the aims is to practice and foster professional skills. Therefore, mutual and self check were carried out some intervals during program process as shown in Fig. 1. These checks are effective to motivate students about team work.

Results and Discussion

Figure 4 shows a cobweb-chart of self evaluation. Totally, students think that they achieve generic skills, such as consensus, sharing information, logical thinking, and so on. In Fig.4, the member of Group C evaluates lower points of their achievement than other groups. This causes that Group C could not act with sharing information inspire of good performance.

The initiative to use TBL in this course program was undertaken to facilitate development of some professional and generic skills along with learning of technical course content. The good summary of the project may be provided by the results of reports and program evaluations.

Table 1 Experiment themes

Group	Object Tittle	Use Skills	System image
A	Proposal of a course guide system of the fairy using AR	・AR ・Beacon ・CG ・Application design	
B	Development of a quiz system of fruit	・CAD ・Arduino ・3D printer ・Machine design ・Aroma ingredients extraction ・Milling machine	
C	Examination of method to offer fruit juice amusingly	・ActionScript3.0 ・Milling machine ・Microcomputer ・Food processing ・Machine design ・Application design	

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Conclusions

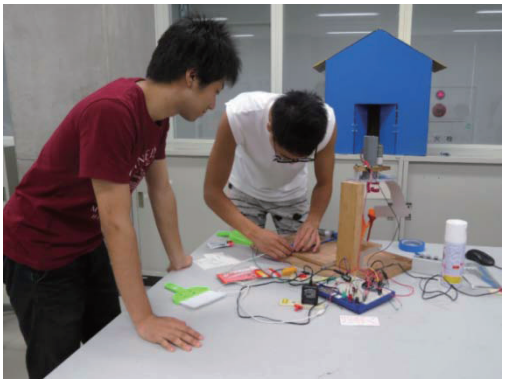
This paper presented a successful implementation of PjBL and TBL in advanced course program. Although, students' major is different, the team member provided each idea and technical skills in the group. Students motivated that TBL The objects that students design and fabrication are well done because students produced through some dissections and revisions. Also, the requirements of mutual and self evaluation in team work process is effective to motivate students individual skills. A combination and of technical and generic skills within this program complemented by the application of technical knowledge acquired from classroom learning. From the course evaluations, the implemented educational activities were satisfied the intended program learning outcomes.

Acknowledgements

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(a) Group working



(b) Presentation and demonstration

Figure 3 Photos for "first construction" session. (a) group working, and (b) presentation and demonstration.

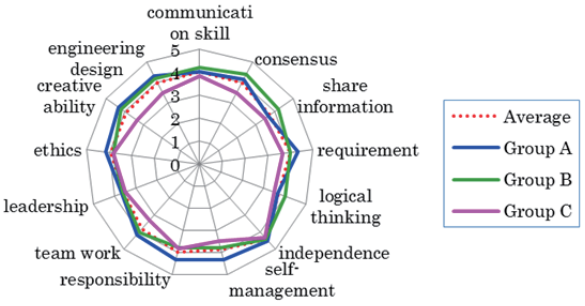


Figure 4 Cobweb-chart of self-evaluation

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New Experiments Organized for Basic Chemical Education Spreading over Different Departments

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Abstract

We attempt to make a new experimental program for basic chemical education. This program is organized by the staffs of Department of Applied Chemistry and Chemical Engineering, Department of Liberal Arts & Science, and the Engineering Educators. So far the class has been organized in an each department. Therefore such a construction of experiment class spreading over different departments is really revolutionary. The sequential contents are arranged from the basic to practical chemical experiments and closely linked to the fundamental chemistry. Furthermore these experiments are followed by the contents in the model core curriculum. In this program the students consider the content everywhere in the experiments. This program thus encourages them to understand the chemical experiment by themselves. The students may acquire both the knowledge of basic chemistry and the skill of experimental operation during the attendance in experiment classes for 7 weeks.

Keywords: *Fundamental chemistry, Pedagogy & Learning, Learning Design and Teaching Strategies, Students' Roles in Teaching & Learning Advances*

Introduction

This experimental program is enforced for 7 weeks as one course of "basic engineering experiment for production" conducted for 15 weeks from April in every year. This curriculum has already been enforced to the upper classes of four engineering departments in the N.I.T. Toyama College until last year. However, because of a request to begin a specialized experimental education from earlier grade, this program is left to each department from this year.

Originally a staff in Department of Applied Chemistry and Chemical Engineering attempted to construct a new experiment class. However, such a specialized class began just in second grade, and students studied only fundamental chemistry in first grade. The staff requested other members for cooperation. One of staffs belonging to Department of Liberal Arts & Science for teaching the fundamental chemistry, and other staffs in Engineering Educators participated in both specialized experiment classes and fundamental chemistry experiment classes. When this experimental program was planned, we considered connecting a specialized class with a basic fundamental class of chemistry. In addition we expected a menu so that the students acquired both the knowledge of chemistry and the skill of experiment. The contents of this program have been developed under the above background, and are so wide including organic chemistry, inorganic chemistry, analytical chemstry, materials science and biochemitry.

Implementing method

Table 1 shows the contents of basic engineering experiment curriculum. This experiment class is done for 7 weeks. As this class is operated for six hours on every Thursday, one chapter a day advances. The most right column shows the correspondence with the model core curriculum.

The first chapter is concerned with the most important knowledge of the chemical experiment. In Chapter 1, the student learns the safety of chemical experiment. The students learn also how to handle glassware, chemical reagents and fire. They further learn how to act at the time of accident. In learning the safety, they perform the training of the dangerous foresight using KYT (accident prediction training). Completing both a laboratory notebook and a report also is learnt. We explain differences between a laboratory notebook and an usual notebook, and let students consider why it is necessary. The experiment on flame reaction is also carried out. It was once introduced as a detection method of the ingredient element in fundamental chemistry. The students summarize the result in their report after the flame reaction experiment.

In Chapter 2, the students study the glass. We reproduce some ancient ways to make some bulky glasses from a silicon dioxide[2]. The ways of fusing and

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Table 1. The curriculum contents of basic engineering experiment for Applied Chemistry and Chemical Engineering

Chapter	Content	Details	Correspondence with the model core curriculum[1)]
1	Before a chemical experiment	• Why do you learn chemistry? • Safety for chemical experiment • Completing a laboratory notebook and a report • Flame reaction	5-2-4 II-D (p. 36)
2	Glass	• About glass • Making glass • Glass fusing and glasswork	5-2-4 II-D (p. 36)
3	Water for experiment	• The water for an experiment • Electric conductivity by the neutralization • Ion of tap water	6-1-5 V-E-3 (p. 68)
4	The concentration of solution	• Molar concentration • How to make the solution • Inorganic analysis for metal cation • Check the method and technique	5-2-3 II-C (p. 35)
5	Materials	• Metal and plastic • Density of various substances	6-1-5 V-E-2 (p. 67)
6	Biotechnology	• Useful microbe • Preparation of the immobilized baker's yeast • Observation with the microscope	6-1-5 VIII-E-8 (p.72)
7	Organic chemistry	• The detection of ethanol (Iodoform reaction) • The detection of sugar	6-1-5 V-E-1 (p. 67)

working of glass also are treated in this chapter. In Chapter 3, the water for experiment is learnt. We explain an ion included in the tap water, and the purity of water necessary for experiment. Until that time, ion is already learnt in the class of fundamental chemistry. The experiment on the electric conductivity of the solution is conducted. The students understand that electric conductivity changes with change of an ion of the solution. In Chapter 4, the concentration of solution is learnt. The students in the class of fundamental chemistry then study a way to calculate the molar concentration. The molar concentration and percent concentration of mass are learnt chiefly. The students not only calculate but also really make the solution. This experiment is related to the method that we have reported before[3)]. We confirmed whether correct solution was made at present individual experiments. The subject of Chapter 5 is concerned with materials. Metals and polymers are mainly studied. This introduces students into inorganic chemistry and polymer science. Many lump-shaped samples of different materials are used as follows; magnesium, aluminum, titanium, zinc, iron, stainless steel, brass, copper and lead, carbon, wood, polymethyl-metacrylate(PMMA), polyethylenetelephalate(PET) and polystyrene (PS), (Figure 1). The students measure the density of those various substances. In Chapter 6, the students experience biotechnology. Studying this subject is first time for them after entrance into our college. The students perform some experiments using the baker's yeast, and observe it with the microscope. In Chapter 7, the students learn organic chemistry. As the organic chemistry is learnt in the latter term, this program has introductory contents of the organic

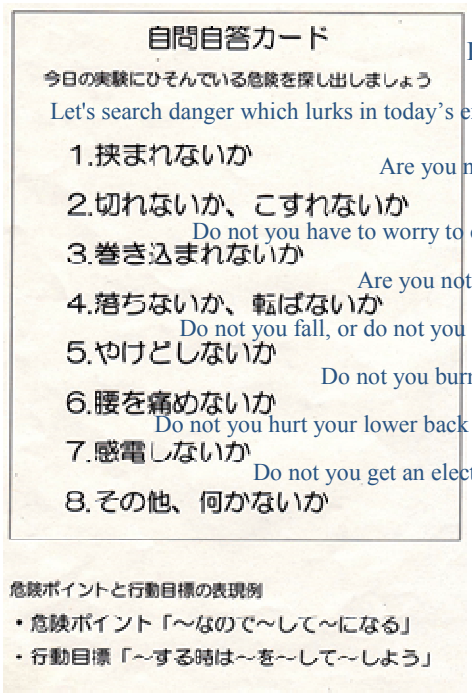


Fig. 1 The lump-shaped samples of metals

chemistry. We use well known ethanol and sugar as test materials.

Results and Discussion

This program is made to connect the subject of fundamental chemistry taught in Department of Liberal Arts & Science with the specialized chemistry in Department of Applied Chemistry and Chemical Engineering. Generally, since the educational contents in the class are left to each teacher, it is rare that the contents in different classes are assembled systematically over departments. Not to mention, there was no attempt to combine different class contents beyond the department. Because such a systematical learning was considered to be predominantly efficient for a student, we have tried to cooperate and construct a department cross-sectional chemical experiment class. We considered widely extended contents of class including organic chemistry, inorganic chemistry, material science and biotechnology. Furthermore, this



KYT card

Fig.2 KYT card

class includes the contents complied with the model core curriculum. Since the safety education is especially encouragd in our college, it is put on the first day. The class content of Chapter 1 is incorporated widely from a primer like "Safety for chemical experiment" and "Completing laboratory notebook and report" to a practice such as "Flame reaction". We adopt KYT in the safety education. KYT cards shown in Figure 2 are distributed to students. KYT reminds the students the danger hiding behind the experiment. KYT is continued for not only fundamental chemistry experiment but also specialized analytic chemistry experiment. Furthermore, we let students purchase a professional laboratory notebook at the first time and use this notebook at subseqent experiment class continuously. Accordingly, the student may preliminarily review the operation of experiment. In chapter 2, 3 and 4, students learn to treat glassware, water and solution which are frequently used in experiment. We adopt the many plans in which students are interested in this class content. For example, at the first class of glass, we have a lecture on the origin of the glass. After that, the students make a glass by an old method, and then they process the glass by fusing. Finally the students produce the glassware for experiment. Figure 3 shows the class of glass experiment. By the class of glass, the students obtain the knowledge of glass and how to handle it. The water and the solution used in the chemical experiment are particularly important. The students learn ion in water using an electric conductivity. As the ion is already studied in the fundamental chemistry, the students may understand furthermore. In addition, learning the ion in the water leads them to understand that pure water is necessary for the experiment. The experiment of prepare solution is done as an examination in this class. The staffs strictly check each student's procedure of solution making to confirm that all the students are able to make solution, because the preparation method of solution is much frequently used while at college. For the same period, the fandamental chemistry gives the students a way of calculation for solution making. The training of solution preparation is conducted for the students to learn in two classes at the same time.

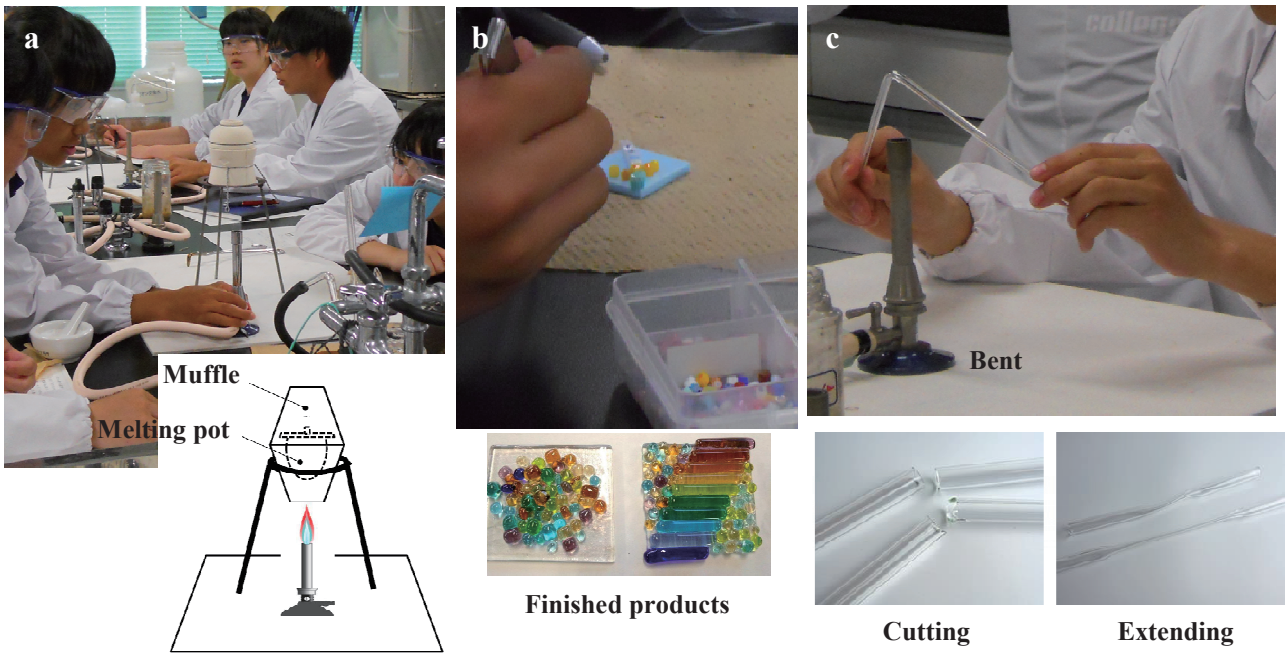


Fig.3 Class of glass a: Making a glass after an old method, b: Glass fusing, c: Glassware producing

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Chapters 5, 6 and 7 show the introduction to the specialized subjects. In metal and polymer classes, the students may realize some differences in materials in weight by treating directly the metal simple substance using the metal densimetry. In addition, they may actually know a variety of high polymerized compounds. In biotechnology class, the students are taught on the biotechnology in many aspects of the experiment.This experiment is divided into five parts. (1) Fixation of the immobilized baker's yeast : This method is an easy way to separate the liquid, and it is a simulation of industrial level of reaction. (2) Alcohol fermentation : Yeast decomposes a sugar to alcohol, carbon dioxide and water. As the educational content of alcohol fermentation contains both organic chemistry and biotechnology, it is most suitable for their introduction. (3) Microscopy observation of baker's yeast : Yeast is confirmed on the state of size and the increase in amount. This experiment aims to familiarize the sudents with the increase in yeast. (4) Iodoform reaction : It is done to confirm the generation of ethanol. When the students learn the iodoform reaction in the latter period, it leads them to the solid understanding. (5) Glucose detection : One of staffs give a demonstration of experiment using the enzyme. The students may observe the color to change from colorless to red after warming. The introduction to a specialty and wide knowledge of chemistry are established after these experiment classes for 7 weeks. This experiment classes attract the interest of student, and therefore the educational effect is high.

Conclusions

We attempt to make a new experimental program for basic chemical education. This program is organized by the staffs of Department of Applied Chemistry and Chemical Engineering, Department of Liberal Arts & Science, and the Engineering Educators. The class has been so far organized in an each department, and thus such a construction of experiment class over different departments is really revolutionary. We consider connecting a specialized class with a fundamental class of chemistry. The class contents are complied with a model core curriculum. The contents widely range from organic chemistry, inorganic chemistry, material science and biotechnology. Especially in Chapter 1, the education on safety is encouraged. In Chapters 2-4, the students learn the contents of glassware, water and solution, which are frequently used in many experiments. Chapters 5-7 give the introduction to each specialized subject. By these experiment classes performed for 7 weeks, both the specialty and the wide knowledge of chemistry are certainly given to the students.

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THEME-BASED INTEGRATED CURRICULUM DEVELOPMENT AND PROJECT LEARNING EXPERIENCES

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Abstract

Helsinki Metropolia University of Applied Sciences (HMUAS) is the largest UAS in Finland, formed in merger of EVTEK and STADIA in 2008. HMUAS and its forerunners have applied various forms of project-based- and problem-oriented teaching. In Industrial Management (STADIA) this was called Total Project Learning since year 2000. EVTEK adopted CDIO 2005.

The funding model of the Universities of Applied Sciences in Finland was reformed in 2013 and entry structure of all engineering programmes within the UAS system was implemented in 2014. The result is overall reduction of funding, based on output results only. This placed high requirements on each UAS own strategy in improving learning results and lowering drop-out rates. Radical changes in all curricula of HMUAS engineering programmes were introduced fall 2014. The first year of studies was organized into four periods of 8 weeks. Each period implements one integrated practical project, supported with theory studies, like mathematics, physics and communications skills. The project details are joint responsibility of a team of teachers.

Teacher's new and changing role as an enabler of learning instead a source of knowledge is discussed. Our first year themes in ICT are "Games", "Robots", "Objects", and "Networks", providing different views on the ICT as a profession. The author's experience is in teaching Robots, using easy-to-use programmable electronics blocks and graphical programming. Students are oriented to innovative design and quick prototyping right from the beginning. Advanced results are discussed with orientation aimed at Health Technology. One year of positive experience encouraged similar integrated curricula in later studies. Selection of major studies is after first year. Motivation and understanding of the field of choice is clearer for the students. Improvements indicate higher study point levels and lower drop-outs, compared to the previous frontal-based and teacher-oriented methods. This problem may be rather non-existent in Japanese kosen, but common in many European UAS's.

Keywords: *CDIO, PBL, curriculum, pedagogy, engineering education, reform, funding*

Introduction

The paper reviews briefly main idea of the CDIO-initiative and a perspective on HMUAS initial approaches in introducing it in engineering education during its merger process. Other aspects can be found in Haapaniemi et al (2013). Soon after, however, a rapid series of educational system reforms were introduced in Finland to improve overall efficiency and impact of the whole educational system. These legislative and funding system reforms have speeded up introduction of new integrated and theme-based curriculums. The principles and implementation of first year bachelor's studies are discussed. Based on the experience and initial results fully module-based curriculums were introduced on most of the engineering programmes. This paper focuses on author's own experience in first year "Robots" theme and its relevance in further elaborating the theme-idea in all later years of study. Observations of the impact are extend to student cognition and group work skills, as well as need of teacher collaboration and potential obstacles from their professional perspective.

The CDIO Approach to Learning

Worldwide CDIO Initiative (2013) present that CDIO (Conceive-Design-Implement-Operate) is as an innovative educational framework for producing next generation of engineers. CDIO Initiative was developed and implemented by Massachusetts Institute of Technology (MIT), Royal Institute of Technology (KTH), Chalmers University of Technology and Linkoping University. Starting point for the development of CDIO Initiative in the 1980's and 1990's was the criticism that engineering education was too theory and science oriented, and there was not enough emphasis on practical skills such as design, communications, ethics, sustainable development and teamwork. CDIO was put to use in 2000; nowadays, there are 97 collaborating educational institutions worldwide utilizing CDIO. More information on CDIO can be found at *www.cdio.org*.

Crawley et al (2007) presents that CDIO Initiative was developed with the input from stakeholders that are students, academics, industry and engineers. In CDIO deep learning of technical fundamentals and set of practical skills are combined into dual impact learning. The main goal of the CDIO is to educate students that

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are able to: 1) Master a deeper working knowledge of technical fundamentals, 2) Lead in the creation and operation of new products, processes and systems, and 3) Understand the importance and strategic impact of research and technological development on society.

The CDIO is based on the principle that product and system lifecycle development and deployment are the appropriate context for engineering education. Crawley et al (2007) describes the four phases of CDIO as follows: 1) Conceive: define customer needs; consider technology, enterprise strategy, and regulations; and, develop conceptual, technical, and business plans, 2) Design: focus on creating the design - plans, drawings, and algorithms - describing what will be implemented, 3) Implement: transform the design into the product, including manufacturing, coding, testing and validation, and 4) Operate: implement product to deliver the intended value, including maintaining, evolving and retiring the system.

CDIO Syllabus presented by Crawley et al (2007) defines specific learning outcomes and CDIO Standards, presented in Table 1; act as a guideline for educational program implementation, reform, evaluation and continuous development.

Table 1: CDIO Standards Crawley et al (2007)

Std 1	CDIO as Context
Std 2	CDIO Syllabus Outcomes
Std 3	Integrated Curriculum
Std 4	Introduction to Engineering
Std 5	Design-Build Experiences
Std 6	CDIO Workspaces
Std 7	Integrated Learning Experiences
Std 8	Active Learning
Std 9	Enhancement of Faculty CDIO Skills
Std 10	Enhancement of Faculty Teaching Skills
Std 11	CDIO Skills Assessment
Std 12	CDIO Program Evaluation

The set of standards allows for flexible and gradual adaptation of the recommendations toward a full CDIO implementation. Our approach is described below.

The CDIO Approach in HMUAS 2008-2013

Helsinki Metropolia University of Applied Sciences (HMUAS) is the largest UAS in Finland. HMUAS 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.

EVTEK started the process of adopting CDIO already in 2005. The goal was to apply CDIO Initiative to all engineering programmes. Schrey-Niemenmaa et al (2010) present the early steps included, e.g. 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 an implementation plan was prepared. 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 or 4th year multidisciplinary innovation project, and 4th year thesis project.

Orientation project: 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.

Innovation project: In the third or fourth 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.

Thesis project: 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. Exchange students from Japan and other countries are typically integrated into the innovation projects and thesis projects; issues related to exchange students are presented more in later chapters.

Recent Steering Level Reforms in National Context

Both universities and universities of applied sciences are funded by Ministry of Education (MoE) and there are no tuition fees for students in Finland. However, the decline in economy has increased the pressure on increasing quantitative results on public financing. Increasing international competition within the industry has also placed new and even higher requirements on the engineering profession. Thirdly, especially in Finland, the rapid ageing results an unfavourable demographic development in terms of public economy.

The implementation methods of political reforms are traditionally divided as 1) legislative reforms; 2) funding model changes; and 3) informational steering. Legislative changes obviously require parliamentary process initiated by the government. Financial model changes may require some legislative changes but are within the mandate of the MoE to implement. Reporting responsibility and publishing comparative information to enable actor's self-steering are the essential elements of informational steering.

As a consequence, many radical political reforms were implemented over the past few years. The universities were given their own legal identity in a form of a private company in 2010 and were thus separated from the direct governmental budgeting. The UAS's had this opportunity already in 2008, and the last ones were forced to enter private status in 2014.

The entry structure, or the possible program titles from the perspective of a potential student, of all engineering programmes was also reformed within the UAS system in 2014. The number of possible programme titles was reduced, simplified and unified. This resulted larger areas of educational responsibilities, which were granted to individual UAS's, leaving them autonomy to decide details by themselves. Together with the output-based funding model, also the responsibility and financial risk was transferred from MoE to the UAS's.

The funding model of the Universities of Applied Sciences in Finland was reformed in 2014. The result is overall reduction of funding, based on output results only. The overall fixed funding is competed with relative performance indicators: if all UAS's increase their performance same amount, their funding still remains the same. This placed high requirements on each UAS own strategy in improving learning results and lowering drop-out rates. Now, after one year, it is possible to review the impact and first practical level experiences of a rather large-scale reform.

Theme-based Curriculum Development by 2014

CDIO, as discussed earlier, is one of the most well-known systematic efforts towards project-based learning. The CDIO initiative has united a number of engineering institutions around a common curriculum structure, including several Finnish universities. Another global model which extends beyond engineering is led by the Aalborg University in Denmark. The CDIO model includes one project in each academic year, whereas the PBL model followed in Aalborg is totally based on thematic project courses. (Vesikivi et al 2015.)

Structural reforms in all curricula of HMUAS engineering programmes were introduced in fall 2014. The general curriculum guideline structure is presented in Table 2. The top level elements acted as a guideline for most program implementations. Specific to ICT programme, the first year themes are also shown under the heading Orientation to ICT. All programmes organize the first year of studies on more or less integrated modules with themes and common to all students in the specific programme. Major subjects are selected at the end of the first year. For example, the Health Technology, as discussed further, is one of them.

All programmes contain Innovation Studies, specifically intended to mix students from different programmes into same project groups. This is continued from the previous curriculums, but supported with rigid methodological studies. Elective Studies are intended to expand, nearly to double, the possibility to freely select personal study paths by taking modules or individual courses from other majors, as pre-requisites allow.

Table 2: HMUAS Engineering Curriculum Guideline

Information and Communication Technology 240 ects			
Orientation to ICT		60	
Games and Mobiles	15		
Objects	15		
Robots (Devices)	15		
Networks	15		
Foundations of the Major Studies *)		30	
Major Studies **)		60	
Innovation Studies		15	
Elective studies ***)		30	
Practical Training		30	
Bachelor's Thesis		15	

All engineering programmes include Practical training at industry and finally Bachelor's Thesis, which is nearly without exception, done at industry.

For non-European readers is necessary to note that we comply with the European Credit transfer System (ECTS), which stipulates that one year of students work equals to 40 weeks or 1600 working hours and is credited as 60 ects. Thus the items in Table 2 represent Orientation to ICT as one year (60 ects), the selected Major as 1,5 years (30+60 ects), and Elective Studies provide now half year timing window of selecting modules or courses from other programmes. This window allows also flexible student exchanges of half year without affecting other parts of the personal curriculum. More flexibility stems from the timing of Practical training and Thesis. However, opposite to the flexibilities, it is even more important to effectively implement the actual study modules with good passing score and results.

Timing reforms means that all the first year of studies were organized into four periods of 8 weeks. Each period implements one integrated practical project, supported with theory studies, like mathematics, physics and communications skills.

Pedagogy reform means that the project details are joint responsibility of a team of teachers. This implementation detail is difficult to document in the curriculum itself. However, it is a critical in successful implementation and should not be overlooked. Significant time and effort was used to create the theme topics and discussing the balance of each teacher's resource to support the theme. These processes are culturally complex, dependent on strength of professions, and on differences in institutional- and national cultures. The time and effort needed in this process should not to be underestimated.

In the ICT programme, all major studies share the same structure of Foundations of the Major Studies (*) being 30 ects, and Majors (**) being 60 ects, thus enabling cross-study of Foundations from other Majors as Elective (***). In comparison between the CDIO and the Aalborg model, our approach to the first year studies favouring the totality of integration and many shorter projects introduce more elements of the latter. Implementation of the Major Studies introduced similar structure, favouring multiple shorter thematic projects.

Results: the First Year Project Learning Experiences

Our first year themes in ICT are "Games and Mobiles", "Robots (Devices)", "Objects", and "Networks", providing different views on the ICT as a profession. Vesikivi et al (2015) reports in detail a cross-comparison of two Finnish teaching groups and two international groups, as well as a longitude comparison of years 2012-2014, showing the impact of the curriculum change.

The author's experience is in teaching Robots, using easy-to-use programmable electronics blocks and graphical programing[1]. Students are encouraged to start from solution-oriented and open approaches to real-world problems, even if they do not have knowledge of all underlying technical details. This kind of top-down -approach is very much opposite to the traditional bottom-up path from theory and components finally towards solutions by the time of graduation. The four theme-based topics are still quite generic. Our special interest is to ensure that the special themes, such as Health Technology are adequately introduced to the potential students as they select their major for the second year. The curriculum lacking such theme-based modules as such, we encourage choosing project topics and applications appropriately. The focus is more on asking relevant questions than finding answers, and more on system level concepts than detail. We expect this innovative design and quick prototyping right from the beginning to stimulate interest in detail also.

Hjort et al (2015) reports our experiences from a student collaboration perspective. Especially relevant result is the early development of reflective and group working skills, which are increasingly needed in the modern working life. This is important in modern client-oriented engineering work, but specifically important in multi-disciplinary and applied fields of engineering, such as Health Technology. Future research will indicate if the positive outlook now will carry forward in later study years.

Teacher's traditional role transforms into an enabler of learning painfully, however. Collaboration among the team of teachers if of vital importance. Weekly co-ordination meetings and sharing of materials are all necessary. As student groups are working in an integrated project style, they certainly expect the same from the teacher team. The old habits of teachers linger on long time. Thus our one year of experience in turning around a large and autonomous group of professionals is relatively short.

The other aspect of teacher's role change is that problem-oriented teaching and projects bring into focus new open problems with possibly no known solutions in advance. Teacher's role will be enabler of learning, helping to find information, guiding and perhaps limiting the scope and complexity of the tasks to a reasonable level. The safety of prepared teaching material and exact pre-planned lecture schedule is subject to change. New unexperienced issues arise. The teacher is drawn into the learning process themselves. Teachers with R&D and industry project experience are likely to be inspired about this style, as reflects their real working life experience. Teachers with more theory background or long traditional teaching experience may find this working style irrational and perhaps constructing knowledge in flawed or incomplete way.

We are still working on more applied and coherent ways to integrate necessary amount of mathematics and physics into the theme-based projects. In general, these subjects are spread over time more, so the future will show the final skill outcome of the curriculum implementation. The timing reform enables differentiation of content more to apply to the selected major, as required by the professional tasks at hand.

Discussion: Themes in Health Technology

Relatively advanced project results within the Robots-theme include: construction and programming of PIC-processor based gyroscope sensor-game, colour sensor with display, simple sound generation, a remote controlled toy car with distance sensor, among others. The phrase "Relative advanced" reflects the fact that the theme was either the second or third of the 8-week themes, so the student background in programming and digital electronics was very minimal prior the course.

Selection of major studies is after first year. Now, the motivation and understanding of the field of choice is clearer for the students. Improvements are shown in higher study point levels and lower drop-outs, compared to the previous frontal-based and teacher-oriented methods. The first implementation of the course showed full pass of the group, with one exception for other personal reasons with the student. The first year of positive experience encouraged similar integrated curricula in later studies, as shown in Table 3.

Table 3: Health Technology Overview

Information and Communication Technology		240 ects	
Orientation to ICT		60	
Physiological Measurement Technology		30	*)
PMT I	15		
PMT II	15		
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	

Foundation to the Major (*) is provided by two 15 ects theme modules on Physiological Measurement Technology, to be implemented as consecutive 8 week periods in fall 2015. Similarly the Major Studies (**) extends in spring 2016 as two period themes of Customer Oriented Software Applications and in fall

[1] E-blocks® and Flowcode® are registered trademarks of Matrix Technology Solutions Ltd, UK.

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2016 with two period themes of Health Technology Devices and Applications.

The curriculum was completed for the later study years after experience on actual implementation of the first year. The main principles remained: 1) all studies are organized as 8 week periods; 2) each period has a strong overall theme which ties the work together; 3) each period has maximum of 3 separate courses of 5 ects each; in example of PMT II below one of them is an applied project course: Health Technology Project 1.

Table 4: Health Technology Thematic Implementation

Information and Communication Technology			240 ects
Orientation to ICT		60	
Physiological Measurement Technology		30	
PMT I	15		
PMT II	15		*)
Physiological Measurements and Sensors	5		
Data Collection and Processing	5		
Health Technology Project 1	5		
Customer Oriented Software Applications		30	
Health Technology Devices and Solutions		30	
Innovation Studies		15	
Elective studies ***)		30	
Practical Training		30	
Bachelor's Thesis		15	

The curriculum design exercise revealed some pragmatic findings in relation to our original principles. First, to gain deep enough knowledge and skills, the same theme can and should cover whole semester with gradually deepening learning objectives. This is why, in fact we described learning objectives for the pair of consecutive modules, in addition to both periods. This outcome is also relevant from the perspective of the industry employer.

Secondly, as our former learning objectives were written mainly on individual course level (typically 3 ects each) the level of detail was extensive but in overall very loosely coupled. In formulating the learning objectives formulated in general and consistent way, frameworks such as the European Qualifications Framework (EQF 2015) proved to be useful, especially as HMUAS holds the ECTS label and is obliged to publish all curricula in English for our partner universities in Europe. In fact, this structured our own work also.

For logistical reasons it is good to keep one group together so that they as much as possible take whole 15 ects offering to avoid overlapping schedules. The period theme should be offered at one campus only, with only exceptionally whole days on other campuses. This situation arises from the large size and distributed schedule planning of the HMUAS organization.

The last fall back to a slightly more course structure relates to possibility in building individual study choices and for administrative need to recognize and credit previous studies. However, as there are only three parallel running courses at any one time in a student weekly programme, the complexity of group-, teacher-, and learning space -coordination is greatly reduced.

The focus is on the fact that the group is working in a particular learning space and will be guided by one or more teacher, or they are expected to continue their project occasionally short periods independently. To maintain this timing pressure over the contact teaching periods, each thematic period actually requires a team work with a target and time limit. This is why in Table 4 shows the integrating applied project.

Conclusions

The paper outlines a historical and administrative context to the current status of our theme-based curriculum development in HMUAS. The history shows that changes in academic organization occur slowly. A short view on our national reforms give a better perspective on policy implementations, which are in line with policy implementations in many OECD countries over last 10 years. These include expecially in increase of institutional autonomy and responsibility, promoting competitiveness and industry co-operation and reduced, output-oriented public funding models.

Our curriculum development and introduction of PBL-principles reflect a response to the steering pressures. The paper discussed the experiences of the first year, fully project and theme-based curriculum. The impacts extend to student grouping, teacher teams and their collaboration. The results are early and references are made to parallel papers for details.

Authors own reflections are on areas of first year robot theme teaching and full Health Informatics programme curriculum design, partly encouraged by experience. The Health Technology programme has been running since 2008, with now a major revision in 2014. As discussed, the first group of major studies in integrated curriculum starts in fall 2015. Our expectation is that the first year experience in learning to collaborate in project orientation carries forward in professional studies. Health Technology proved to be a popular choice of major studies and we can expect a motivated and informed group to begin with.

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ACTION RESEARCH: CASE-STUDY APPROACH VS PROBLEM-BASED LEARNING APPROACH WITH PROGRESSIVE GUIDANCE, PEER ASSESSMENT AND SELF-REFLECTION

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Abstract

This paper presents the action research project which compares two different approaches "Case-study approach" & "Problem-based learning approach with Progressive guidance, Peer assessment and Self-reflection" of teaching the module "Thinking and Problem Solving" for Year-1 Diploma students in the School of Engineering, Nanyang Polytechnic. Both groups work on the same problem: (a) smoking & (b) time management.

Students in the 1st group were taught using the "Case-study" approach. They were divided into teams. Each team was tasked to analyse the cases, discuss and present their analysis results. Students were observed to be less interested in these cases. Some students would refer to the "model answer" from previous batches of students for analysis results. Some students pointed out the lack of creative thinking training via case study.

Students in the 2nd group were taught using the "Problem-Based Learning" approach. Students were divided into teams of 3 to 4 students and they presented their findings toward the end of the module. The progressive guidance by lecturer facilitates the students in knowing how to put theory into practical problem solving and ensures that each path that they have taken is correct and does not deviate too much from the right path forward. The peer assessment encouraged students to focus on other groups' presentations and enhance their learning. Individual self-reflection further consolidates the students' learning values and deepens the learning and thinking processes.

The results for the Action Research project which spans over the two years using 77 Year-1 students (qualitative students' feedback, quantitative students' feedback, students' engagement, staff feedback) were gathered and analyzed.

The results show that the proposed "Problem-Based Learning" approach with Progressive guidance, Peer assessment and Self-reflection offers more benefits for students taking the "Thinking and Problem Solving" module than the "Case-study" approach.

Future plan is to expand the methodology to other suitable modules in the School of Engineering so as to benefit more students, modules and staff.

Keywords: *action research, active learning, problem-based learning, peer assessment, thinking skills*

Introduction

This paper presents the action research project which compares two different approaches "Case-study approach & Problem-based learning approach with Progressive guidance, Peer assessment and Self-reflection" of teaching the module "Thinking and Problem Solving" for Year-1 Diploma of Telematics and Media Technology (DTMT) students in the School of Engineering, Nanyang Polytechnic.

A problem exists where we have an opportunity to make a difference and to make things better. Problem solving is transforming an actual current situation (Now state) into a desired future situation. Two key questions posed by Crawley, E., Malmqvist, J., Ostlund, S. & Brodeur, D.R. (2007) helped in the design of the module topics and student learning outcomes:

- What is the full set of knowledge, skills, and attitudes that engineering students should possess as they leave the university, and at what level of proficiency?
- How can lecturer do better at ensuring that students learn these skills?

Key topics of the module are:

1. Thinking Skills
   * Critical thinking
   * Creative thinking

2. Problem Solving Skills
   * Problem solving models
   * Cause analysis
   * Solution generation and selection
   * Implementation, monitoring and evaluation

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The student learning outcomes are:

At the end of this module, students will be able to:

1. develop a systematic approach to creative thinking
2. develop a systematic approach to critical thinking
3. identify and analyse problems
4. generate ideas and possible solutions to problems

Materials and Methods or Pedagogy

Two groups of students were taught using two different approaches. The first group (control group) of 38 Year-1 students from the Diploma in Telematics and Media Technology program was taught using "Case-Study" approach, which bridges the gap between theory and practice and between the academy and the workplace (Barkley, Cross & Major, 2005). The second group of 39 Year-1 students from the same diploma program was taught using the "Problem-Based Learning" approach. Both groups work on the same problem:

(a) smoking
(b) time management

Students in the first group were divided into teams of 3 to 4 students. Each team is to analyse the cases, discuss and present their analysis results. Students were observed to be less interested in these cases. Some students would refer to the "model answer" from previous batches of students for analysis results. Some students pointed out the lack of creative thinking training via case study.

Students in the second group were divided into teams of 3 to 4 students and they presented their findings toward the end of the module. Students from other teams were expected to question the presentation team and marks would be awarded for asking useful and relevant questions. Students were required to rank the performance of other teams with the following criterion:

1. Problem statement – clarity & conciseness
2. Critical thinking to identify the root cause of the problem
3. Creative solutions
4. Best solution identification
5. SWOT analysis
6. Survey done and analysis
7. Presentation slides and skills
8. Question-and-answer
9. Team work

Student assessment of other students' work has many benefits to learning for the assessor and assessee. It helps students develop the ability to make judgement which is an important skill for life-long learning (Brown, Rust and Gibbs 1994), promotes higher order thinking skills, encourages students to focus on other groups' presentations and enhances their autonomous learning capability. In the implementation, it was noted that students were much more participative and motivated in their learning.

In the progressive guidance, students were to identify problems that they like to work on/ trouble them, exploit and analyse the likely causes, identify root cause, develop potential solutions and determine the best solution to solve the root cause of the problem.

Examples of problems are:

1. How to minimize stress during examination period?
2. How to manage time well?
3. How to perform well in multi-tasking study/ work environment?
4. How to be a successful person/ student?
5. How to achieve good module grades and good CCA performance?
6. How to avoid being late for lesson/ appointment?

During the group project discussion, close guidance was given to students to exploit the critical thinking and creative thinking skills that they have learned in lecture as they move from one step of the project to the next in solving real-life problem. An example of a mind-map developed by students is given below.

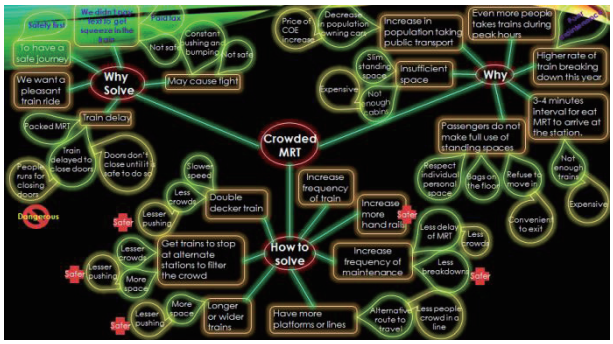


Figure 1: An Example of Mind-map

Such progressive guidance facilitates the students in knowing how to put theory into practical problem solving and ensures that each path that they have taken is correct and does not deviate too much from the right path forward. During the guidance process, the lecturer will also share with the class if there are interesting ideas to explore to seek the class opinion. Students were encouraged to challenge/ criticise not so well-thought-of ideas or expand the good ideas further. This is especially useful in stimulating the students.

Wiggins G. (1993) denotes that students can prove the knowledge learned through applying what they have learned to solving real world problems. Individual self-reflection further consolidates the students' learning values and deepens the learning and thinking processes. In the reflection, individual student shared what they have learned in the module which can lead to learning from experience (Stevens D.D. and Cooper, J. E., 2009). To facilitate fair

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assessment, students were given a one-page limit for self-reflection writing. An example of reflection is given below:

"I have learnt many things in the past 17 weeks and have benefited a lot from the real-life project. Different plans or projects require many different approaches to tackle multiple problems but keeping efficiency at the same time. The many skills we learnt: SWOT Analysis, Creative Thinking Method, Critical Thinking Methods, What-if Analysis, Root Cause Identification, 5-Why Method, Problem Solving Models, Product Development Strategy, Fishbone/ Tree Diagram and Mind Maps, all taught us to think not only just on the surface, but to delve deeper into the problems and solutions and view it from different angles.

While doing the project, my team and I came across many hurdles. Firstly was the Product Development Strategy. Although our topic is on stress management, we do not offer products to reduce stress, but instead offering counselling services. It is something not physical unlike the other groups which have physical items, like IT-based solutions and electronics' gadgets. We ultimately decided on "Good Service and Responsiveness" as a product development strategy, since only by "Good Service and Responsiveness" could good counselling services be delivered to customers.

The peer assessment had provided a good opportunity for us to learn from each other. The project development journey with good advices and close guidance from lecturer has been fun and fruitful, and I hope I will have more of such opportunities again!"

Interesting **T**an **K**ah **K**ee (**TKK**) Young Inventor Awards that other students won in the past were used at the beginning of each lesson to stimulate their thinking. An example that students won under my supervision titled "Tear-Easy Envelop" is given in Figure 2.

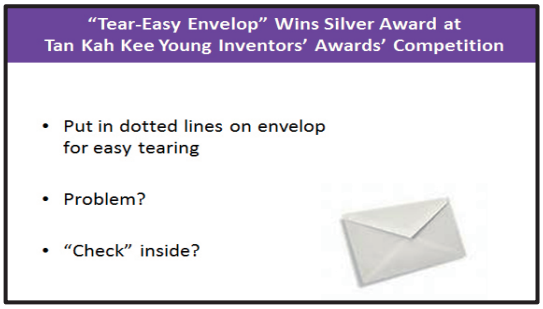


Figure 2: An Example of TKK awards for mind stimulation

Another example of TTK awards is "Refreshing wake-up device" – an alarm clock that uses the sense of smell for people with hearing impaired.



Figure 3: An Example of TKK awards for mind stimulation

Problem-based learning approach offers the following potential benefits:

- The learning motivation of the students can be enhanced through connecting to real life projects. Deeper learning can be achieved when the students are able to establish association between concepts learned in lecture and real life applications. Students are able to excel and learn better if they have an environment that is centred around them (Land & Hannafin, 2000).
- Critical thinking, creative thinking and problem solving abilities can be cultivated through solving the real-life problems.
- They will also get to understand that learning goes beyond solving tutorial, case study and examination questions and extends into solving complex problems in real world.

Two surveys were conducted at the end of the semester on lecturers and students.

The survey on students collected feedback on:
- Increase in learning motivation
- Usefulness of peer assessment
- Effectiveness of linking concept to real life application
- Effectiveness of progressive guidance
- Timeliness of progressive guidance
- Motivational effects of progressive guidance
- Value of self-reflection

The survey on lecturers collected feedback on:
- Ease of motivating students
- Usefulness in explanation of concept
- Effectiveness in linking concept to real life application
- Value in accelerating learning
- Student engagement

Results and Discussion

i) Quantitative students' feedback

Quantitative students' feedback was obtained via survey done with 39 students for the problem-based approach which gave the following results:

1. 97.4% find the problem-based learning has motivated them very well.
2. 100% find that peer assessment has made them learn more.
3. 100% participate actively in lesson activity.
4. 97.4% feel that seeing how theory is used in real life project encourages them to learn about the topic.
5. 97.4% feel that they have benefited a lot from the progressive guidance.
6. 100% feel that the progressive guidance is timely and motivating.
7. 95% feel that self-reflection consolidates their learning in a meaningful way.
8. 100% find that the open-ended questions at the beginning of each lesson helped them to be more creative and to look at the root cause of the problems from different angles and were useful for their project development.

Quantitative students' feedback for the 38 students for the case-study approach gave the following results, which were not as good as the problem-based learning approach:

1. 71.1% find the case-study learning has motivated them very well.
2. 76.3% participate actively in lesson activity.
3. 71.1% feel that case-study is not enough for them to connect to real-life project.
4. 73.7% feel that seeing how theory is used in case study analysis encourages them to learn about the topic.

ii) Qualitative students' feedback

The qualitative students' feedback for the problem-based approach shows very positive comments:

1. The peer assessment enables me to learn a lot of things from other teams.
2. Lesson is exciting and fun.
3. Problem-based learning makes me more confident and proficient in thinking effectively and creatively. It was a great experience.
4. Self-reflection is very useful. Inquiry-based questions help us to think better.
5. The module was fun and it was something new to experience.
6. The lessons taught me something that I can benefit for life!
7. I like the SWOT and root cause analysis which can be very useful for decision making.

The qualitative students' feedback for the case-study approach as listed below was not as positive as the problem-based approach:

1. While case study helped me analyzed cases, I would prefer solving actual real-life problems.
2. As there are model answers available from previous batches of students, it is better to work on real-life problem than case study.
3. Case study does not allow me to solve the problems that I am facing now.
4. Analyzing cases sharpen my critical thinking skills and team work.
5. I am not sure how to utilize case analysis for improving my creative thinking skills.
6. Lesson is engaging.
7. Good team synergy.

iii) Student engagement results

The student engagement results were summarised in Table 1.

	% of students with > 95% attendance	% of students with > 5% late for lesson	Student participation in Q&A
Control group	89.5	13.2	Fair
Second group	100	2.5	Very good

Table 1: Comparison of Student Engagement Results

Student engagement results show that the percentage of students with an attendance rate of 95% and above has increased while the percentage of students with greater than 5% late for lesson (> 10 minutes late) has reduced significantly. The students also participated very actively in Q&A.

iv) Staff feedback

Feedback from the lecturer shows that students learned via the problem-based learning approach were much more participative, creative, engaged and motivated in the learning process than students learned via the case-study approach.

Conclusions

The qualitative students' feedback, quantitative students' feedback, students' engagement results and staff feedback of the Action Research project which spans over the two years using 77 Year-1 students show that the proposed "Problem-Based Learning" approach with Progressive guidance, Peer assessment and Self-reflection has provided more benefits for students learning the "Thinking and Problem Solving" module than the "Case-study" approach.

They serve as an enabling tool to enhance students' learning experience by motivating them, nurturing their enthusiasm for their subjects, developing deeper problem solving skills, building their metacognitive skills and preparing them for solving real world problems innovatively.

The future plan is to expand the methodology to other suitable modules in the School of Engineering so as to benefit more students, modules and staff.

Acknowledgements

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EVALUATION OF A NEW CREATIVE EDUCATION PROGRAM WITH TRIZ

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Abstract

Recently, (1) engineering skill and (2) creative skill has become more important for engineering. However, it is difficult to foster creative human resources who have both engineering and creative skills. In this study, we present an education effect of our proposed education program with TRIZ. To evaluate the effect, a trial lesson is conducted. This study evaluated the education effect by Curiosity test. The Curiosity test can measure the curiosity in terms of qualitative and quantitative. As results, in 60% students, the qualitative curiosity had been increased through our proposed program with TRIZ.

Keywords: *Engineering development, Problem-solving, TRIZ, Curiosity test*

Introduction

Recently, intellectual property has become more important for engineering development in complex industrial structure, such as through internationalization, diversification and advancement of services. In such the industrial structures, both 1) engineering skill and 2) creative skill are required for engineers. The engineering skill is an ability of realization through technology. The creative skill is ability to creative something new.

However, to foster creative human resources who have both the engineering skill and the creative skill is difficult. In our previous work, to foster creative human resources in KOSEN, we proposed a new education program with Theory of Inventive Problem Solving (TRIZ)[1]. In the proposed program, the target of achievement is following two acquisitions.

(1) Acquisition of proposal skills in technology design and development.

(2) Acquisition of problem-solving skills utilizing creativity.

This paper presents an evaluation of the education program with TRIZ. We show an education effect of the program by a trial lesson. To evaluate the effect, we introduce a Curiosity test [2]. The Curiosity test can measure a curiosity in terms of “qualitative” and “quantitative”. By using the qualitative curiosity, we can measure a level of creativity.

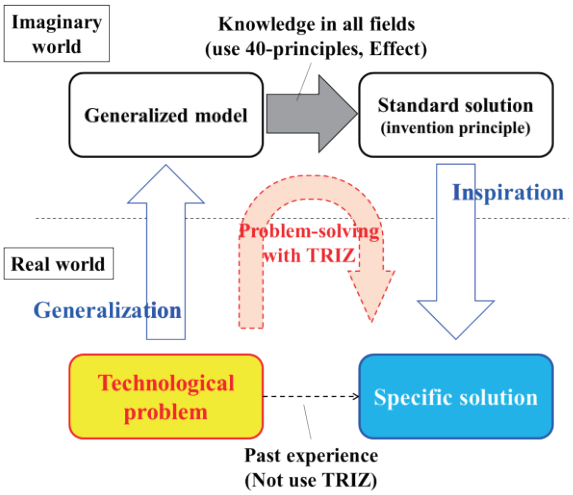


Figure 1 Overview of a problem-solving with TRIZ.

Education program with TRIZ

To develop creative human resources in KOSEN, we had proposed a new education program with TRIZ in ISATE2014. The TRIZ is an inventive problem-solving methodology that was proposed by Genrich S. Altshuller in 1946. Figure 1 shows an overview of problem-solving with TRIZ. As shown in Fig. 1, a technological problem is generalized. Then, using knowledge in all fields, the standard solution is derived. Finally, the specific solution can be obtained by inspirations. In the TRIZ, tools of "40-principles", "9-windows" and "Effect" are used in order to lead to the standard solution effectively.

Table 1 shows our proposed program with TRIZ. As shown in Table 1, the program consists of 15 classes, and it is consisted of three parts. The No. 1 to 5 introduce TRIZ and 40-principles. Next, the No. 7 to 10 explain a generation of idea with Effect. Finally, the No. 11 to 14 give a lecture of future spatial prediction using 9-windows. Between the each part, we conduct an exercise of how to use these tools.

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Table 1 Proposed program with TRIZ.

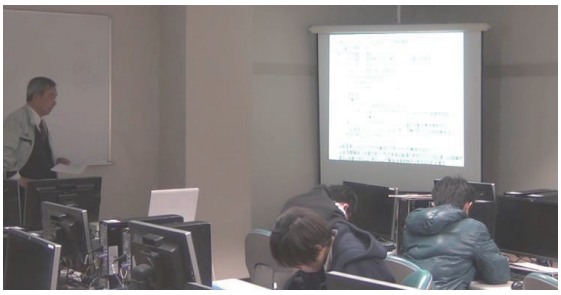
No.	Title of class and contents
1	**[Introduction]** Explain about ability required for engineering and signification of learning creativeness.
2	**[Requirements for a creative engineer]** Explain about requirements for becoming creative engineers.
3	**[Methodology for developing creativity]** Introduction of TRIZ, and explain about basic concept of problem-solving with TRIZ.
4	**[Approach to solve technical problems]** Applications of problem-solving with TRIZ, and explanation of step for generating ideas.
5	**[40-principles]** Explain about tool of "40-principles".
6	**[Practice of technical problem solution 1]** Training of problem-solving with "40-principles".
7	**[Invention principles with technological contradictions]** Show technological contradictions with case examples, and introduce procedure of TRIZ application.
8	**[Generation of ideas that have identical function (What is "Function"?)]** Explain about "Function" and generation of ideas that have an identical function.
9	**[Application of "Effect" for generation of ideas]** "Effect" tool is database of science and technology principles. Explain about creative pattern of ideas with "Effect" tool.
10	**[Practice of technical problem solutions 2]** Training for generation of ideas using "Effect".
11	**[Future technological forecast using roadmap]** Introduction of a roadmap, which shows an evolution pattern of technologies. Explain about prediction of a future with the roadmap.
12	**[Future spatial prediction using 9-windwos]** Introduction of "9-windows", and explanation of how to use it for future spatial prediction.
13	**[Generation of ideas using TRIZ]** Explain about future prediction with "9-windows", and discussion of a resolution for the future prediction with TRIZ.
14	**[Practice of technical problem solution 3]** Training of future prediction using "9-windows", and generation of specific solution.
15	**[About invention]** Explanation of intellectual property rights and a creation of technology via innovation. Discussion of importance of cycle of intellectual creation.



(a) Lecture 1



(b) Lecture 2



(c) Curiosity test

Figure 2 Photos of the trial lesson.

Trial lesson and evaluation of the education program

We conducted a trial lesson for evaluation of the education program with TRIZ. Figure 2 shows pictures of the trial lesson. The trial lesson was conducted in 10 students who are fifth grade students of National Institute of Technology oyama-collage.

In this study, to evaluate an education effect of our program, Curiosity test [2] is introduced. Using the Curiosity test, we can measure someone's level of curiosity in terms of "Qualitative curiosity" and "Quantitative curiosity". The qualitative curiosity is a height of level of both intellect and creativeness. The quantitative curiosity is a breadth of the scope of curiosity. The qualitative curiosity indicates a level of creativity.

Figure 3 shows a questionnaire form for the Curiosity test. As shown in Fig. 3, there are 96 items of questionnaire about interest. In No. 81-96, answerer fills out one's own concerns. The Curiosity test conducts by following five steps.

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Table 2 Overview of questionnaire of Curiosity test.

No.	issues	(イ)	A	B	C	…	S	T
1	Solar heat utilization							
2	Interior design							
3	Bird-watching							
4	Japanese woodblock prints							
36	Volunteer activities							
37	Black hole							
38	DIY							
39	Puzzle							
47	Comet Halley							
48	Computer art							
49	Herb							
50	Recycling							
79	Body clock							
80	Alchemy							
81	***							
95	***							
96	***							

No.80-96 : Fill out own concerns (No.81～96)

[Items of curiosity level]
A : I have a concern from newspaper of TV and so on.
B : I want to know its principle, and use for making new ideas.
S : I hope a mere unexpected thing.
T : I have a willingness to use own ingenuity to it.

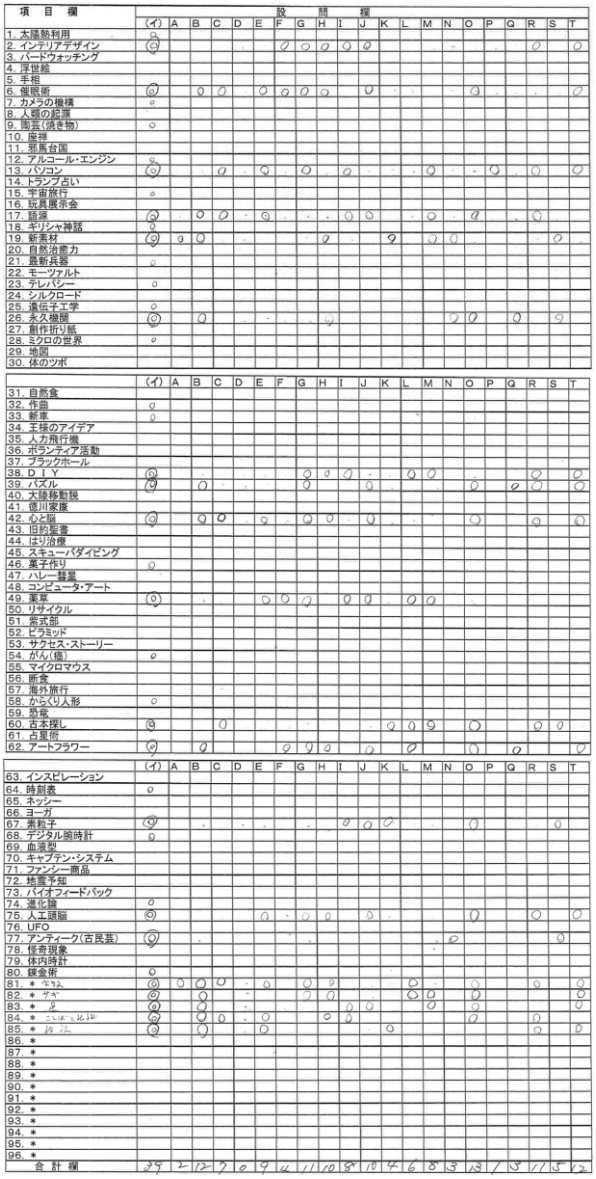


Figure 3 Example of an answer of the Curiosity test.

(Step 1)
Select one's own interests from items of from No. 1 to No. 80, and enter ○ in the space (イ).

(Step 2)
Fill out one's own interests without items of from No.1 to 80, and enter ○ in the space (イ).

(Step 3)
Count the number of the mark ○. If the total number of ○ is number of more than 20, select 20 items of particular concern from the items marked ○ and change the marks to ◎. If the total number is number of less than 20, change all marks to ◎.

(Step 4)

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Select curiosity level of the items which checked ◎. Select the appropriate items of from A to T, and write in ○. If there are no appropriate items, keep in blank.

(Step 5)

Calculate the value of both qualitative curiosity and quantitative curiosity. The quantitative curiosity is calculated as following.

Quantitative curiosity = $X_1 / (80 + X_2)$

The X_1 is the total number of both ◎ and ○ on (Z). The X_2 is the number of items filled in No. 81-96. The qualitative curiosity is calculated as following.

Qualitative curiosity = $(1 \times N_1 + 2 \times N_2 + 3 \times N_3) / X_3$

The N_1 is the sum of the number of ○ on A, D, F, I, N, P or Q. The N_2 is the sum of the number of ○ on C, E, J, K, M or S, and the N_3 is the sum of the number of ○ on B, G, H, L, O, R or T. The X_3 is the total number of ○ on A to T.

In this study, we conduct the Curiosity test before and after the lesson. Figure 3 shows one example of an answer of the Curiosity test. We evaluated an education effect of the proposed program with TRIZ by results of the test.

Results and discussion about the education effects

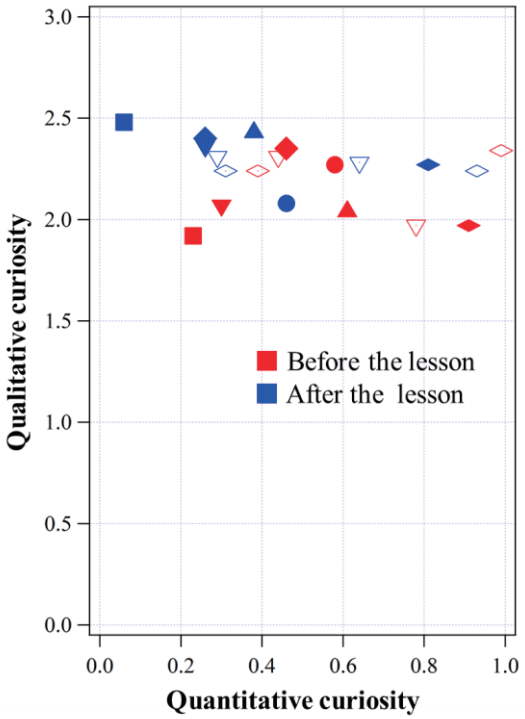
Figure 4 shows a summary of the result of Curiosity test of 10 students. The vertical axis is a level of the qualitative curiosity, the horizontal axis is a level of the quantitative curiosity.

As shown in Fig. 4(a), after the trial lesson, values of the qualitative curiosity are increased more than 2.0 in all students. It shows that they got a good quality of curiosity through the education program. Especially, the students of Group (A), whose level of the qualitative curiosity were near 2.0, make a significant improvement through the lesson. For example, one student improved the level of qualitative curiosity from 1.92 to 2.48. It means that the proposed program with TRIZ have a good effect on improvement of qualitative curiosity to students whose level of qualitative curiosity were low.

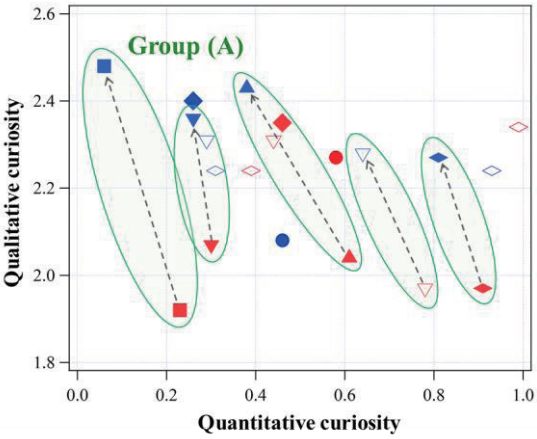
On the other hand, as shown in Fig. 4(c), it is not effective in students (Group (B) and (C)) who had a more than 2.0 qualitative curiosity. In Group (B), their level of qualitative curiosity is rarely different from before the class.

Conclusions

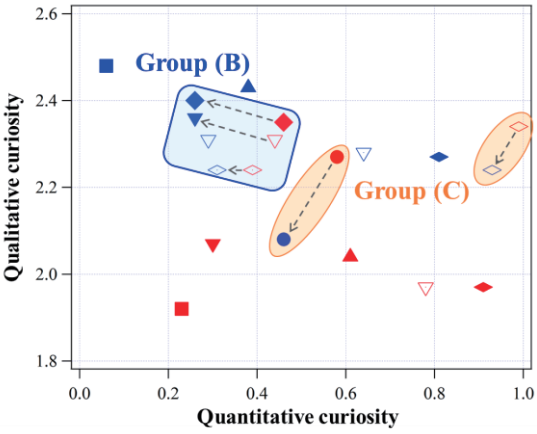
This study presented an education effect of the education program with TRIZ by introducing the Curiosity test. Using the Curiosity test, we could show the improvement of an intellectual creativity through our proposed education program with TRIZ. As the result of the Curiosity test, the level of qualitative curiosity had been increased in 60% students.



(a) Summary of the Curiosity test



(b) Results of Group (A)



(c) Results of Group (B) and (C)

Figure 4 Results of the Curiosity test

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In the future work, we will consider introduction of the creative education program to education curriculum of KOSEN.

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LLOYD'S MIRROR INTERFERENCE LITHOGRAPHY AS A MICROMACHINING EDUCATION

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Abstract

Despite the importance of a MEMS technology workforce, the fundamentals of manufacturing MEMS has not been effectively taught in the laboratory course. A fine pattern lithography using the hologram technique, which has been developed to a PBL type educational program for a nanotechnology laboratory course to get a deep understanding about the fundamentals of MEMS technology, was proposed and discussed. Apparatus of the laboratory is an accessible, simple system that can be used in an ordinary environment requiring no special facilities.

In the laboratory course, manufacturing the fine grid patterns as well as the fine striped patterns by using the Lloyd's mirror fabricated to obtain the interference of violet light (λ =441.6 nm) from He-Cd laser and discussion on the results were assigned. The wet etching process was assigned to manufacturing fine resist patterns on glass substrates. As for the results, half-pitch, depth, aspect ratio and cross sectional profile etc. of the patterns were measured, and less than 0.5 μ m half-pitch and about 500 nm depth pattern were successfully achieved. The results were discussed by comparing with both the optical theory and other experimental results with the mask aligner.

Based on the education experience, it was discussed how the suitable procedure that lets students notice the presence of the problem in their experimental results should be. An educational program that makes students possible acquire a capability for finding problem and solving the problem using these manufacturing processes was proposed and a possibility as an actual experimental program was discussed.

It was recognized that this program was a very influential and hands-on method, so it would be possible to introduce a laboratory experiments with the concept of PBL type education to adjust to the several levels of the students.

Keywords: *Lithography, Horogram, Fine Pattern, Lloyd's mirror, Micromachine*

Introduction

Society is experiencing many changes because of nanotechnology and the nanotechnologies in the field of IT, environment, energy and life science will create large and unexpected break-through in the future life. The Minister of Education, Culture, Sports, Science and Technology (MEXT) has been supporting the nationwide project "Nanotechnology Platform Japan (NTPJ)" to establish a reliable research infrastructure (Platform) for scientific innovation by the alliance of the institutes which have cutting edge equipment and research know-how.

Kagawa prefecture is recognized as one of the strongest regions in the nation for nanotechnology research and development on the diagnosis and treatment of health related conditions. It is anticipated that many of the current businesses in the area stretching from Kagawa to neighbor prefectures will begin to embrace the new developments and that many new businesses will be created. As these and new companies embrace nanotechnology, a large demand will most likely be created for graduates with a background in nanotechnology. Therefore, nanotechnology education is a natural fit for the mission of the career-focused polytechnic university where students, faculty staff use scientific theory and research to solve real-world problems. Nanotechnology education represents the interdisciplinary efforts of traditional areas of science, mathematics and engineering.

In the spring of 2004, Tokushima Bunri University at Kagawa launched undergraduate programs in a new department of nano and bio material engineering, where faculty from several departments collaboratively formulated to nanotechnology education in the initial stage. "Project Laboratory" is one of the core curriculum in the new department for junior-level students. "Project Laboratory" comprises four topics of nanotechnology, i.e. photo luminescent nanoparticle, cellulose material, micromachining (i.e. micro fabrication) and enzyme science. Each topics has a 4-period laboratory program.

In the present study, the experience of the surface micromachining education using Lloyd's mirror interference lithography is described. An educational

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program that makes students possible acquire a capability for finding problem and solving the problem using the manufacturing processes is proposed and a possibility as an actual experimental program is discussed.

Experimental Methods

The lithography process was considered by using micro slide glass (Matsunami Glass Ind., Ltd.; 60 mm x 60 mm x 1 mm). The glass substrates were coated by DNQ novorac resit (Microposit S1813) at spin coater. The positive DNQ resist has strong absorption bands in the ultraviolet wavelength range from approximately 300 nm to 450 nm, which covers i- and h-line. The thickness of resist is arround 1.2 μm at spin speed 5000 rpm. The substrates were followed by soft baking at 120°C for 3 min.

The exposure process was conducted by using an interference pattern using Lloyd's mirror and He-Cd laser (λ=441.6nm). Figure 1 and Figure 2 show the experimental set up of the interferometer and a photograph of the equipment respectively. As shown in Figure 1, the interference pattern is produced on the substrate as a result of the combination of the direct ray ant the reflected ray. The interval (d) of the interference fringes and the spacial frequency (ν) are given by $d = n\lambda/\sin 2\theta$ and $\nu = 1/d$ respectively, where θ is the mirror angle, n is the integer. Calulaion results for these values are shown in Table 1 at typical mirror angles. To prevent the reflection from the reverse side of the glass substrates, a reflection free slide glass (black painted glass) was attached with index matching oil (Xylene). Exposure time (T) is determined by the intensity (I) of light and the optimum exposure energy (E) of the resist: $E = T \cdot I$, where T in sec, I in W/cm^2 and E in J/cm^2. The intensity of light was measured by an optical power meter. Accoring to the data sheet of Shipley Ltd., the optimum exposure energy is about 30 mJ/cm^2 for 1.0 μm thickness resist. After the exposure process, the substrates were developed for 1 min. and rinsed in pure water. In order to keep the resit stable, the substrates were dried with a blower.

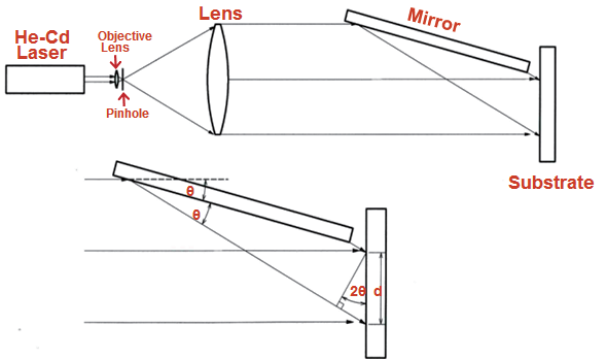


Figure 1. Experimental set up by Lloyd's mirror interferometer and He-Cs laser.

Table 1. Interval of the interference fringes and spacial frequency at typical mirror angles (θ).

2θ (deg.)	Interval (μm)	Spacial Frequency (cycle/mm)
5	5.067	197
10	2.543	393
15	1.706	586
20	1.291	775
25	1.045	957
30	0.883	1,132

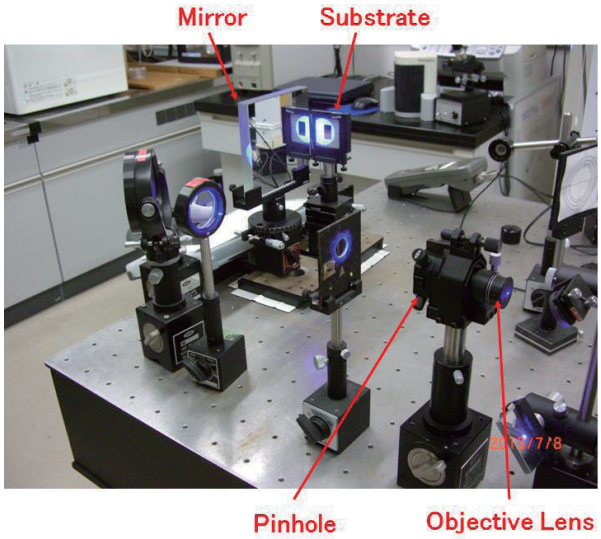


Figure 2. Equipment of Lloyd's mirror interferometer.

Experimental Results

It is easy to confirmed by visual inspection whether the lithography process was successful, because the exposed area of the substrate surface after the developing process looks iridescent as shown in Figure 3, which means there are fine pattern on the substrate. Figure 4 shows a typical scanning probe microscope (SPM) image of the resist after developing process when the substrate was exposed at the mirror anger θ=5°. The interval of etched resist pattern of this sample was measured 2.5μm which is in good agreement with the optical theory. As shown in the

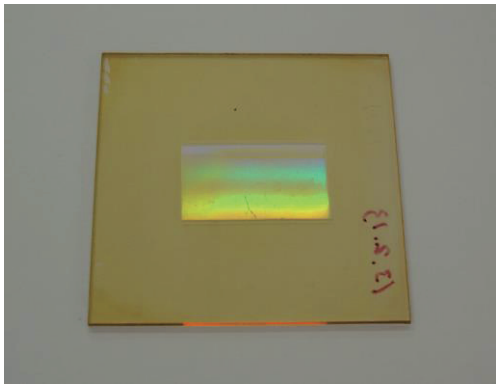


Figure 3. The resist on the substrates after the developing process.

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Figure 4, the cross section of etched resist was wedge-shaped with about 424 nm depth.

Since the width of the edged space is about 1.0μm at any mirror angles, the most fine pattern is 1.0μm line/space, which is achieved at mirror angle θ=11° ,whose depth is about 244 nm.as shown in Figure 5,

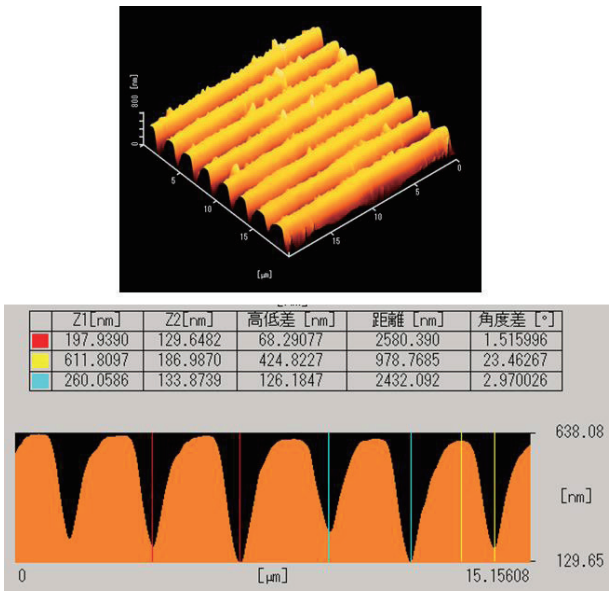


Figure 4. SPM image of the patterned resist on glass substrate: θ =5° , d=2.5 μ m

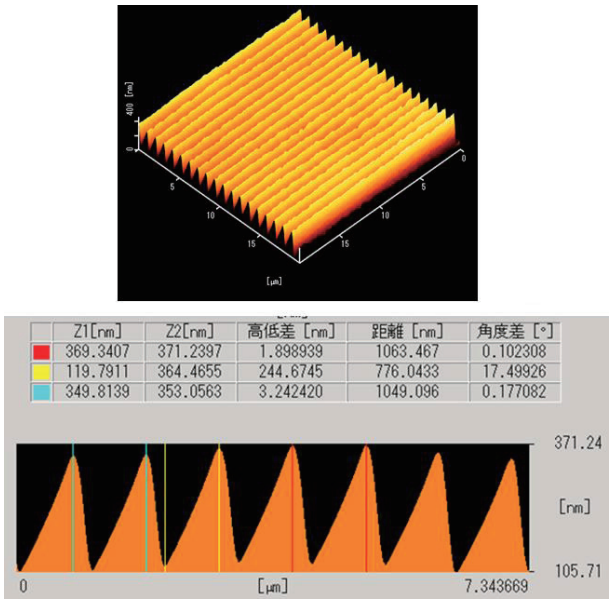


Figure 5. SPM image of the patterned resist on glass substrate: θ =11° , d=1.2 μ m.

Exercise of the Laboratory Course

This laboratory is a 4-period (4 day) program and each period has 180 minute. The first day is for the guidance of this laboratory: the objective of experiment and the instruction for the facility, and for the preparation of the glass substrates. It is important to let students to keep in mind the attention points on the facility usage and the necessity of the process conditions during the experiment. After the guidance, students get work started. Firstly, the provided glass substrate is cut a appropriate size and cleaned. The number of substrates handled at a time was decided to be same number of students in one group, so that each student can experience the whole process and evaluate their own substrate by themselves. Each student carries out the process with different conditions and compares the result with others. This method is intended for students to understand well how the process going.

The second day is for the lithograpy process. Firstly the substrates are spin coated with resist and baked. The thickness of resist depends on the spin speed, and the baking conditions (temperature and time) are affected by the room temperature and the air humidity as well as the resit thickness. So students should record precicely these conditons on their worksheet.

Then the substrates are exposed by the Lloyd's mirror interferometer at a mirror angle. In order to determine the exposure time the power of light on the substrate is measured at the laser wavelength by a optical power meter. The exposure time depends on not only the power of light as discribed above. However it is weekly affected by the mirror angle, fluctiation of light etc. Therefore it is meaningful to try change the exposure time around the caluculation result. After the exposure, the substrate is developed in a beaker and linsed by pure water. The important point of the developing process is to remove the exposed resist complitely. So the developer and the pure water should be renew oftenly. It is easy to confirmed by visual wheather the lithography process was successful as discribed above.

The third day is for the examination. In this laboratory, a digital optical microscope (DOM: KEYENCE VHX-900), a secondary electron microscope (SEM: HITACHI S-4800), and a scanning probe microscope (SPM: SII Nanopics 2100) are used for the examination to the surface. Students measure the interval and the depth of etched pattern. Cross sectional shape is also observed by the SPM or the SEM. The measurement by SEM needs preparation of spiceman.

The final day is for the presentation and discussion. Firstly the students discuss on their experimental results with the process parameters in their group. The result of discussion is prepare a presentation material in one group. Then they publish their presentations for the class and discuss with other groups.

In the group discussion, suggested topics are followings;

- The resist was positive type. Did the etched area correspond with the bright area ?
- Confirm the iridescent surface of the substrate by visual inspection. If you could not confirm it, consider the exposure time or the soft baking time.
- Observe the resist pattern by microsocope. If there were any resudial resist or disorder of patten, consider about the developing time.
- Measure the interval of etched pattern and compare it with the calculation by the optical

interference theory.

- Measure the depth (d) and the width (w) of the etched area by SPM and estimate the aspect ratio (d/w) of the etched pattern.

Discussions

In the group discussion the students think about why the differences of their own made substrates come from, and what the cause of the differences could be, by comparing their own made substrates with others. Some of them may notice the differences even if they use same process conditions. In the discussions, there might be no answer about the question what is the best process conditions because the lithography process is likely affected by the unknown enviroment conditions or accidents. Through these experiences, some students recognize the necessity of more sensitive treatment for the micro size fabrication, others feel the significance of taking lab-note on the experimantal conditions more precicely.

As for the advanced topics in the group discussions, following are worthy of consideration;

- What kinds of factor concern with the depth and the width of the etched area ?
- Why the cross-sectional shape of the etched line is not rectangle ?
- Find out the way how to make grid pattern by the Lloyd's mirror interferometer.
- Compare the resist pattern on substrate with the similar pattern made by the mask aligner in an extra-curricular activity.

However students can not conduct the experiment again in the regular period of the program if they fail or want to try the advanced topics, so students should simulate all processes including optional experiments as completely as possible in the first period.

Conclusions

The nanotechnology education at the undergraduate level in Tokushima Bunri University has lurched in the Spring of 2004, which has been impressive and timely. "Project Laboratory" is one of the core curriculum in the new department for junior-level students. In this course, the Lloyd's mirror interference lithography was developed as a micromachining topics.

Although the apparatus of the laboratory is an accessible, simple system that can be used in an ordinary environment requiring no special facilities such as the electron beam mask writer etc., nano size ($\sim 1\ \mu$ m) fabrication can be achieved. Then the Lloyd's mirror interference lithography is appropriate for a surface micromachining education.

Based on the education experience, it was shown that students can learn about a basic series of lithography process and the evaluation technics of microfabrication. Though this program students can also understand the attention points on the facility usage, and notice the necessity of the precise process conditions during the experiment.

Through the group discussions, they can consider about why the differences of their own made substrates come from, and what the cause of the differences could be. Some groups can deduce what the best process condition is, others can reach a hypothesis that the best process condition should be.

It was concluded that the presented program was very useful and applicable as a PBL method education for the nanotech laboratory exercise.

Acknowledgements

The authors would like to thank Mr. A.Kawamura and Prof. K. Chiba of Tokushima Bunri University for their contributions in early development of the "Project Laboratory" course.

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The Research of Water Quality and Aquatic Organisms in Katashina River Collaborated with Local Researchers

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Abstract

In this study, water quality, diatoms, aquatic insects and freshwater fish in the low flow section and the maintenance flow section in Katashina River were examined. Water quality, diatoms, aquatic insects and freshwater fish in the low flow section in winter period of 2010, and in the maintenance flow rate section in winter period of 2011 in Katashina River were examined. The results are summarized as follows, 1. The pH was about 7, thus neutral. Nitrogen concentrations of Katashina River water were as high as 0.15mg-N/l in this period. 2. The amount of Melosira varians in the maintenance flow section was decreased comparing that in the low flow section. 3. Most of the freshwater fish was Tribolodon hankonesis at two sites. These results indicated that Katashina River environments were improved slightly

Keywords: *Multiple Institutions Collaboration, Tributarie of Tone River, low flow section, water quality, biological research, diatoms, aquatic insects, freshwater fish*

Introduction

Gunma prefecture at northern of Tokyo has many dams for drinking water and the hydroelectric power station in the rivers which are the tributary of Tone river. Until 2010 in winter seasons, the Katashina River, a tributary of Tone River has suffered a decreased flow rate section of 2.7 km due to flow diversion to the hydroelectric power station of Hiraide Dam, resulting in deterioration of the river environment as a wildlife habitat. In 2011, a new hydroelectric power station (Shin-Tonami electric power station) was built by Gunma Prefecture to improve the river environment. The water of river maintenance flow is used by the new hydroelectric power station.

This flow rate is 1.83m^3/s (Hiraide dam:0.05m^3/s＋ Shin-tonami electric power station:1.78m3/s).

In this study, water quality, diatoms, aquatic insects and freshwater fish were examined at the low flow section (2010) and the maintenance flow section (2011 to 2013) at Katashina River.

Materials and Methods or pedagogy

Katashina River and sampling sections

Figure 1 shows that Katashina River is located in the northern part of Gunma Prefecture. Figure 2 shows that five sampling sections were selected on the Katashina River. River water was sampled from the Katashina River occasionally.

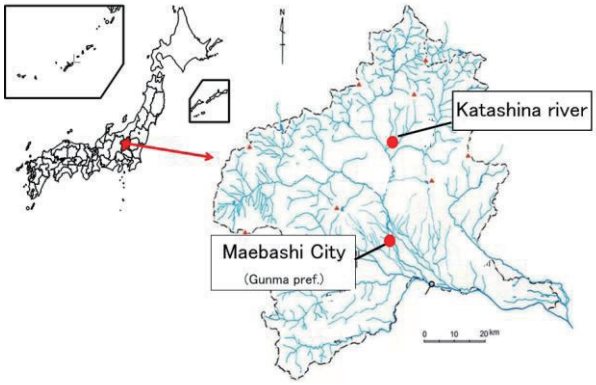


Figure 1 Katashina River was located in northern of Gunma prefecture, Japan

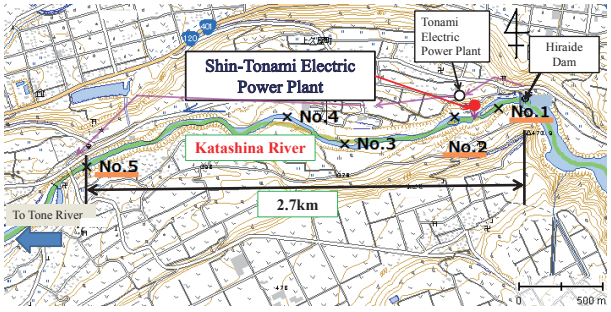


Figure 2 sampling five sections, number 1 to 5 on Katashina River

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Analytical method

Nitrogen compounds (inorganic nitrogen, NH_4-N, NOx-N(=NO_2-N+NO_3-N)) and PO_4-P were analyzed using an autoanalyzer (ACCS-Ⅱ). Electrical Conductivity (EC) and temperature were measured using a hand-held conductivity meter at the sites. The pH was measured using pH meter in our laboratory. BOD in Katashina River was expected small value, it was not analyzed.

Diatom, Aquatic insects and Fish sampling method

Diatom cells were collected with attached growth on submerged rocks. This is the usual approach in studies for environmental monitoring and screening of diatom abundance. Afterwards, the sample is preserved using 60% ethyl alcohol and the cell content is cleaned. The sample is examined with a microscope, and diatom taxa and abundance in the samples are obtained by counting 200 cells per sample. Aquatic insects were caught using a net and a steel frame (25cm*25cm) four times at three sites occasionally. These samples were conserved using 60% ethyl alcohol. Freshwater fish were collected by a net and an electric shocker at two sites for ten minutes occasionally.The biological indicators have peculiar features, it is possible that we get to know present situation of the river environment.

Results and Discussion

Water quality

The pH was about 7 in all sections. Figure 3 shows the results of river water quality about NO_3-N concentration of Katashina River water were as high as 0.15mg-N/l in this sections. There is no effect of wastewater. The effect of the field in the left side in Katashina River is indicated. These results indicated that continual study of the water quality are necessary.

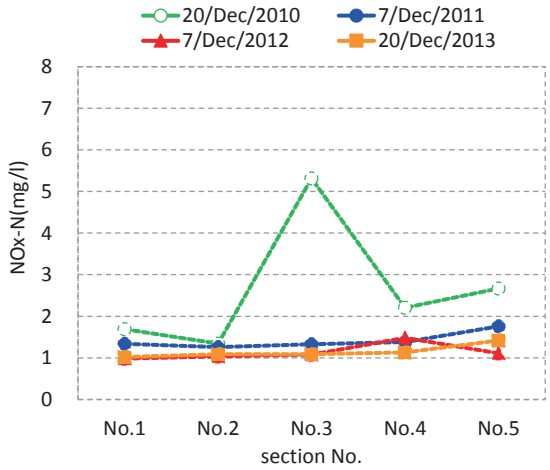
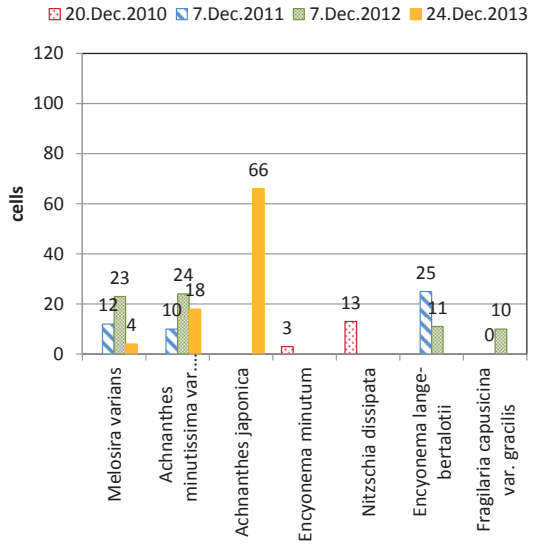


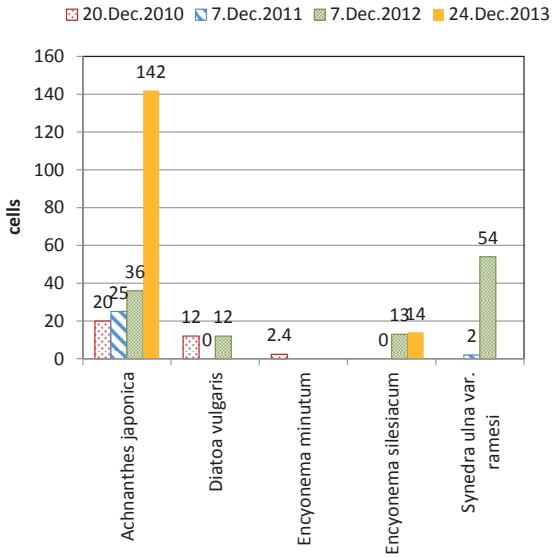
Figure 3 Inorg-N concentrations in Katashina River water from section number 1 to 5

Diatoms

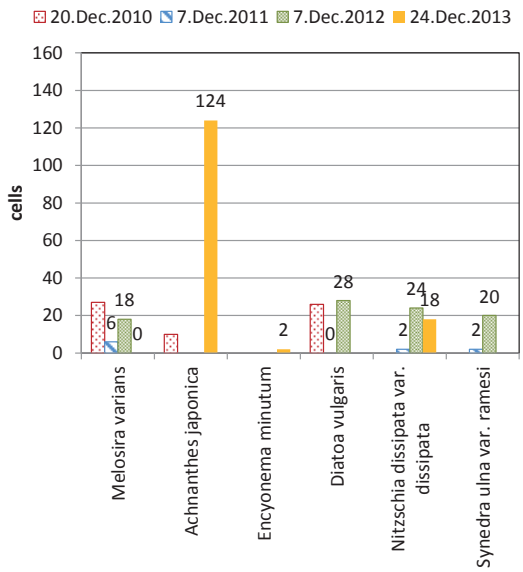
Figure 3 shows diatom kinds of the each section. The amount of Melosira varians in the maintenance flow section (2010) was decreased comparing that in the



(a) The genera of diatom at section number 2



(b) The genera of diatom at section number 3



(c) The genera of diatom at section number 4

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Figure 4 the kinds of diatom from section number 2 to 4 in Katashina River

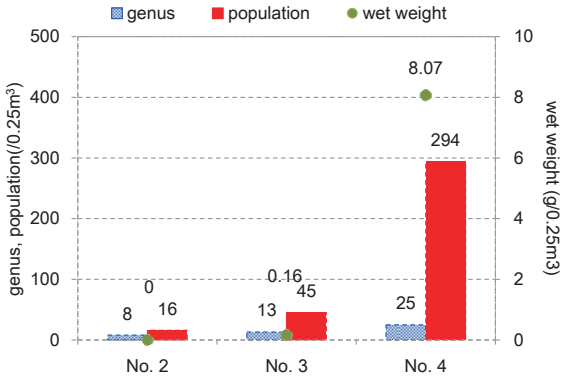
low flow section (2011 - 2013). The environment for diatoms might be in the maintenance water flow section. Mesosaprobic flora is decreased. Spring water flora is increased.

Aquatic insects

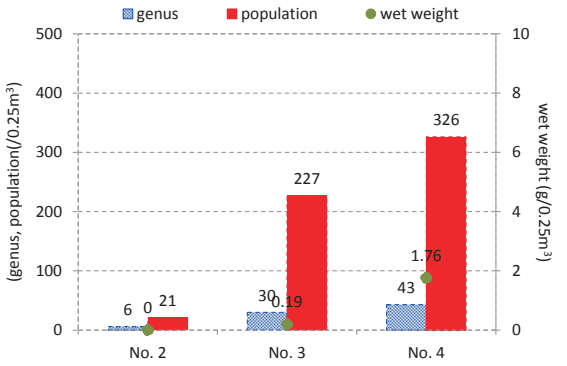
Figure 5 shows that genus, population and wet weight of aquatic insects in each section. The genus varied, and the population increased at the downstream in maintenance flow section (2011). The species become rich at section No.2 – 4. Genus and population is increased.

Freshwater fish

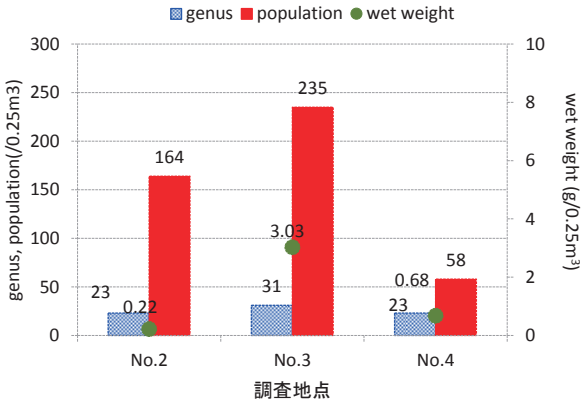
Table 1 shows the number of the fish collected in section number 3 and 4. Most of the freshwater fish was *Tribolodon hankonesis* in low flow section and the maintenance flow section. *Liobagrus reini* endangered species was observed at section no. 4. The large body *Tribolodon hankonesis* was observed. These results indicated that large body fishes increased. It was not possible to confirm the change clearly, compare with low flow section and maintenance flow section.



(a) Genus, population and wet weight of aquatic insects in low flow section (2010)



(b) Genus, population and wet weight of aquatic insects in the maintenance flow section (2011)



(c) Genus, population and wet weight of aquatic insects in the maintenance flow section (2013)

Figure 5 genus, population and wet weight of aquatic insects in section no.2 to no.4

Table 1 the number of the fish collected in section number 3 and 4 from 2010 to 2013

section no.	fish	20. Dec. 2010	7. Dec. 2011	7. Dec. 2012	24. Dec. 2013
No.3	*Phoxinus logowskii steindachneri*	2		2	2
	Tribolodon hankonesis	73	30	45	46(12)
	Zacco platypus		1		
	Pseudorasbora parva		1		
	Hypomesus nipponensis	2			
	Liobagrus reini			1	1
No.4	*Phoxinus logowskii steindachneri*			1	1
	Tribolodon hankonesis	47	72	143	45(7)
	Zacco platypus	1			3
	Pseudogobio esocinus esocinus	2	3		1
	Pseudorasbora parva		1		
	Phinogobius sp. CB		1		
	Hypomesus nipponensis				
	Liobagrus reini	2	1		1
	Cobitis biwae	1	2		

*() is the number of large body fish (12cm over)

Conclusions

Water quality, diatoms, aquatic insects and freshwater fish in the low flow section in winter period of 2010, and in the maintenance flow rate section in winter period of 2011 in Katashina River were examined. The results are summarized as follows,

1. The pH was about 7, thus neutral. Nitrogen concentrations of Katashina River water were as high as 0.15mg-N/l in this period. 2. The amount of Melosira varians in the maintenance flow section was decreased comparing that in the low flow section. 3. Most of the freshwater fish was Tribolodon hankonesis at two sites.

These results indicated that Katashina River environments were improved slightly.

Acknowledgements

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SCIENCE FAIRS: DEVELOPING SCIENTIFIC VOCATIONS IN HIGH SCHOOL STUDENTS AT THE UNIVERSITY OF GUANAJUATO.

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Abstract

Nowadays, it is important for High School Students to be early in contact with the scientific knowledge for awakening their interest to pursue scientific careers. The High School program at the University of Guanajuato comprises two steps: the basic one consist of several areas: Mathematics, Experimental Sciences (Physics, Chemistry and Biology), Social Sciences, Human Development, Communication (English, Spanish and TICs), during the first four semesters. The specialized area (Fifth and sixth semesters) requires to course specific subjects in Sciences, Engineering, Social Sciences, Economics, and Arts, in order to apply to university studies.

Before 2009, most of the students were mainly interested in Administration and Business than in scientific programs. It was realized the need to develop strategies for awakening the student's interest into the scientific knowledge. The Sciences Fair had the purpose of allowing the students of using the scientific method for the analysis of nature's phenomena to solve particular problems by using a scientist approach. The Sciences fairs topics were: Water Sciences (2010); Energy (2011); Minerals and Elements (2012); Chemistry (Alchemy) (2013); Art, Science and Movement (2014). Around 560 students enrolled in the 3rd semester participated in each Fair.

The academic interests of the students were assessed before and after the participation in the Science Fairs. Before the student participation in the Fairs, 30% out of the students were interested in sciences programs, after the Fair, it was augmented to 42% in Natural and Exact Sciences. In the area of engineering, before the Fair the percentage of students interested was 23%, and after the fair it was increased to 33%. This represents a significant increment in students interested in Sciences and Engineering areas.

Our results indicate the need to early expose the students to the scientific method through short and interesting problems to help them to decide their future profession. The activities carried out in the Fairs helped the students to make a proper decision to enroll in a specific area of the High School Program (5th and 6th semesters) to subsequently applying to university studies. The Scientific Fairs promoted the scientific talents in High School students.

Keywords: *Science Fairs, constructism learning theory, collaborative work, teaching strategy, scientific vocation development.*

Introduction

Formal education, being forger of professionals, has in its hands a great challenge: to prepare thoughtful, critical people, that are able to solve problems that the globalized world brings through innovative educational models. High school education, in particular, has among its challenges implementing educational models to achieve in students meaningful learning of science.

The advances in technology and changes in the organizational infrastructure put an increased emphasis on teamwork within the workforce. Workers need to be able to think creatively, solve problems, and make decisions as a team. Therefore, the development and enhancement of critical-thinking skills through collaborative learning is one of the primary goals of the University of Guanajuato (Universidad de Guanajuato, 2011). Under its Vision to 2020 (Universidad de Guanajuato, 2010), building capacities and developing innovative ways of connecting science to social necessities is a priority We must help to make the learning of the sciences more attractive to young people, increase society's appetite for innovation, and open up further research and creativity activities.

The present research was designed to study the effectiveness of collaborative learning as it relates to learning outcomes at the college level, for students in technology.

Educational practice must respond to the four pillars of learning, as declared by Delors & Unesco (1996): learning to know, learning to do, learning to be, and learning to live together, so that upon graduation students are able to cope in a self-sufficient and independent manner with each of the real-life situations. Thus, the role of teaching results in significant learning, which should transcend beyond the classroom and have an impact on the social and economic context.

Strategies for meaningful learning centred on learning acquired through experience must focus on the construction of knowledge in real contexts, as certain authors (Vygotsky, 1978; Bruner, 1985) suggest, and in the development of reflective skills, critical thinking and high standards, as well as interaction with the community (Rau & Heyl, 1990).

According to the experience of the authors of this report, teaching of science topics has always been a challenge; therefore, achieving meaningful learning among our students is the key that should govern each of our actions in the classroom, to increase self-confidence in our students and develop social and communication skills in them. In the end, one of our goals is to make our students conscious of the fact that everything that surrounds them involves, in one way or another, *science*.

Develop scientific relationship by promoting innovative pedagogies in science education, attracting more high school students towards science, with a special emphasis on the development of vocational preferences at early times and addressing the challenges faced by students, in pursuing careers in science, technology, engineering and innovation.

Making science education and careers attractive for young people is an ambitious goal, since it targets to improve science and technology in our society.

Innovative formal and informal science education teaching and learning is important in order to raise both young boys' and girls' awareness of the different aspects encompassing science and technology in today's society and to address the challenges faced by young people when pursuing careers in Science, Technology, Engineering and Mathematics.

This is the reason why we have found *Science Fairs* as an application of the constructivism theory (Vygotsky, 1978; Bruner, 1985), as well as an opportunity for collaborative learning (Gohkale, 1995), generating a meaningful teaching strategy that favours science learning.

Constructivism

Constructivism is a theory -based on observation and scientific study- about how people learn. Bruner (1985) suggests: that people construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences. When we encounter something new, we have to reconcile it with our previous ideas and experience, either changing what we believe, or discarding the new information as irrelevant. In any case, we are active creators of our own knowledge. To do this, we must ask questions, explore, and assess what we know (Vygotsky, 1978).

In the classroom, the constructivist view of learning can point towards a number of different teaching practices. In the most general sense, it usually means encouraging students to use active techniques (experiments, real-world problem solving) to create more knowledge and then to reflect on and talk about what they are doing and how their understanding is changing. The teacher makes sure he understands the students preexisting conceptions, and guides the activity to address them and then build on them (Johnson, 1996).

Constructivist teachers encourage students to assess how the activity is helping them gain understanding. By questioning themselves and their strategies, students in the constructivist classroom ideally become "expert learners." This gives them ever-broadening tools to keep learning. With a well-planned classroom environment, the students *learn how to learn* (Biggs & Tang, 2007).

When they continuously reflect on their experiences, students find their ideas gaining in complexity and power, and they develop increasingly strong abilities to integrate new information. One of the teacher's main roles becomes to encourage this learning and reflection process (Gardner, 1983).

Aplying the constructivism theory to a science classroom, we can conclude that the teacher must focus on helping students restate their questions in useful ways; each student has built his or her own knowledge, according to their own reflection on their previous experiencies. Therefore, it is up to the teacher to be aware of the student's current knowledge, and, just as Polamn (2000) suggests: when one of the students comes up with a relevant concept, the teacher must seize upon it, and refer to the group that this might be a fruitful avenue for them to explore.

Science Fairs, as we used them in this work, are prime examples of the application of the construtivism theory: it all starts when the teacher helps his students find a question they want to answer. Some teachers accomplish this by printing up lists of topics copied from books or Web sites. That is a starting point, but most students need further guidance, because it is hard to pick a good question to start with. That's precisely why, as Bruner (1987) advises, teacher involvement right from the start is essential.

Once the question is chosen, the student must afterwards design and perform relevant experiments. Then, he or she must discuss what they have learned, and how their observations and experiments helped (or did not help) them to better understand the concept (Polamn, 2000). Once the students have compiled their measurements, the next step is for the teacher to show them how to analyze the obtained information. Teachers should show students how to organize the data into categories that make sense.

Collaborative learning

Collaborative learning is an educational approach to teaching and learning that involves groups of learners working together to solve a problem, complete a task, or create a product (Gokhale, 1995). It is based on the idea that learning is a naturally social act in which the participants talk among themselves. It is through this discussion that learning occurs.

The approaches of collaborative learning complement and -in certain cases- interwine with the principles of constructivism. According to Gokhale (1995) there are five approaches:

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(1) Learning is an active process whereby learners assimilate the information and relate this new knowledge to a framework of prior knowledge.

(2) Learning requires a challenge that opens the door for the learner to actively engage his/her peers, and to process and synthesize information rather than simply memorize and regurgitate it.

(3) Learners benefit when exposed to diverse viewpoints from people with varied backgrounds.

(4) Learning flourishes in a social environment where conversation between learners takes place. During this intellectual gymnastics, the learner creates a framework and meaning to the discourse.

(5) In the collaborative learning environment, the learners are challenged both socially and emotionally as they listen to different perspectives, and are required to articulate and defend their ideas. In so doing, the learners begin to create their own unique conceptual frameworks and not rely solely on an expert's or a text's framework.

Thus, in a collaborative learning setting, learners have the opportunity to converse with peers, present and defend ideas, exchange diverse beliefs, question other conceptual frameworks, and be actively engaged (Gokhale, 1995).

In this context, Science Fairs implement the collaborative learning approaches since they are more than science lessons, because the students take a cross-curriculum approach. They simultaneously learn about measurement, visual display, oral presentation, writing and also must develop several social skills, needed to transmit their discoveries to others. This results in increased self-confidence and autonomy; it also helps to strengthen their knowledge for their future college studies.

Materials and Methods or pedagogy

The Escuela de Nivel Medio Superior de Guanajuato (from here on, referred to as *ENMS Guanajuato*) is a High School directly incorporated to the University of Guanajuato (UG) that has around 1,500 students enrolled, comprising the three grades offered. It is a public school, and being one of the only options existing in the city of Guanajuato, the socioeconomic level of the students is widely diverse. The average age of students when admitted is around 15, and they expected to graduate before they are 18.

Each year, the number of students who incorporate to the school are around 560, which are distributed in fourteen groups, seven with a Morning Schedule and the other seven with an Afternoon Schedule. Each of these groups has from thirty to fourty-five students.

The High School program at the University of Guanajuato comprises two steps (Universidad de Guanajuato, 2011): the Basic Area, which covers the first two grades (four semesters), and the Terminal Line selected by the student, in his or her last grade (fifth and sixth semesters). The Basic Area comprises courses from diverse academic subjects, being a sort of "Core Curriculum" that all students must complete in order to graduate. When the student reaches his or her last grade, he or she must chose a Specialization Area (or "Terminal Line"). There are six Terminal Lines:

(I) Arts
(II) Science
(III) Government and Politics
(IV) Economics
(V) Social studies
(VI) Engineering

All of them are intended to prepare students in their respective fields in order for them to apply to college studies.

The Science Fair

Each year, the Science Area teachers for all third semester (Second Grade) students organize a Science Fair. Although all fourteen groups take part in the event, not every student gets to present a science project: a previous selection process must take place. That is why, from the start of the semester, with the main intention that all students team up in groups and develop an investigation project.

Each science teacher will pick the best work of his or her class: those, which has more quality in the development of the idea and the presentation. This results in each of the fourteen groups having a representative project in the Fair. In all cases, the teachers base their approaches in the constructivist theory, promoting the main idea of the students building their own knowledge.

The *Science Fair* itself is done at the end of the semester and features workshops, conferences and poster expositions. The students who don't get to present a science work still get to participate by assisting with decoration, logistic, space adjustments, by promoting the event, or by being aide or master of ceremonies.

The workshops has performed according to academic subjects. The most common projects are developed in the fields of biology, physics and chemistry, although the more recent fairs have also included projects in Mathematics, Arts and Music, intending to integrate all academic subjects, in the aforementioned cross-curriculum approach.



Figure 1. Science Fair

The Science Area teachers make an evaluation of all projects, and select those who will represent the school in the State Science Contests.

Results and Discussion

The focus of the *Science Fair* is to bring the student close to the essence of scientific work.

The most recent editions of the Fair have integrated subjects such as Mathematics, Arts and Music. By taking part of projects in these topics, the students have the opportunity to measure their strengths and weaknesses in different fields. This helps them take a better choice when selecting a terminal line.

The Fairs also serve the purpose of promoting the Science and Engineering Terminal Lines, as described in this paper.

From 2009 to 2014, we have seen an increase in the enrolment of students in these specialization areas, as showed in the following figures.

The analysis of the data on Figure 2, Figure 3 and Figure 4, shown the number of students enrolled in the terminal line of Science and Engineering programs respectively, after having done the scientific exhibitions during the period between 2009 and 2014. Is important to stand up the increase in the number of student; because have a significant change.

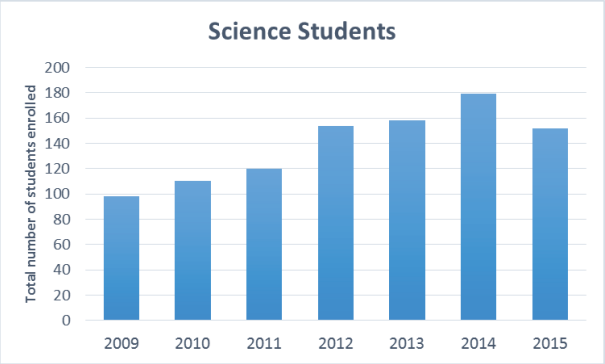


Figure 2. Increase of enrolled students at the Science Terminal Line

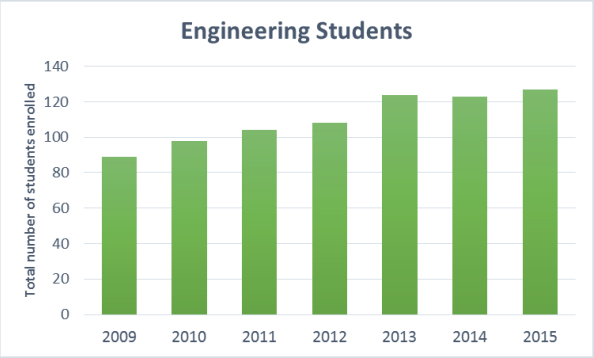


Figure 3. Increased of enrolled students at Engineering terminal lines

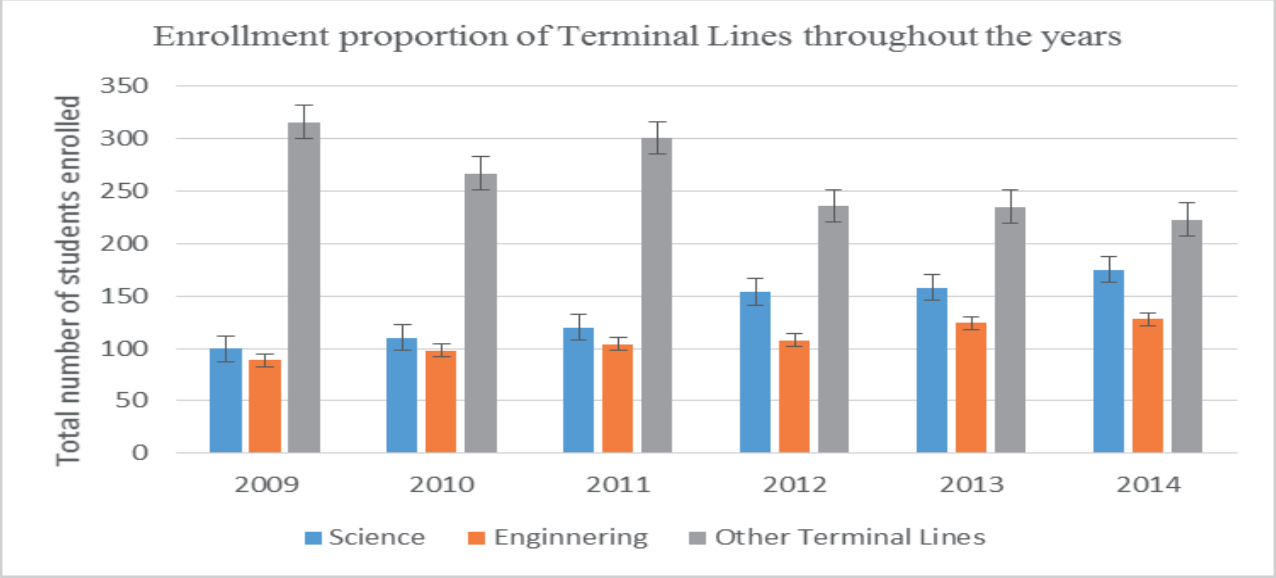


Figure 4. Increase of enrolled students at terminal lines.

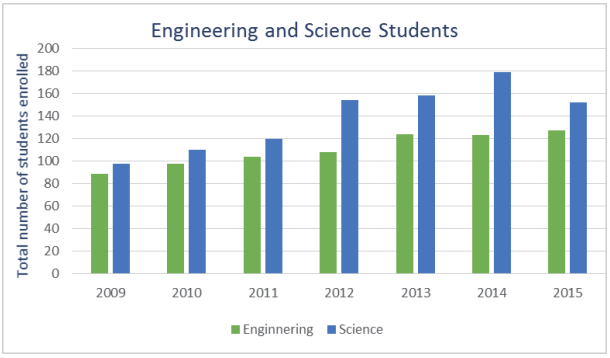


Figure 5. Increase of enrolled students at terminal lines.

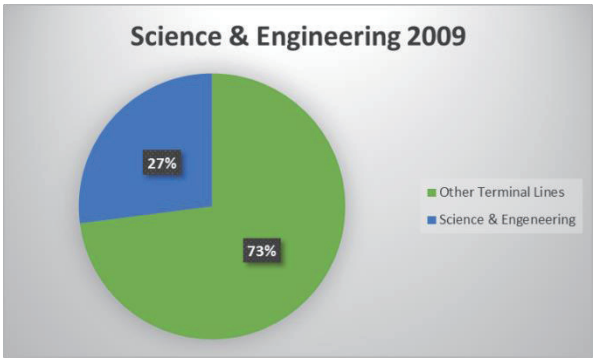


Figure 6. Porcentage Increase of enrolled students in Science and Engineering.

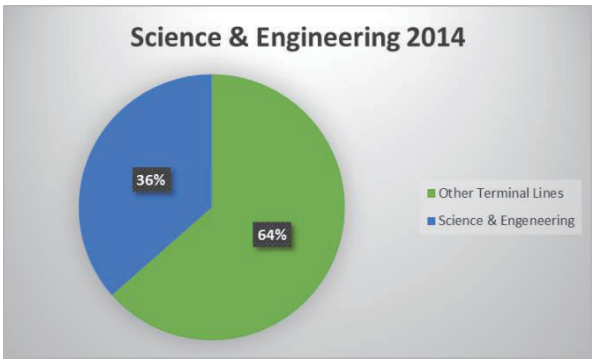


Figure 7. Porcentage Increase of enrolled students in Science and Engineering.

The analysis of the data on Figure 5, Figure 6, and Figure 7 shown the number of students enrolled in the Science and Engineering programs respectively, after having done the scientific exhibitions during the period betw een 2009 and 2014. Is important to stand up the increase in the number of student because have a significant change 27% to 36%.

Conclusions

This report to provide a deeper understanding of young people's attitudes to science education, particularly regarding the value young people place on science education (for themselves as individuals and for society in general), as well as the key factors determining their continued engagement with formal and informal science education.

The project's main intention to show that the implementation of the Science Fairs in High School level as an innovative teaching strategy. Will strengthen the significant learning of science to develop scientific skills in students; arouse curiosity for research and to make scientific; the desire to learn in all its forms and the ability to relate to scientific and technological advances, effective and critically, facilitating create, communicate and build their own knowledge.

Collaborative work done by science teachers in educational activities such additional classroom allows students. The develop skills of communication and expression; pursuant to competition in the area of experimental sciences, which implies: The use of the scientific method for the analysis of the phenomena of nature , which allow you take care of yourself and solve the problems of their environment ethical and responsibly.

The science education tends to help improve understanding and interaction with the world, to encourage participation and strengthening basic scientific expertise , which favors students develop their skills of observation, analysis, reasoning, communication abstraction; among others, allowing them to think and develop their thinking independently. Moreover through collaborative teamwork and the student can start building their scientific culture and developing their individual and social personality.

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FOSTERING PRACTICAL YOUNG ENGINEERS THROUGH OVERSEAS INTERNSHIP PROGRAM FROM 2005 TO 2014

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Abstract

National Institute of Technology, Sasebo College (NIT-SC) started a mutual exchange internship program with Xiamen University of Technology (XUT), China, in 2005. The aim was that, by deepening their mutual understanding, young Japanese and Chinese engineers could develop the ideas of working toward their common goal of economic prosperity in their respective countries. Through the program, the students had opportunities to participate in overseas educational factory tours. Besides, having different cultural backgrounds, the students had opportunities to carry out the goal-oriented collaborative activities. The results of the survey showed that those students had the positive impressions about the program, and estimated its activities valuable to become practical engineers.

Then, NIT-SC started the next educational program with broader scopes including Chinese, Korean and Swedish universities in 2009. Through the cooperative work, this program aimed to educate and train practical young Japanese engineers who could apply their knowledge and skills fully to their work in the factories in not only China but also other countries. At the same time, this program also aimed to educate and train young engineers who would acquire an understanding of the organizational structure and cultural background of global companies. Although this educational program ended in 2011, since then, we have furtherly continued the student's mutual exchange internship program with XUT by the support of Rotary Club of Sasebo North, our college's alumni association and the Student Exchange Support Program of JASSO. In addition, we have implemented an overseas factory tour targeting the 4th grade students in all of the four departments at NIT-SC. On June 28th, 2014, the Memorandum of Understanding was made between XUT and the nine colleges of National Institute of Technology in Kyusyu-Okinawa Region, Japan, in order to promote the academic exchange and the cooperative relationship on education and research.

Keywords: ***Internship Program, Mutual Exchange, Factory Tour, China, Cooperative Work***

Introduction

It is often said that these days young Japanese people seem to lack interest towards international societies. The number of Japanese students who are eager to go abroad for their study is not as large as it used to be, so they can't foster their internationality. As a result of it, the number of young Japanese people who can play their active roles in foreign countries can become smaller. In order to solve this problem, it is expected that young people have ample opportunities to actively contact foreign students. Especially, when it comes to engineering industry, educational programs need to provide young engineers with such chances without any prejudice about one another while working on the tasks for the shared goals. In addition, participating in such activities, students are expected to foster their communication skills in English, which is now considered as an international language.

In this paper, we will report the fostering practical young engineers through overseas internship program carried out at National Institute of Technology , Sasebo College (NIT-SC) from 2005 to 2014 [(1)-(8)].

1. Mutual students exchange program with a Chinese University from 2005 to 2008

Sasebo City is in the northern part of Nagasaki Prefecture, Japan. It has been a friendship city of Xiamen City, which has been one of Special Economic Zones of China, since 1984. Sasebo City has established another special program with a view to promoting the academic cooperation with Xiamen City since 2004. NIT-SC is located in Sasebo City and its aim is to educate and train students to be practical engineers. After graduating from our college, many students start to work at companies or factories which need highly sophisticated engineers. The percentage of graduates who works in companies of Nagasaki or north-west part of Kyushu area is high. These days, the numbers of local Japanese companies have been operating their factories in China. Because of its location, Japanese companies in the north-western part of Kyushu area especially have their advantages. In addition to such a locational advantage, Nagasaki Prefecture has a long and close historical relationship with China up to the present time. Therefore, good educational results can be expected through starting an

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international internship program between our college and some universities in China. Considering these, NIT-SC has been promoting mutual student exchange program involving internship at factories in China with a partnership of Xiamen University of Technology (XUT), China, since 2005.

The main purpose of the program was to let Japanese students meet Chinese students face to face sharing their ideas and cultural backgrounds so that Japanese students would be able to play active roles as leading engineers at Japanese companies in China.

As for the program, 4 to 6 students and 2 to 4 teachers of XUT visited NIT-SC for about three weeks from the end of July to the beginning of August. During this period, students and teachers of XUT joined class activities at NIT-SC and took some tours to see factories or historical sightseeing places in the northern part of Kyushu. They also had chances to experience homestay at Japanese families. Thus, they could experience not only engineering education but also cultural learning through this program.

On the other hand, 4 to 6 students and three teachers of NIT-SC visited XUT in China for about three weeks from the middle of October to the beginning of November. During the period, they observed classes, joined experiments and took tours to historical sightseeing places in and around Xiamen City. They also had chances to join homestay. Then, since 2006, the program has provided NIT-SC students with chances to join internship at a factory of Japanese company in China. Though the term was about three days, they could have chances to work with local Chinese workers at the factory manufacturing electric transformers and automatic-controlled-devices.

Figure 1 shows the evaluation on this program answered by students who had participated in. Overall speaking, the students evaluated activities in this program highly. Though the entire term was only about three weeks, it was planned to let students have ample chances to talk with students having different cultural backgrounds. Besides, it was planned to let students observe how the factory was operated abroad and experience the work themselves at a factory. Japanese students especially evaluated these two points highly.

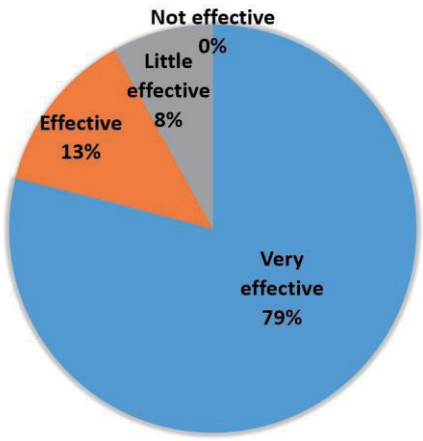


Figure 1. "How do you evaluate the activities in the program?"

This experience made them have higher motivations to study engineering and start to think of overseas working situations as one of their future options (Morishita et al. 2012)[(7)].

Based on this program, in 2007, a class of Electric and Electrical students (40 students) of NIT-SC visited Xiamen City as their school excursion, in which students had originally joined factory tours in Japan. Though the period was about a week, it was programmed that NIT-SC students had a meeting with XUT students, visited factories of Japanese companies in China, and took tours to cultural or historical sightseeing places around Xiamen City (Figure 2). According to the survey answered by these students, many of the students indicated positive opinions towards the purposes of the program such as experiencing factory tours in China and working on some simple collaborative tasks with XUT students. (Now, all of four departments of NIT-SC provide students with chances to join overseas factory tours when students are fourth graders. Two departments visit Taiwan, one visits Singapore, and one visits Xiamen, China, to have factory tours.)



Figure 2. Students visiting factory of Japanese company at Xiamen City in China.

At the end of every school year, an international forum was held either in Sasebo City or in Xiamen City. After presenting the outline of the program and outcomes of each activity in the forum, the survey was carried out to collect the data of the audiences' evaluation. Every year, the result showed the audiences evaluated the program very highly (Sasebo National College of Technology, 2011, 2012)[(5)(6)]. When the third international forum was held in Xiamen City, Chinese participants evaluated the program very highly saying that "this program has very good influence on students' education, and that it is worthy to continue the program from now on."

2. Cooperative Problem-Based Learning with Chinese, Korean, and Swedish Students from 2009 to 2011

At the end of every fiscal year, a special school activity evaluation committee, most of whose members were outside scholars and engineers, was held. While the program succeeded in getting high evaluation

among them, some important refinements were pointed out (Morishita et al. 2012)[7]:

(1) There need to be more chances for students to use English to communicate.
(2) There need to be opportunities for students to engage in more technical tasks or more practical internship.
(3) The program can be more global when it involves not only Chinese university but also others.

Then, to broaden the scope of the program, NIT-SC furtherly sought the partnership with some other Chinese university, a Korean University and a Swedish University. In addition, as for this new program, NIT-SC decided to put more foci on international collaborative activities in which students with different mother language and cultural backgrounds were to discuss environmental issues or energy issues so as to deepen their understanding of engineering science and improve their communication skills in English.

Based on the previous program, NIT-SC started "International Engineer Course" with a view to supporting students to improve their problem solution abilities and communication skills using English. In this program, small group activities were emphasized so that each student would contribute to the success of the group works, as a result of it, experience the feeling of achievement with English. Such activities were expected to raise the level of each student's motivation of further study. The main activities were as follows:

(1) "International Engineer Course" started for 4th graders and advanced course students, who were interested in working overseas.
(2) The mutual student exchange course would be planned not only with XUT but also with other universities.
(3) Problem-based activities would be integrated into the program so that students could work together towards the solution with foreign students using English.
(4) Small-group activities were emphasized so that each student could understand their role of joining discussions and assigned tasks.
(5) "Cross-Cultural Laboratory was prepared so that students could engage in communication activities using Skype or e-mails.

In starting the next program, NIT-SC established its academic relationship with Peking University, China, in 2007, Royal Institute of Technology, Sweden, in 2009, and Inha University, Korea, in 2010. This expansion was expected to provide students with wider varieties on the topics which students would discuss in small group works. As for the new program, problem-solving activities were also introduced in order to make students' discussions more active and practical. Such activities were expected to let students recognize present social and engineering problems, analyse them, and seek for their own original solutions working with foreign students sharing the same interests as future engineers.

In January and December, 2011, 4 Chinese students, 2 Korean students, and 1 Swedish student were invited to NIT-SC so that they could join collaborative tasks with 6 NIT-SC students. In this collaborative task, they were divided into two groups and worked on the different assignments. Later on, each group was to do the presentation about their assignments. Though there was only one student from Swedish University, the number of Chinese, Korean, and Japanese students were placed evenly in each group so that they would find themselves in the situation which required them to use English as their common language. There were two themes of the assignments; one was about energy issues and the other environmental issues.

As for the discussions, however, Japanese students couldn't join the discussion as actively as other foreign students did at the first meeting in January, 2011 (Figure 3). It turned out that they hesitated speaking out in English because they were not confident to engage in such kind of activities whether they really could or not. Considering this problem, before the second meeting in December, 2011, Japanese students had special lectures on how to participate in the discussion in English and using Web communication devices such as Skype or e-mails. As a result, Japanese students could speak out their opinions or ideas in the discussion more often and enjoyed more contributing to the fulfilment of collaborative tasks than the first meeting. It also turned out that the content of their discussion was more technically-oriented.



Figure 3. Discussion session at NIT-SC.

At the final day of the second meeting in December, 2011, the international forum was held in Sasebo City.

Figure 4 shows a scene at the forum in which students delivered the results of their discussion to the audience. After the forum, the special school activity evaluation committee of NIT-SC evaluated the program as follows:

(1) This program is effective to promote international friendship and understanding among students.
(2) It is impressive that each student tried to contribute to his/her group to complete their task.

(3) It seems that the two themes are rather abstract. It may be easier for students to focus on the task if the theme is more specified.
(4) Though this program is good, the number of students is very limited. It should plan to involve more students.



Figure 4. The international forum held at Haustenbos? in Sasebo City (2011).

3. International exchange program involving other Colleges of Technology in Kyushu-Okinawa Region in 2014

As for 2012 and 2013, the mutual student exchange programs were carried out between NIT-SC and XUT, China, just like before.

Then, in 2014, it has been a decade since NIT-SC started the mutual student exchange program with XUT, China, to encourage students to pay attention to international societies as their possible future working places. To celebrate the 10th anniversary of the program, with cooperation of XUT, NIT-SC held a commemorative ceremony and the international forum in Sasebo City on June 28th, 2014.

In the forum, Ex-president of NIT-SC, Dr. Masahiro Inoue delivered the main speech of what would global engineers be expected. (Dr. Inoue was the president of NIT-SC when the original program started.) Then, NIT-SC graduate, Mr. Naoki Kono, who joined the original program and visited XUT in 2007, delivered the speech about what he learned through this program and it is very useful in his present working career, which he has carried out several projects with Chinese companies (See Figure 5).



Figure 5. The 10th commemorative international forum in Sasebo City (2014).

On that day, as a part of cooperative program of 9 Kyushu-Okinawa Colleges, all of which belong to National Institute of Technology, these 9 colleges （including NIT-SC） and XUT reached the agreement of the new mutual student exchange treaty. (In Figure 6, the left is Dr. Zhu Wenzhang, the vice president of XUT, and the right is Dr. Mitsuhiro Nakao, president of NIT-SC.) .



Figure 6. A signing ceremony of the Memorandum of Understanding between XUT and the nine colleges of National Institute of Technology in Kyusyu-Okinawa Region, Japan.

The brand new start of the international mutual student exchange program involving more universities and colleges than when NIT-SC originally started the program, it is expected that this new treaty will enable student exchange program to be more fruitful, and contribute to the promotion of fostering engineering who can play active roles in international societies.

4. Conclusion

Based on the firm historical relationship between Sasebo City and Xiamen City, the program of fostering practical engineers was planned and carried out by NIT-SC. At the evaluation committee, the first program could get high evaluation. Following the success of the program with XUT, the next program was planned and carried out with Chinese, Korean and Swedish universities, with focusing more on technical engineering education. In addition, as for the revised program, more emphases were also put on letting students engage in collaborative tasks whose themes were about energy issues and environment issues. At the end of each fiscal year, the special school activity evaluation committee was held, and the program succeeded in getting high evaluation in the meetings. At the same time, several refinements were also suggested, and these suggestions were the essential driving force to make the program itself more beneficial.

Considering students' comment and judgements of the special school activity evaluation committee, this program can be summarized to be successful so far. By involving all colleges of National Institute of Technology in Kyushu-Okinawa region, this program is expected to expand its scope and bring more success to students who will be engineers with global sense in the future.

5. Acknowledgements

This education program has been supported by the Ministry of Education, Culture, Sports, Science and Technology, Japan and Rotary Club of Sasebo North, NIT-SC's Alumni Association and the Student Exchange Support Program of JASSO.

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PRACTICAL USE OF THE MINUTE PAPER TO BRING OUT INTELLECTUAL HONESTY OF STUDENTS

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Abstract

Intellectual honesty is the most important thing when people learn, especially for students. The process that to realize question oneself and to find answers of them with possible way will make a deep understanding. And the ability of to realize questions, intellectual honesty, is must attitude to whole life.

Almost Japanese students tend not to be able to ask you a question positively during class. In this study, the minute paper was adopted as the first step to make the situation that student could ask a question positively. The basic minute paper consisted of three part, part one: to write the point of the class, the opinion of students, part two: to write questions of the class and part three: exercises of the class. The time to write minute paper was kept last ten to twenty minutes of each class and the paper was returned next class. A teacher answered questions of students and marked the answers of exercises before the paper was returned.

All students wrote keywords of the class to part one. Approximately half of students wrote some question, basic and sharp questions, a quarter students wrote "no question" and a quarter students didn't write anything to part two. All students answered exercises on part three because the answers of part three's exercise were evaluated as their marks. To stimulate a deep thought in stages with the way to cope with questions of students and to figure out a good way to the notice of questions will be connected to growth of students.

The minute paper was started to answer for questions of students. However, it realized that intellectual honesty is more important for teachers. Sharp questions from students are including valuable ideas to development of teachers and class. The minute paper will be able to use to maintain to encourage students' acute sensitivity of having questions for the development students' faculties to be able to energetic in whole life.

Keywords: *Minute paper, understanding degree confirmation, active learning, sharp questions, development students' faculties, intellectual honesty,*

Introduction

Intellectual honesty is the most important thing when people learn, especially for students. The process that to realize question oneself and to find answers of them with possible way will make a deep understanding. And the ability of to realize questions, intellectual honesty, is must attitude to whole life.

Almost Japanese students tend not to be able to ask a question positively during class. In this study, the minute paper was adopted as the first step to make the situation students could ask their questions positively.

Materials and Methods or pedagogy

The basic minute paper consisted of three parts (Table 1). Part 1 asked "What is the most important thing of today's class?" The aim of the question is to catch the point of the class. Part 2 asked "What is the question about today's class?" The aim of the question is to catch questions of inside of students. And part 3 was exercises of the class. The size of the basic minute paper was A5 and it was B5 when more than two exercises on part 3.

145 students, 40 students from the 2nd year, 42 from the 4th year, 36 from the 5th year, and 27 from the advanced course, completed the minute paper. The time to write minute paper was kept last ten to twenty minutes of each class and the paper was returned next class. A teacher answered questions of students and marked the answers of exercises before the paper was returned.

A survey about the minute paper to show in Table 2 was carried out to same students. Purposes of the survey were to grasp a student's thought and impression, effectiveness of the minute paper to help notice a question for a student and improvements of my class. 13 questions of the survey were graded on a scale of one, disagree, to five, strongly agree. There was the space for any comments or requests for improvement of the lecture and minutes paper.

Results and Discussion about the Minute Paper

All students wrote keywords of the class to part one. Approximately half of students wrote some question,

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Subject :	Date :	
Student No. :	Name :	
○ What do you think is the most important thing you have learned during today's class?		
○ Do you have any questions about today's class?		
【Exercise】		

Table 1 Basic minute paper

Subject :	Date :
Student No. :	Name :

1. Please circle the appropriate number in each question.

5: Strongly agree 4: Agree 3: Somewhat agree 2: Somewhat disagree 1: Disagree

Questions	Answers				
(1) I can write minute papers freely and easily.	5	4	3	2	1
(2) Minute papers shorten emotional distance between you and teacher.	5	4	3	2	1
(3) Minute papers make it easier to ask questions.	5	4	3	2	1
(4) Minute papers help me ask questions.	5	4	3	2	1
(5) Minute papers help me find a problem.	5	4	3	2	1
(6) I am glad to have a feedback of what I wrote on minute papers.	5	4	3	2	1
(7) A feedback of what I wrote on minute papers raise my motivation.	5	4	3	2	1
(8) I do not know how/what I should write minute papers.	5	4	3	2	1
(9) Writing minute papers help me understand the contents of lecture.	5	4	3	2	1
(10) Writing minute papers give me a feel of burden.	5	4	3	2	1
(11) If it is mandatory to write minutes papers I do not want to do so.	5	4	3	2	1
(12) Minute papers are important aid in learning.	5	4	3	2	1
(13) You should use minute papers.	5	4	3	2	1

2. Any comments or requests for improvement of the lecture and minutes paper

Table 2 Survey sheet

basic and sharp questions, a quarter students wrote "no question" and a quarter students didn't write anything to part two. All students answered exercises on part three because the answers of part three's exercise were evaluated as their marks. There were many students who filled in a question as the lower grades.

Results and Discussion about a Survey

Figure 1 to 6 shows results of the survey.

Figure 1 and Figure 2 show minute paper helped students ask questions and find a problem easily, respectively. Figure 3 tells you that answering questions carefully by instructers makes them happy in learning. Figure 4 shows that the upper year you are in, the less understanding on what you should write on minute paper. These answers can also be found in a free description of questionnaires. This results tell you how important for instructors to create an atmosphere that makes it easier to ask questions when they are in lower year. Since we received positive feedback on minute paper as shown in Figure 5 and Figure 6, we will make efforts to improve it to assist students in learning.

Conclusions

The minute paper was started to answer for questions of students. However, it realized that intellectual honesty is more important for teachers. Sharp questions from students are including valuable ideas to development of teachers and class. The minute paper will be able to use to maintain to encourage students' acute sensitivity of having questions for the development students' faculties to be able to energetic in whole life.

Acknowledgements

I make acknowledgement of all students' cooperation.

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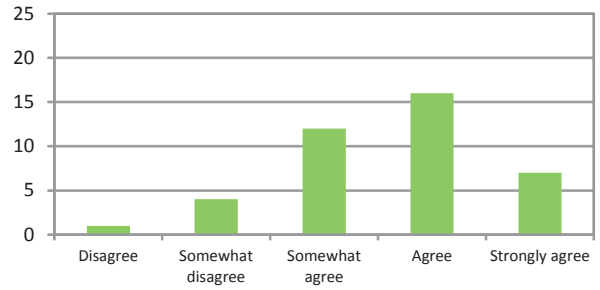
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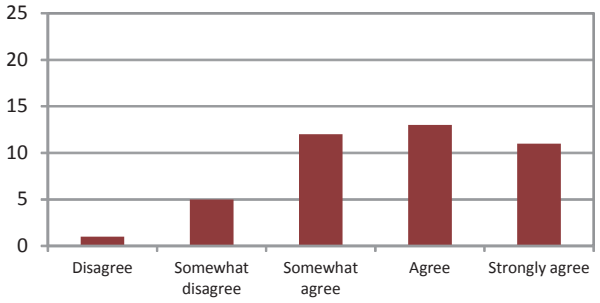
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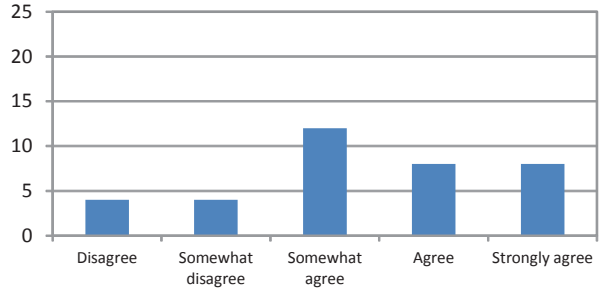
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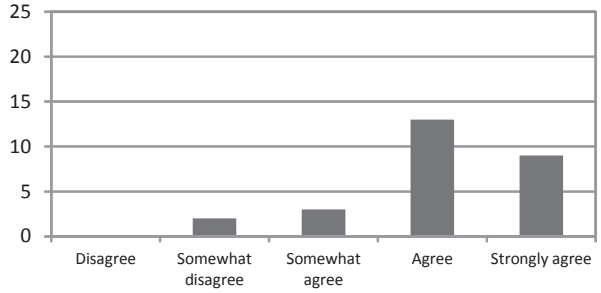
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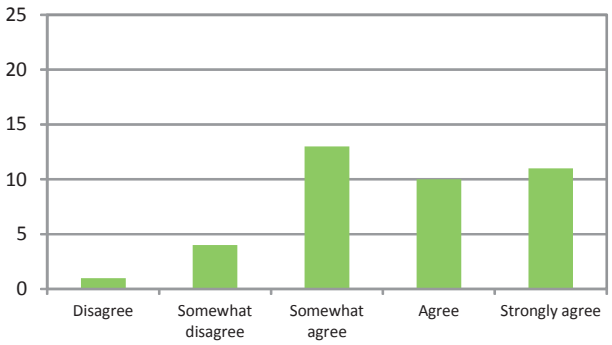


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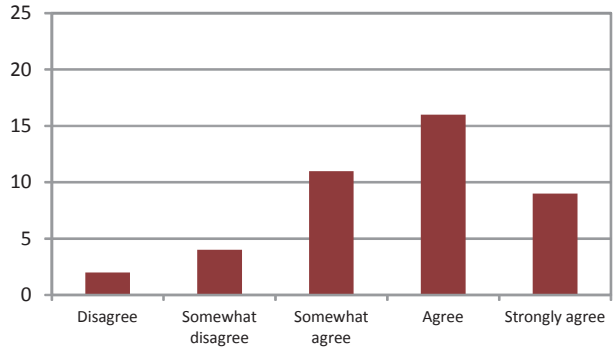


(d) advanced course students

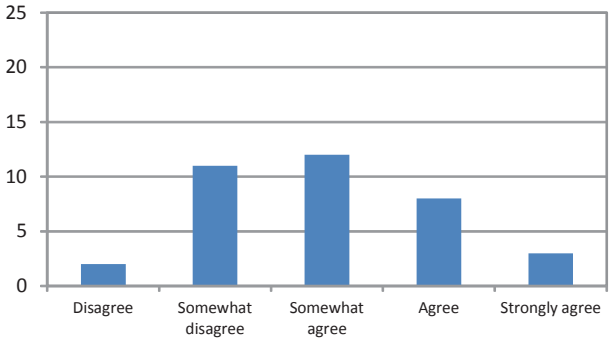
Figure 1 Results of survey (1) I can write minute papers freely and easily.



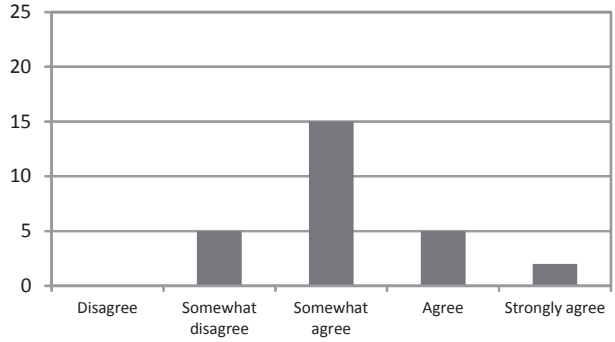
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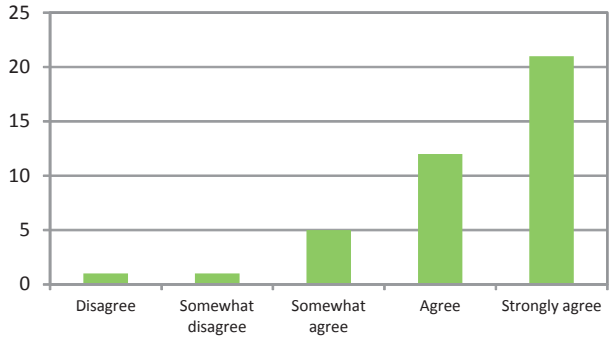
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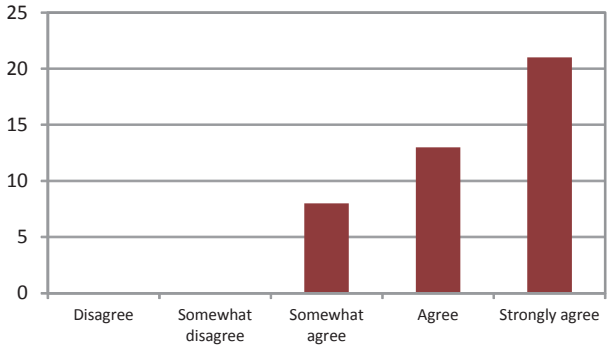
(d) advanced course students

Figure 2 Results of survey (5) Minute papers help me find a problem.

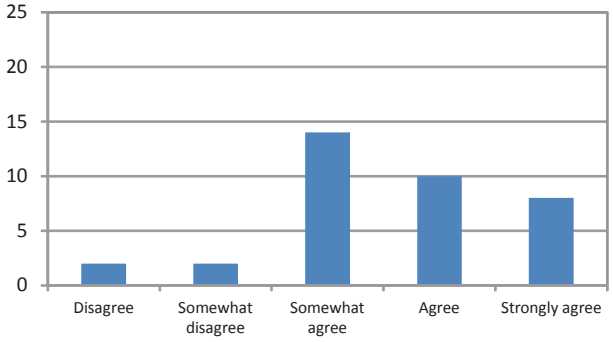
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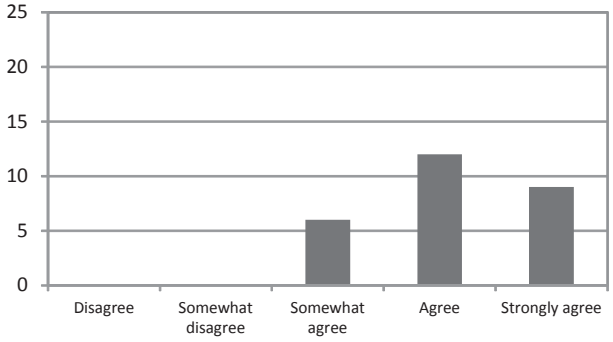
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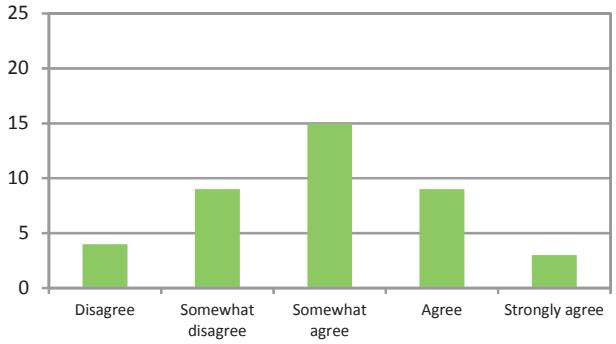


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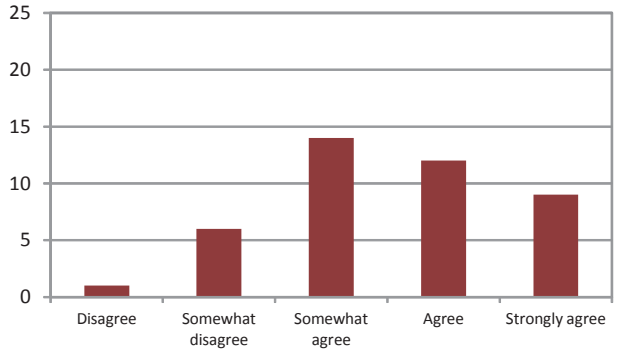


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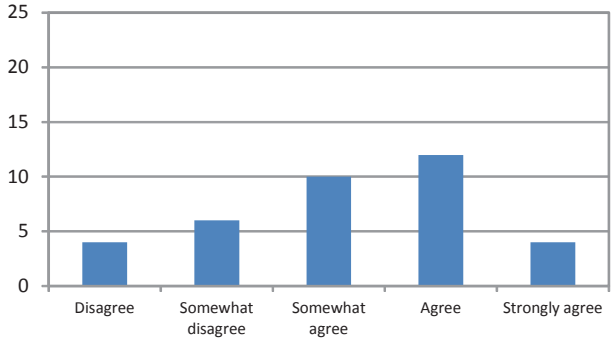
Figure 3 Results of survey (6) I am glad to have a feedback of what I wrote on minute papers.



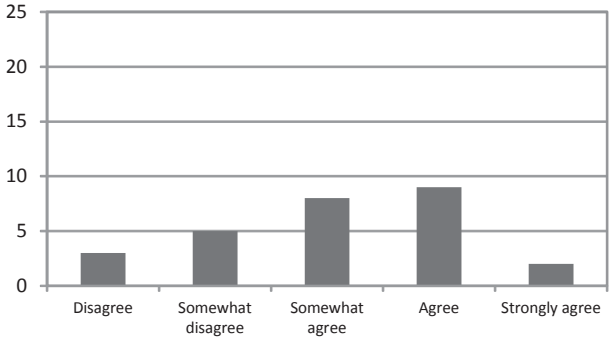
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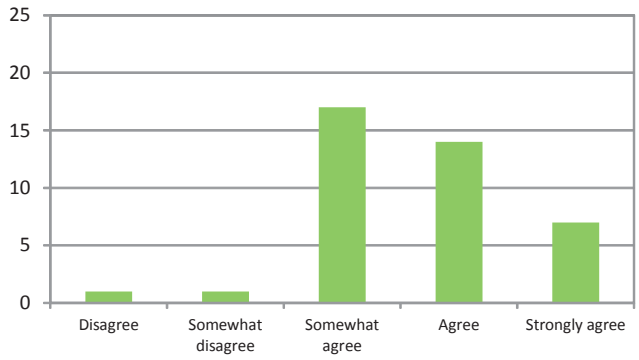
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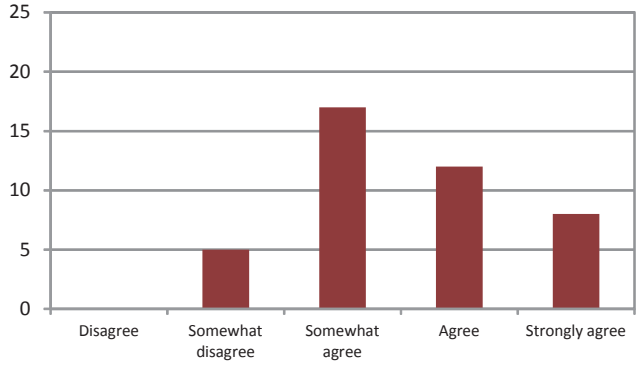
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Figure 4 Results of survey (8) I do not know how/what I should write minute papers.

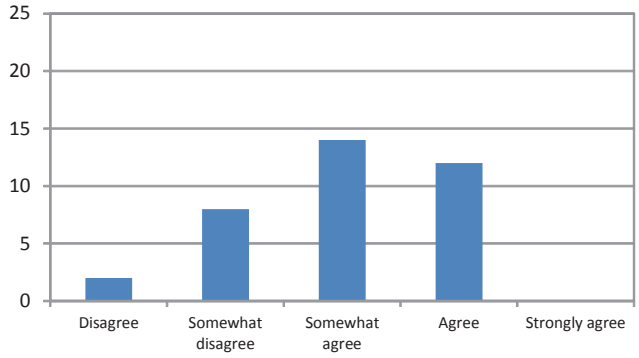
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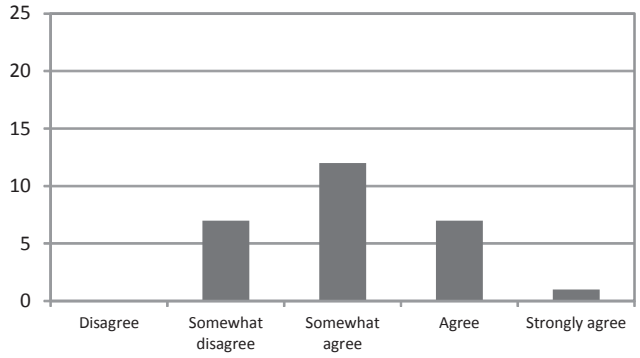
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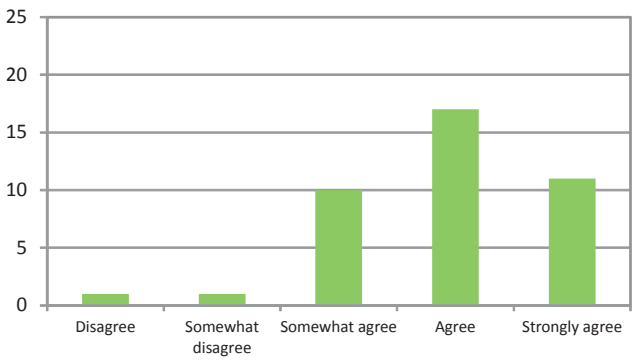


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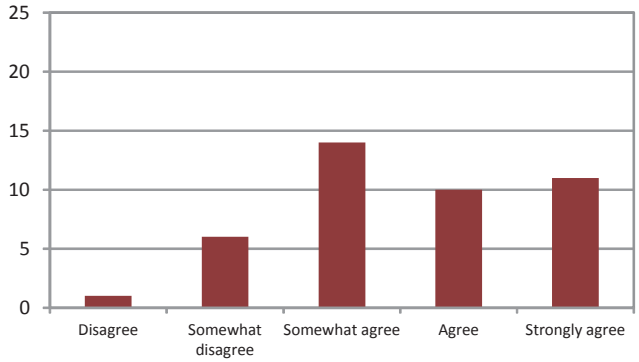


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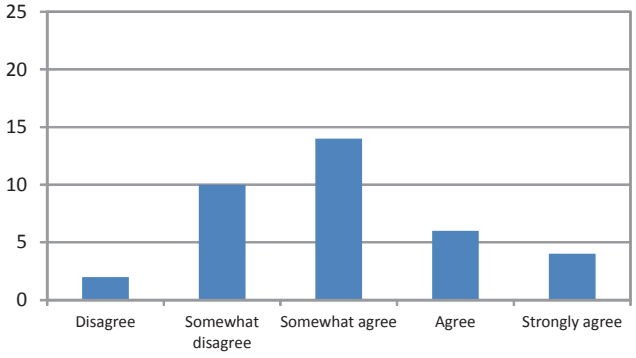
Figure 5 Results of survey (6) I am glad to have a feedback of what I wrote on minute papers.



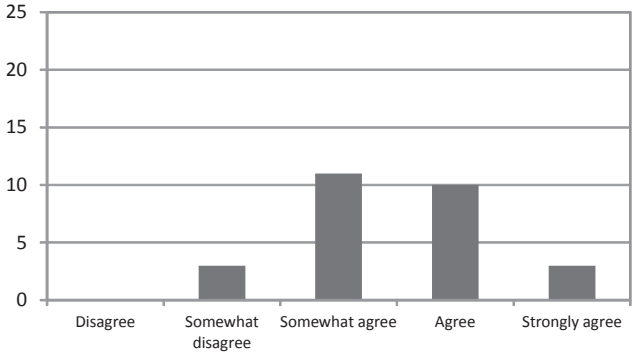
(a) 2nd year students



(b) 4th year students



(c) 5th year students



(d) advanced course students

Figure 6 Results of survey (8) I do not know how/what I should write minute papers.

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NEXT GENERATION SCIENTIST CULTIVATION PROGRAM

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Abstract

Adequately dealing with secondary educational issues related to energy and environmental concerns has been difficult in Japan. A 3-year science and environmental education program (Ariake Next Generation Science Club for jr. high school students) was instituted locally to help these problems. The stated aim of the program was to cultivate future scientists with a high awareness of environmental issues. Students were given a different environmental problem based on learning task each year which they had to report on. The effectiveness of this program was measured using a self check evaluation questionnaire given to the students, and then collaborated by teachers, parents, and other staff who participated in the program. Participants generally had a good experience and were found to be motivated to solve the environmental problem presented, to develop the skills necessary to do so, and to indicate a desire to pursue a future related to science and engineering. Overall the program has been a success and we hope to continue the implementation in the future.

Keywords: *Science and Engineering Education, Career Education, Environmental Problem, Junior High School Student, Advanced Course Student*

Introduction

Ariake National College of Technology (ANCT) is the sole industrial institution of higher education in the areas of southern Fukuoka and northwest Kumamoto prefectures. As such the school has struggled to maintain awareness of science and engineering in the minds of young people, the school has instituted a variety of events and lectures aimed at elementary and jr. high school students. However, the effectiveness of these one-off programs has been minimal.

The program of "Arao Regional Revitalization Industry-University-Resident Cooperation Program - Food, Brewing and Community Development from Machinaka Laboratory -" was adopted as a theme of the Support Program for Contemporary Education Needs (Good Practice) from 2006 to 2008 [National Institute of Technology, Ariake College (2012), The Good Practice Executive in National Institute of Technology, Ariake College (2008)]. In the program, advanced course students, teaching staffs, citizens have tackled many regional regeneration problems in Arao city. However, after the support program expired, there have been few programs in which our college students could participate. Therefore, an opportunity for practical education in cooperation with an institution of higher education in the region has been needed.

To respond to this need, ANCT proposed a 3-year science and environmental education program, "Ariake Next Generation Science Club (ANGS Club)", for junior high school students [Ishimaru (2014), Tsubone (2013)]. This new program, which selects an environmental issue for a main theme, has been adopted by the Future Scientist Program of Japan Science and Technology Agency (JST) since 2012. The main aim of this program is to cultivate the future scientists with a high awareness of environmental issues, by giving students a chance to solve environmental problems and experience research procedures that scientists generally follow. The ANGS program steps are shown in Figure 1. For each of the three years, we chose a different environmental problem, i.e., "Energy Problem and Solar Cell" in first year, "Removal of Fine Laver from Wastewater in Laver Production" in second year and "Water Quality Improvement in Channels" in third year. The students in ANGS Club have tackled these themes. Through annual activities each year, the original aim was achieved to some extent. Particularly, the students had strong interests in science technology and environmental problems together with learning special knowledge and skills of personal computing including software applications, e.g., Excel and Power Point. At the same time, however, we also found some points which should be improved in the program. In addition,

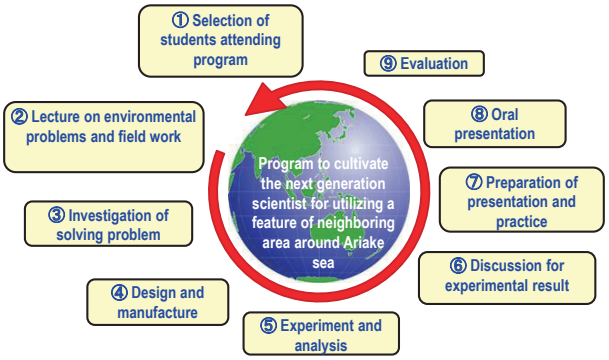


Figure 1 ANGS program steps.

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it is noted that we employed the advanced course students of our college as teaching assistants to the program. They are studying engineering in our college and were role models for junior high school students. This exposure had significant effects on the student's career education and goals. Furthermore, the advanced course students also received some benefits due to participating in the program over and beyond their areas of speciality. Both groups of students found it meaningful to interact and cooperate with each other and the community that they belong to.

In this paper, contents and outcomes of the 3-year science and environmental education program are reported. In addition, the effect of this program on ability development of junior high school students are discussed below.

Outline of 3-year science and environmental education program

a. Theme Decision

In this program, a different environmental theme was selected every year. The themes were "Energy Problem and Solar Cell" in the first year, "Removal of fine laver from wastewater in laver production" in the second year and "Water quality improvement in channel" in third year. Each theme was matched with the appropriate department at ANCT. The environmental problems were based on real needs of the surrounding location – Arao, Omuta and the Ariake Sea.

b. Decision procedure of attending students

The recruitment for junior high schools was conducted through the Arao city and Omuta city boards of education, home pages, newspapers, and so on. The applicants filled in an application form for five questions concerning: (1) Interest in the field of science and mathematics, (2) Environmental problems that you are aware of, (3) Contents that you want to study in ANGS Club, (4) Future occupation and (5) Self promotion. The contents were evaluated by the teaching staff and teachers in each city's board of education. The students attending the lecture were selected based on the score of application form.

c. Participants and staffs

Recruitment for this program has been conducted for junior high schools in Omuta and Arao cities through each board of education. Participation expenses were free because all charges for the program were supported by Future Scientist Program in Japan Science and Technology Agency (JST). Many applicants responded: 30 people for 10 subscribers (all the first grade students) in first year, 12 people for 4 subscribers (all the first grade students) in second year and 6 people for 5 subscribers (3 first grade and 2 second grade students) in third year applied to ANGS Club. Basic information of third year participants is shown in Table 1. Desire to continuously participate in the ANGS Club has been high because the ratio of participants to next year continuance was 96 %, and the 3-year continuance was 90 %. Furthermore, although the lectures were given more than 10 times each year, the percentage of attendance to the lectures achieved very high value of 95 %.

Table 1 The informations of participants in 2014.

No.	Grade	Sex	Area of junior high school
1	Third	Female	Yanagawa city in Fukuoka
2	Third	Male	Fukuoka city in Fukuoka
3	Third	Male	Omuta city in Fukuoka
4	Third	Female	Omuta city in Fukuoka
5	Third	Female	Arao city in Kumamoto
6	Third	Male	Nagasu town in Kumamoto
7	Third	Female	Arao city in Kumamoto
8	Third	Male	Arao city in Kumamoto
9	Third	Male	Saga city in Saga
10	Second	Male	Omuta city in Fukuoka
11	Second	Male	Omuta city in Fukuoka
12	Second	Male	Omuta city in Fukuoka
13	Second	Female	Ooki town in Fukuoka
14	Second	Male	Arao city in Kumamoto
15	Second	Female	Arao city in Kumamoto
16	First	Female	Kumamoto city in Kumamoto
17	First	Male	Omuta city in Fukuoka
18	First	Male	Omuta city in Fukuoka

Junior high school students, their siblings, their caretakers, their teachers and their boards of education, and so on also could join in the ANGS Club. In addition, 5-7 teaching staff who were expert on mechanical engineering, electrical engineering, chemical engineering, mathematics and physics, and 5-7 advanced course student/teacher assistants also were included. The speciality and the number of teaching staff and teaching assistants changed depending on the theme.

d. Ability cultivated by ANGS Club

ANGS Club aimed to develop the following abilities:

(1) Interest in the field of science and mathematics

The junior high school students were encouraged to use math and science through specialised fields of mechanical engineering, electrical engineering, chemical engineering, biology and so on. This practical application of math and science was hoped to increase their interest.

(2) Knowledge on the field of science and mathematics

The knowledge base of the students was hopefully increased through discussions and lectures that related to environmental problem they were ask to tackle.

(3) Interest in environmental problems

The themes selected by ANGS Club closely relate to environmental circumstances in the surrounding area. These familiar and local themes from the district make junior high school students more directly understand the importance of problem and increase their motivation.

(4) Knowledge of environmental problems

Original text books made by the teaching staff every year were used in ANGS Club in order to study the chosen environmental problems. Particular attention was paid to the difficulty of the contents and manner of expression to insure that it matched the student level. In addition, the student got first hand experience of difficult nature of solving environmental problems through laboratory experiments. Furthermore, field work and research were included in the program. The student were required to study many things related to the environmental problem.

(5) Interest in the professions of scientist or researcher

The junior high school students conducted the survey, experiment and so on together with teaching staff and teaching assistants of advanced course students in ANGS Club. The teaching staff and teaching assistants have actual research experience so they can give good guidance. The junior high school students can have a broad experience through the many activities and receive a variety of influences from the teaching staff and teaching assistants.

(6) Ability to think about things through a scientific and engineering point of view

All the participants were encouraged to logically think through the environmental problems, discuss and then decide on the ways of solving the problems and conduct the actual experiments.

(7) Ability to arrange and summarize the experimental results

A notebook computer was lend to each junior high school student in ANGS Club. The students arranged the experimental data with Excel and summarize knowledge and data obtained from the experiments and share their findings in presentation materials using Power Point.

(8) Organization skill (Writing and presentation skills)

The junior high school students made a presentation based on their experimental results and give oral presentations at the end of the annual program at the Children Environmental Conference. Furthermore, students kept a lab research notebook as shown in Figure 2.

(9) Ability to field of the question and answer

Each student in the ANGS Club has the chance to give an oral presentation followed by question and answer session where their mentors will ask them questions cultivating their ability to field questions and demonstrate what they have learned.

(10) Attitude to act on initiative

Students were divided into small groups and must work as a team. This was hoped to encourage initiative and to get them to perform various roles. They were also encouraged to engage in preplanning in their lab notebooks so that they were better prepared for group work and to help them formulate their own ideas.

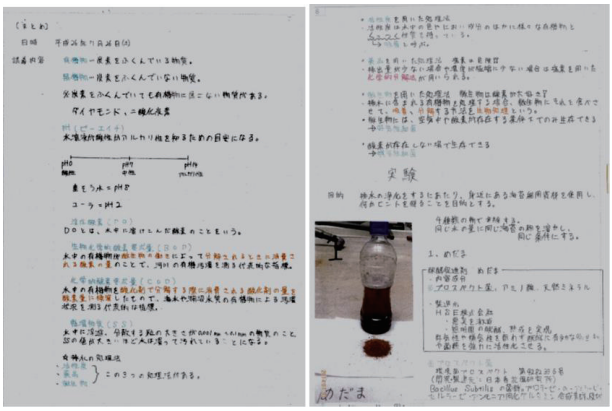


Figure 2 Example of research lab notebook used in ANGS Club.

(11) Operating skill of internet and personal computer

The students were encouraged to use the computer by collecting information on the internet, using Microsoft Office, and e-Learning. Moodle was used to encourage discussions and to further their research and communication skills. Students learned to upload and down load materials, and became more familiar with common computer functions and software. As an example, a Moodle exchange from the ANGS Club is shown in Figure 3.

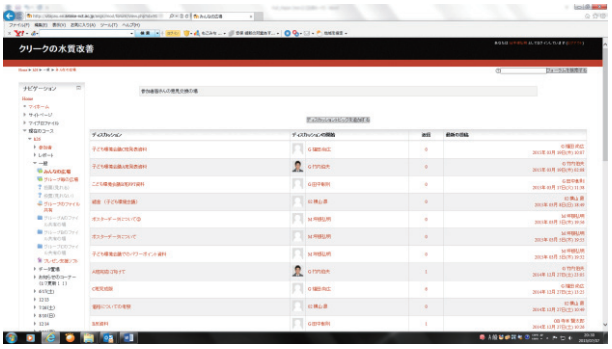


Figure 3 Moodle exchange from ANGS Club (http://utapau.ee.ariake-nct.ac.jp/angs/mod/forum/view.php?id=91).

e. Schedule and contents of the program

The program ran from 2012 to 2014. The schedule and contents of the program for 2014 are shown in Table 2. The students also attached a conference the next year, The Second Children Environmental Conference 2015. The program was 3 years long and had very good long term attendance rates with only one student opting to quit participation.

The 2014 contents started with several ceremonies, and, lectures on environmental problems, basic knowledge, technical terms, and so on as shown in Figures 4-6. Then, the middle few times were recreation to deepen relationships among participants. The recreation, basic experiments and field work as shown in Figures 7-9. In the third year, graduate research for

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Table 2 The schedule and contents of the program in 2014.

No.	The date and time	Contents
1	Ju. 7th (Sat.) 13:30-16:30	【Lecture】 ANGS Club entrance and opening ceremony, and invited lecture
2	Jul. 13th (Sun.) 13:30-16:30	【Lecture】 Topics of water and pollution materials, concept of concentration
3	Jul. 26th (Sat.) 13:30-16:30	【Lecture】 Problems of laver wastewater from the point of view of chemistry and treatment of wastewater
4	Jul. 31st (Thu.) 13:30-16:30	【Lecture】 Examples of water cleaning method・recreation
5	Aug. 10th (Sun.) 13:30-16:30	【Experiment】 (1) Experiment using activated carbon (adsorption), (2) Experiment using bacteria (biology), (3) Experiment using breaching agent (chemical material)
6	Aug. 11th (Mon.) 13:30-16:30	
7	Aug. 30th (Sat.) 13:30-16:30	【Graduate research】 Plan and preparation of graduate research
8	Sep. 6th (Sat.) 13:00-17:00	【Field work】 Field work of channels in Ooki town
9	Sep. 23rd (Tue.) 13:30-16:30	【Graduate research】 Preparation and experiment
10	Oct. 18th (Sat.) 13:30-16:30	【Graduate research】 Experiment
11	Nov. 15th (Sat.) 13:30-16:30	【Graduate research】 Experiment
12	December 13th (Sat.)13:30-	【Overnight training】 Experiment, analysis of experimental data, discussion, preparation of presentation
13	Dec. 14th (Sun.) -12:00	
14	Dec. 27th (Sat.) 13:30-16:30	【Evaluation】 Oral presentation
15	Mar. 21st (Sat.) 13:30-16:30	【Presentation】 The Second Children Environmental Conference 2015



Figure 4 The entrance and opening ceremony of ANGS Club in 2014.



Figure 5 The invited lecture about water treatment by Prof. Jyoko.



Figure 6 The basic learning on water treatment.



Figure 7 The recreation (Bach Volleyball).



Figure 8 The basic experiments to study water treatment.



Figure 9 The field work at channels around Ooki town.

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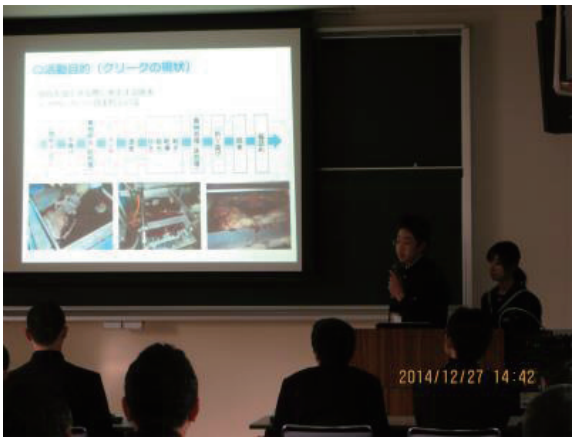


Figure 10 Results presentation of ANGS Club in 2014.



Figure 12 The Second Children Environmental Conference 2015.

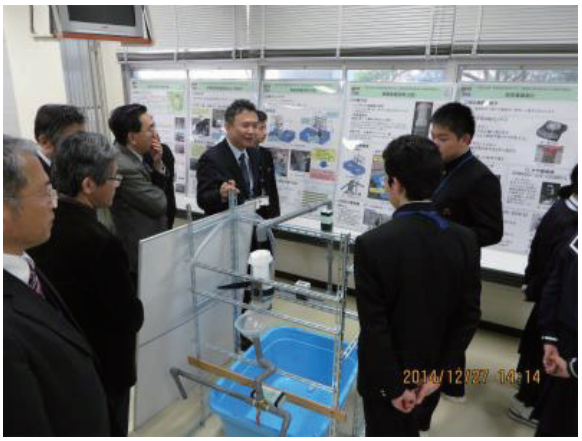


Figure 11 Explanation of experimental devices with posters in ANGS Club in 2014.

the ANGS Club students was included in the program. The students thought and planned way of solving environmental problems, and conducted the experiments in small groups. The experimental data was analysed, and the experimental results and obtained knowledge were summarized using Power Point. The students were evaluated on oral and poster presentations and explanation with posters and experimental devices as shown in Figures 10 and 11. Finally, the students joined The Second Children Environmental Conference 2015, and explained their research and discussed with many participants including teachers of education boards and junior high schools, their families, citizens and so on, as shown in Figure 12.

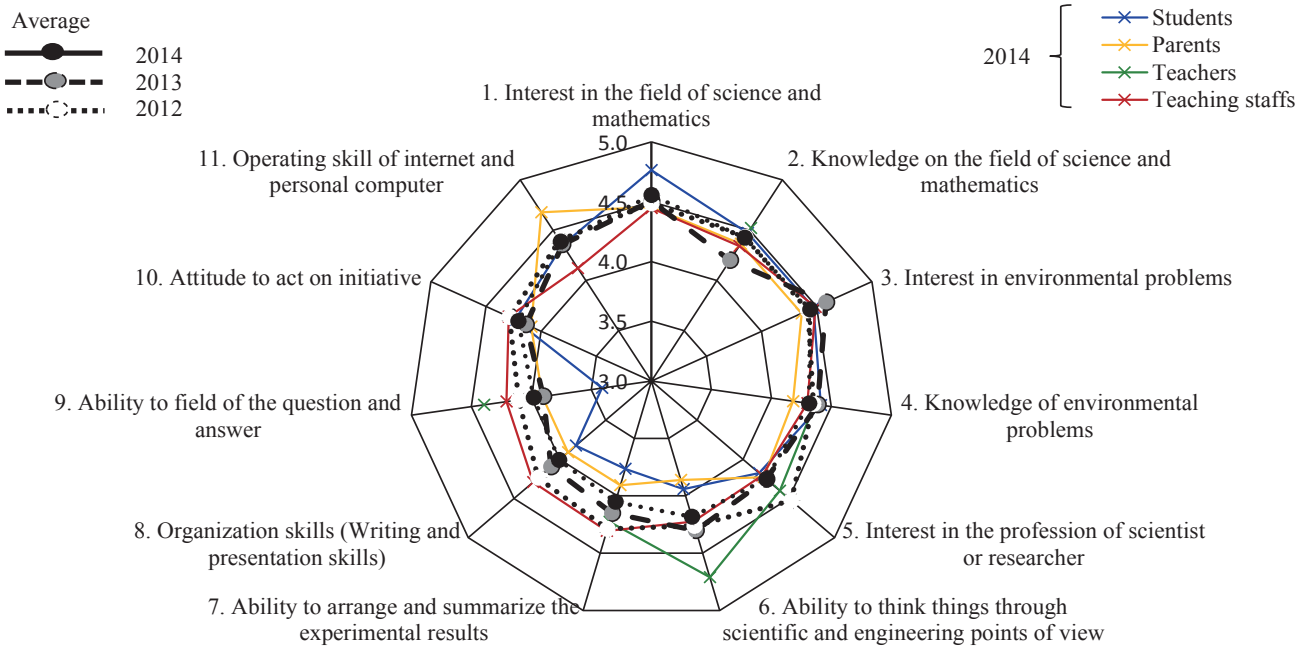


Figure 13 The evaluation results for the students in ANGS Club.

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Evaluation Results and Discussions

In the program, in order to grasp the students' level of understanding, a 5 level self-check survey (5: highest – 1: lowest) was conducted for each student. Average values of self-evaluation were 4.3 in first year, 4.3 in second year and 4.4 in third year. Although the students have tackled very difficult problems, the values in every year were basically very high. If pressed, when the students needed to decide for themselves on the plan and think through the method of the research, which they had little experience, the self-evaluation showed a lower value of about 4.0. On the other hand, when what needed to be done was clear for the students, e.g. basic experiments prepared by teaching staff, data reduction and so on, the values were very high at 4.5-4.7. This data suggests that students could successfully understand most of the content in the program.

In order to reveal the develop of the student abilities while taking part in ANGS Club after a year, questionnaires were given to the students, their parents, teachers of education boards and junior high schools, teaching staff and teachers of National Institute of Technology, Ariake College. The questionnaire results were compared with general and same grade junior high school students (5: very high - 3: same - 1: very low). The 11 target abilities for the evaluation are mentioned in section d. The evaluation results are shown in Figure 13. Here, the students, parents and teaching staff evaluated the students through the annual program in ANGS Club.

As a result, the ability development for the students were very high on the whole. Particularly, the evaluation numbers of (1) - (3) were excellent with values of 4.8, 4.5 and 4.5 in 2014, respectively. The results suggest that this program increased student interest in science, mathematics and environmental problems.

By looking at each evaluator, the evaluations by the parents for number (11) and the teachers of education boards and junior high schools for number (6) were very high at 4.7. On the other hand, the evaluation by the students for number (9) was not as good as the results of the other evaluation numbers. The tendency was almost same in 2013 and 2012.

In comparison with the evaluation results of 2012 to 2014, many evaluation numbers were highly evaluated from 4.0 to 4.5 in every year. Although the theme changed every year, the educational program through the ANGS Club helped students develop their abilities.

Conclusions

In National Institute of Technology, Ariake College, a science and environmental education program, "Ariake Next Generation Science Club (ANGS Club)", for junior high school students was suggested and conducted during 3 years from 2012 to 2014. In cooperation with education boards in Omuta city and Arao city, the surrounding junior high schools, the associations and groups on environmental problems, the committees in our college and so on, the educational program could be successfully carried out for the junior high school students having high interest in the field of science and mathematics. In addition, the educational effects of ANGS Club on developments of student abilities were clearly shown by the evaluation results. Particularly, it seems that the program strongly effects the students in their career goals. Furthermore, the advanced course students also obtained the opportunity to experience practical education in cooperation with their region. This program will be continued on and after 2015.

Acknowledgements

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FLIPPING THE CLASSROOM FOR ACADEMICALLY WEAKER STUDENTS: AN EVIDENCE-BASED APPROACH

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Abstract

This paper summarises the approach and outcomes of a flipped classroom teaching innovation with a group of first-year students, identified as academically weaker, in a Digital Electronics module at a post-secondary institution. The paper outlines the pedagogic framework employed in the innovation and how high effect teaching methods were combined with appropriate educational web tools to create highly effective learning experiences for students. While a range of educational web tools were used in the design and delivery of the programme, the focus was on their ability to enhance aspects of the learning process. In this way good pedagogy was the basis of good design, from which technology could provide further enhancements in terms of the student learning experience and attainment opportunities. A 3-phase flipped classroom (pre-class, in-class and post-class) was implemented. Through a range of carefully structured active learning activities such as formative assessment quizzes, problem solving, and peer instruction, students engaged with complex digital electronics concepts. Educational web tools (e.g., screencast-o-matic, socrative and kahoot) were thoughtfully and creatively integrated (from an evidence-based perspective) throughout the 3 phases to enhance the student learning experience. The innovation was carefully evaluated to both assess the subjective experience of the students in terms of how they felt about the programme and their learning, as well as actual attainment levels in terms of meeting stated outcomes. Comparison was made between the flip and nonflip classes with results from the end-semester examination indicating that the flip students were able to perform better than their peers and their results were comparable to the best cohort in the school. Of key importance is the understanding of what makes the learning experience one that fosters both a positive learning experience for the student as well as one that enhances attainment. Certainly, from this experience, it can be argued that the flip experience can become an effective format for student learning, but underpinning it, there must be a strong evidence-based pedagogy guiding the learning process and the selection and creative use of educational web tools.

Keywords: *flipped classroom, active learning, engineering education, peer instruction, education technology, evidence-based*

Introduction

Digital Electronics is a fundamental module which all first year students in the School of Electrical and Electronic Engineering (EEE) have to study regardless of their prior knowledge. Based on past experiences, students with no "O" Level Additional Mathematics tend to get left behind and do poorly in this module. Teoh and Wan (2014) conducted a pilot programme for this module on a test group consisting of academically stronger students i.e. students who had done well in "O" Level Additional Mathematics and concluded that their flipped classroom teaching methodology had positive outcome on test results.

A separate pilot programme was conducted at Villanova University in Villanova, Pennsylvania (Bidwell, 2014). The pilot flipped engineering courses and found that the bottom third of students' grades were more than 10 percent higher than in a traditional classroom. This encouraged us to continue the previous research and explore flipping course content for weaker students. The key research questions were (1) does the flipped classroom approach provide similar positive results with academically weaker students; and (2) what kind of modifications in pedagogic strategies and methods (if any) are most useful for such students?

Methods and Pedagogy

The Case for Flipped Classroom Using Evidence-Based Teaching Approaches

Teoh and Wan (2014) demonstrated the effectiveness of a 3-phase Flipped Classroom approach and highlighted the uniqueness of their implementation as one that combined the best practices of other practitioners and functionally useful web tools, in terms of supporting different aspects of the learning process, and creatively adapting the learning experience to the situated context of the particular student groups.

For this pilot implementation for academically weaker students, we decided to build on the success of the 3-phase flipped classroom approach and to reinforce the concepts of incorporating the best practices of other practitioners by adopting an evidence-based teaching approaches (e.g., Hattie, 2009; Petty, 2009; Hattie & Yates, 2014; Sale, 2015).

As described by Petty (2009), evidence-based teaching is about adopting strategies that are known to have the greatest average effect on student achievement and to understand why these methods work so that we can adopt these methods to meet the unique needs of our learners, our subject and other important contextual factors. Additionally, constant review of our teaching, to see what works in our classroom and to have the creativity and judgement to decide on the best methods and be able to adapt them within the context of our teaching is essential.

In our implementation, we adopted high effect teaching methods (e.g., feedback, problem-solving and peer instruction) throughout the 3 phases of flipped classroom. A range of educational web tools (e.g., screencast-o-matic, socrative, kahoot) were carefully selected and weaved into the 3 phases to enhance the students learning experience. The combination of high effect teaching methods and supporting educational web tools was constantly reviewed and modified, based on feedback, to enhance the students learning experience. The basis and methodology for such enhancement will be described in the next section.

In our context of academically weaker students, lack of motivation had been identified as a potential barrier to students learning. Therefore, we deliberately focused on high effect teaching methods and educational web tools that seemed most likely get student attention and stimulate interest. This involved active engagement with the content learning and providing some fun to the learning experience.

Implementation

The implementation methodology was similar to the previous pilot as described in Teoh & Wan (2014). Key improvements includes: (1) reinforcement through evidence-based pedagogic design; and (2) high impact web tools were systematically applied to enhance the learning experience and attainment for the designated student group.

The module, Digital Electronics 2 (ET1004), chosen for this pilot is the second part of the module, Digital Electronics 1 (ET1003) used in Teoh and Wan (2014). ET1004 was the best alternative module available due to the pilot timing. ET1004 is a compulsory module for first year students in the School of Electrical and Electronic Engineering (EEE). Topics covered include counters and shift registers, signed numbers and arithmetic circuits and MSI logic circuits IC's like decoders and encoders, multiplexers and demultiplexers. 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). Similar to the previous pilot, the 2-hour lecture was flipped.

The pilot was implemented for 2 Electrical and Electronic Engineering (DEEE) classes for 15 weeks. The 2 classes selected for this pilot have an average GCE "O" level score of 21 and have not studied "O" Level Additional Mathematics. Altogether 35 students were involved in this pilot run. DEEE is one of the 7 courses offered by the EEE School. The cohort size for DEEE is 23 classes.

The overall structure of the implementation had three Phases:

- Pre-Classroom Phase
- Face-to-Face Classroom Phase
- Post-Classroom Phase

Pre-Classroom Phase

The pre-classroom phase involved the familiarisation of basic concepts and key facts at the knowledge and comprehension level. This was done through a series of lecturer-created short videos using free software called Screencast-o-matic. Curated videos and cartoons from Youtube, relevant reading materials and Powerpoint presentations with voice-over were also used to add variety to learning.

To check for students' readiness for the face-to-face classroom phase, a free student response system called Socrative was used. Questions were posted through Socrative to validate students' understanding of key concepts; the tool further allowed instant visualisation enabling us to identify areas of concern which could then be addressed during the face-to-face classroom phase.

Throughout the 15 weeks, a communication tool, WhatsApp, was used to inform students of new resources, Socrative quiz deadlines and to maintain a two-way communication and feedback with the students. WhatsApp helped to add elements of "personal touch" in the pre-classroom phase which was critical in the building of rapport with the students.

We observed that initially most students did not look at the pre-class materials or do the quizzes. For the first 2 weeks, we had to meet them face-to-face to explain the rationale of the flipped approach and outline the goals or tasks in advance. We followed up with

WhatsApp to encourage them further. With the ongoing open and honest two-way communication and feedback, the students warmed up to the flipped approach, leading to higher student participation.

Face-to-Face Classroom Phase

The face-to-face classroom phase assumed that students have completed the pre-class assignments and come to class with the desired knowledge of the subject material or specific questions which they have difficulty in. Classroom instructional strategy was adjusted depending on the result of the Socrative quiz. Combinations of instructional strategies consisted of the following:

- Mini lectures on topics which students did not perform well on in the quiz;
- Engaging students actively in applying the content used to real work/world contexts through good thinking and simulated practice;
- Introducing more challenging and intriguing problems for students to work on collaboratively and solve;
- Increasing utilization of peer discussion and assessment while working on group tasks;
- Mid-point quiz to test understanding and deal with learning concerns; and
- Wherever possible, weaker students were provided with the necessary learning support to enable them to keep on track to mastery learning.

What was done differently in this pilot was the use of Kahoot, an interactive game-based student response system, to conduct mid-point quiz. The tool was highly effective in terms of getting student attention and had an excellent *von Restorff Effect* (injected novelty into the learning experience). This hit the 'sweet spot' in terms of an appropriate motivation strategy for this student group.

Post-Classroom Phase

At the end of every face-to-face session, students were asked to do an exit poll using Socrative to evaluate the effectiveness of the learning experience and to identify areas which they did not fully understand. In situations where there were prevalent difficulties on a particular topic, a "Question and Answer" video was made using Screencast-o-matic to specifically answer areas of learning difficulty. This post-classroom phase was especially important in helping to close the learning loop (e.g., effectively connecting the new knowledge to prior knowledge) with the students before the next lesson.

Students were also asked to provide feedback on areas that may help to improve their learning experience. Flipping the classroom is a dynamic process of reviewing and modifying the teaching practices to meet our students' needs. The feedback received from the students as well as our own observations will help to enhance the methods used in the next lesson.

Results and Discussion

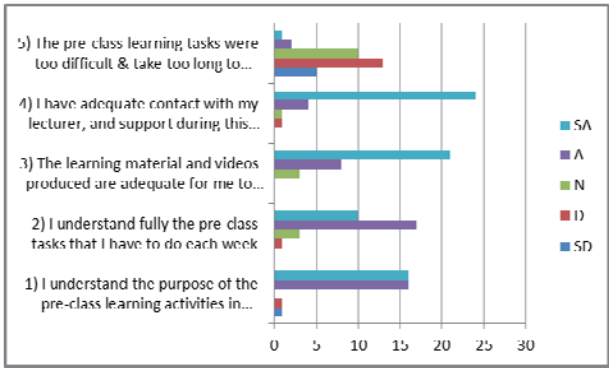
Student Feedback

After 15 weeks of implementation, a student survey was conducted to assess the subjective experience of the students in terms of how they felt about the programme and their learning. Students were asked to respond to questions about each phase and also give their overall opinion of flipped classroom.

Altogether 33 out of 35 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.

The Pre-classroom Phase

1) I understand the purpose of the pre-class learning activities in Digital Electronics
2) I understand fully the pre-class tasks that I have to do each week
3) The learning material and videos produced are adequate for me to understand the material covered
4) I have adequate contact with my lecturer, and support during this pre-class phase
5) The pre-class learning tasks were too difficult & take too long to complete



Student comments:

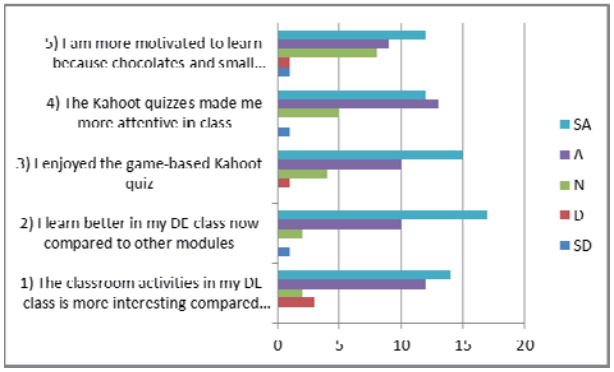
"I think the pre-class stage is good because when I don't understand a certain topic I could watch the videos again to understand. If I still don't understand, there is class time to clarify my doubts."

"I loved the idea of this pre-class stage because it prepares the students ahead."

As this group of students did not study Additional Mathematics, the pre-class materials were helpful to them as they were able to view the materials repeatedly. This helped them to reinforce understanding of key concepts and to better prepare for the face-to-face sessions. One interesting result here was the high number of students strongly agreeing that they had adequate contact with their lecturer, and support during

this pre-class phase. Although we did not see the students during this phase, keeping contact through WhatsApp was vital. This made sure that the students did not feel alone in the learning journey and any immediate concerns could be addressed.

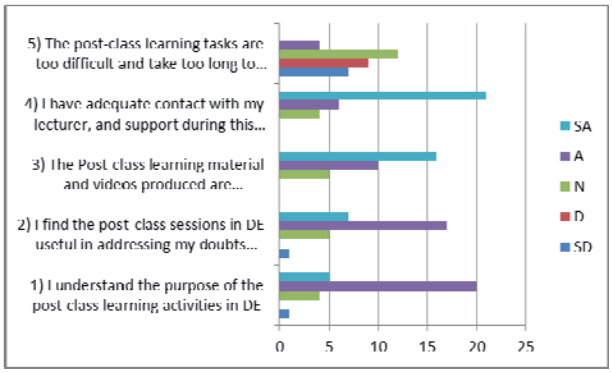
The Classroom Phase
1) The classroom activities in my DE class is more interesting compared to other modules as a result of flipped teaching
2) I learn better in my DE class now compared to other modules
3) I enjoyed the game-based Kahoot quiz
4) The Kahoot quizzes made me more attentive in class
5) I am more motivated to learn because chocolates and small prizes at the end of Kahoot game were given out



Student comments:
"The lesson is more fun than other modules because we get to play games where we also learn at the same time. We won't fall asleep or talk about other things with our friends in class."
"Having class discussions and different point of views to solve a question"
"We need to make sure that we can think fast during kahoot. It is a good way to get us involved in class as we are able to challenge each other competitively."

The positive results in the classroom phase were anticipated as the methods used were of high effect sizes (Hattie, 2009). The survey results and feedback on Kahoot suggested that gamification of content was an effective way to engage weaker students, as it provided a good attention grabber and injected some fun into the learning experience.

The Post-classroom Phase
1) I understand the purpose of the post-class learning activities in DE
2) I find the post-class sessions in DE useful in addressing my doubts arising from the lesson in class
3) The Post-class learning material and videos produced are adequate for me to clarify my doubts if any
4) I have adequate contact with my lecturer, and support during this post-class phase
5) The post-class learning tasks are too difficult and take too long to complete



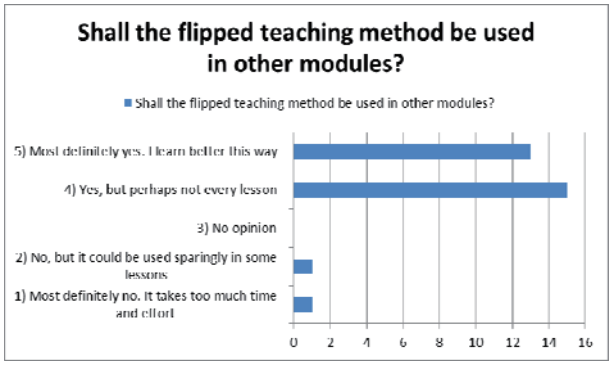
Student comments:
"It helps me to understand what I learn in class. We can use this platform to clear our queries and doubts so that especially for some of us who may be too shy to ask during class. The EXIT poll let us ask questions without being shy."

Most students had understood the purpose of this post-classroom phase and found that this phase was useful in clarifying their doubts. However, we noted that there was a slightly muted response with regard to the question if post-class activities consumed too much time or was too difficult. This was understandable since this 3-phase flipped classroom approach had largely deviated from the standard module offering in the sense that where the students were expecting an end to a standard module, they were now being engaged in a post-mortem. Nevertheless, results indicated a positive effect of post-classroom phase in advancing course content.

We noticed that there was a high number of students strongly agreeing to the statement that they had adequate contact with their lecturer, and support for both pre- and post-class phase. This suggested to us that teacher presence in and out of the classroom was an important factor in engaging weaker students.

Overall
Should the flipped teaching method be used in other modules?
1) Most definitely no. It takes too much time and effort
2) No, but it could be used sparingly in some lessons
3) No opinion
4) Yes, but perhaps not every lesson
5) Most definitely yes. I learn better this way

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The results showed that almost all the students preferred the flipped teaching method, with a slightly higher number highlighting their concerns if this method were to be implemented in every lesson. Informal conversations with students pointed towards their concerns about potential workload if all lessons were flipped. While they felt that they learnt better this way, the issues of workload, time management and self-regulation are important factors to consider in the pre-classroom and post-classroom phases.

Student Performance

Also, 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. The performance of students in ET1004 module in the flipped classroom pilot were analysed and compared against both the entire cohort of students, and students from similar backgrounds.

Module Results (ET1004, DE)
Flipped class mean = 83.7
Cohort mean = 76.8
Cohort Standard Deviation (s.d.) = 14.1
Outperformance of Flipped Class = 0.5 s.d.

Mean of classes with similar students = 74
Outperformance of flipped class = 0.69 s.d.

Despite being academically weaker students, the pilot class outperformed the cohort mean by 0.5 standard deviations. More significantly, when compared against students of similar backgrounds, the outperformance was larger – at 0.69 s.d.

None of the students in this pilot class failed the module. The fail rate of the cohort and those of similar classes were 5.0% and 6.8% respectively.

We thought it was instructive to also compare the performance of this pilot class against its peers in another technical module to gauge the effect of flipped teaching on the class. ET1006 - Principles of Electrical and Electronic Engineering (PEEE) was chosen for this comparison. All classes in this module were taught in the traditional way through a series of lectures, tutorials and laboratory sessions.

Module Results (ET1006, PEEE)
Flipped class mean = 60.7
Cohort mean = 69.9
Cohort Standard Deviation (s.d.) = 15.4
Outperformance of Flipped Class = -0.6 s.d.

Mean of classes with similar students = 64
Outperformance of flipped class = -0.21 s.d.

Here, the pilot class underperformed both the entire cohort and classes with similar backgrounds by 0.6 s.d. and 0.21 s.d. respectively.

The fail rate for the pilot class in ET1006 was 22.8% while that for the whole cohort was 7.9%. For classes with similar students, the figure was 11.6%.

We did not analyse the reason for the underperformance of this class when compared to its peers. But one reason could be that this class is weaker than originally thought. If so, this makes the outperformance in the flipped class in ET1004 all the more remarkable. This result reinforced that our selection of high-effect teaching methods and web tools were useful in motivating and engaging academically weaker students in the subject content and thus achieved better performance.

Conclusions

The flipped classroom, using evidence-based teaching principles and practices together with the effective use of appropriate web educational tools (e.g., Kahoot to check key understanding, provide two-way feedback and create some fun) are likely to foster both a positive learning experience and enhance attainment for students. Certainly, from this experience, it can be argued that the flip experience can become an effective format for student learning. However, underpinning it, there must be a strong evidence-based pedagogy guiding the learning process and the selection and creative use of educational web tools.

In summary, a key success factor in this innovation was the use of motivational strategies throughout the whole learning experience, which required some creativity. This helped to create a psychological climate which was both success orientated and fun for the student involved. There is, of course, a strong evidence base to why and how this works (e.g., Jensen, 1996; Dewey, 1998; Mlodinow, 2012).

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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Topic 5

Industry and Multiple Institutions Collaboration

（産官学連携・国際交流）

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International Students' Collaborative Project between Republic Polytechnic and Kitakyushu College ~Joint Final Year Projects between Two Institutes~

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Abstract

Since the first International Symposium on Advances in Technology Education was held in 2007, National Colleges of Technology in Kyushu-Okinawa Region and Polytechnics in Singapore have been promoting educational collaborations. Kitakyushu College has been developed student/staff exchange programs with several Polytechnics. With Republic Polytechnic, we have launched a joint Final Year Project (FYP) in which students of Republic Polytechnic are co-supervised by faculties of Kitakyushu College. It should be noted that the subject "Thesis Research" in Kitakyushu that is chosen to be similar to FYP is related to the Republic Polytechnic's projects, so that the students of both schools can collaborate easily during the semester 1, and continue their project topic in the semester 2. For the year 2015, the chemical reactor system is chosen to be a common platform of project. Thus, students of both schools will design, fabricate and evaluate their systems as works of international collaboration. For example, the students (sender) will send parts of system with an invoice/technical report prepared by themselves to another school students (receiver), and they will build the system and report the results, like a real international division of manufacturing production. The details of program activities are discussed from the viewpoints of effective global education program.

Keywords: *International Exchange Program, Co-supervior, Final Year Project (FYP), Thesis Research, International Division of Labor, Multiple Institutions Collaboration*

1. Introduction

As the global education is a very creative and effective approach of raising students' awareness of their own roles in the world, it really motivates the students to become active, responsible, collaborative and global citizens. Therefore, many educational institutes of higher learning have been developing educational collaboration relationships in order to promote global education. This symposium, the International Symposium of Advances of Technology Education (ISATE), is one of good examples of the institutional collaboration. Since 2007, many faculties of educational institutes have exchanged and shared their pedagogy and future visons, as well as established international educator networks through ISATE. One of successful outcomes is a Memorandum of Understanding (MOU) between five polytechnics in Singapore and the National Institute of Technology Japan (formerly Institute of National Colleges of Technology: INCT) signed in 2011. The MOU includes student and staff exchanges between the polytechnics and all National Colleges of Technology belonging to INCT and visits by polytechnic students to Japan and vice versa. Basing on this MOU, the first author was attached to Republic Polytechnic from September 2014 to March 2015 to promote educational collaboration between two schools. This paper discuss an international students' collaborative project including an opportunity of short term exchange program as a global education implementation. The details of project are discussed.

2. Method and Discussion

National Institute of Technology, Kitakyushu College (formerly Kitakyushu National College of Technology) has been developed global education programs with several Polytechnics in Singapore and other foreign educational institutes. These activities include short-term and/or long-term student exchange, international symposiums and faculty attachment programs. The faculty attachment program is organised by the National Institute of Technology, and many college staffs have deepened the friendship and cooperation with other countries' school staffs. After the staff attachment to Republic Polytechnic 2014, we have launched a joint Final Year Project (FYP) in which students are co-supervised by faculties of Kitakyushu College.

2. 1. Academic Calendar and Modules

Table1 shows academic calendars of both schools and a scheme of this program. There are some difference, but both schools adopt the two semester system and the summer vacation is set to be mainly in September. During the semester 1 (from April to August), the project supervision to the students are provided through the web (video-meeting) as well as actual face to face meetings; The first face to face meeting was held in May. In the following semester 2 (from October to February), the students are provided opportunities to be attached to Kitakyushu College as an international internship.

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Table 1. Academic calendars of both schools and scheme of this program.

	1st Semester	Summer Vacation	2nd Semester
Kitakyushu College	7 April to 30 September	12 August to 23 September	1 October to 22 March
Republic Polytechnic	20 April to 12 September	13 September to 18 October	19 October to 7 March
This program	Supervision via the Internet / Student Collaboration		Student Attachment

A telecommunications application software, Skype, is employed mostly to communicate with each other. Although the resolution of picture on a display was found to be not good enough to see the details, the materials sent as attached email supplement compensate the lower quality of pictures. Simple hand drawings during the meeting are also useful to explain and show the processes of project tasks. Through the meetings, both Kitakyushu College students and Republic Polytechnic ones exchange ideas regarding the project and enjoy conversation on their daily life as well as culture stuffs. There is only one hour time difference between Japan and Singapore. So, it is relatively easy to have video meetings via the Internet in terms of scheduling. However, as we have a thesis research mainly on Thursday in Kitakyushu College and FYP on Wednesday in Republic Polytechnic, the meeting time duration tends to be confined. If we have FYP on the same day, we can have the video meeting freely and it also enable us to make a bilateral experiment via the Internet. It should be suggested that educational collaboration between schools seems to be improved dramatically by adjusting class schedule.



Fig. 1 A scene of video meeting.

2. 2. Research topic

The research topic of "Thesis Research" in Kitakyushu College was chosen to be similar to FYP in Republic Polytechnic's project, so that the students of both institute can collaborate easily during the semester 1, and continue their project topic in the semester 2. For the year 2015, the chemical reactor system, a microreactor, was employed as FYP topics. A microreactor is a micro-channel reactor in which chemical reactions are designed to take place in a confinement with typical lateral dimensions <1 mm (Fig. 1). Because of high energy efficiency, reliability, and a superior degree of process controllability, microreactors possess many advantages over conventional large scale (bulk) chemical reactors.

Both school students design, fabricate and evaluate their own systems as works of international collaboration. In this semester 1, Republic Polytechnic students designed the micro-channel and send it by email. Then, Kitakyushu College students fabricated the channel basing on the received design and sent fabricated parts of system with an invoice/technical report prepared by themselves to Republic Polytechnic students (receiver). Republic Polytechnic students will build the system and report the results, like a real international division of labor.

(a) (b)

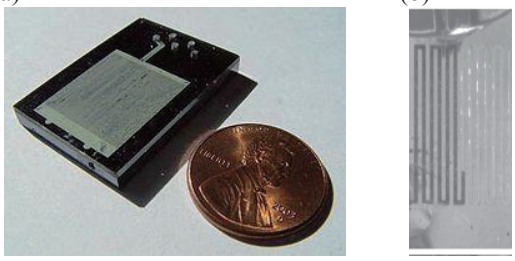
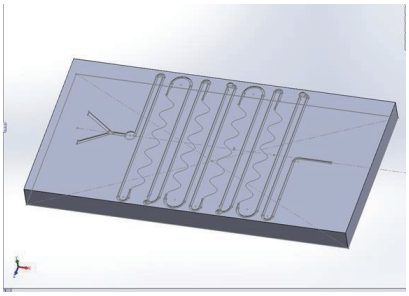


Fig. 2 A example of (a) microreactor and (b) micro-channel

A typical microreactor consists of micro-channels for mixing, a pumping system, and so on. Thus, Kitakyushu College students and Republic Polytechnic ones collaborate together to develop their own microreactor. Figures 3 (a) and (b) show the micro-reactor design developed by Republic Polytechnic students. This structure is fabricated on Acrylic resin plates using a Machining centre at Kitakyushu College. The prototypes with other elements sent to Republic Polytechnic will be assembled and be evaluated.

(a)



(b)

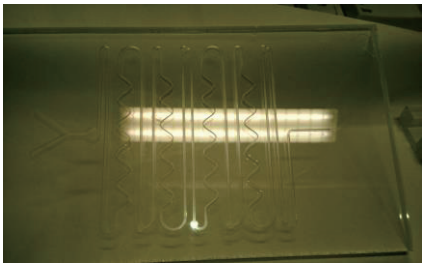


Fig. 3 The microreactor (a) design developed by Republic Polytechnic and (b) Prototype microreactor

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2. 3. Experience of international division of labor

Since the microreactors are developed through the collaboration between two institutes in two countries, the students experience an international division of labor. In addition, Kitakyushu College students try to prepare an invoice (bill) for shipments. In the business, the invoice that indicates the products, quantities, and values for products is an important commercial document issued by a seller to a buyer as well as for the custom report. As the invoice is a summary of their work and important to deliver the products to collaborator, they feel this is a good experience of business process and manner. Although they talked with Republic Polytechnic students via Skype easily, it is still difficult to find the country code for international calling. They also experienced to simulate checking the parameter sheet and the classification of Japanese export control regulation. It should be noted that the export control is the important thing to keep in mind even for educational institutes. Of course, our prototype microreactor that is a simple patterned Acrylic resin plate, does not fall under the category of regulation. Through the examination of export control regulation, the students could learn the responsibility of manufacturer for international collaboration. It is better to note that the real examination of regulation was done by the faculty, not by the students.

輸出令第6項		貨物等省令第5条	
項番	項目	項番	項目
輸出令第6項	次に掲げる貨物（2の項の中欄に掲げるものを除く。）であつて、経済産業省令で定める仕様のもの	貨物等省令第5条	輸出令別表第1の6の項の経済産業省令で定める仕様のものは、次のいずれかに該当するものとする。
輸出令第6項（1）	軸受又はその部分品（4の項の中欄に掲げるものを除く。）	貨物等省令第5条第一号	軸受であつて、次のいずれかに該当するもの又はその部分品（国際規格ISO3290（転がり軸受―軸受の部分品―転がり軸受用の玉）で定める精度がグレード5以下の玉を除く。） イ　玉軸受又はころ軸受（円すいころ軸受を除く。）であつて、日本工業規格B1514―1号（転がり軸受―軸受の公差―第1部：ラジアル軸受）で定める精度が4級以上のもののうち、内外輪及び国際規格ISO5593で定める転動体がモネル製又はベリリウム製のもの ロ　削除 ハ　能動型の磁気軸受システムであつて、次のいずれかに該当するもの

Fig. 4 An example of export control documents: Export Control Classification excel file that is similar to one students try checking. (in Japanese)

Proforma invoice #: 1986

SENT BY

School Name: Kitakyushu National College of Technology
Name/Department: Hideaki Aburatani
Address: shi5-20-1 Kokuraminami-ku
City/Postal Code:Kitakyushu-shi,Fukuoka
Country:Japan
Tel./Fax No.:

SENT TO	AIRWAYBILL No.
Company Name: Name/Department:Dr. Yihua Wang, SEG Address: 9 Woodlands Avenue 9 Singapore 738964 Republic of Singapore City/Postal Code: Country:Singapore Phone No.:	Number of pieces: Total Gross Weight: Total Net Weight: Carrier:

Description of goods	Commodity Code	Country of origin	Quantity	Unit Value, Currency	Subtotal value, Currency
Microreactor Prototype Piezoeletric pump Prototype Result of piezoelectric element's impedance			2 1 1		

Fig. 5 An Example of Invoice prepared by Kitakyushu College Students (Unfinished one)

2. 4. Delivery of the parcel

Efficient and fast delivery is very important in the world logistics. It is surprisingly noted that less than 3 days are needed to deliver the parcel from Kitakyushu to Singapore using the express mail service (EMS). Table 2 shows a list of Delivery Days for other countries from Kyushu region. Typical fees for EMS service are JPY1,100 for 500 g parcel and JPY1,800 for 1000 g parcel. This also tells the students facts that the world is connected closely and it is a small world where there is no distance between people and business. These activities provide opportunities to the students to learn the legal responsibility and a basic idea of international logistics.

Table 2. List of Delivery Days (EMS: Kyushu)

Country/Area name	Number of delivery days
Indonesia	5
Hong Kong	2
Singapore	2
Thailand	3
Taiwan	2
Malaysia	3

(It should be noted that it takes about 7 days, if we use a normal airmail service)

2. 5. Student Attachment to Kitakyushu College

Through this project, the students begin to be interested in joining the partner school for further study. For Republic Polytechnic students, Kitakyushu College is preparing a short term exchange program up to 5 months period. Because of the duration of their stay, they have to obtain the student visa status in Japan. During their stay in Kitakyushu College, they are arranged to join some lectures in the advanced school, lab-work as well as continuing their FYP in the laboratory. However, it should be noted that this program is an on going one, and the number of student coming to Japan has not been determined, yet. In addition, these opportunity is opened to the students who are not directly involved in the project, since the students in my laboratory feel familiar with Republic Polytechnic students and are ready to welcome them.

To encourage their study in japan, the financial support is another key issue to be discussed. For the short-term exchange students, there are only two possible founding for their living expenses: Sakura Science Program and Japanese Students Services Organization (JASSO) scholarship. Last year, we could get Sakura Science Funding to invite Republic Polytechnic students, but it is for a short stay up to 20 days. Thus, the JASSO is suitable for this program. As this program was planned after the deadline for JASSO scholarship in October, we could not apply for it. For the continuity of the exchange program, we have to keep applying these scholarships in addition to other possible ones.

3. Conclusions

In this paper, our collaborative project between two schools is presented. The microreactor is chosen to be a common platform of the project, and the students design, fabricate and evaluate their systems like a real international division of manufacturing production. It seems that our students start to rise their awareness of being global engineers in the world. The Internet video meeting provides opporunity to talk and to collaborate with foreign students easily. Although it is not a real face to face meeting, the video meeting seems to help students to be more involved in the meeting/project emotionally. Moreover, it makes both school students to be friends and collaborators. It is quite obious that only text based exchang (i.e. e-mail) cannot provide such emotional involvement. Althogh the students are familiar with ICT and social media, typical business processes (sending packages and writing invoices) are new for the students and are found to be a really good experience. The following student attachment is an ongoing activity. We will find out the progress of our global education program later on. It is suggested that the activities in this program can be used for further promotion of international collabration between educational institutes for higher education in many countries.

Acknowledgements

We acknowledge the support from International Relation Offices of Republic Polytechnic and International Relation Committee of Kitakyushu College. We also acknowledge the financial support from Sakura Science Program in 2014.

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https://en.wikipedia.org/wiki/Microreactor

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REPORT ON THE IMPROVEMENT OF TRAINIG PROGRAM COOPERATED WITH A LOCAL ADMINISTRATION

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Abstract

A new training program has been carried out in Electronic Mechanical Engineering Department in Yuge College since 2010. It is aimed to train students' creativity and to get closely connection with Kamijima City that is a local administration.

A contract of cooperation for the area activation is made between the Kamijima City and the Yuge College. 10 percents of population of Kamijima City is concerned with the Yuge college, such as the students, teachers, staff members and their families.

The Yuge College has become an important educational institution, which is responsible for higher education in this Kamijima City area. Kamijima City is located in the Seto Inland Sea consist of some isolated islands include with Yuge island. Furthermore, one of the key features of Kamijima City is that has higher educational facilities include with Yuge College on the Yuge Island.

It is possible to study various lectures and practices in the Electronic Mechanical Engineering Department focused on electronics and mechanics. In addition, the traditional techniques such as welding or lathe can be mainly trained in the skill practice programs. However, there are few programs to acquire creative skills.

Based on these backgrounds, this unique program aimed to train engineers who have the creative skills to make something new. The students design cup coasters with CAD tools on computers and a numerical controlled machine processes them in this program. Kamijima City presents them to visitors as novelties. All of their expenses are supported by Kamijima City.

The target group for this program is third grade students. First, they can learn the operation of CAD tools and look into characteristics of Kamijima City. Then they draw some symbolic design of Kamijima City for the coaster using CAD. After that, they process stainless sheet using a numerical controlled machine with the CAD data.

The result of questionnaire shows that the students worked on this training positively. Moreover, the other, few students can find who are using their coasters in and around Kamijima City.

Keywords: *cooperative education, creativity education, training program, engineering education*

Introduction

A new training program has been carried out in Electronic Mechanical Engineering Department in Yuge College since 2010. It is not only aimed to train students' creativity but also aimed to get closely connection with Kamijima City that is a local administration.

The Yuge College has become an important educational institution, which is responsible for higher education in this Kamijima City area. Kamijima City is located in the Seto Inland Sea consist of some isolated islands include with Yuge island. And 10 percents of population of Kamijima City is concerned with the Yuge college, such as the students, teachers, staff members and their families. More, one of the key features of Kamijima City is that has higher educational facilities include with Yuge College on the Yuge Island.

It is possible to study various lectures and practices in the Electronic Mechanical Engineering Department focused on electronics and mechanics. Especially, the traditional techniques such as welding or lathe can be mainly trained in the skill practice programs. However, there are few programs to acquire creative skills.

Based on these backgrounds, this unique program aimed to train engineers who have the creative skills to make something new. These three concepts such as “creativity”, “individuality” and “presence” are based to plan this training program. This training program is set up for the third grade students experiment.

Students embody the features or characteristics of Kamijima City in their designs of the cup coasters. They design the cup coasters with CAD tools on computers and a numerical controlled machine processes them in this program. In this process, they can show their ability of creativity and individuality.

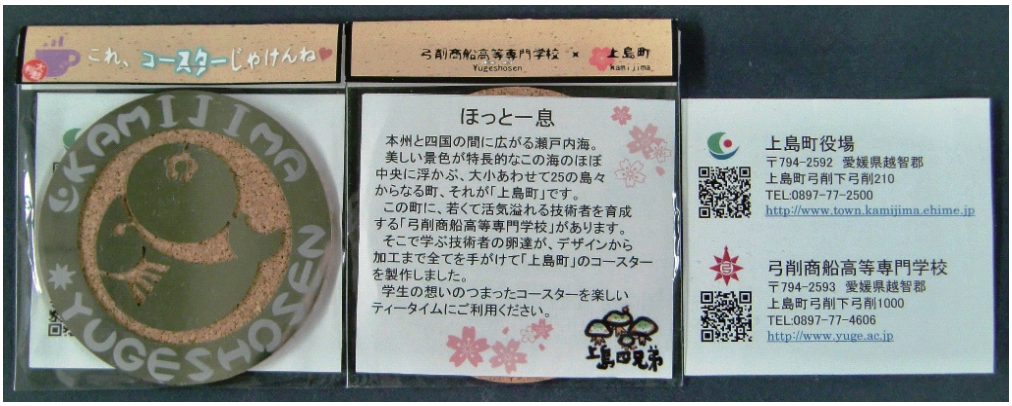


Figure 1 The external appearance of the Kamijima cup coaster



Figure 2 The various designs of the Kamijima cup coasters

Kamijima City that is collaborated with us, presents the cup coasters to visitors as novelties and it makes city's presence felt, the advantage of higher education and technology on Kamijima City over the vicinity.

Some examples of the cup coasters

Figure 1 shows the external appearance of the cup coaster. A cup coaster is packed with a thin plastic film with a sheet that is written on some publicity comments and contact address in Japanese. As shown in Figure 1, both symbol marks of Yuge College and the Kamijima City are printed on the package.

The Kamijima cup coaster is made of a stainless steel plate based on a corkboard. The thickness of the stainless plate is 0.8 mm. The thickness of the corkboard is 2 mm and 90 mm diameter.

Figure 2 shows the various designs of the cup coasters. The left one displays Yuge Bridge that is one of a symbolical structure in Kamijima City, waves and undersea view. The middle one shows a yacht mark and a cherry blossom that are used as symbols of Kamijima City. More, Japanese hiragana characters for "Kamijima" are shown in it. Similarly, the yacht mark and a compass mark that is the symbol of the Yuge College are shown in the right one.

All of their expenses are supported by Kamijima City.

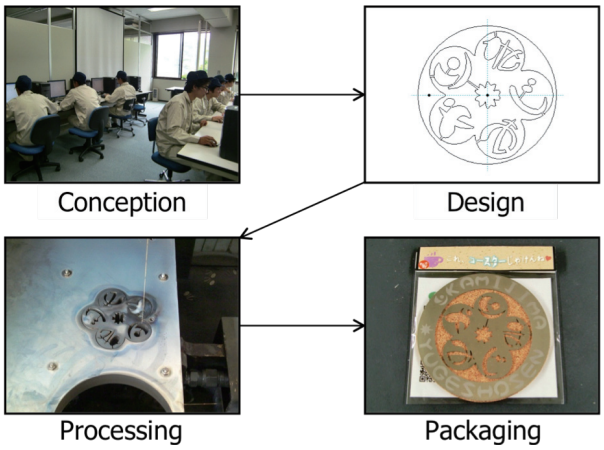


Figure 3 The outline of the program procedures

Table 1 Material properties and sizes

Base	Cork
Thickness	2 mm
Diameter	90 mm
Material	Stainless steel (SUS 304)
Surface finish	# 400 polished
Thickness	0.8 mm
Diameter	90 mm
Characters	Sand blasted finished
Particle	White alumina # 200

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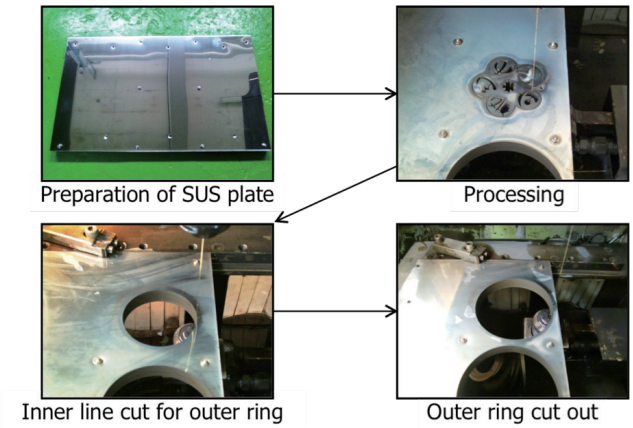


Figure 4 The procedure of the wire cutting process

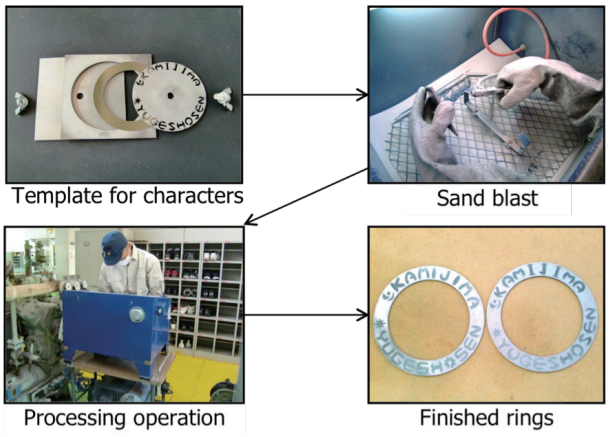


Figure 5 The procedure of the outer rings

The training program procedure

Students plan something symbolic characteristics of Kamijima City. First, they look into features of Kamijima City before they draw their concepts by brochures, pamphlets and so on. Second, they draw their notion using CAD tools on computers. They have to cram their ideas and some restrictions of a wire cutter into their drawings. They usually adapt their drawings to suit regulations of wire cutter. Then, they hold a sort of a competition to select the best drawing in each group that is consisted of seven or nine students. The only selected design can move on the third step.

Third, wire cuttings, sand blastings and finishings on cork plates. Last, packaging and handling to Kamijima City. The outline of these procedures is shown in Figure 3.

The procedure of the wire cutting processes is shown in Figure 4. Teachers prepared some stainless steel plates for wire cutter because of size limitation of the cutting machine.

The students set the stainless steel plates on a wire cutter that is numerical controlled and make ten to twenty works of product for the group members and Kamijima City. They also make outer rings to print names of "Kamijima" city and "Yuge" college.

Figure 5 shows the procedure of the process of outer rings. The templates for characters are prepared in advance. The template is cut the "KAMIJIMA" and "YUGESHOSEN" characters out. Students set one of them on the outer ring and process with sand bluster. The samples of outer ring are shown in Figure 5.

It is very first time to manage to plan to product something for the students. Many students work harder in traditional practices.

The presence of Kamijima City

Figure 6 shows a festival named “Islander”. It is hold in Tokyo every year from more than fifteen years ago. The festival is held under the auspices of a Center for Research and Promotion of Japanese



Figure 6 A snap shot of “Islander 2012”


技術の粋「上島コースター」
弓削商船高専 町と共同開発

Figure 7 A feature story on a major newspaper

Islands/Ministry of Land, Infrastructure, Transport and Tourism, and aim to promote and encourage the isolated or remote islands. The Kamijima cup coasters are handed out to the festival visitors as novelties.

The Kamijima cup coasters were introduced on a major newspaper as shown in Figure 7. It said that the coaster is made with the very essence of the most advanced technology.

Results and Discussion

The results of questionnaire are shown in Figure 8 and 9. The students worked on this training positively. Through the training, about 70 percent of students got

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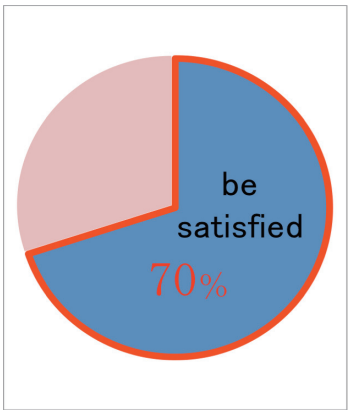


Figure 8 The results of the questionnaire for satisfaction

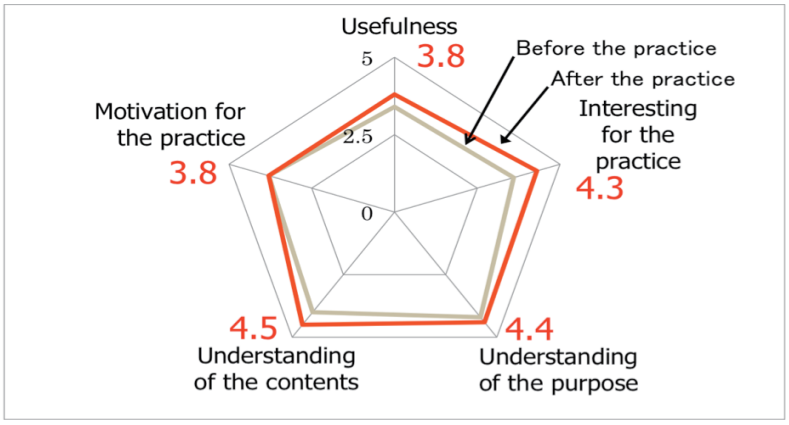


Figure 9 The results of the questionnaire

satisfaction in this training. It is considered that this training specialized in the contents that the students make things by themselves. This can also be shown in the result in Figure 8. The item for "interesting for the practice" is marked 4.3 and the item for "understanding of the contents" is also marked 4.5. However, the point for "motivation" is not increased. The reason is not clear but we guess that they hit a wall when they tried to design their ideas. Sometimes like this difficulty reminds them of negative feelings. Moreover, more, it is considered that they spent too much time tackling the work and little time discussing with each other.

We expect that the creativity of the students are cultivated by to design the cup coasters in a some limitations on size, processing, cost, relationship with the Kamijima City and so on. For example, to make a prototype of the cup coaster is very difficult because of cost problem. The students have to make some meetings to get feedback from teachers or technical staffs before processing the cup coasters. The students have experience that can be the driving force to study in these feedback meetings.

On the whole, a lot of students were very satisfied with the training.

Conclusions

Establishing the new training practice cooperated with a Kamijima City that is a local administration. This unique program aimed to train engineers who have the creative skills to make something new and more, to make the presence felt of Kamiima City by the products in the training practice.

Main results obtained from questionnaire are as follows:

(1) About 70 percent of students are satisfied with this training program.
(2) The point of understanding of the contents, of the purpose and interesting for the practice in questionnaire increased after the practice.
(3) However, the point of motivation for the practice dose not increased. The reason of this is not clear and it requires a further examination.

Acknowledgements

The authors want to thank the students of the third grade and all stuffs of Technical Support Center in National Institute of Technology, Yuge College.

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Education Program Development on Embedded Systems for Malaysian Students -Response of Malaysian and KOSEN Students to Introductory Commodity Gadgets-

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Abstract

By strong growth as a technology-oriented nation, Japan has been able to achieve the status of a pre-eminent economic power in the world, although it is poor in natural resources and depends on import. This growth was realized by Japanese Engineers, who have not only high quality knowledge and techniques but also engineers' ethics which is a strong sense of responsibility for own works. To keep the status that Japan is recognized and praised in the world for years, engineers and KOSEN (National Institute of Technology) students who become engineers in the near future have to cultivate engineering design including both world-class technologies and high level of the ethics. Furthermore, for accepted foreign students and foreign institutes, to provide the engineering education promotes internationalization of KOSEN. In this paper, as an approach of the internationalization, a section of an embedded systems laboratory is provided for students in Malaysia (Universiti Teknologi Malaysia). The laboratory has been provided in Yonago KOSEN as the engineering education. As materials, the laboratory mainly uses several products that students has seen in real life, such as electronic billboard, weight scale, electronic organ, anti-collision system and so on. For implementing these systems, students understand its mechanism, feel accomplishments, and are interested in embedded systems. Furthermore, engineers' ethics are grown in the uncompromised implementation for high performance systems. As results of providing introduction of the laboratory for Malaysian students, they show interest for making embedded systems like KOSEN students. Besides, they try to develop new products or extend the systems actively, and answer many idea of making systems in questionnaire. Consequently, in engineering education, to address the development of commodity gadgets is also effective for Malaysia students. In addition, there are many embedded products in Malaysia like Japan, thus, Japanese education tools such as materials and handouts can be reused with a few localizations. Future issues are cultivation of engineers' ethics with developing high level systems.

Keywords: *international cooperation, embedded systems, sensing and control, physical computing, Arduino*

Introduction

Japanese engineers have high quality knowledge, techniques and responsibility for own works. Thereby Japan keeps status as a high-technology country. To maintain the level from now on, engineers and KOSEN students of future engineers have to cultivate the qualities. Besides, if KOSEN can practice the approach to foreign students and foreign institutes, internationalization of KOSEN is promoted.

As an approach of the internationalization, introduction of an education program about embedded systems practiced in Yonago KOSEN is provided for Malaysian students, who are 3rd years of Department of Electronic Systems Engineering, Malaysia-Japan International Institute of Technology, Universiti Teknologi Malaysia. This program adopts a laboratory style that implements basic models of several products. Through the implementation, students understand mechanisms and their responsibility is grown. This paper explains the approach and shows Malaysia and Yonago KOSEN students' reactions for the approach.

Outline of Education Program in Yonago KOSEN

The education program is provided for 5th-year students of Department of Electronic Control Engineering, Yonago KOSEN. This is a 2 credits class named "Microcomputer Control". In this class, students learn following contents in laboratory style using commodity gadgets as material:

(1) Introduction Section : digital and analog I/O
Students built circuits and connect sensors on breadboard, to make cocking timer, weight scale and so on.
(2) Application Section : motor controlling and wireless communication

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Students embed and solder sensor circuit and motor-driver circuit, build universal car-kit, and then assemble them with microcontroller board to make car equipped with automatic braking system and wireless-controlled car.

Besides, in this class, Arduino board is adopted as microcomputer board.

Program Methods and Materials

For Malaysian students, introduction section of the program is provided for 1 hour a week 2 times. In the section, laboratory gives priority to obtain basic skills and to raise the interest for making systems. Therefore, following considerations are provided for students who are not good at programming or building circuits:

- ✓ circuits consist of a few electronic devices and easy wiring,
- ✓ next program is completed by editing only a few lines, as shown in Figure 1,
- ✓ program uses only if, else and else if statements,
- ✓ sensor is used only variable resistance type and controller implemented type.

For the concept, students make following systems as exercise:

(1) timer system using switch and LCD,
(2) advanced: electronic billboard like information of LRT (one of main transportations in Kuala Lumpur),
(3) weight scale using pressure sensor and LCD,
(4) advanced: over-load warning in elevator (most students often take elevator in the university),
(5) illumination controller using photo sensor and LED.

Arduino boards, LCD boards and several sensors are got at the internet store in Kuala Lumpur environs. Other parts, such as resistors, jumpers, switches and so on, are sold at electronic parts shop in Kuala Lumpur.

Results of the Program

The education program is provided for 7 Malaysian students (Figure 2). Figure 3 shows questionnaire results for Malaysia students after finishing the laboratory for all 2 hours. Furthermore, results for 33 KOSEN students are also shown:

(a) understanding level of the laboratory
(b) level of difficulty about circuit building

As the result, both students are able to understand this laboratory and circuits. Therefore, learning techniques little by little with expanding systems is effective. However;

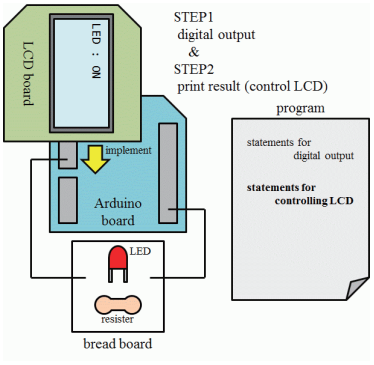
(c) level of difficulty about programing

For Malaysian students, programing in the laboratory is a bit difficult. It is caused by difference of their curriculum. Malaysian students have programing class for a semester; KOSEN students have it for 4 semester. Hence, Malaysian students are inferior to KOSEN students in programing.

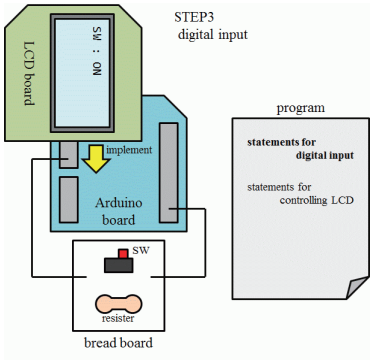
Furthermore, other results are shown in Figure4:

(a) experience of making systems before the laboratory

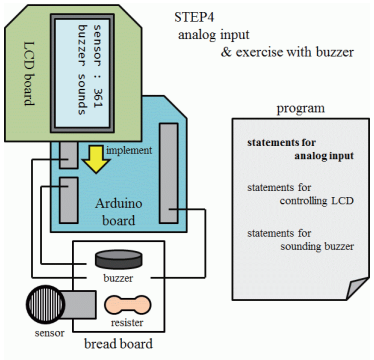
Both students don't have enough experience of making systems.



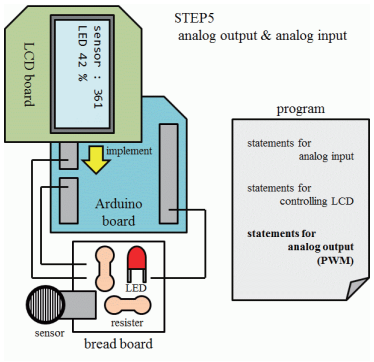
(a) Add Digital Output



(b) Add Digital Input



(c) Add Analog Input



(d) Add Analog Output

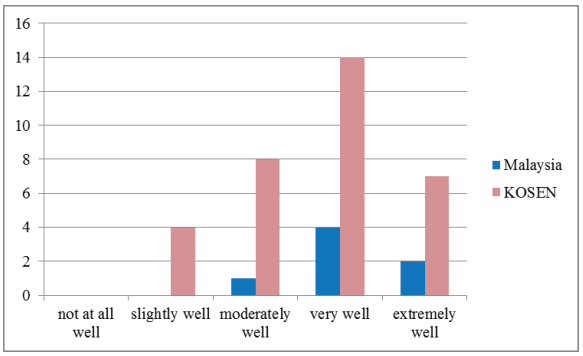
Figure 1. Procedure of the Laboratory

(b) level of understanding about mechanism of products
(c) interest for making products

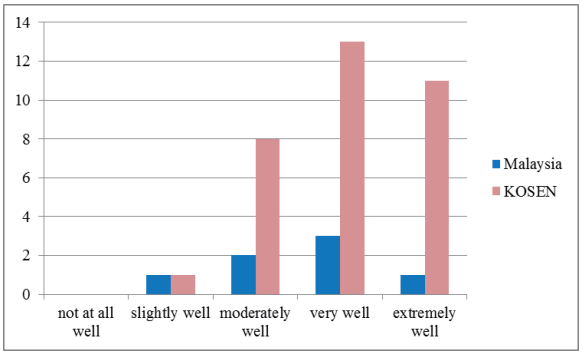
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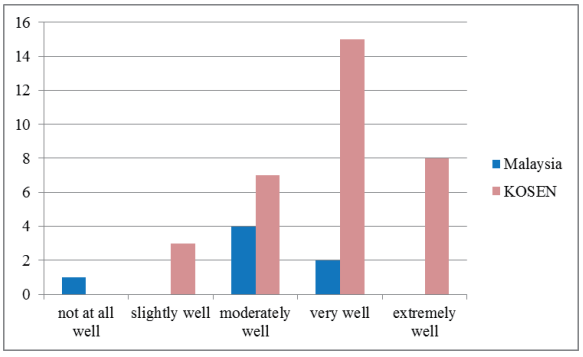
Figure 2. Laboratory for Malaysian Students



(a) Level of Understanding



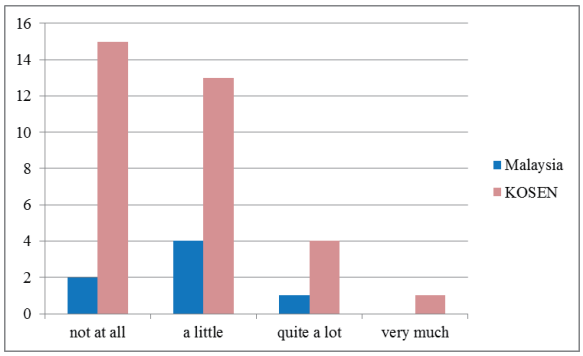
(b) Difficulty of Circuit Building



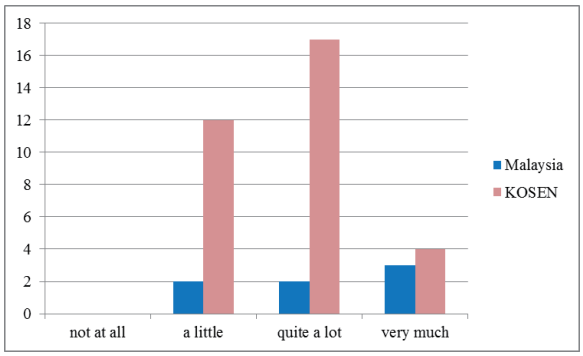
(c) Difficulty of Programing

Figure 3. Questionnaire Results (General)

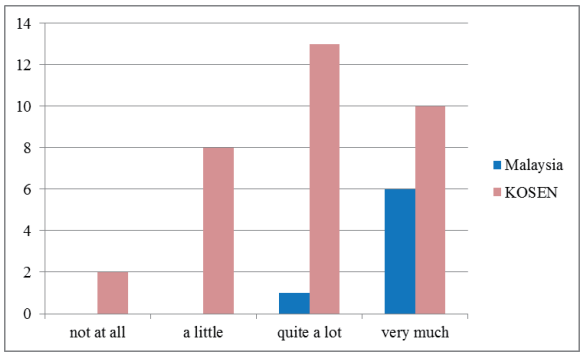
By contrast, after the laboratory, they can understand and show interest for products and systems. In particular, Malaysian students are active for making products and extending systems, and answer many ideas in free form field. There are many students who have strong admiration for Japanese manufacturing in MJIIT, thus we think that the difference is caused by this disposition. Therefore, education program using several products as materials is effective to raise the interest for making.



(a) Experience of Making Systems



(b) Level of Understanding Mechanism



(c) Interest for Making Products

Figure 4. Questionnaire Results (Making Systems)

Conclusions

In this paper, education program for embedded systems practiced in Yonago KOSEN is presented. Furthermore, introduction part of the program is provided to Malaysian student. Questionnaire results show that the program is effective to understand about products used as material and to raise interest for making systems.

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REPORT ON INTERNATIONAL EXCHANGE ACTIVITIES BETWEEN IVE(HONG KONG) AND KUMAMOTO KOSEN(JAPAN)

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Abstract

Hong Kong Institute of Vocational Education (Chai Wan) (IVE(Chai Wan)) started up international exchange activities with National Institute of Technology (NIT), Kumamoto College (KNIT) in the ISATE in Kumamoto, Japan in 2008. Then, three MOUs were signed between Vocational Training Council (VTC) and NIT in 2009, 2012 and 2013 to promote international exchange activities for students and staff.

In the past 8 years, a number of exchange activities between IVE(Chai Wan) and KNIT were organized. These included one to two-week student exchange programmes, one to three-month semester based project and internship, invited staff presentation in local and international symposiums, cross-campus teaching, an international symposium jointly organized by IVE Engineering Discipline and KNIT. In 2015, IVE(Chai Wan) and KNIT became sister campuses with support by both campus management.

In this paper, the factors for the success of these exchange activities and the good practices shared between the two institutions in this long-term and growing collaboration relationship will be addressed. A key factor will be stressed in the paper is that technical exchange with its high concentration on content and expertise is pivotal to the success in these student and staff exchange activities in addition to factory visits and cultural exposure activities. This is the golden rule in all student exchange programmes as concluded and strongly believed by the international exchange teams.

In order to make success of these exchange activities, other administrative factors such as timing, budget, accommodation and transportation arrangement and selection of students are also important. This paper will also share the past experience in these aspects.

Staff exchange activities developed after the stable and sustainable relationship was established through organizing student exchange programmes. IVE(Chai Wan) and KNIT staff members exchanged views in curriculum design, program delivery and assessment through cross-campus teaching, bi-directional talks on invitation in both Hong Kong and Japan, as well as joint supervision of student projects and internships etc. In 2013, IVE Engineering Discipline and KNIT jointly organized the 3rd International Symposium of Technology for Sustainability (ISTS) in Hong Kong. Through this symposium, both academic and administrative staff of both institutes established excellent working relationships for future collaboration. Sharing of the good practices to maintain good relationships with international partners will also be addressed in this paper.

Keywords: *International Exchange and its Development, Multiple Institutions Collaboration, Staff and Student Exchange.*

Introduction

Internationalisation is the process of integration an international, intercultural or global dimension into the purpose, functions or delivery of post-secondary education. [Knight (2003)]. IVEs and Kosens are the two major post-secondary education institutions in Hong Kong and Japan respectively to train up global engineers. The importance of design and implementation of internationalisation activities are well aware by the management.

International exchange programmes can enhance students' language ability, cultural sensibility and understandings of the world. Throughout technical exchange activities, students are able to broaden their technical knowhow and professional judgement. Consequently, it enhances their employability. The exchange activities can also enlarge international exposures and enhance technical skills of staff members.

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Start up

International relationship can be built up through staff networked activities such as academic visit, international symposium and workshop etc. The official collaboration should start up with Memorandum of Understanding (MOU) between institutions. The MOU shows support and commitment from the management to conduct official exchange activities.

The pilot start up exchange activity can be cross institution teaching by staff member in order to familiarize the academic standard and language ability etc. between institutions to prepare the future exchange programmes for staff and students.

In 2008, IVE(Chai Wan) started up exchange relationship with KNIT through the ISATE 2008 in Kumamoto. The first exchange activity was an IVE staff teaching in KNIT in February 2009 under the MEXT Good Practice Project funded by the Japan government [KNCT (2011)]. The success of first exchange programme made green light from management to sign the first MOU in March 2009 in Hong Kong to start up various types of staff and exchange activities.

Student Exchange Programmes

The first student exchange programme was conducted in KNIT in March 2009. Staff from both IVE(Chai Wan) and KNIT strongly believed that technical exchange is the key success factor for student exchange programmes. Therefore, the team designed a number of technical projects in the past seven years. It included control of mobile robot, design and make of air balloon, control of solar tracking system and efficiency analysis of renewable energy system etc. On top of technical content, each exchange programme also included factory visit, cultural exchange and sightseeing activities. The proportion between technical content 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, management and funding supporters.

In addition, bi-directional exchange is also important for sustainable relationship so there was at least one student exchange programme in Hong Kong and Kumamoto each year. Timing for exchange activities is critical factor. Since academic calendar between Hong Kong and Japan is different, it is difficulty to arrange exchange programmes to suit the best time from both sides. After several pilot projects, it was decided that the Japan and Hong Kong programmes were conducted in March and August respectively in each academic year. The duration of the exchange programme was 7 days to 10 days. Sometimes, August programme was conducted in both Hong Kong and Japan for 2 to 3 weeks. By such arrangement, both IVE and Kosen students experienced different roles as host and guest, this enhanced their coordinating and organising ability.

Budget is critical success factor in a student exchange programme. Apart from IVE(Chai Wan) and KNIT financial support, with good track records, IVE(Chai Wan) was able to get a number of additional funding supports from the Hong Kong Government, Vocational Training Council (VTC) and industrial donation. It helps more students, especially with financial burden family, to join the exchange programmes. In general, IVE students are required to pay around one-third to half of the total expenses of the trip. In some cases, full sponsorship was sought with support from the Hong Kong Government and industrial donation. Under such good financial subsidy scheme, selection of participants is an important quality assurance procedure. Hong Kong side selection procedure consists of written assessment and oral interview parts. The selection criteria are based on language ability, technical knowhow, understanding of the exchange programme and past records of extra-curricular activities etc.

Accommodation is essential element in each trip. Under the well-established dormitory system in Kosen, IVE students could enjoy the low cost accommodation in KNIT together with their fresh dormitory experience. Not only the low cost benefit to the students, IVE and Kosen students were able to communicate more in the dormitory after the daily activities. This provided a golden opportunity for them to build up sustainable relationship. There were many post activities arranged between IVE and Kosen students such as cross-country visits and friendship building in e-communication platform etc. to strengthen their friendship. IVEs do not have campus based dormitory but corporate based dormitories in VTC are under construction. The VTC management is planning to offer low cost accommodation to Kosen students after the construction work is completed. During the past years, KNIT students stayed at a youth hostel near the IVE(Chai Wan) at affordable price under a big discount after negotiation by staff members of IVE(Chai Wan).

Yearly based one to two weeks short stay exchange programmes are able to keep sustainable collaboration between IVE(Chai Wan) and KNIT. It also serves as a training platform for staff to organise exchange activities. In the Department of Engineering in IVE(Chai Wan), there was around two-third academic staff trained up to organise international exchange activities in the past 5 years. The trained staff can be the trainer of IVE Engineering Discipline to support other sister departments in different IVEs to organise similar programmes. After the MOU between VTC and NIT in 2012, the exchange programmes extended to other NITs such as Kagoshima, Kitakyushu [Shirahama & Lee (2013)], Akashi, Toyama and Nagano colleges etc.

After 4 years short stay exchange experience, the collaboration between IVE(Chai Wan) and KNIT staff members were well established. The exchange team brought up new idea to start cross-campus

teaching for award bearing modules in 2012. However, due to a number of constraints such as curriculum design, academic calendar and external accreditation, it was difficult to have credit exemption semester based exchange students between two institutions. The staff members changed their mind to arrange semester based project work or internship in each campus. This allowed one to three months award bearing modules to be conducted and assessed away from its home country campus. The first long stay exchange programme was from March to May in 2013, there were two IVE(Chai Wan) students completed their final semester project in KNIT. This proposal continued to run in KNIT as well as in other NITs, such as Kagoshima [Wong and Lee (2015)], Yatsushiro and Nagano Colleges etc. The IVE students conducted their final semester project by joint supervision between Kosen and IVE teachers. The assessment of the project work followed the assessment scheme as stipulated by the IVE programme document. This long stay programme provides an opportunity for IVE and Kosen students to study curriculum required modules away from its home country campus. It serves a platform for them to be an overseas exchange student. Throughout this scheme, IVE and Kosen students have opportunity for in depth technical and cultural exchange experience in their applied research work. Students encounter real working and daily life experience throughout the 2 to 3 months period. From the staff exchange point of view, they can understand more about the curriculum design, academic standard, assessment method and quality assurance procedure between each institution. This in-depth understanding enlarges the articulation opportunity for the students such as opportunity for IVE students to study advanced course in NIT. In August and September 2014, students from NIT, Kumamoto and Nara colleges completed their internship in IVE(Chai Wan).

Staff Exchange

Various types of staff exchange activities had been conducted since 2009, it included cross-campus teaching, invited talks in local and international symposiums, jointly organising international symposium and staff attachment.

The first staff exchange programme was an IVE(Chai Wan) staff to teach a one-week technical communication class in KNIT in February 2009. The class provided first-hand information to the IVE staff to know the language ability and technical knowhow of Kosen students. In the subsequent years, IVE staff conducted a number of classes in KNIT such as Java programming and design of mobile robot to prepare for the short stay programmes.

The IVE(Chai Wan) and KNIT international exchange teams invited opposite side staff members to deliver professional talks related to technical exchange and international affairs. IVE staff members delivered keynote speech in International Education Symposium in 2009 and Monodzukuri Camp Symposium in 2011 organised by KNIT. [KNCT (2011)]. In 2015, two professors from NITs delivered talk in Hong Kong related to internationalization and robocon competition. Large number of students and academic staff are benefited from these talks.

In November 2013, IVE Engineering Discipline and KNIT jointly organized the 3rd International Symposium of Technology for Sustainability (ISTS) in Hong Kong. ISTS is a student level international symposium and it provides a good platform for IVE and NIT students to present their applied research work. Keynote speech and workshop to share Hong Kong and Japan education system were also conducted in the symposium. This joint effort event enhances the collaboration between two partners, particular for cultural exchange between the administrative staff.

Good Practices Sharing

In order to develop sustainable and growing up relationship, the following good practices are shared. [Jonathan Lee (2013)] [Lee (2014)]

(1) Commitment from the management.

The management should provide opportunity for staff to build up network with overseas partners such as funding support to attend conference, symposium and visit etc. Agreement to sign MOU is an important indicator to commit exchange partnership.

(2) Objective for internationalization.

At start, objective for internationalization should be well defined and agreed by both parties. For example, both IVE(Chai Wan) and KNIT internationalization teams aimed to foster practical and innovative engineers in global market so high concentration of technical content is arranged in each of exchange programme.

(3) Programme design and variety

Students are major stakeholders in exchange activities. Programme content is an important element to attract their participation. The key content and its variety, such as the technical content and cultural exchange activities, should change from time to time to attract the participants. This can be done by collecting feedback from students at the end of each programme. The programme design team can also invite students to be the co-opted members to design the programme content.

(4) Financial support

Budget of each exchange programmes is crucial factor to the students. Apart from funding support of the hosting institutions, the host can seek additional support from government funding and industrial donation etc.

(5) Timing for exchange programme

Different countries have different academic calendar so it is difficult to find common time slots to suit best timing between different institutions. Term break is one of good choice for short stay programmes. Regular pattern for exchange activities is recommended.

(6) Train the trainer scheme

Organising an exchange programme is not a simple and easy job. It is recommended to train up staff members

by using train the trainer scheme through organising of exchange activities.

(7) Accommodation and transportation partnership

Accommodation and transportation are essential arrangement in each exchange programme. Contract with fixed commercial partners for fast and low cost service is recommended.

Conclusions

This paper reported the development of international partnership between IVE(Chai Wan) and KNIT since 2008. Key factors for development and good practices sharing have been addressed in this paper.

Acknowledgements

The authors would like to acknowledge Vocational Training Council (VTC), Hong Kong and National Institute of Technology (NIT), Japan funding support for the exchange activities in the past years. We would also thank for Dr. Lawrence Chan from VTC, Dr. Masanao Ebata and Dr. Tsutomu Matsumoto from NIT for their kind support and advice to start up the collaboration between IVE(Chai Wan) and KNIT.

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Figure 1 Mobile Robot Path Tracking Project for Exchange Programme in Hong Kong, August 2009



Figure 2 Monodzukuri Camp in Hong Kong, August 2014



Figure 3 Students and Supervisors for the Semester Based Project in Kyushu Kosens, Japan, May 2015

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EDUCATIONAL TRAINING PROGRAM FOR THE MANUFACTURING CONTROL SYSTEM USING THE NEW TYPE OF PROGRAMMABLE LOGIC CONTROLLER SYSMACNJ

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Abstract

The Educational Training System was developed as a tool for the development of the new generation of engineers. The National Institute of Technology, Japan (hereinafter called KOSEN) and Omron Corporation (hereinafter called Omron) had collaborated and launched an innovative project in 2011. The training system presented in this paper is one driving part of the project which has been developed for the competition of the students of the KOSEN. The competition, named "Control Technology Educational Camp" (hereinafter called "Control Camp") is held once a year, conducted for a week. Six teams which consist of three students each address the problem of manufacturing technology by using control instruments such as PLC (Programmable Logic Controller), sensor, servo-motor, switch, lamp, and programmable terminal. In 2014, the 3-axis-stage and a smart camera vision system was developed as the control system for the Control Camp. The purpose of this competition is not only to overcome and resolve the challenging problem but the students also learn to cooperate, to gain a positive attitude, and to develop originality. A new type of PLC named SysmacNJ, manufactured by Omron, is utilized as the controller of the training system. It has two note-worthy functions. One of them is a high-speed processing function which can synchronize the control of servo motors and other control equipment. The other function is that the SysmacNJ can implement the controller designed by MATLAB / Simulink. This function makes it easy to implement a number of complex feedback control systems. Because of these two sophisticated functions, SysmacNJ has attracted attention from KOSEN and even private corporations recently. By using the SysmacNJ, the desired outcome of the Control Camp can be achieved effectively and substantially. The training subject in 2015 is the "Sway control". It requires the manipulation of the 3-axis-stage to replace hanging load without sway. The participating students have to create a program to manipulate the 3-axis-stage to put the items into a small moving hole as fast as possible. This requires a high-level sequence control programming skill and innovative thinking around the movement of physical objects. In this paper, the functions and usage of the training system are shown in detail, as well as introducing the specifics of the competition outline.

Keywords: *3-axis-stage, sway control, programmable logic controller, problem based learning, manufacturing technology, competition, sequence control*

Introduction

The Control Camp was started in 2011. The ultimate purpose of this competition is to inspire the students of the KOSEN to develop their ability by themselves. The Control Camp is held for one week in the summer vacation once every year. A challenging problem is presented to the participating students on the first day of the Control Camp. The students discuss the strategies to cope with the problem in the team and create programs to control the 3-axis-stage, or use sensors to detect the current states of the task. A new type of PLC named "SysmacNJ" is utilized to control the 3-axis-stage. SysmacNJ is so high-functional that many high-level practical skills are required in the Control Camp. Only one week seems to be quite a short period to enhance their capability to the practical level of the production control system. However, it has been found that some students are able to reach the point to handle the control equipment skilfully. Moreover, a few students' improving of their ability exceeds the expectation of the staff of the Control Camp consisting of a number of teachers from the KOSEN and employees from Omron. This is one of the biggest outcome of the Control Camp. We hope that the Control Camp will motivate the participating students to study hard so that KOSEN can put them out into the world as leading engineers.

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Three-axis-stage Control System

Figure 1 shows the 3-axis-stage control system developed as a pick & place educational training apparatus for the Control Camp in 2014. A vision sensor is installed at the right above the turntable. The positions of the items or the marks on the turntable can be obtained by the vision sensor. The X, Y, and Z-axis of the 3-axis-stage are at a right angle to each other and moved by AC-servo motors which are able to control the accuracy of the moving position and velocity. A chuck is installed on the Z-axis, it opens and closes by a solenoid. The turntable can be rotated by the motor installed beneath it. The motor is controlled by the inverter, and the rotation angle can be measured by the encoder which is also installed beneath the turntable. All of the control equipment, such as; AC-servo motor drivers, vision sensor, inverter, and encoder are connected to the SysmacNJ by the EtherCAT (Ethernet for Control Automation Technology). The EtherCAT is a high-speed industrial open-network and makes possible synchronized control of all of the control equipment. The control panel has pushed buttons, lamps, 7-segments LEDs, rotary switches, buzzer, etc. They can be used to input/output the signals to the 3-axis-stage, and as a state monitor.

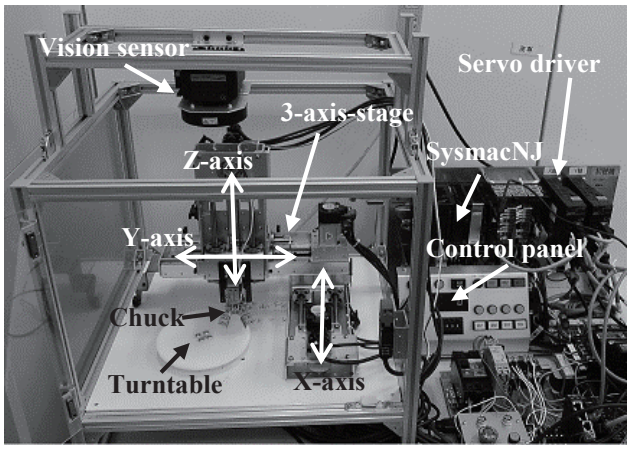


Figure 1 Three-axis-stage control system

The New Type of PLC "SysmacNJ"

The 3-axis-stage is controlled by the PLC named SysmacNJ, which has a high-speed processor released by Omron in 2011 July. PLC is one of the most essential devices for manufacturing a wide range of productions, and uncountable PLCs are applied for high-efficiency automation. The SysmacNJ might be promising to bring a fresh technology to the world of industry because it 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 at great speed. Many teachers of KOSEN began to introduce the new PLC "SysmacNJ" as an educational tool in their classes.

SysmacNJ is compliant with the International Standard "IEC61131-3", which means SysmacNJ can be utilized for globalization of the industrial system. SysmacNJ makes it possible to program not only by the ladder diagram but also by the ST (Structured Text) language. The ST language makes it easy to implement complicated calculations or even control algorithms expressed by mathematical scheme.

The program development tool is the integrated software, "Sysmac Studio". It can program to control not only SysmacNJ but also all of the peripheral equipment, such as servo motor, inverter, vision sensor, and programmable terminal. It contributes to a large reduction of production processes.

Control Technology Educational Camp

The Control technology educational camp (Control Camp) was successfully started in 2011 collaboration between Omron and KOSEN. The main purpose of the Control Camp is the development learning performance of the students through construction of the industrial production control system. The Control Camp is held for a week during every summer vacation of the KOSEN. A challenging problem is presented to the students on the first day of the Control Camp. The students discuss the strategies, how to create the program, what kind of sensor should be used, to find their original solution through uncountable trial and error attempts. Only one week seems too short to find the solution, but the students concentrate extremely hard in order to reach the incredible high level of performance.

To enter the Control Camp, students have to overcome two difficulties. One of them is the application assignment, and the other is the previous assignment.

Application assignment: The application assignment consists of basic and creative sequence control problems. The students solve the problem by using the FA (Factory Automation) control kit provided free by Omron. The submitted solutions are evaluated by the staff of the Control Camp; teachers of KOSEN and employees of Omron. Only the students who have passed the evaluation can participate in the Control Camp.

The FA kit is shown in figure 2. This is very useful when learning about basic manufacturing technology. This kit is used as the training system at the most popular seminar named "Introductory of Control Equipment" and the seminar is most frequently held by Omron. The front control panel has a power switch, four push-button switches, a selector switch of the control input signal of the conveyor belt, and three lamps. Beneath the control panel is a signal input/output terminal to connect control equipment such as PLC, timer, counter, relay, etc. Moreover, several kinds of sensors, such as the nearby sensor, the photoelectric sensor can be used to detect the item on the conveyor belt. You can study almost all of the basic sequence control of producing technology by using the FA kit. This training kit is used to learn the important production system skills in many KOSEN. It is portable with a special case to be able to bring it and conduct a class at different places.

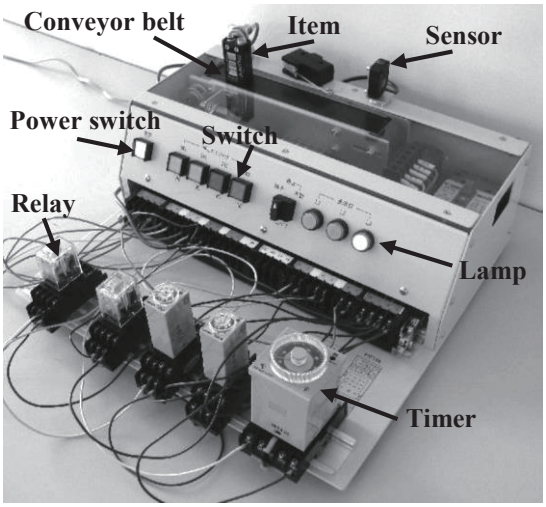


Figure 2 FA control learning kit

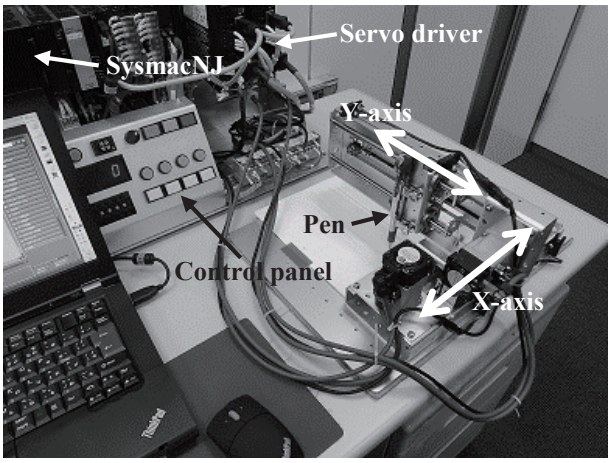


Figure 3 Two-axis-stage control system

Previous assignment: The previous assignment is for learning how to control the 2-axis-stage control system as shown in figure 3. This system was developed by Sato belonged to Sendai College with the aid of Omron in 2012. This system is widely used as a training system for teachers and students of KOSEN. X and Y-axis are the same as those of the 3-axis-stage. Students learn the fundamental setting method and programming of the servo control system as shown below:

1) Setting of the extension units of SysmacNJ and the I/O mapping
2) Basic program of sequence control (ladder diagram program)
3) Parameter setting of the servo driver (including setting by the auto tuning function)
4) Test drive of the servo motors
5) Motion control programming
6) Synchronized control of XY-axis

Method number 6 of the above list includes that students can learn the way how to control the 2-axis-stage to draw any diagram, such as triangle, circle, alphabet, and so on with the pen attached on the base plate of the Y-axis.

Challenging assignment of the Control Camp: After the study of sequence control and motion control through the application and previous assignments, students try the challenging assignment in the Control Camp. The project names in the Control Camp are always catchy that students are eager to start right away. For example;

2014: "Fortune catcher project – (mission) Develop a robot to catch a high-speed moving item by using image recognition and automatic follow-up technology!"
2015: "Sway isolation project – (mission) Develop a robot for high-speed transportation of hanging item with sway control!"

The challenging assignment using 3-axis-stage is able to apply directly as to some practical factory automation technology. It means, the participants of the Control Camp can acquire the real skill of industrial control systems.

Figure 4 shows a picture of the presentation held on the last day of the Control Camp 2014. One in the group is showing their achievement by giving the demonstration and explanation to the other students and the staff of the Control Camp. The challenging assignment was shown as per below:

1. Detect the positions of all of the items on the turntable by vision sensor.
2. There are two different size of items on the turntable. At first, pick the large items by using the chuck and move them into the large hole of the turntable which is turning at a rate of rotation, then pick and insert the other small items to the small hole.
3. Put the items in the small box prepared beneath the turntable by releasing the item when the hole of the table comes just above the box.
4. Move the 3-axis-stage as fast as possible and complete your task in a short time.



Figure 4 Presentation in the Control Camp 2014

The challenging assignments have three significant hurdles to overcome. Firstly, item position has to be detected precisely by using a vision sensor and an encoder. The encoder is installed beneath the turntable to measure the rotation angle. Secondly, the 3-axis-stage has to accelerate, move to just above of the item, and rotate at the same speed with the turntable. Thirdly, after picking up the item by chuck, the 3-axis-stage has to accelerate again, move to just above of the hole, turn with the hole at the same rotation speed, and release the item just above the small box. This motion technique can be utilized by a real manufacturing system of pick & place of items moving on a conveyor belt.

Control Camp 2015: An intelligent concept will be included in the Control Camp 2015 held in August. The concept is "Sway control". Sway control technique is applied to the case of carrying by gantry crane or overhead traveling crane in a production plant. Sway control is important for efficiency of the manufacturing process. The simplest method of the sway control is feedforward control of acceleration of the crane motion. It is easy to implement the feedforward control because it needs only the sway period. Moreover, acceleration control can be implemented on SysmacNJ easily by ST programming. It may take only a few hours to implement the sway control algorithm by the students of KOSEN. However, the sway control motion of the 3-axis-stage looks like the stage has a kind of intelligence. The performance of the 3-axis-stage at the Control Camp 2015 will be expected to bring the students a great thrill and pleasure.

Results and Discussion

Control Camp has been held five times. The total number of participating students has reached 78 and they came from 29 KOSEN. Skills and knowledge of conducting of the Control Camp have been accumulated in the organizing staff, the attraction to participate in the Control Camp is definitely increasing. However, the difficulty level is getting higher and required skill to solve the assigned work is also getting more specialized. Almost all of the submitted application assignments are great, and many participating students learned through the Control Camp not only manufacturing control system but also teamwork. They must have obtained many important experiments. But there is a possibility to narrow down the participating KOSEN to the Control Camp because the challenging assignment might be too difficult to solve for the students who had never used the SysmacNJ or even never studied about sequence control system.

In 2014, a competition named "Manufacturing Technology Contest" has been held co-hosted by Omron and Numazu College. The participating students studied very hard and achieved significant results. However, there were not any students who had completed all of the assignments.

The purpose of the Contest is to cultivate the students of KOSEN who are familiar with sequence control using SysmacNJ. The participation coverage is limited only to the KOSEN of the Tokai-Hokuriku area. There are 8 KOSEN, 21 students from 7 KOSEN participated in the Contest and assembled a team for each KOSEN. The 3-axis-stage control system shown in figure 1 was delivered to each KOSEN. The students took on some challenging assignments for about three months. On 18th of December in 2014, a presentation meeting was held in Nagoya to show their achievement.

The organizer had extremely high expectations of the participants, the assignment level was much higher than the one of the Control Camp. Just one team seemed to have their control skill reach the point of accomplishing all of the work, but the other teams could not go through the assigned works because of the shortage of time.

The Contest was successful in cultivating the ability for the operation and programming skill of the SysmacNJ, but the Contest was not sufficient to encourage the students to try another challenging problem. The authors are planning to have another Contest in 2015, but we should be considerate of the fact that the Contest assignments will not be too difficult in order to build confidence and motivate the students to try another competition.

Conclusions

The manufacturing technology cultivation project named "Control Technology Educational Camp" was a successful and well organised event. All of the students who participated in the Control Camp acquiered the professional skills to control SysmacNJ and the other control equipments. The authors' next mission is to expand the number of sequence control engineers in many KOSEN, and to continuously educate and produce world-class skilled professionals.

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FACILITATING WORKING LIFE RELEVANCE AND INDUSTRIAL COLLABORATION IN ENGINEERING EDUCATION

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Abstract

In all fields of Engineering Education, it is of major importance that students gain competences relevant for the requirements of the working life and, thus, become able to aim at successful professional careers. Reaching this goal is especially challenging in Information and Communications Technology (ICT) that develops very rapidly. Significant technologies may become obsolete and new ones emerge already during a student's study time.

In this paper, different approaches to address this challenge in Bachelor's level Engineering Education is discussed. These elements include both curricular tools, different ways of university-industry collaboration, as well as faculty competence requirements and development processes. The aim of this paper is to describe these elements embedded in the Finnish applied Engineering Education in general and in the ICT Engineering Education of Turku University of Applied Sciences (TUAS) in particular. It is also reflected how the CDIO initiative has impacted the development of these topics at TUAS.

Keywords: *CDIO, Information Technology, Project-Based Learning, Work Placement*

Introduction

The international CDIO Initiative (http://www.cdio.org) has defined three overall 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). In other words, it is of major importance that 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 related to Information and Communications Technology (ICT) that develop very rapidly. Significant technologies may become obsolete and new ones emerge already during a student's study time. How should the engineering studies be organized in order to assure that the students' competences are valid when they graduate and, on the other hand, that they are able to develop their knowledge and skills continuously?

In this paper, different approaches to address this challenge in Bachelor's level Engineering Education is discussed. These include both curricular tools, different ways of university-industry collaboration, as well as faculty competence requirements and development processes. The aim of this paper is to describe these elements embedded in the Finnish applied Engineering Education in general and in the ICT Engineering Education of Turku University of Applied Sciences (TUAS) in particular. It is also reflected how the CDIO initiative has impacted the development of these topics at TUAS.

For example, the Finnish applied Engineering Education curriculums include a mandatory work placement, and most of the Bachelor's thesis projects are based on industrial assignments. Furthermore, the TUAS ICT Engineering curriculum contains several active elements integrating real-life projects and other working-life-oriented methods from the very beginning of the studies. These experiences play a significant role in providing realistic engineering context to the students at an early phase and, thus, improving both their study motivation and competences to apply their knowledge and skills in solving complex engineering tasks. Furthermore, a mandatory competence requirement for permanent faculty members is to have at least three years of industrial experience and this connection is sustained in many ways throughout the career paths.

Degree Structure Regulations

National legislation and regulations form the fundamental structures of educational systems and provide the constraints for different engineering degree programs, too. In Finland, the higher education degrees are relatively loosely defined by the government. According to the law, the Finnish universities of applied sciences shall provide education that is based on the

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requirements and development needs of working life and its development, as well as on research, artistic and educational foundation, aiming at professional expert tasks. Furthermore, it is given that the extent of the applied Bachelor of Engineering degree is 240 European Credit Transfer System (ECTS; 60 cr = 1600 hour of study = one academic year of full time studies) credits (four full academic years), and the curriculum shall contain Basic Studies, Professional Studies, Free Choice Studies, Work Placement, and a Thesis. (FINLEX, 2014a and 2014b)

That is, the higher education institutes (HEIs) have significant degrees of freedom to decide the curricula and their implementation locally even though it is typical that many significant developments are, in practice, planned in cooperation between the HEIs and several national cooperation initiatives are organized, for example, by the Rectors' Conference (www.arene.fi) exist. Even though the HEIs can independently decide how they implement their degree programs based on the governmental constraints, their quality assurance systems and operations are regularly audited by The Finnish Education Evaluation Centre (FINEEC) that is an independent government agency responsible for the national evaluation of education (http://karvi.fi/en/). In other words, all the Finnish HEIs and their efforts to implement the national requirements are regularly evaluated to reach a mature culture of continuous development.

In addition to the overall assignment to promote working life, one of the most important elements facilitating this goal already defined in the national Act (FINLEX, 2014b) is the requirement to include a work placement period to all the degree programs. Nowadays, the extent of this mandatory work placement is not directly regulated, but a traditional minimum in the B.Eng. programs is 30 ECTS that equals to approx. five months of full time industrial work. This work placement is typically organised in two or three parts so that the requirements for the position and tasks get more advanced when the studies proceed. The students shall usually find the work placement positions by themselves although the HEIs often provide help by arranging industrial forums and contact events as well as broadcast job openings to the students.

The work placement period seems to be a very important element supporting the students' professional growth. From a practitioner's perspective, it can be stated that when a student is able to get an interesting work placement position, usually after the second academic year, it clearly affects the motivation for the last two years of study. Even if the student had been unsure about on his/her career choice and, perhaps, not been able to reach the best grades, a successful work placement experience and change the direction. Also, a typical path after a good work placement leads to part-time employment, later to a thesis project assignment, and, finally, to a full-time employment after graduation. This process provides a very well-functioning recruitment tool for the companies as well.

Curricular Solutions

The curriculum forms a basis for the degree program also from the perspective of working life relevance. As explained, the Finnish HEIs have significant degrees of freedom in designing and developing their curricula according to their best understanding. In order to support the students' working-life-oriented professional growth, it is important to include elements supporting this starting from the beginning of the studies. The international CDIO initiative encourages, for example, that an engineering program should adopt the principle that product, process, and system lifecycle development

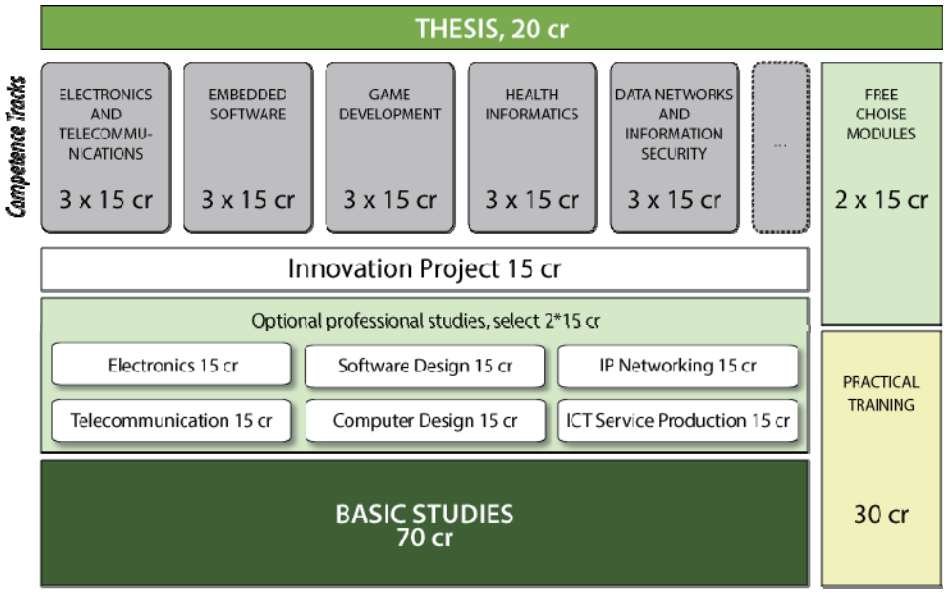


Figure 1: Curriculum structure of the B.Eng. degree program in ICT at TUAS (TUAS, 2015)

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Figure 2: Student team presenting their project (an automatic Arduino-controlled coffee maker) in the Product Development course's final exhibition day.

and deployment – Conceiving, Designing, Implementing and Operating (CDIO) – are the context for engineering education (CDIO, 2010). Naturally, this goal can be reached using many different tools an approaches. One recommendation is that the program should include two or more design-implement experiences – one at a basic level and one at a more advanced level.

The Figure 1 illustrates the most recent curriculum structure of the B.Eng. degree program in ICT at TUAS (TUAS, 2015). The curriculum includes the sections required by the national regulation and, furthermore, it aims at promoting working life relevance by implementing the CDIO principles concerning the design-build experiences. The central element in this is the Innovation Project (i.e. the CDIO Capstone course). The course extent is 15 ECTS cr thus covering one fourth of the third academic year's content. During the course, spanning over most of the academic year, the students plan and implement a complex innovation project that is usually based on an industrial assignment or aims at starting up a new business. The students work in multidisciplinary teams and develop their product, process, and system building skills, as well as the ability to apply engineering science in real-life challenges.

The Innovation Project in its current form is a rather recent development in the program's curriculum. The program has had a long tradition of project-based activities but prior to the introduction of the CDIO Capstone concept most of these projects had been run with selected volunteer students. Introducing this course in the curriculum meant that participation in the project became mandatory for all students and, accordingly, also the number of projects and required coordination rocketed. The first Innovation Project course pilot was run during the academic year 2012-2013 and it consisted of only two multidisciplinary teams of volunteer students. The main goal of the first pilot was to design and test the course structure and the project steering process model. Based on the encouraging results and experiences of these projects, an extended pilot with more students and external project assignments was started autumn 2013 in order to improve the course practices. Finally, the first round of curriculum-connected innovation projects were implemented during the academic year 2014-2015, and the next season is already being planned.

Although implementing the project course is still under development, the results have been encouraging. The students have improved their skills both in team work and engineering topics as well as developed their understanding on the professional context. The project owners (clients) have also been in most cases very satisfied and many of the results have been taken into use in a way or another. Some of these project teams have already been successful in different student technology competitions, and some students have found employment through the connections created during the projects. More information on the recent projects can be found on the website (http://capstone.dc.turkuamk.fi) of the course, and a detailed description of the development of the course has been published by Kulmala, Luimula and Roslöf (2014).

Active Learning and Teaching Methods

In addition to structural and curricular solutions, utilization of different active learning and teaching methods play and important role in facilitating working life relevance throughout the degree program. Active learning can include several different ways to engage the students' active role and responsibility in the process to depending on the context. These methods include, for example, various team work activities, project assignments, simulations, demonstrations, laboratory exercises and other interactive learning opportunities. These activities help the students to learn more and, especially, to recognize by themselves what and how they learn (CDIO, 2010).

TUAS has a long tradition in developing and applying different active learning approaches. For example, we were one of the early Finnish problem-

based learning practitioners in the engineering education context (Roslöf and Tuohi, 2005; Tuohi and Roslöf, 2007). Examples of current efforts in this field in the B.Eng. in ICT degree program include the CDIO-inspired (CDIO, 2010) introduction to engineering course offered in the very beginning of the studies, as well as the project-based learning environment "The FIRM".

Our implementation of the introduction to engineering course underlined by the CDIO Standards is called Product Development. The extent of its current version is 10 ECTS cr and, thus, it covers 2/5 of the content of the programs first autumn semester. In short, the students learn the fundamentals of industrial product development process, and basic topics in software engineering as well as computer design during the course. In addition to the topical content, it is equally important that the students get the opportunity to develop their team work skills and get introduced to a collaborative way of working. The early development phase of this course is documented by Roslöf (2008).

The practical course implementation consist of weekly themes that support the student teams (ca. 10 persons in each) to develop a new product prototype during the semester. Most of the activities happen in the teams supported by mentor teachers. The weekly themes are also guided by expert lectures on the discussed topics, and the teams produce different deliverables (reports, presentations, demos) on each theme. Finally, the course concludes on an exhibition day in December when the teams present their solutions to their fellow students, teachers, and industrial representatives. A snapshot form the course exhibition is presented in Figure 2.

Another example on utilization of active learning methods and environments is the TUAS ICT project office called "The FIRM". The FIRM operates like a small company providing support services and development projects to both university internal and external customers. The FIRM has a responsible teacher who mentors the operations and is responsible for both defining the learning objectives together with the students, and assessing the students' performance. The FIRM has an internal organization that consists of students. The student manager is responsible for general administration, staffing and selling activities, student project managers run their assignments, and different technical student staff members focus on implementing their tasks. The learning happens in a real-life context when working with the customer projects and solving practical challenges connected to them. The students can take certain mandatory courses working in The FIRM, or complete their free choice studies there. It is also possible to focus a major part of the advanced studies on these activities (as a student manager or a senior expert, for example) and specialize in IT service business topics. The FIRM's learning environment simulates a typical ICT company, too (see Figure 3).

Faculty Competence Development

In order to sustain good working life relevance in any field of education, the faculty competence is an element that shall not be forgotten. In any university, the typical, and clearly very important, way to develop the faculty competence and, accordingly, to keep the educational contents updated is to exercise versatile Research, Development and Innovation (RDI) activities. This is the case at TUAS as well. There are numerous RDI projects running simultaneously, and most of the faculty members are active in the projects that deal with state-of-the-art topics.

Yet, as the role of the universities of applied sciences is to provide highest professionally-focus education, there should be also other elements that support the faculty members' competence profiles and development especially from the industrial perspective. An important tool to reach this goal is that all faculty members that teach professional disciplines in the Finnish universities of applied sciences must have at least three years of field relevant industrial experience before they can get a permanent teaching position at the

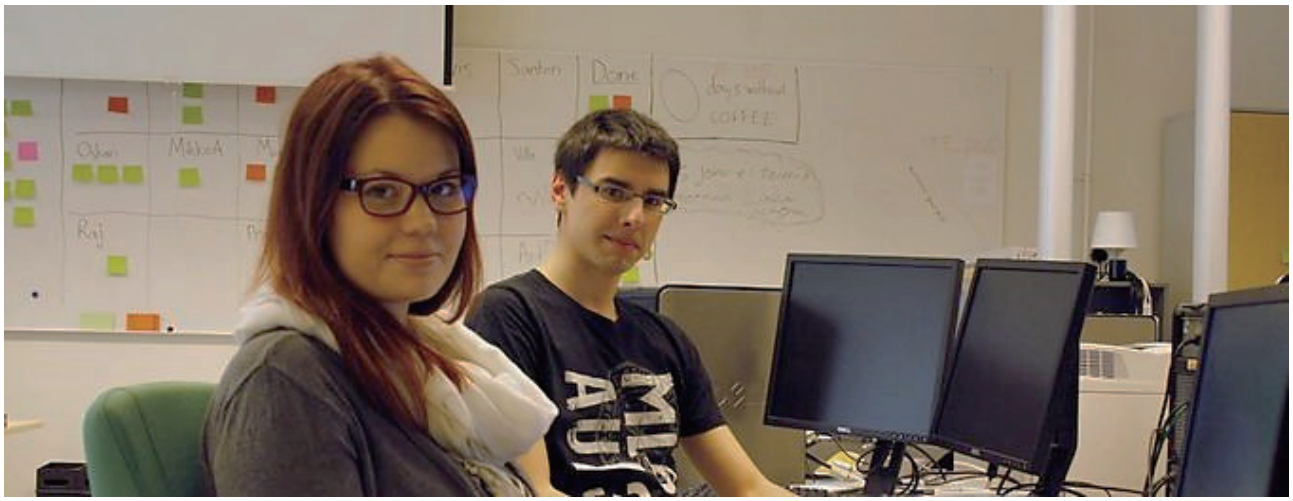


Figure 3: Students learn new knowledge and skills in a company-like learning environment The FIRM (photo: TUAS Communication Unit).

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university. In practice, many faculty members have a significantly longer industrial background, and this is also one important issue evaluated when recruiting new staff. In other words, most of the faculty members are not only performing applied RDI activities but have made industrial careers, gained practical skills, and built professional networks already before joining the university.

Yet, the working life practices and processes develop rapidly especially in the fields connected to ICT and its applications. Despite a solid industrial background, it is beneficial to update one's knowledge in a deeper way than "just" participating in RDI projects or other industrial joint ventures. Unfortunately, there is no automatic system for sabbatical periods enabling to spend time in the industry in Finland, but these type of arrangements are supported if the teacher is able to find a fixed-term industrial opportunity. For example, one of our principal lecturers spent a full year working in the R&D department of an international software vendor recently. There has also been separately funded projects that have enabled visits to different companies and other organizations typically for 1-2 months. An example of this is the InnoHealth project that aimed at developing education and faculty competence especially in the topics in health informatics. During the project 18 health care lecturers and 10 engineering lecturers had the opportunity to collaborate with different organizations connected to the field, including spending a period working at the organization. The results of the project were very positive from both the faculty members' and the industrial partners' perspectives (Kontio, Lakanmaa, and Kontio, 2015).

Industrial Collaboration

In addition to the already presented elements facilitating working life relevance and industrial collaboration, there are, of course, many other ways, too. For example, all the TUAS units have Industrial Advisory Boards whose role is to support the unit in developing their operations and degree programs especially considering the topics relevant for the working life needs of the region. Also the ICT Unit has an Advisory Board that currently has 12 members representing different types of ICT enterprises and organizations. The board meets typically three or four times a year to discuss, for instance, the future development of the curriculum and different opportunities for new joint RDI projects.

Yet, it is important to remember also the "smaller" everyday activities that are important to the students' overall experience and provide opportunities to learn. Both the organization's formal partnerships and the faculty members' personal networks make it possible to offer real-life project assignments and interesting work placement positions to the students. An important tradition is as well the fact that most of the TUAS engineering thesis projects are made based on industrial assignments although it is, naturally, also possible to complete the thesis in the university's RDI projects, or select a topic connected to a new company start-up.

Conclusions

In this paper, several different approaches to maintain and develop the working life relevance and industrial collaboration in Bachelor's level Engineering Education was discussed. These elements were both disucssed in general, and providing specific practival examples connected to the B.Eng. degree program in ICT at TUAS.

In order to be able to provide the students proper means to pursue succesfull professional engineering careers, it is important that the theoretical content is coupled with practical assingments and real-life engineering context from the very beginning of the studies. Sharing these best practices in the international engineering education community and learning from each other is a significant way to ensure that this can be reached also in the future.

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INDUSTRY BASED PROJECT For WATER RECLAMATION And WATER RESOURCES TECHNOLOGY MODULES

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Abstract

Learning in the polytechnic is to prepare students for their future work environment. In the traditional classroom-based learning, students study the core knowledge without contextualizing their learning in the real world context and may not have the opportunity to develop non-discipline related skills and workplace competencies such as communication, management, teamwork, problem solving & creative thinking, which are all valued by employers.

In order to better prepare students for their work environment, it is essential that they are provided with authentic "real-world" situations and problems for them to "practice" their skills and be more employment-ready. To do so, collaboration with Industry is essential.

Collaboration with industry brings "authenticity" to classroom learning as industry partners are able to share real-life problems they face in the industry and allow for students who have little practical experience to develop a sense of the issues that they will face in future. This collaboration can also lead to more authentic learning experience where students are given the opportunities to participate in projects with the industry partners where students learn from both academic & vocational teaching. Through this partnership with the industry, students not only gain work experience, but also get a better understanding of industry expectations and skills required which would better prepare them for their future employment.

The Water Reclamation Technology (WRT) and Water Resources Technology (WRTG) modules in the School of Design & Environment in Ngee Ann Polytechnic are two modules that leverage on their close links with the industry to allow students to have an authentic learning experience. The modules require students to work through authentic real-world issues provided by the industry partners using the 4-stage PBL framework; meeting the problems, problem analysis and learning issues, discovery and reporting, and presentation and evaluation.

Students' reflections and survey responses were used to evaluate their learning experience. These showed that that more students moderately agree that industry based project help them to develop project management (75%) and critical thinking skills (56.25). About 43.75% of students strongly agree on the impact that working on industry based projects has on teamwork, and written communication skills. They returned a 'moderately agree' rating for the impact on their development of problem-solving skills.

This paper presents the alignment, design, execution, assessment and evaluation of such industry based projects for students.

Keywords: *industry-based project, real life problem, authentic problem, problem solving skill, critical thinking skill, project management skill*

Introduction

Providing students with an authentic learning experience has always been a challenge for educators as the confines of traditional classroom settings do not allow for many opportunities for students to interact with the real world. As part of the learning experience in NP, lectures strive to overcome this issue by bringing industry partners in to ensure that students' learning is contextualized in the real-world environment. In the findings by Dabbagh and Cecily (2010), students revealed that while learning through authentic problems, they had opportunities to apply their knowledge & skills and also link theory to practice. Olga, Anna and Robin (2010), also documented that authentic problems in curriculum promote higher levels of cognitive development, hence enabling them to function in a complex environment.

Collaboration with industry also allows for a curriculum that facilitates theory and occupation-based learning simultaneously. Projects and problems that originate from Industry bring the element of "reality" to students and prepare them for the real work environment. It resembles the real situations that students might face in future in their work place (Rouvrais et al., 2006; Bergami, 2008, Olga, Anna & Robin, 2010). Learning to know and learning to do are inseparable, but the latter is more linked to the work readiness (Schiewer, 2013; Gharehbaghi, 2015).

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At Ngee Ann Polytechnic, Water Reclamation Technology (WRT) and Water Resources Technology (WRTG) modules are offered respectively to third year and second year students of the Diploma in Sustainable Urban & Design Engineering. One of the diploma objectives is to develop communication, management skills, teamwork, acquire problem solving, creative thinking skills as well as cultivate an aptitude for lifelong learning. Thus, to fulfil the course objective industry partners were identified and consulted to tailor real-life and authentic problems for these two modules. Many of the problems identified by the industry are open ended, allowing for students to explore different ways in which they can solve them. These problems are presented to the students using the Problem Based Learning (PBL) approach as the teaching team has identified this pedagogy as being most suited to develop the learning objectives of the modules and the professional skills that they want to develop.

Materials and Methods

Industry partners in the field of sustainable technologies and environmental engineering were identified and consulted to tailor the real-life and authentic problems. The 4-stage PBL cycle framework; meeting the problem, problem analysis and learning issues, discovery and reporting, presentation and evaluation (Tan, 2003) was used.

This framework best fits the objective of an industry-based project (Saed, 2015) which are developing skills, attributes and competencies mainly transversal (communication, management skills, & teamwork) and technical (problem solving & creative thinking skills) in a cross-disciplinary context (Rouvrais et al., 2006). Furthermore, the PBL framework facilitates critical thinking in students, while providing opportunities to discover, question, observe and analyse information (Jonassen and Hung, 2008; Chua, Tan and Liu, 2014).

Stage 1 – Meeting the problems – A Collaborative process with Industry

A summary of activities and area of developed competencies in this stage are presented in Table 1.

At the first meeting with industry partners; Building Research Institute of Housing and Development Board, (HDB) and Ecosoft Pte Ltd, module documents containing course objectives, module objectives, syllabus and synopsis were shared. Furthermore, the objectives of collaboration with them in terms of students' skills, attributes and competencies development were explained. Subsequently, problem statements were developed in collaboration with the Industry. Problems tailored by HDB were structured for the WRTG students where the students were required to investigate the influence of floating wetland and mangrove on water quality within the study site which is a 4 km stretch of Punggol Waterway with eight designated study stations.

Table 1. Activities and competencies for stage one

Activity 1.1 Students form groups, conduct meetings and brainstorm sessions. **Competencies that are developed** Team work Management Oral communication
Activity 1.2 Students identify main concepts and elements of the problem. They understand the facts behind the problem such that they generate ideas that may lead to most likely acceptable solutions for the problem. **Competencies that are developed** Problem solving Critical thinking
Activity 1.3 Students submit the preliminary project proposal to school facilitator & industry partner. **Competencies that are developed** Written communication Management

As for collaboration with Ecosoft Pte Ltd, the problem is less structured. The site and scope of the problem was not as well defined. Students taking the WRT module may make a request to visit any plant nursery farm and look into the issues raised by the owner in terms of managing their water resources and wastewater.

One of the advantages about collaboration with industry partners such as these is that, regardless of being structured or less structured, different learners were able to engage with the problem in their own preferred ways. In other words, regardless of their academic strengths, students were able to demonstrate their capabilities in the non-context areas.

Stage 2 - Problem analysis & learning issues

The activities and the area of competencies developed in this stage are presented in Table 2.

WRTG students working on HDB problem are expected to plan and prepare for their field work (water sampling at Punggol Waterway) independently. This includes preparing for their laboratory work which will take place immediately after they return from the field work where they will need to test the quality of the water samples collected. The main deliverables at this stage include a water sampling plan and preparation check list for field work, and an experimental plan and check list for the subsequent laboratory work. The field work and water sampling for HDB is conducted monthly. Students schedule themselves in such a way that each group will get to conduct field work at least once during the semester. They subsequently inform the lecturer about their overall plan including field and laboratory works.

Table 2. Activities and competencies for stage 2

Activity 2.1 Students apply what they have leaned; the technical knowledge and concepts and then make connection between them and the problem. They recommend hypotheses prior articulating the problem statement and they establish objectives. They choose methodology and procedures. **Competencies that are developed** Oral communication Team work Problem solving Critical thinking
Activity 2.2 They assign individual tasks to each member. **Competencies that are developed** Management Team work

For the WRT project in collaboration with Ecosoft Pte Ltd, each group of students will need to visits a plant nursery to find out what are the issues face before they can propose a solution. Making appointments, communicating and explaining about the intent of the site visit to the plant nursery owner are carried out independently by students. Prior to their site visit, they deliberate among themselves as to what kind of data they need to collect, what kind of questions they need to ask and what to look out for so that they can determine what further actions can be taken. The main deliverables at this stage are a clear survey plan, a questionnaire and data collection methods for their site visit.

Stage 3 - Discovery and reporting

The activities and the area of competencies developed in this stage are presented in Table 3.

Table 3. Activities and competencies for stage 3

Activity 3.1 Students share their findings within their group. They ask questions from each other and clarify their doubt. They need to convince and challenge each other. **Competencies that are developed** Oral communication Team work Critical thinking Problem solving
Activity 3.2 As a result team will have a collective understanding of the problem and solution to it. They document it in the format of technical reports. **Competencies that are developed** Management Written communication

For HDB project, WRTG students will have to conduct field and laboratory work. In addition to testing the water quality of the sampling stations, they are also to observe and record everything at the sampling stations that might eventually point them to reasons and justifications of their testing results.

Students are expected to synthesize the information based on their observations and correlate them with their laboratory findings. They are then expected to be able to explain and justify their observations. In addition, each group of student is expected to compare and contrast their own results with previous groups that have conducted their water sampling in the previous month. They must justify and relate the differences (if any) between their results and those recorded by other groups.

For the WRT students, with the information collected from the plant nursery, they are required to make recommendations, to help improve the water and wastewater management at the nursery. A key consideration for their recommendation is to reduce environmental pollution while keeping the cost low.

Stage 4 - Presentation & evaluation

The activities and the area of competencies developed in this stage are presented in Table 4.

Table 4. Activities and competencies for stage 4

Activity The group articulates their evaluation to lecturer and peers. The presentation will include reasons, evidence and supporting documents contributing to the solutions and evaluation. The main objective of the presentation is to justify their findings and to convince the lecturer. There will be feedback and Q&A session and groups need to response. **Competencies that are developed** Oral communication Team work Critical thinking Problem solving Management

Both projects were graded based on how well students carried out their project planning and management, and field work. In addition, students were required to submit a written report. For WRT module, evidences of data analysis and discussion, correct identification of the issues, relevancy of the information collected at the site visit, practicality and relevancy of the recommended solution were critically assessed. In the case of WRTG module, experimental and laboratory skills were assessed too in addition to those mentioned for WRT.

The feedback as well as the "question & answer" , from peers and lecturers are very important in this stage. They must be open ended, such that they

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encourage the students to develop deeper understanding, make connections, and recognize the limits of their knowledge and application skills, while facilitating students' development as problem solvers and their achievement of module objectives (Rodgers et al., 2015). Question like "*How many different alternative solutions did you consider before finalizing your decision*" are highly recommended (Olga, Anna & Robin, 2010).

Results and Discussion

Students's reflections and the Module Experience Survey (MES) findings were used to evaulate the effectiveness of the industry based project in the water technology modules. In addition a survey was also created and students's responses were sought to indicate if the industry based project had helped them to develop the following skills: (1) teamwork; (2) project management; (3) problem solving; (4) critical thinking; and (5) written communication.

Results of the survey are presented in Figure 1. An equal percentage of students (43.75%) strongly agree and moderately agree that the industry based project helped them to develop their teamwork skills while 12.50% agreed. The same pattern of responce was observed for written commhnication skills.

For critical thinking skill development 31.25% strongly agreed, 56.25% moderately agreed followed by 12.50% who agreed on the role of the industry based project. Only 6.25% and 18.75% agreed and strongly agreed, respectively on their project management skills developement, while the majority (75%) moderately agreed. About 31.25% strongly agreed, 43.75% moderately agreed, and 25% agreed that the indutry based project had contributed in developing their problem solving skill development.

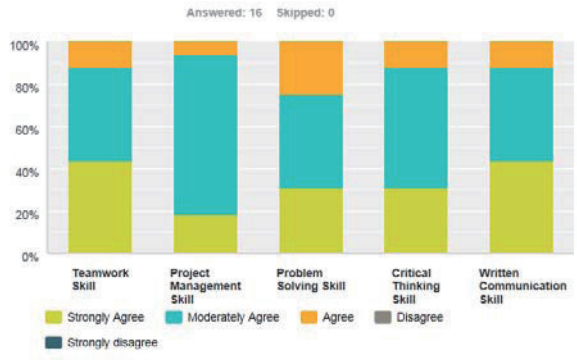


Figure 1. Overall results of the survey

The effectiveness of this industry collaboration was also triangulated through students' reflections and comments on the experience via a survey on the industry based project and a polytechnic-wide survey that tracks students' learning experience in NP, the MES. A selection of the reflections and comments are reproduced below:

- *…give us a chance to apply them…*
- *...At the end of the day, for true learning and understanding to occur, experience is King.*
- *…like the lab tests and field work…*
- *Hence we are glad and thankful to have been able to bring home many practical and useful knowledge*
- *…simulated the things learned...& we experienced ...*
- *…good balance between theory and hands-on experiences built on the concepts learnt during lectures through projects collaborated with…*
- *...project collaborated with the industry is important especially when there is a need to know what the common practices are…*
- *...for giving us this opportunity to gain many wonderful and valuable learning experiences on-site throughout the entire project…*
- *Overall, this visit is a very enriching and fruitful experience for us. We saw some of the measures used by the industry, and gained a deeper appreciation for good water management. Such learning experiences are rare and cannot be taught in the classroom*
- *This project has also given us an opportunity to grow and refine our skills in conducting research and interview. We are truly thankful for this wonderful opportunity and we look forward to more of such meaningful projects in the future*

Conclusion

In general, the results showed that indutry based projects are perceived by students as helping to develop students professional competencies that are needed for their future workplace. It is therefore important for schools to actively make and maintain such connections and collaborations with industry as partners in developing graduate skills and employability.

Acknowledgements

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How can outbound student exchange benefit students' learning in Vocational Education and Training (VET)

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Abstract

The purpose of the paper is to propose a new VET module which includes outbound exchange activities for students to go outside Hong Kong to learn and experience in a global environment, and understand the global development of a specific trade as well as sharing its good practices so that students are able to think locally, nationally and globally in their respective academic disciplines.

Keywords: *outbound exchange, trade-specific activities, learning outcomes, intercultural competence*

Introduction

Hong Kong is an externally-oriented economy [1]. For the last decade, the status of Hong Kong being an international hub of financial services, trade and shipping has been enhanced. Hong Kong's leading role in providing various services over the world, especially in Asia-Pacific Region such as financial services, supports for international trades and professional services etc. has been strengthened over the past decade. In this regard, it is necessary to prepare all graduates to be able to work in a global environment.

VTC is the largest organization in Hong Kong which provides comprehensive vocational education and training (VET) to meet the needs of industry and to produce well-educated and well-trained manpower to support the industries in the global market [2]. VTC has been continuously reviewing the VET programs to meet the changing needs of the current and future knowledge and skills requirements of the workforce. One of the initiatives is the internationalization of VTC's products and services in which the outbound student exchanges certainly benefit our students' learning and enable them to understand more of their respective trades.

In fact, the outbound student exchange is one of the means to achieve internationalization of the curriculum which is the incorporation of an international and intercultural dimension into the content of the curriculum as well as the teaching and learning arrangements and support services of a program of study [3]. Through the outbound activities, students in a global environment can be inspired that they can learn different ways of doing things and different ways of thinking.

Survey of Outbound Student Exchanges

A survey was conducted with over 1,300 VTC students who had participated in outbound student exchange programs in the past academic year to see how satisfied they were with the learning experiences outside Hong Kong. The activities were organized by various disciplines with the support of International Development Office.

Results

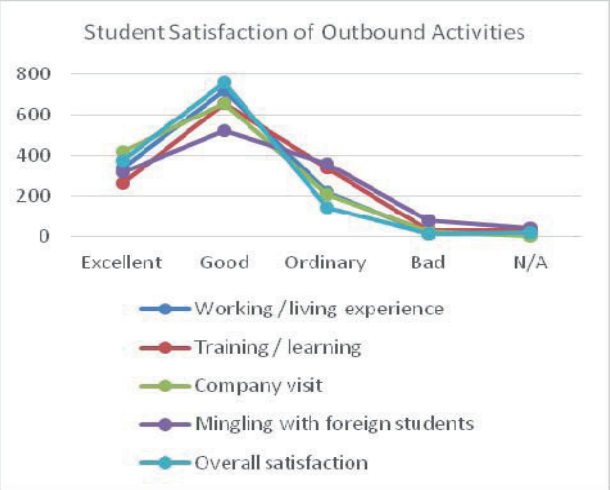
The results are shown in the following Table 1 and Figure 1.

Table 1: Overall assessment of outbound exchange activities by students

	Satisfaction	Excellent	Good	Ordinary (Average)	Bad	N/A	Total
1	Working / living experience	339	717	218	13	18	1305
2	Training / learning	262	653	335	27	28	1305
3	Company visits	418	653	207	25	2	1305
4	Mingling with foreign students	313	518	359	77	38	1305
5	Overall satisfaction	372	759	141	16	17	1305

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Figure 1: The graph of the above survey – student feedback on outbound activities



From the survey, it was found that over 85% of the students were very satisfied with the outbound exchange activities for learning outside Hong Kong. Through the outbound activities, it is believed that students' learning interests in the VET subjects can be enhanced and their understanding of the global development of the trade can be fostered. It is also expected that students taking part in these outbound activities can expand their social network.

Proposal

It is suggested a module with 26 curriculum hours is designed. Apart from the basic VET knowledge, the international elements like enriching the professional development, increasing multicultural competence, and contributing to the globalization of trade experiences are also incorporated in the module. The module should have learning outcomes, learning contents, teaching strategies and an assessment plan. The learning contents of the module may consist of three parts:

(1) general discipline-related information about the trades and the relevant cultures (6 hours);
(2) outbound activities for trade-specific knowledge, skills and attitudes (16 hours); and
(3) student reflection (4 hours).

For Part (1), a standard general package is prepared by International Development Office for the country the students are arranged to go to. This part should be delivered before departure so that students can have an overview contexts of the related trades, the society as well as and cultures of the country.

For Part (2), the learning contents, which are prepared by the academic staff of the program board, are specific to the trade with various activities to be conducted in the visiting country on a 5-day trip such as visits, workshops, exchange activities and sharing sessions etc according to the learning outcomes of the module. The learning contents should include trade-specific international and intercultural knowledge, skills and professional attitudes. The outbound activities can

(i) arouse students' learning interest;
(ii) allow students to understand the VET subject from an international perspective; and
(iii) foster long-lasting memories for students.

For Part 3, it includes reflection on the impact and outcomes of teaching and assessment practices on student learning. Each student is required to submit a reflection report after returning from the outbound activity to illustrate what he/she has learnt in the module.

Proposed Module

A module with 26 curriculum hours which includes the outbound activities is proposed in Table 2. The learning contents of the module consists of three parts: (1) general information and cultures; (2) trade-specific knowledge, skills and attitudes; (3) student reflection. The assessment plan is shown in Table 3.

Table 2: Learning Contents and Curriculum Hours

Note: * the report should include the things that students have learnt in outbound exchange program.

	Part	Learning Contents	Teaching Strategies and Delivery	Curriculum Hour
1	General information about the related trades and relevant cultures	Trade history; Culture, economy and education; Pre-departure briefing and logistical support	Lecture; Briefing; Conducted before departure	6
2	Trade-specific activities and exchange	Overview of trade; Market & business model; Strategies; Implementation; Problem solving; Professional attitudes	Visit to companies and institutions outside Hong Kong; Experience sharing instead of knowledge transfer; Exchange with students etc.	16
3	Student reflection	Good practice sharing; Impact on difference; Evaluation	Report* writing; presentation after returning	4

Table 3: Assessment Plan

Continuous Assessment (CA)	50%
End of Module Assessment (EA)	50%
Total	100%

The module should be approved by the validation panel in which external members from trade and internal staff from other than the same program board will meet to challenge the proposed module. The program / module board concerned should respond to the comments in the validation meeting accordingly.

Discussion

Benefits

There are many benefits of a validated module which includes outbound student exchanges. For instance, apart from broadening students' exposures, what students learn in trade-specific outbound activities is recognized. Furthermore, the outbound program can be organized with stringent teaching strategies and assessment plan. Lastly, it encourages closer collaboration with the partner institutions.

However, a student exchange program itself though embedding international elements does not have any learning outcomes, teaching strategy and assessment plan. Therefore, what the students learn in the outbound exchange programs can never be recognized by the program board concerned and is merely treated as extra-curricular activities which allow student to broaden their general exposure only. A module with outbound activities can benefit students' learning.

Drawbacks

There is also a cost implication in organizing outbound activities.

Furthermore, not every module is suitable to arrange outbound activities and it depends on the nature of module which shall not be too academic. The most suitable modules for outbound exchange are those allowing students to interact with overseas students and/or industrial practitioners, to understand different modes of business or system operating in different situations, as well as getting an overview of the related trades over the world.

It is sometimes difficult to get control of the expected outcomes of the third parties like visiting companies, the ones who make sharing, or traffic congestion etc.

The core work involved in the module contents must be done by academic staff of program boards. As there are many variables in conducting outbound activities, the module should be critically reviewed annually to improve the module such as reflection on the impact, outcomes of teaching, assessment practices on students' learning, a review of contents and pedagogy, and logistical arrangements etc.

Conclusions

It is more effective to internationalize students to get a global understanding of the trade and development of intercultural competence by a structured VET module with international elements embedded rather than just by a student outbound program. Furthermore, having a structured VET module which includes outbound components can ensure that every student of the module has at least an opportunity to learn and experience outside Hong Kong in the respective academic discipline. Furthermore, since all students are assessed according to the learning outcomes, what they have learnt will be recognized by the program board.

Recommendations

It is recommended that more international elements like in-depth outbound exchange activities can be added to the curriculum. As the outbound activities involve substantial logistical arrangements, support services from the International Development Office (IDO) other than the academic departments should be guaranteed. Besides, Internet-based tools such as Online International Learning (OIL) Project [4] can be used to help link students from different places and facilitate more engagements between them before and / or after conducting the outbound activities.

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International Exchange and Study Cooperation in Ulaanbaatar, Mongolia

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Abstract

As part of activity of "The training of the practical and creative engineer by the cooperation of KOSEN, Company and Asia" adopted by Cooperation program by Nine National Colleges of Technology in Kyushu-Okinawa region Japan, we carried out the students interchange of the Kyushu KOSEN and the Mongolian University of Science and Technology "MUST" in Ulaanbaatar, Mongolia at August, 2014. The participation number of students of KOSEN was eight students, 7 students form Miyakonojo and one student from Kumamoto. One of the students of Kyushu KOSEN participated in served as overseas internship. He carried out a research about "study on the apartment complex district in Ulaanbaatar, Mongolia" that Miyakonojo KOSEN cooperates with MUST. The students who belong to Dept. of Architecture and Dept. of Language that specialty is Japanese, participated from MUST. In addition, two Mongolian students who belonged to Japanese KOSEN (Miyakonojo KOSEN and Toyota KOSEN) also participated.

The students interchange were aimed for improvement of the communicative competence using English and understanding of the different culture through the interchange. Students of Kyushu KOSEN observed the University, city area and suburbs from Ulaanbaatar by the guidance of Mongolian students, thereby both Japanese and Mongolian students deepened interchange. Through it, they were able to understand sudden urban development of Ulaanbaatar and living environment and lifestyle of local people. In addition, Japanese students explained one's local culture that lives, Life in KOSEN, One's study theme and more by presentation in English.

The most Japanese side students had never been to foreign country before this time, they feels difficult to communication by the English conversation, shopping, taking the meal at the restaurant, use means of transportation and more. Japan and Mongolia are not countries of the English zone each other, however, they acted for communicate with one another simply because they were put in such situation. Therefore they were able to develop more practical communicative competence. It may be said that these are the ability that is essential to play an active part globally. At the same time, we think that contribute to upbringing of the talented person who receives different culture, and can live together.

Keywords: *Mongolia, Interchange of students, Understand different culture, Communication, International collaboration, Practical and creative engineer*

1. Introduction

National Institute of Technology, Miyakonojo College (MNCT) concluded an academic interchange agreement with Mongolian University of Science and Technology (MUST) in 1995, thereafter two schools perform interchange, the collaborative investigation of exchange, the staff of a school and the student of the academic document and information each other. The interchange of MUST and MNCT began from the activity that several staff of a school of MNCT "gave a light" for using a wind-power generator for Mongolian nomadic herders. Mongolia depended on the Soviet Union for many supplies after World War II, but the Soviet Union collapsed in 1993, and Mongolia was not able to import supplies. The nomadic herders had the generator to use the gasoline for, but they ran life with the help of a candle because they did not have money to buy gasoline. The group of six staff of a school of MNCT thought to use the wind more than an average of 2.5 meters for wind-generated electricity in Mongolia through the year. The staff of MNCT thought about nomadic herders. 1) low cost, 2)maintenance to be cheap and to be possible, 3)easy to carrying (movement), 4) field available for relatively simple 5) eco-friendly. The staff of MNCT established "the meeting which gave Mongolia wind-generated electricity" and worked on the development of the wind-power generator. Three staff of MNCT went to Mongolia in the same year. They installed three wind-power generators and performed a situation investigation into velocity of the wind in Mongolia and an investigation into situation of other energy. They developed a new type of wind-power

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generator which could generate electricity from an about wind speed of 1 meter per second and acquired the patent afterwards. The activity that they gave a wind-power generator for became the big topic in Mongolia.

In the future, MUST is for maintenance and development of wind power generator, it is necessary to provider of various information of Mongolia. And because MUST have worked on the development of small wind power generator, you MUST was determined exchange with our school. Feeling of the academic interchange increased in both schools, and, in 1995, MUST concluded arts and sciences interchange agreement with MNCT. In addition, various private interchange spread between Miyakonojo and Ulaanbaatar citizens, and State of Mongolia Ulaanbaatar City and Miyakonojo City will conclude the pledge of the friendship interchange city in November, 1999.

Since MUST and MNCT promote cooperation and the interchange of the education of both schools and the study. In addition, MNCT participates in member of overseas technical training acceptance business of Miyazaki, and MNCT accepts 14 members of Mongolian training to date from 1996. The MUST architecture subject and MNCT architecture subject concluded a study tie-up in December, 2013. In MUST and MNCT, interchange (exchange) of a student, the staff of a school, collaborative promotion, seminar and participation, the research activities to a meeting and exchange of the information about the publication, the economical support about research activities recommend the interchange of a researcher and the student through the educational study-like mutual help of both engines. Is adopted in August, 2014 by "Cooperation program by Nine National Colleges of Technology in Kyushu-Okinawa region, Japan" (9 KOSEN project) in "The training of the practical and creative engineer by the cooperation of KOSEN, Company and Asia", Kagoshima, Okinawa, four people including the principal of 3 technical colleges of Miyakonojo made a voyage to Mongolia and concluded a memorandum about the arts and sciences interchange with Mongolian Institute of Technology with 9 technical colleges. In addition, as part of this business, two times overseas internship (in Aug. 2013 and Aug. 2014) and student alternating current (in Aug. 2014) in MUST were held on in Ulaanbaatar city.

In this paper, we report to contents and the result of the student interchange program in MUST performed in August, 2014.

2. The Student Exchange in Mongolia University of Science and Technology

The scale everything spreads across a national frame on a global scale and not only, to modern people living in international interdependence relations, each one merely understands international relations and cultures, but also notices the responsibility as the member of the global community, and it is necessary to be still more strongly conscious of a point how lives. An individual has a viewpoint called the many culture symbiosis based on the mutual understanding and establishes self as a member of the global community beyond the national frame and sends it, and it is independent, and the talented person who can act is demanded. Japanese Government pushes forward acceptance in a university and the society of the foreign student to bring up the talented person that globalization and the Japanese of the Japanese university can play an active part in the world. On the other hand, in late years the number of Japanese students studying in the overseas university decreases. (Fig. 1.)

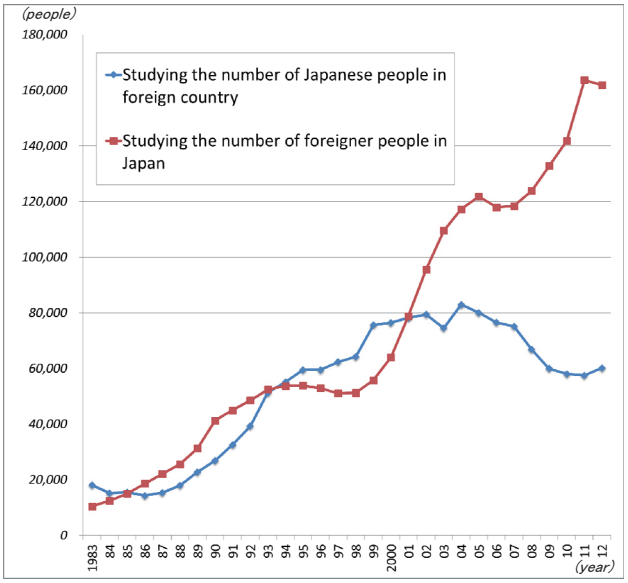


Fig. 1. Changes in study abroad's number

While a talented person having imagination to be able to produce new value, ability, besides, to send own thought to positively in the global community is demanded without remaining only in linguistic ability in the global community; by 9 KOSEN project in "The training of the practical and creative engineer by the cooperation of KOSEN, Company and Asia". They activate the interchange with the higher education system of Asian countries through the overseas training in the training of the creative engineer and strengthen the relations with Asian countries, and even the development of the acceptance company of the overseas internship or internship in Japan of the foreign student build a collaborative relationship.

As part of this 9 KOSEN project, performed the student alternating current of MUST student and technical college student in Mongolia Ulan Bator in the period of from 2 to 7 on August in 2014. The participation number of students of KOSEN was eight students, 7 students form Miyakonojo (included 4 people from chemical engineering and 3 people from architect) and one student from Kumamoto (from control and information system engineering). In addition, one person served as overseas internship in MUST (Department of Architecture, Gonchigbat laboratory) and MNCT (Department of Architecture, Sugimoto laboratory) performed the investigation of "Study on the Apartment Complex District in Ulaanbaatar, Mongolia". The students who belong to Dept. of Architecture and Dept. of Language that specialty is Japanese, participated from MUST. In

addition, two Mongolian students who belonged to Japanese KOSEN (Miyakonojo KOSEN and Toyota KOSEN) also participated. Through it, they were able to understand sudden urban development of Ulaanbaatar and living environment and lifestyle of local people. KOSEN Students visited the university and the city center, outskirts of the city by the guide of Mongolian students. Among them they were the exchanges.

2.1. The 1st Day (2, Aug. 2014)

In the morning, we inspected MUST. We held an opening ceremony with the I.Gonchigbat professor of the department of architecture and students who participated in student interchange. In addition, we made arrangements about a schedule of the student interchange and city area investigation. After that, We inspected Mineral Museum in MUST and learned about the mining industry that is main industry of Mongolia and the mineral resources with the professor of the department of geology mineral.

In the afternoon, we inspected city area and MUST (Student dormitories) with Mongolian students, and we received explanation about the student life and summary of each department. (Fig. 2.)

2.2. The 2nd Day (3, Aug. 2014)

In the second day, we performed a visit to city with MUST students, KOSEN students and exchange student of NIT. In the morning, we inspected Zaisan Tolgoi Hill. (Fig. 3.) We could see the whole Ulaanbaatar city area from Zaisan Tolgoi Hill. (Fig. 4.) We were realize the social problem of latest year Mongolia, there were the situation of the air pollution of Ulaanbaatar and the situation of construction rush. In the next place, we inspected Gandan temple where is the most famous Tibetan temperature. We received explanation about Mongolian history by MUST students.

In the afternoon, we were divided into architecture team and environmental team (facility tour). Architecture team investigated facilities distribution and design survey of Ulaanbaatar city area. (Fig. 5.) This investigation is collaborated it in Sugimoto laboratory (MNCT, Department of Architecture) and Gonchigbat laboratory (MUST, Department of Architecture).

Environmental team was inspected Chinggis Khan palace in Ulaanbaatar suburbs. It restored the palace which existed of Chinggis Khan. They learned about the style of the Mongolian historic building and they performed a quality of the water investigation by the viewing.

At night, KOSEN students and MUST students held party at the hotel. (Fig. 6.) We ate many Mongolian food. KOSEN students gave presentation about “My home town (tradition and culture”, ”My school life at the KOSEN”, “My investigation” to MUST students. After presentation, there was a lot of question from MUST students. It found that MUST students has a high interest to Japanese culture and student life of KOSEN. Other, we played the origami using Chiyogami of Japan, favorite music and comics, fashion, their hobbies, etc., and tried to exchange a student seems to topic.



Fig. 2. State of the Department of the description



Fig. 3. At the inspected Zaisan Torugoi Hill



Fig. 4. View of Zaisan Torugoi Hill



Fig. 5. State of Ulaanbaatar city investigation



Fig. 6. State of presentation

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2.3. The 3rd Day (4, Aug. 2014)

The third day, acted and divided from the morning to the architecture team and the Environmental team (company visits). Architecture team was investigating the facility distribution of radius 500 meters area around the surveyed Apartment complex and design survey. Investigation was the cooperation of the interpreters to Mongolian students belonging to KOSEN. Is it looked state of construction rush and undeveloped roads from investigation. Environmental team inspected the famous Mongolian cashmere factory. They visited all the steps in the guide of the employees who have experience studying in Japan. From inspection, many of the steps is not a robot, it was found that it is performed manually. In addition, since female employees are large, it was found that higher social advancement of the Mongolian women. (Fig. 7)



Fig. 7. State of description in the GOBI cashmere

2.4. The 4th Day (5, Aug. 2014)

Fourth day was training in Ulaanbaatar suburbs (Terelj). Moving to the suburbs from Ulaanbaatar city, it was possible to see the vast grassland. From the fact that the development of the road is progressing in Ulaanbaatar suburbs, we felt Mongolia's economic development. We inspected the Chinggis Khan Image (museum) and Turtle Rock (Fig. 8.) to move the middle.

This day was staying in tourist ger camp, it was to experience riding in grassland. While feeling nature and magnificent history of Mongolia and we can have experience to the traditional life of Mongolia in the ger. (Fig. 9.)

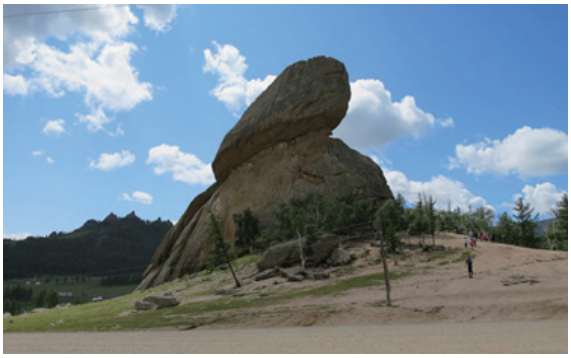


Fig. 8. Turtle Rock



Fig. 9. State of Horse Riding experience

2.5. The 5th Day (6, Aug. 2014)

In the morning it was moved from the Ulaanbaatar suburbs to Ulaanbatar city. There were a lot of settled ger district in Ulaanbaatar suburbs. Air pollution has become a problem in Ulaanbaatar city by the smoke that is discharged from the settled ger district (Fig. 10.) of stove. In addition, because the infrastructure it is underdeveloped, it was seen status quo is progressing water pollution and soil pollution.

In the afternoon, architecture team visited the JICA to the interviews. From the hearing, it was possible to learn about the situation and urban planning projects of the current Ulaanbaatar.



Fig. 10. Ger District of Ulaanbaatar Suburbs

2.6. The 6th Day (The Last Day: 7, Aug. 2014)

The last day, we were a free action date of the student only. Takes the communication between KOSEN and MUST students, it was decided to schedule. After that, we went to city tourism. We saw the cultural and historical ones that the Mongolian ethnic costumes, Emperor Weapons, bugs and tools such as using in Mongolian National Museum.

We received a guide in English in Choijinrama temple. Mongolian students, I was technical college students both questions a lot in English. In addition, department of Architecture students of the NIT has description in the MUST students about the differences between Japanese temple. We were watching the traditional arts of Mongolia in the National Theater. While taking the communication among students



Fig. 11. At the National Theater

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MUST-KOSEN, it was possible to exchange information on the history and culture of another country. (Fig. 11.)

3. Conclusions

This time was done "The student exchange in Mongolia, Ulaanbaatar" and "Overseas internship in MUST". Through learning, experience and exchange in Mongolia, there was a scene that confused the situation of different lifestyle, culture and the city in Japan. The most Japanese side students had never been to foreign country before this time, they feel difficult to communication by the English conversation, shopping, taking the meal at the restaurant, use means of transportation and more. Japan and Mongolia are not countries of the English zone each other, however, they acted for communicate with one another simply because they were put in such situation. Therefore they were able to develop more practical communicative competence. It may be said that these are the ability that is essential to play an active part globally. At the same time, we think that contribute to upbringing of the talented person who receives different culture, and can live together. This time, students participated in the interviews of international collaborative research and local institutions. As a result, the students were feeling the society of the research you are doing of their own. This resulted in a positive impact on the commitment for subsequent studies. In addition, after completing the student exchange, student exchange with the help of communication tools (SNS, etc.) it has been continued. This exchanges it is considered to have contributed not a little to the development of students with a global perspective. It is planned that second round of "The student exchange in Mongolia, Ulaanbaatar" is carried out in 2015. These activities are not only temporarily performed, it is important to continue to develop into ongoing activities. In the future, how to not only ensure the continuity of project, it is important to carry out the evaluation and post-verification of international exchange. Then, the problem is that students and teachers to share information, we will conduct a more effective project.

Acknowledgements

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INDUSTRIAL INTERNSHIP PROGRAMME: PERCEPTIONS OF POLYTECHNIC ENGINEERING STUDENTS

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Abstract

This study aims to investigate student perceptions of internship programme at a polytechnic in Singapore, and attempts to determine the factors that predict overall internship satisfaction. A total of 339 final Year engineering students participated in the survey upon completion of their internship programme. Overall, the students rated their perceptions and satisfaction of their internship programme positively. The four internship factors, namely, perceived performance, perceived usefulness, pre-internship preparation and internship support by workplace supervisors and lecturers showed positive and significant correlations with each other. The findings established that perceived usefulness of internship and internship support by workplace supervisor and lecturer had significant effects on overall internship satisfaction. The findings have important practical implications for lecturers and school administrators in providing positive internship experience for students.

Keywords: *Internship; perceptions; industrial attachment; polytechnics; engineering*

Introduction

In recent decades, professional engineering bodies dedicated to education and accreditation all over the world have emphasised that engineering curricula needs to have both training in problem solving and soft skills in order to achieve competencies for engineering practice (Grimson, 2002; Goel, 2006). Internship programme or industrial attachment plays a key role in achieving some of these competencies. While the exact nature of each programme may differ according to the aims and objectives set by the respective learning institutions, all internship programmes are mainly developed to provide opportunities to students to experience and gain practical knowledge in authentic professional environments before they graduate. Learning institutions attempt to merge students' learning gained in campus-based environment with real-work environment (Brennan & Little, 1996; Hughes, 1998; Johnson, 2000) through internship programmes.

Participation in internships is also regarded as increasing the employability of the students when they graduate. The employment market not only demands graduates who have a high level of academic knowledge, but also requires those who demonstrate core competencies critical for job success in the work environment (Binks, 1996; Johnson, 2000; Okay & Sahin, 2010). Some of these competencies such as working in teams, presenting orally and problem-solving skills can enhance graduate employability (Mason et al., 2009) in the job market. Thus, through internship placements, students have the opportunities to develop these much needed skills while pursuing their academic qualifications in the learning institutions (Semedo, Newman-Ford, Lloyd, & Thomas, 2010; Young, 1995).

While the benefits of an internship programme are manifold and well documented in the literature; internship programmes have to be constantly evaluated to ascertain their effectiveness as to whether the students actually benefit from their internship experiences. At the same time, it is important to understand the factors that influence student satisfaction towards internship so that timely interventions by the school can be implemented, if needed. Although there is a plethora of studies in the literature on student internship from various disciplines, literature on internship in Singapore, especially in the engineering discipline in higher education, is limited. Therefore, the significance of this study is to fill this gap in the literature by investigating the perceptions and satisfaction of engineering students towards internship programme in a polytechnic in Singapore.

Literature Review

In Singapore, the establishment of SkillsFuture Council in 2014 (Ministry of Education, November 2014), a national initiative, is focusing on developing an integrated system of education, training and career progression; promoting industry support for individuals to develop work-skills, and foster a culture of lifelong learning in the workforce. Hence, there is an increased interest to enhance the internship programmes at Polytechnics and the Institutes of Technical Education (ITEs) in Singapore in order to strengthen students' applied learning at the workplace (Ministry of Education, February 2015). Today, most employers realised and accepted that the training of engineers is

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not the sole responsibility of the learning institution but a shared responsibility with industry partners. Training aims to change trainees' performance through improved knowledge, skills, and attitude (Hoque & Usami, 2007).

A study conducted by Renganathan, Amri, and Su Li (2011) on students' perceptions of industrial programme offered by a private technological university in Malaysia showed that the engineering students rated their industrial internship programme favourably. Generally, students viewed the learning through practical experience during the internship positively. In addition, factors related to the schools' operational and administrative efforts and the roles played by the host company were also identified as important in determining the success of the industrial internship programme.

In another study on public relations interns by Daugherty (2011), it was found that there was a mismatch in expectations between the employers and students. Busby, Brunt, and Baber (1997) found that hospitality students were satisfied with their internship, especially in the areas of technical skills and knowledge which improved during internship. In the study by Emenheiser, Clayton, and Tas (1997), a majority of the respondents were satisfied with their internship, and stated that it strengthened their problem-solving ability in the hospitality industry. On the flip side, Taylor (1988) suggested that poor supervision was the most likely condition that led to dissatisfaction with internships. Nelson (1994) stated that repetitious work with little freedom to apply and test knowledge along with the high risk that accompanies inadequate or untimely feedback would relate to dissatisfaction with supervision. It is also evident in the study that hospitality interns reported greater satisfaction when they have a supportive relationship in the work setting. Fagenson (1989) indicated that mentor relationships provide invaluable benefits for students on internship programme.

Research Questions

Based on the above literature review, the following research questions were formulated and guided the data analysis in the study:

(a) What are the reported levels of student perceptions and satisfaction of the engineering internship programme?
(b) Explore whether there are any relationships among the internship factors?
(c) What are the internship factors that predict students' overall satisfaction with internship?

Methods

Sample

The sample for this study consisted of 339 School of Engineering students in their final year of study at the polytechnic, and having completed their internship during the first semester of Year 3. Out of the total students who participated in the study, 243 (71.7%) were males and 96 (28.3%) were females. The median age of the sample was 21 years.

Instrument

A 14-item questionnaire employed in the study was designed based on the pre, during and post-internship experience by the students. The students were asked to evaluate each item on a 5-point Likert scale, ranging from 1 being "Never" and 5 being "Always". A single measure of overall satisfaction with internship programme was also included in the questionnaire, using the similar 5-point Likert scale.

Ethics

Ethics approval for the research was sought from, and granted by the polytechnic ethics review committee. Students participating in the survey were assured of anonymity and all individual data were de-identified in the data set for analysis.

Results and Discussion

Descriptive statistics consisting of mean and standard deviation for the individual items in the administered questionnaire are found in Appendix A. The mean perception ratings of all items ranged between 3.88 and 4.56, greater than the mid-point of 3.00 on the 5-point Likert scale. This result indicated an overall positive response to the constructs that were measured in the study. The standard deviation (SD) of all the items ranged between 0.66 and 0.85, indicating a narrow spread around the mean scores.

The lowest mean rating for "interview training session" (M = 3.88, SD = 0.85) suggested that students perceived this to be area that could be further improved. On the other hand, students rated their ability to accomplish the tasks the highest (M = 4.56, SD = 0.66). The overall satisfaction of students with internship experience had a fairly high mean of 4.35, with a standard deviation of 0.83.

The collected data was subjected to an exploratory factor analysis. A principal components factor analysis of the 13 items using varimax rotation, with Kaiser Normalization was conducted. The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.93, above the recommended value of 0.6, and Bartlett's test of sphericity was significant (χ^2 (78) = 3527.90, $p<0.01$), confirmed the factorability of the data. The result of the factor analysis yielded four factors which explained 81.03% of the total variance. The four internship factors were identified as perceived performance, perceived usefulness, pre-internship preparation and internship support by workplace supervisor and lecturer. Next, a confirmatory factor analysis based on the 4-factor model using fit indices (χ^2/df=2.07, CFI=0.98, TLI=0.98, GFI=0.92, RMSEA=0.056) was computed, and the result showed a good model fit based on the data.

Descriptive statistics, reliabilities and correlations among the four internship factors are shown in Table 1. Cronbach's alphas of the four internship factors were found to be ranging between 0.77 and 0.94, indicating high internal consistency reliabilities.

Table 1: Descriptive statistics, reliabilities and correlations among study variables (N= 339)

	Factors	Descriptive Statistics		Cronbach's Alpha	Correlation			
		Mean (M)	SD		(1)	(2)	(3)	(4)
(1)	Perceived performance	4.42	0.60	0.91	–	0.75**	0.45**	0.76**
(2)	Perceived usefulness	4.47	0.66	0.94		–	0.44**	0.75**
(3)	Pre-internship preparation	3.93	0.79	0.88			–	0.43**
(4)	Internship support	4.41	0.71	0.77				–
	Overall internship satisfaction	4.35	0.83					

Note: ** $p < 0.01$.

All the four internship factors had mean ratings above 3.00, ranging from 3.93 to 4.47. The pre-internship preparation factor had the lowest rating (M = 3.93, SD = 0.79) and it consisted of two items on "interview training" (M=3.88, SD=0.85) and "resume training" (M=3.99, SD=0.82). The rating suggested that students wanted more in terms of trainings that better prepare them for internship. The resume writing and interviewing skills are seen to have a positive influence on how well the students performed during the interviews, and whether the students would be hired by the company that they desired to work for.

The pre-internship preparation assumes importance to the students because it sets the expectations for the internship programme as it helps to prepare the students by providing them with the relevant trainings and information before they work in the industry. Thus, besides training students in resume writing and interviewing skills, students also need to be aware of the objectives of the internship so that they will view the internships as an opportunity to learn and apply the knowledge they gain in their classrooms. At the same time, students need to be prepared adequately in order to cope with the challenges and demands of the work. In essence, pre-internship preparation aims to manage student expectations of the internship programme.

Table 1 also shows the correlations among the 4 internship factors. The result showed that all the four internship factors were positively and significantly correlated with each other, ranging from 0.43 to 0.76 ($p<0.01$). The perceived performance was highly correlated with internship support by workplace supervisor and lecturer ($r=0.76$, $p < 0.01$). One plausible reason is that student interns felt that they could perform better during the internship when there are strong supports from the supervisor and the lecturer. The roles of the internship supervisor and lecturer are critical as they not only provide technical and supervision to the interns, but also emotional support to the students, especially those students who are working in the industry for the first time. In the School of Engineering, the lecturers are encouraged to visit the student interns at least three times during the internship programme to discuss and understand any problems or issues the students would face as well as to monitor their progress during the internship. This also serves as an avenue for the students to seek help and guidance from their lecturers face-to-face, in addition to other means of communication such as telephones calls, text messaging and emails.

Table 2: Results of multiple regression analysis (N= 339)

	Dependent variable: Satisfaction with internship experience				
Independent variables	**B**	**SE**	***β***	***t*-value**	**Sig.**
Perceived performance	-0.08	0.08	-0.06	-1.01	0.31
Perceived usefulness	0.90	0.07	0.72	13.53**	0.00
Pre-internship preparation	0.05	0.04	0.05	1.34	0.18
Internship support	0.17	0.06	0.14	2.62*	0.01
$F(4, 334)$	163.60				
R^2	0.66				
Adjusted R^2	0.66				

Note: ** $p<.01$; * $p<0.05$

In order to determine which factors predict the students' overall internship satisfaction, a multiple regression was performed using student overall satisfaction as a dependent variable and the four internship factors as independent variables (see Table 2). A significant model ($F(4, 334) = 163.30$, $p<0.001$) predicted 66.0% of the sample outcome variance. It was found that among the four internship factors, perceived usefulness of internship ($\beta=0.72$, $t=13.53$, $p<0.01$) and internship support by workplace supervisor and lecturer ($\beta=0.14$, $t=2.618$, $p<0.05$) were significantly associated with overall internship satisfaction. As noted earlier, the support system provided by the school lecturer and workplace supervisor is critical because it helps in providing the much needed emotional support to the interns; the interns know that they can share and discuss the challenges they faced in the new work environment. This support system reassures the student interns, and thus could have contributed to a positive effect on their overall satisfaction.

The percieved usefulness of internship was a strong predictor of the overall satisfaction. Students valued the learning experience considerably, and the knowledge and skills they acquired while doing meaningful jobs in their internship. The internship helped students to understand the expectations of an employee at the workplace and also the need to adapt and respond positively to unplanned changes at work. Overall, the internship prepared the students for work readiness in the industry. Hence, all these perceptions of internship usefulness contributed to students' overall satisfaction of internship, and students will gain more confidence in their abilities to adapt and succeed in the workplace after they graduated from the polytechnic.

Conclusion

This study is an attempt to investigate the student perceptions of internship experience, and to determine the factors that contribute to overall student satisfaction with interenship programme. Overall, the findings suggested that the students have positive perceptions and satisfaction about their internship programmes. The four factors, namely the perceived student performance, perceived usefulness of the internship, pre-internship preparation and internship support by workplace supervisor and lecturer are positively correlated with each other. The perceived usefulness and internship support by the workplace supervisor and the lecturer had a significant effect on the overall internship satisfaction.

The study findings provided important practical implications for school educators and administrators when evaluating the internship curriculum. As stated earlier, there is an opportunity to further enhance the pre-internship training so that students are better prepared in terms of knowing the expectations and objectives of the internship programme. The support system provided by both the polytechnic lecturer and workplace supervisor is critical for the success of the internship programme. Thus, both the supervisor and the lecturer needs to reorient and made aware of the internship curriculum so that they are able to meet the demands and requirements of the internship programme effectively. Finally, students value the learning experience and the knowledge and skills they had acquired during the internship programme.

Based on the findings of the study, some key recommendations that could enhance the internship programme for the polytechnic students are:

(a) Communicate the objectives and expectations of the internship programme clearly to the students during pre-internship preparation briefing;
(b) Reinforce to the lecturers and workplace supervisors that they are assuming the roles of mentors or coaches to the student interns by providing internship support and helping them develop the skills at the workplace; and

(c) Review the diploma curricula to ensure the relevance and currency of classroom learnings can be integrated and applied at the workplace by the students during their internships.

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Appendix A. Descriptive statistics of questionnaire items

	Items	***Mean (M)***	***SD***
Factor 1: Pre-internship preparation			
1	The resume training session conducted by my school has equipped me with useful knowledge for effective resume writing.	3.99	0.82
2	The interview training session conducted by my school has equipped me with useful knowledge on effective interviewing skill.	3.88	0.85
Factor 2: Perceived student performance			
3	I was able to accomplish the assigned tasks.	4.56	0.66
4	I was able to identify issues and solve them effectively.	4.32	0.69
5	I was able to communicate (both verbal and written) effectively with others.	4.36	0.72
6	I was able to take initiative and offered assistance to others.	4.39	0.73
7	I was able to work with others and contributed well as a team player.	4.45	0.70
Factor 3: Internship support by workplace supervisor and lecturer			
8	I received adequate supervision and guidance from my company supervisor and colleagues.	4.43	0.78
9	I can approach my school liaison officer for assistance if I encounter any issue with my internship.	4.39	0.79
Factor 4: Perceived usefulness of the internship			
10	I have gained useful work and learning experience from this internship.	4.54	0.71
11	The internship has helped me understand the expectations of an employee at the workplace.	4.51	0.70
12	The internship has prepared me for the working world.	4.42	0.75
13	The internship has helped me understand the need to adapt and respond positively to unplanned changes at work.	4.43	0.73
14	Overall, I am satisfied with the internship experience.	4.35	0.83

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INTERNSHIP EXPERIENCES IN MECHANICAL ENGINEERING AND CIVIL ENGINEERING FIELDS OF HELSINKI MUAS

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Abstract

In Finnish education system for technical fields the co-operation with industrial companies has been emphasized very powerfully during the last 10 years. The Civil engineering (CE) department of Helsinki Metropolia University of Applied Sciences (HMUAS) started their internship projects in 1996 and Mechanical engineering (ME) department in 2004. Internship is a core of CDIO activities in the curriculum of production technology studies at HMUAS. In the poster we will introduce the different development steps of internship from the very beginning up to these days when the routines are tested and the co-operative teaching and learning is in power. We will show examples of different project works, many enjoyable results of the students working and studying together with industrial specialists. Our purpose is to show how fruitful and encouraging the internship as a way of studying technology can be. We will emphasize the importance of good preparations before the start of internship and we will teach our way and methodology to get successful results for each counterpart. For a large number of students internship has been the road to be recruited after graduation by industrial companies which know them well already. It has been an easy way of joining the project groups of already well-known co-workers. Today every student of technology will make a joint innovation project of 10 credit points (ECTS) within a project where the subject is given by a company outside the university campus. Many times student's graduation thesis work (15 ECTS) is a continuity of earlier works made for the company. When starting the working life the student is well prepared for the challenges of work. Time needed for starting to be effective and productive will be shortened. We strongly suggest this development for wider and deeper co-operation between educational institutions and the industrial, commercial and other working life companies.

Keywords: *Internship, co-operation, CDIO, PBL, learning by doing, motivation*

Introduction

There is an increasing need to educate engineers who are ready to start effectively working after the graduation. They should have some experience about the practices of their own fields like for instance the operations of a metalworking factory. Well-organized internship periods during the studies has made this possible.

We have an all-time need for excellent partnerships between educational institutions and the industrial companies.

Systematic co-operation with the civil engineering related companies was started in 1996 and 2004 respectively in metalworking production engineering. HMUAS staff members, mostly the teachers, have good connections to the companies of their own fields. Many times teachers have been working in those companies before joining HMUAS.

There is a variety of small development work as well as everyday operational advancements to be made where the company staff does not have time to do them. Students are a very suitable capacity to be used in this kind of projects. It is a win-win situation for all counterparts.

The CDIO Approach in HMUAS

Helsinki Metropolia University of Applied Sciences (HMUAS) is the largest University of Applied Sciences in Finland. HMUAS 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. 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

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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 thesis project.

Orientation project: 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.

Innovation project: 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.

Thesis project: 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.

Internship in Bachelor of Civil Engineering (CE) Studies

During 4 years (8 semesters) curriculum a student must earn 240 ECTS, 60 ECTS a year. The first 1.5 years are 'general studies', 2nd, 3rd and 4th year he/she is studying professional subjects.

CE department has been *a pioneer in CDIO*. It had run CDIO already some 15 years when HMUAS started the innovation projects in every curriculum in 2010. The model was taken from the internship structures of CE department.

Types of internship in CE department

First year

- safety in Civil Engineering
  - companies present their fields and give safety devices to students for free (safety shoes, helmets, glasses, vests)
  - companies take the students to building sites and present their organization
- October seminar (Figure 1) - the objectives of the seminar are:
  - to assist the students to select the correct option of specialisation:
    - Construction and Site Management, Environmental Construction, Structural Engineering
  - to promote the students to get contact with the companies and prepare the way for traineeship
- students are training in companies at the end of spring term (for 5-10 ECTS)

Second year

- (Again October seminar for those who haven´t selected their specialization)
- students are training in companies at the end of spring term (for 5-10 ECTS)

Third year

- Innovation project (10 ECTS) - the goal of the project work is to familiarise students with a practical study programme, where the background knowledge given is adapted to a practical task defined by a company, and directed by both HMUAS staff and the company:
  - students get confronted with new challenges and the co-operative project work environment,
  - students learn project work methods and reporting, including the important responsibilities within group works.
- students are training in companies at the end of spring term (for 5-10 ECTS)

Fourth year

- final thesis work (15 ECTS) is carried out in companies



Figure 1: CE department students in October seminar selecting internship company

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During the first 3 years after 1996 CE department was collecting experience to find the best practices for the structures of internship. At that time companies were asked mainly to give subjects and guidance for students. They didn't invest into these operations. After the department started to ask the companies a small amount of money the companies took it more seriously and started to invest and put capacity to the guidance and instructions of students.

Now every company takes at least two students to make a project and pays 2000 € per project (1000 € per student) to CE department.

Internship in Bachelor of Mechanical Engineering (ME) Studies

In ME department there is one practically oriented study curriculum called **production technology**, which is educating engineers who are able to manage and develop the whole metalworking factory. From now on we are discussing how the internship has been organized for the students of production technology.

There are three different ways of getting started:

- student has been working in a company and asks the company the opportunity to make an internship project,
- company informs the teacher about the project subjects, or
- some managers of the companies come to ME department to make presentations about the possible project subjects.

Internship arrangements today

The ME department has signed an agreement with the company and the student will sign the agreement with the company as well. Students are insured by HMUAS.

Practical start is taking place in the middle of September of the 4th year of studies. Time given for the work is 400 hours (30 ECTS). Most of this time the work is made in the company. Usually students are working 3-5 days a week in the factory and 2-0 days at school. Company provides them with necessary facilities like safety shoes, special clothes, computer and a table. Company is paying the lunch and travel costs but not a salary (student and the company can freely negotiate the salary).

Company will give an instructor for the project. The teacher of MUAS will be another instructor and he/she will visit the company a few times, usually 2 to 4 times during the internship.

The student writes a report of the internship project and presents the results of the work in the company. The report includes a diary of daily activities during the internship period which now takes the whole fall semester, about 3.5 months. Several members of the company staff and the responsible teacher of HMUAS will attend the presentation session and discuss the results. In some cases the ED of the company is also attending. The manager of this project in the company is evaluating the presentation and the written report as well as student's behaviour in the factory, attitude and other things. Final evaluation is made by the responsible teacher of HMUAS.

Companies involved

In the field of mechanical engineering there are about 50 potential companies on the list from the year 2004. Today the number of actively participating companies is 10 to 15. Most of them are medium size or small. Typically they have *own products, product development and production process* - the internship students can see and experience the core of industrial activities and functions.

Some examples of the subjects of the projects:

- realizing 5S (organizing the working place, tools and others; TPS, Toyota production system) in a section of production process
- redesigning of CIP (Continuous Improvement Process) tables
- applying of TPM (Total Productive Maintenance) for new machine tools
- checking and rewriting the work sequences of assembly work in a factory producing electrical motors
- applying LEAN ideas for better productivity
- developing logistics of a factory
- designing a tool or a device for making the production process more effective
- arranging storages in a new way
- designing layout for a new factory or a section
- developing material handling of assembly lines
- better management of product info in part manufacturing
- developing and making more effective the packing and importing of the goods
- creating a function model for the safe use of tools and devices; designing of a fixture
- etc.

Development of ME internship during the years

From the beginning of internship, in September 2004, all the 17 production technology students went to ABB Helsinki factory once a week 8 hours a day for about 3 months. Their job was to go through the instruction manuals of the assembly sequences of HX type electric machines. They were following the assembly work of different models of HX electric motors and updated the written instruction manuals. They also participated some of the assembly work.

During the first two years students attended three different internship periods starting during the fall semester of 3rd study year. Credit points for each period was 10 ECTS, totally 30 ECTS. This equals one semester studies of the 8 semester engineer degree studies. Students had an opportunity to experience three different kinds of companies. This was one of important principles of the internship.

From 2007 until 2010 in students made internship in two different companies. Today there is only one internship period during the fall semester of 4th grade studies. The earned credit points are the same 30 ECTS. Now students can work 3-5 days a week in the factories during internship period when earlier they could work only on one day weekly.

Earlier the companies had several projects and wanted to take 2 to 6 students. Now a company takes usually only one or two students to work as a small team.

Some of the companies are actively asking the students every year, some don't have a capacity to organize the instructor for the students.

Successful internship projects

Typical subjects for successful internship projects have been *LEAN, CIP, 5S, TPM, layout modifications, designing of fixtures and devices using CAD programs, etc*.

For instance the 5S of ABB Helsinki factory producing induction motors has been realized by the production technology students of HMUAS.

Many students have after graduation got full time work as engineers in the company where they have done internship (Figure 2). This is a clear indication of success. With some of the companies like ABB this is the case almost every year.

> *training -> internship -> graduation thesis -> 4 months trial time -> full time engineer of the company*

Figure 2. Training and Internship in a company have been positive steps for many students in finding a job as an engineer of the same company.

Example of failures

During the first steps of internship in fall 2004 two students of production technology entered a repair and maintenance factory. They were given a project work of organizing logistics and storages of spare parts and such in a new way.

The job was not defined in more details. There was not any active instructor for the students and they could quite freely go and come. Responsible teacher of MUAS visited the company a couple of times during the internship period. No real results of the work were reported. The company has not given any other internship work for the students of HMUAS after this case**.**

Effects on learning

Internship works are always selected to solve some problems of the production, to develop some parts of production processes functioning more effectively and so on. There is *a high motivation* built in as a real-life situation for the student and all counterparts. Usually students are much better motivated also for other studies after they have completed their internship work. So *internship gives a positive kick* for further studies.

It also gives a good opportunity for the students to show abilities in solving problems in engineering field.

Effects inside the company

Internship work subjects are usually works to be made, but the company people don't have time or capacity to do them. These students are a very good capacity for the company:

- young people having newest knowledge of theories,
- students want to show what they can do,
- company does not need to pay salary,
- the company might be able to get the student to make his final thesis work next, and
- after graduation company can hire the student as a full time worker.

What have the students learned?

We have asked the students about the arrangements, what they have learned and what do they want to learn. Here are some of their common experiences of what they have learned:

- behaving and working as a member of a team
- communication skills
- how to work in the meetings
- working independently, taking the responsibility
- working according to the given time limits
- being member of a bigger project
- I have noticed that I am on my own field
- learning new facts about production, maintenance, designing and administration
- specialists of companies are actively teaching important things about production like production control, quality, storages, maintenance, effects on environment, etc.
- learning to use computer programs in real situations
- how to modify the layout of the factory
- designing tools and devices to make the work easier and more effective
- understanding company processes better
- developing testing of large parts of products
- developing handling and logistics of large parts
- how to use different planning and designing programs

What do the students want to learn more?

- working as a manager of a section
- working more with 'papers'
- production control
- production development
- how to develop a section of production or a manufacturing cell
- controlling the machine tools
- controlling the safety

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- more information about the companies
- learn different kinds of tasks which the engineers are doing in their everyday works
- how to start using a new system
- seeing and understanding the company as a total system
- students wanted to realize internship period without any disturbances: no lectures and no school during this period but internship 5 days a week
- students would like to more independently make the decision about the company for their internship
- earlier and more detailed information about the contents of internship
- better guidance during the internship period from the company and from HMUAS !

Difficulties of internship

Many of the companies misunderstood the internship being usual training for students. So the students were working the whole 400 hours in the same position as productive members of production process.

In internship the students are meant to do many kinds of works in different situations and on different levels of the total process. They are there to learn in real-life practical situations how the functions of factory are operating.

Sometimes the company did not arrange any instructor and guidance. In early years of internship some companies did not teach the students much.
Students want to get a salary for their work. They also wanted to get better and more detailed rules concerning the internship written on the paper.

Developing internship

The last 20 years have given directions for the best practices of internship. Many production companies have taken it very positively and are using it as a way of educating new engineers for the company. Internship has become a smooth way of recruiting new people for running and developing the factories.

Some ideas of developing the internship:

- planning of the contents of internship should be made carefully between educational institutes, company specialists and the students
- companies should be informed better about the contents and opportunities of internship
- everyone should understand clearly the difference between internship and training
- all the instructors in the company should be educated for the job of giving guidance to the students
- companies should put more capacity and efforts for organizing the internship

International aspects

International student exchange programs could adapt the students into the internship works with the students of the host institute. This way foreign students can learn the ways of thinking and doing and other important working culture of the host country. The international internship will become a natural way of better understanding each other. The CDIO framework of project based learning offers a good starting point to use it in international context also.

Results and Discussion

Internship applications have caused dramatic changes in the study programs of engineering curriculums. Student's motivation for learning is seemingly better. This can be seen for instance in increasing numbers of graduations. Learning outside the classrooms in real-life situations shows to the student if he is in his own field or not. He is learning valuable skills like solving problems independently and as a member of a team, participating discussions and decision making in the meetings, etc.

Conclusions

Internship is an excellent way of organising teaching and learning today. Working with industrial companies keeps the educational institute up-to-date with the applications and solutions of new technologies.

Started in 1996 more than 1000 graduates of CE department have gone through the studies applying CDIO and internship principles. In ME department the number of production technology students who have done the internship in factories started in 2004 is about 200.

Acknowledgements

We are grateful to the large number of Finnish companies which have given opportunities to apply CDIO and internship in educating engineers of HMUAS. This is a modern and very promising road to future success for the engineering industries.

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English picture-book reading to children coupled with English extensive reading

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Abstract

In recent years, increasing numbers of Japanese colleges and universities have been introducing extensive reading programs into their English language education program. In 2013, the Ministry of Education, Sports, Science, Culture and Technology publicized the "English Education Reform Plan corresponding to Globalization" with the goal of establishing an educational environment related to globalization from elementary to lower/upper secondary education levels. By coupling English extensive reading with English picture-book reading, the author and an English Study Society (ESS) student conducted an off-campus class for a group of first to fourth grade elementary school students. We read aloud the English picture book selected from the Oxford Reading Tree series, translating it into Japanese and describing their cultural differences. For the participants to clearly see the material, the English picture book was projected on an overhead screen for the entire class. At the end of the session, the class took a quiz regarding the presented English words. Overall, we received favorable comments from the children and teachers, and the students gained confidence from the learning process. Therefore, it can be concluded that English picture-book reading to an off-campus class can play an important role in early English education and increase the motivation of extensive reading learners. Furthermore, we would like to share the findings of this study with other educational institutions.

Keywords: *English picture-book reading, English extensive reading, off-campus class, early English education, presentation skills, communication skills*

Introduction

The author has utilized extensive reading (ER) since he first read a picture book to his son at bedtime. Recently, a number of studies have been conducted about ER at many educational institutions, and early English education has now become highly publicized in Japan. Moreover, our college has established a "student-led" off-campus class that highlights the nurturing associate proficiency.

Methods

1. ER activity

Once a week, our English Study Society (ESS) performs an ER activity where one member selects the most suitable picture book for elementary school students and presents it to the class. Similarly, in the present study, a Stage 3 book from the Oxford Reading Tree series was chosen by the author after it was then read aloud to a class comprising first to fourth graders at an elementary school.

2. Off-campus class

The announcement of this off-campus class is first made by the City Board of Education to the elementary school, and then, the off-campus class is held in the school library. In addition, a projecter, screen and overhead camera are utilized to project the picture book to the entire class. **Figure 1** exhibits a typical scene of the classroom.



Figure 1. A scene of the off-campus class

Results and Discussion

During the 2014 fiscal year, a total of nine classes were held at the elementary school. The number of pupils ranged from 30 to 60 students, and each class was timed for approximately 30 minutes. Moreover, the picture book was 16 pages in length and consisted of

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less than 100 words. The examples of the feedback from grade school students are shown in **Table 1**.

Table 1. Examples of the feedback from grade school

・Thank very much you for reading an English book for us.
・I became interested in English by your reading.
・I am happy to see you. Please come to our school again.
・You provided an additional explanation in Japanese so that we could understand the story.
・I like to listen to someone reading a story. You were such a good narrator that I enjoyed myself.

Conclusion

Although the feedback was generally positive and the English picture-book reading was effective for the elementary school students, there is some difficulty continuing such an activity as a conventional club venture. Thus, it is important to find ways of motivating the club members in order to continue conducting this type of off-campus class. Finally, we would like to share both the format and the findings of this study with other educational institutions.

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FABRICATION OF DIAMOND-LIKE CARBON-BASED MICRO/NANO DEVICE USING ROOM-TEMPERATURE NANOIMPRINT BY INDUSTRY-UNIVERSITY COLLABORATIVE RESEARCH

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Abstract

The fabrication of diamond-like carbon (DLC)-dot array patterns by room-temperature curing nanoimprint lithography (RTC-NIL) method using polydimethylsiloxane (PDMS) molds as application to the DLC-based emitter used as the next generation flat panel display was investigated by industry-university collaborative research.

The DLC film which has excellent properties similar to diamond properties was used as a pattern material. A PDMS was used as a mold material.

We fabricated the PDMS mold with concave dots. Each dot is 500 nm-diameter and 300 nm-depth. We carried out the RTC-NIL using the PDMS molds under the following optimum conditions of 0.1 MPa-imprinting pressure and 1 min-holding time. We etched the residual layer with ECR trifluoromethane (CHF_3) ion shower under the optimum conditions of 300 eV-ion energy and 3 min-etching time. The imprinted hydrogen silsesquioxane (HSQ) patterns on DLC film was etched with an ECR oxygen (O_2) ion shower under the optimum conditions of 400 eV-ion energy and 10 min-etching time. As a result, we succeeded in fabricating convex DLC-dot array patterns with high accuracy which has 500 nm-diameter and 400 nm-height.

Keywords: *diamond-like carbon, room-temperature curing nanoimprint lithography, glass-like carbon, hydrogen silsesquioxane, polydimethylsiloxane mold, ion etching, industry-university collaborative esearch*

Introduction

The diamond-like carbon (DLC) exhibits unique electrical, mechanical, thermal, optical and chemical properties such as low dielectric material, high hardness, low coefficient of friction, high transmission and negative electron affinity. Because of this, it is expected to have various applications. For example, it can be used as an emitter for next generation flat panel display (FPD) and microgear for micro electro mechanical systems (MEMS). Therefore, the nanopatterning technique for DLC is essential to the fabrication of functional DLC-based micro and nano devices.

The room-temperature curing nanoimprint lithography (RTC-NIL) using polysiloxane that we developed has certain advantages, including short process, high throughput and low cost compared with conventional thermal-cycle NIL. We have already investigated the nanopatterning of diamond films in RTC-NIL using glass-like carbon (GLC) molds that we developed. However, we found that the convex DLC patterns cannot be fabricated by this process because of the use of GLC mold with convex dots. To overcome this problem, we proposed the use of polydimethylsiloxane (PDMS) mold with concave dot array patterns and also the use of ladder-type hydrogen silsesquioxane (HSQ) as RT-imprinting material which has high etching resistance to oxygen (O_2) ion shower and we can expected to be pressed under low imprinting pressure and RTC, compared with cage-type HSQ.

The fabrication of DLC-dot array patterns in RTC-NIL method using polydimethylsiloxane (PDMS) molds

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as application to the DLC-based emitter used as flat panel display was investigated by industry (ELIONIX INC., Shin-Etsu Chemical Co., Ltd. and TOKYO OHKA KOGYO CO., LTD.) - university (Toyohashi University of Technology) collaborative research.

Here we report the fabrication process of the PDMS mold with concave dots using for RTC-NIL, the optimum etching conditions of electron cyclotron resonance (ECR) CHF_3 ion shower etching to remove residual layer of HSQ and the etching selectivity of HSQ film against DLC film in ECR O_2 ion shower. Moreover, we demonstrate the fabrication of DLC-dot array patterns in RTC-NIL using PDMS molds.

Fabrication process of PDMS mold for RTC-NIL

Figure 1 shows the fabrication process of the PDMS mold with concave dots for RTC-NIL. First, The PDMS consists of main component [SIM-360, Shin-Etsu Chemical Co., Ltd] and curing agent [CAT-360, Shin-Etsu Chemical Co., Ltd.] (a). The main component and curing agent were mixing at weight ratio of 10 to 1 respectively (b). The mixed solution was stirred with spatula for 10 min (c). Next, we fabricated the GLC master mold with convex dots which has 500 nm-diameter and 700 nm-height put into mold holder (d). In addition, the mixed solution poured into mold holder (e) and then degassed with vacuum degassing apparatus [VLBR, AS ONE Corporation] and cured at room temperature for 36 h (f). The mixture released from mold holder (g), and heated with electric furnace [BMINI-1, NITTO KAGAKU Co., Ltd.] under the temperature of 150 ℃ for 15 min (h). Finally, we fabricated the PDMS mold with concave dots (i).

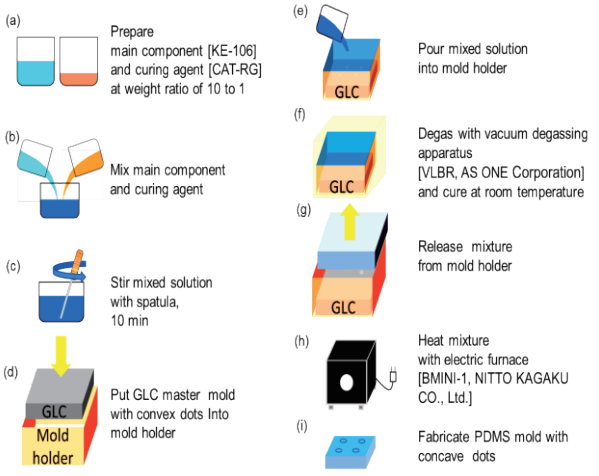


Figure 1. Fabrication process of the PDMS mold with concave dots for RTC-NIL

Nanofabrication process of DLC-dot array patterns in RTC-NIL using PDMS mold

Figure 2 shows the nanofabrication process of DLC-dot array patterns in RTC-NIL using the PDMS mold. The DLC film (ta-C: tetrahedral amorphous carbon, 500 nm-thickness, 2 nm-arithmetic average roughness *Ra*, Toyohashi University of Technology) was synthesized

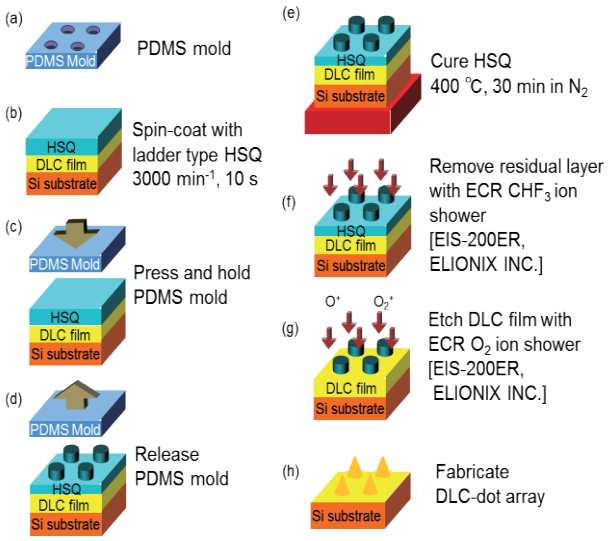


Figure 2. Nanofabrication process of DLC-dot array patterns in RTC-NIL using the PDMS mold

by T-shaped filtered arc deposition (T-FAD) method on Si substrate (10 mm-square, 0.5 mm-thickness) and was used as pattern material.

First, the DLC film deposited on Si substrate was spin coated with the ladder-type HSQ (OCNL103 T-2 20000, TOKYO OHKA KOGYO CO., LTD.) at 3000 min^{-1} for 10 s (b). The PDMS mold and a 500 nm-thickness HSQ coated substrate without curing were pressed under the following optimum imprinting conditions of 0.1 MPa-imprinting pressure and 1 min-holding time (c). Next, PDMS molds was released after curing (d). The imprinted HSQ patterns were cured at 400 ℃ for 30 min in nitrogen (N_2) atmosphere, using a hot plate (e). The samples were removed the residual layer with an ECR CHF_3 ion shower (f) and etched the DLC film with an ECR O_2 ion shower under etching conditions of high etching selectivity (g). As shown in figure 3, an ion shower apparatus with an ECR ion source (EIS-200ER, ELIONIX INC.) has various excellent characteristics such as discharge at low gas pressure, control of ion energy in the lower energy range and high ionization rate compared with a traditional Kaufman ion source. Due to an electrodeless discharge system, an ion source can produce ion shower of excellent uniformity and stability, ionize various gases and produce ion shower accelerated up to 2 kV. An ECR ion source can gain stable ion shower for long time without damage to the ion source using reactive gas like O_2. Therefore, it is suitable for reactive ion shower etching using O_2 gas which makes volatile products (CO, CO_2) chemically react with the DLC film. In this study, we carried out experiment, setting the DLC film on Si substrate within a range of the 20 mm in effective diameter. Finally, we observed the DLC-dot array patterns using the three-dimensional scanning electron microscope (3D-SEM) with four secondary electron detectors (ERA-8900FE, ELIONIX INC.) (h).

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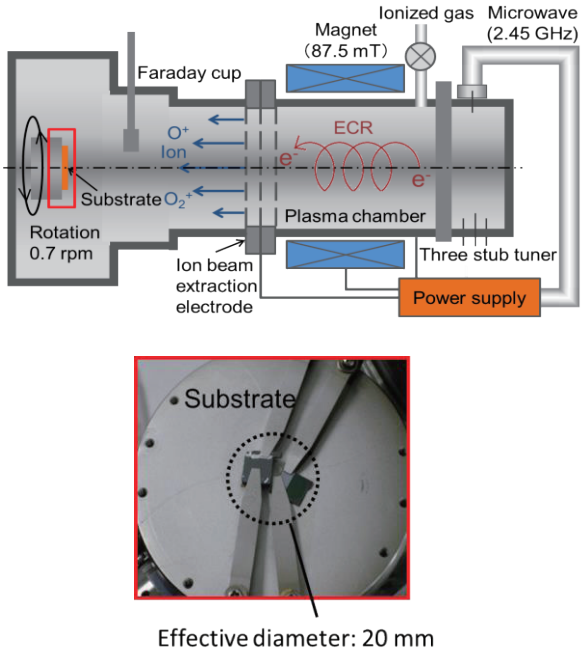


Figure 3. Schematic diagram of ion shower apparatus with an ECR ion source and the appearance of substrate holder

Etching characteristics of ECR ion shower

Figure 4 shows the dependence of the etching rate of HSQ film on CHF_3 ion energy. The etching rate increased linearly with increasing CHF_3 ion energy. As a result, we found that residual layer of HSQ can be removed with CHF_3 ion shower. The optimum etching condition to remove the residual layer was 300 eV-ion energy because of the effect of irradiation damage.

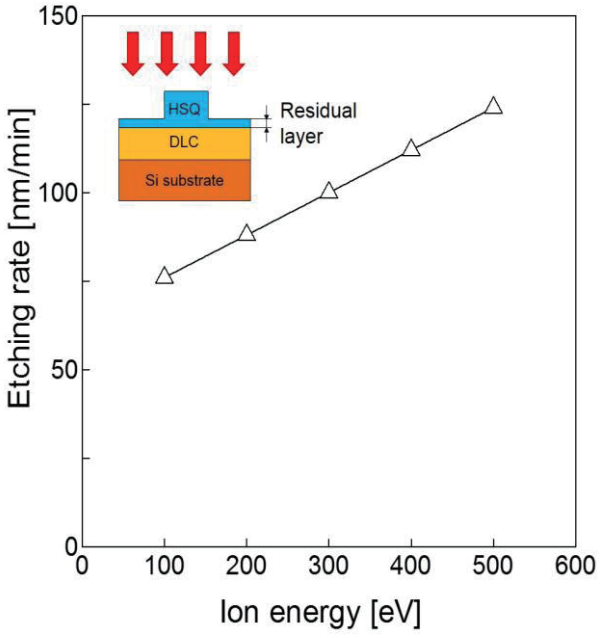


Figure 4. The dependence of the etching rate of HSQ film on CHF_3 ion energy

Figure 5 shows the dependences of the etching rate and etching selectivity on O_2 ion energy [etching rate of DLC film: ○, HSQ film: △ and etching selectivity of HSQ film against DLC film: ▲]. Each etching rate increased almost linearly with increasing of O_2 ion energy. The maximum etching selectivity of HSQ film against DLC film was as high as 5, which was obtained under condition of 400 eV-ion energy, because a chemical sputtering reaction between a DLC surface and O_2 ions that generate volatile products (CO, CO_2) exceeds physical sputtering.

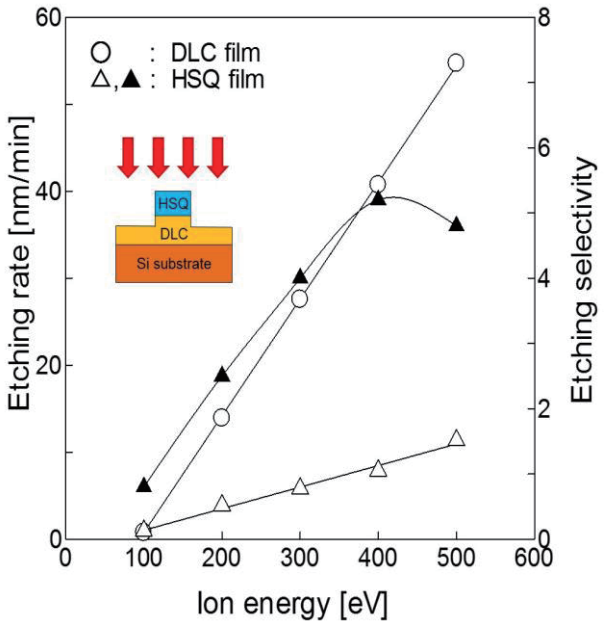
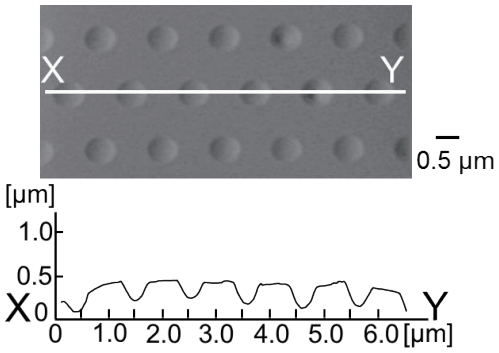


Figure 5. The dependences of the etching rate and etching selectivity on O_2 ion energy

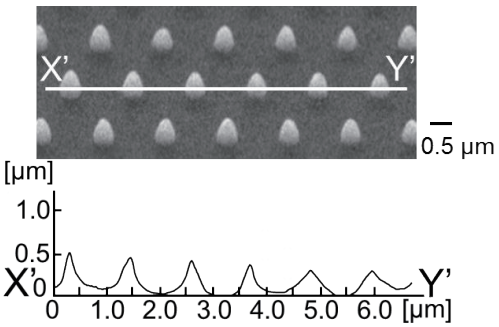
Fabrication of DLC-dot array patterns

Figure 6 (a) shows SEM image and its cross-sectional profile of PDMS molds with concave dots for RTC-NIL which have 500 nm-diameter and 300 nm-depth. We carried out RTC-NIL, and found that residual layer of imprinted HSQ pattern was 300 nm, and then removed residual layer in CHF_3 ion shower etching under conditions of 300 eV-ion energy and 3 min-etching time. Consequently, figure 6 (b) shows SEM image and its cross-sectional profile of DLC-dot array patterns after ECR O_2 ion shower etching under conditions of 400 eV-ion energy and 10 min-etching time. The resulting sharpened DLC-dot array patterns which have 500 nm-diameter and 400 nm-height with an aspect ratio of 0.8 were fabricated with high accuracy. The DLC-dot array patterns were sharpened with increasing of etching time because the etching rate of ion incident angle of slant face is faster than that of ion incident angle of plane. Here, an incident angle is defined as the angle between the surface normal and the incident ions.

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(a) PDMS molds with concave dots



(b) DLC-dot array patterns

Figure 6. SEM images and its cross-sectional profiles of DLC-dot array patterns in RTC-NIL using PDMS molds

Conclusions

The nanopatterning of DLC-dot array patterns in RTC-NIL using the PDMS mold was investigated by industry (ELIONIX INC., Shin-Etsu Chemical Co., Ltd. and TOKYO OHKA KOGYO CO., LTD.) - university (Toyohashi University of Technology) collaborative research. As a result, the sharpened DLC-dot array patterns which have 500 nm-diameter and 400 nm-height were fabricated with high accuracy. The RTC-NIL technology using PDMS molds with concave patterns that we developed has been shown to be useful for the nanopatterning of DLC films and is expected to be applied to DLC-based functional micro/nano devices such as an emitter for the next generation FPD.

Acknowledgements

We would like to give thanks to TOKYO OHKA KOGYO CO., LTD. whose comments and suggestions were innumerably valuable throughout the course of our study. We would also like to thank Shin-Etsu Chemical Co., Ltd. whose meticulous comments were an enormous help to us.

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ROLLER HEMMING: ANALYSIS AND DEVELOPMENT OF AN AUTOMOTIVE ASSEMBLY

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Abstract

Automotive Industry in Mexico is growing at a tremendous pace for the last 5 years, pushing local suppliers to develop new market opportunities. PEMSA, a local stamping company, is developing roller hemming process, in order to be more competitive, and to have a flexible metal forming method at low cost. Roller hemming engineering development is performed on a joint research project between PEMSA and University of Guanajuato. A parametric numerical simulation of an experimental hemming assembly made by a robot arm mounted roller is presented. The proposed geometry was generated on a CAD commercial software and then imported into a commercial code for an explicit finite element analysis. The analysis includes the simulation of the deep drawing, spring back, folded back, spring back, and hemming processes in order to include residual stresses, plastic stresses, and thinning generated in each previous manufacturing step. Several materials models were tested to match experimental data, before the roller hemming analysis was performed. Main hemming parameters were roller speed, roller diameter, entry angle, bending radius, and overhang. The analysis showed that residual stresses and sheet thinning due to deep drawing and folding do not affect the hemming process. Additionally, an analysis of experiments was performed, using a five factors factorial design with one replica, in order to get main effects on "roll in", hemming thickness and maximum roll force. These response variables were measured on four different points around the rolled edge. It was observed that roll diameter, entry angle, and the initial bending radius are dominant parameters. The methodology developed was applied on a closure automotive part with closed path roller hemming, performing again a design of experiments on the roller hemming process.

Keywords: *Hemming, deep drawing, FEA, DoE, Roller, Roll-in, Roll-Out, Roll force, metal forming.*

Introduction

Roller hemming is a method used in the automotive industry to join two pre-formed metal panels. This process generally includes an inner panel inside a foldable exterior panel, which is bent with a robot guiding a parallel roller along a given path [1]. The sheets are joined by plastic deformation without using any additional fastening element. Among the advantages of this type of union is the low weight of the union, since it is not necessary to add additional material, the increased stiffness of the component and a significant reduction in risk of injury to eliminate any sharp edges. Usually this process is applied in vehicle doors, hoods, or trunk lid. These structural units are commonly referred as closure panels.

Roller hemming was introduced in the market in the 90s and has large areas of application in the automotive sector because is it a flexible process and requires less investment on new product development, compared to conventional processes [2].

Roller hemming research had been made on theoretical, numerical and experimental studies aimed at improving the process, analyzing the plastic material recovery (springback), the optimum roller radius and fracture limit, sheet metal thinning in 2D surfaces and in fewer publications in 3D surfaces, by solid elements and shell elements.

N. Le Maout [3] proposed the S.Thuiller [4] specimen but adding the effect of the pre-stretching induced during the drawing process. The influence of Bauschinger effect, anisotropy and deformation history in the final geometry is studied. Materials characterization was performed through tension tests at different orientations of rolling, 0 °, 45 ° and 90 °. It was found that the material has a low variation of the flow stress in the flat sheet and only a slight Bauschinger effect. The identification of a mixed model of anisotropic hardening elastoplastic however, has given the best description of the mechanical behavior.

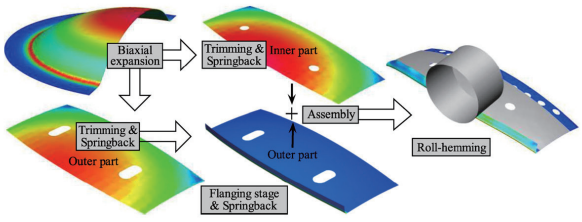


Figura 1. Roller hemming methodology proposed by N. Le Maoˆut [3]

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The N. Le Maout specimen has the limitation of analyzing the roller hemming process on paths that do not have abrupt changes; this work presents the study of the process on a specimen that includes vertices as those commonly found in the corners of doors, gates and hoods.

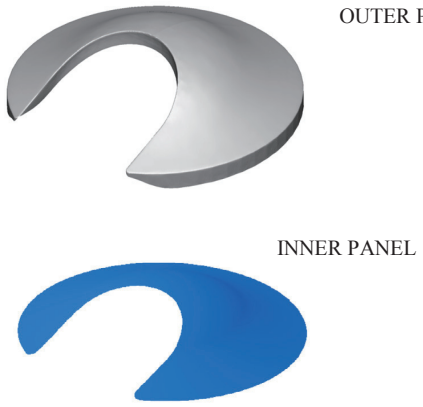


Figure 2. Proposed roller hemming assembly [2].

Methodology

Finite element analysis were performed to model drawing, cutting, folding and roller hemming on our modified Le Maout [3] specimen, reporting results at each manufacturing stage.

Material model Hill 48 with isotropic hardening law is the criteria most commonly used [5]. The complete assembly of the tooling that was used to draw the prototype is showed in Figure 3.

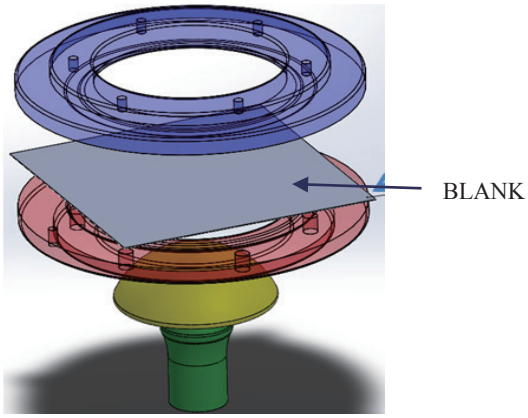


Figure 3. Drawing fixture assembly

Finite element modeling of drawing stage

The finite element analysis models only the surfaces of interest; details of solid geometries such as holes, chamfers and fillets are omitted as long as they do not affect.

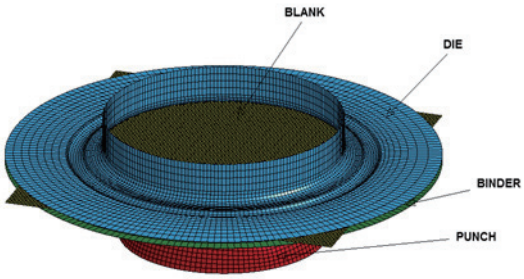


Figure 4. Finite element model of drawing stage.

The second general step to reach the final roller hemming is to take the mesh from the drawing model with results and cut the mesh to generate the model that will serve for the next step, which involves bending, Figure 5, back spring analysis was also performed.

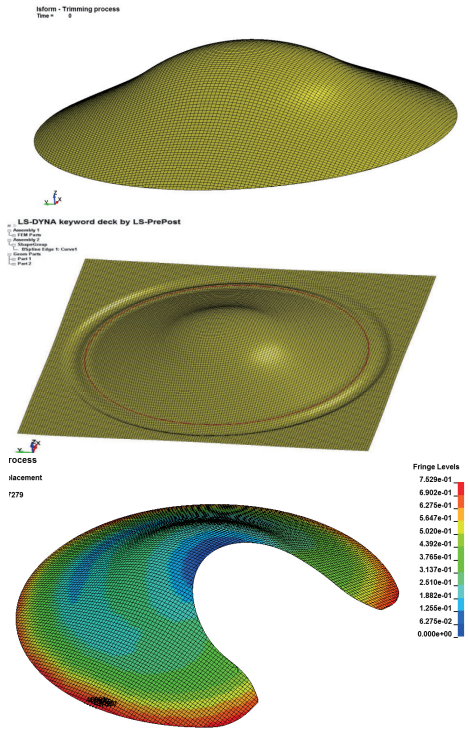


Figure 5. Back spring, outer and inner trimming.

90º Roller hemming geometry

The geometries were generated based on a profile obtained of the location of the nodes on the previous stages analysis, through MATLAB and CATIA. The roller hemming simulation was conducted in two parts: first, the outer flange was folded on to the inner (Figure 10, red flange). Several hemming roller diameters were used because it was observed that if roller diameter is too small, the roller hits and drags the flange in the direction of movement without folding the flange. On the second part, the inner flange was folded also.

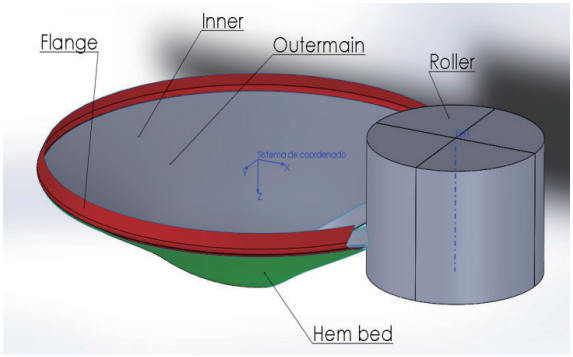


Figure 6. Roller hemming assembly

Roller hemming finite element model

The model was performed with inner, hem bed and roller like rigid parts. Inner and hem bed are fixed, and roller like a mobile part. A mapped mesh was used with Shell elements. Stresses and strains came from drawing and trimming stages. Roller path was calculated in MATLAB, and imported into LS-DYNA. Two roller hemming steps were analyzed, 45º and 90º.

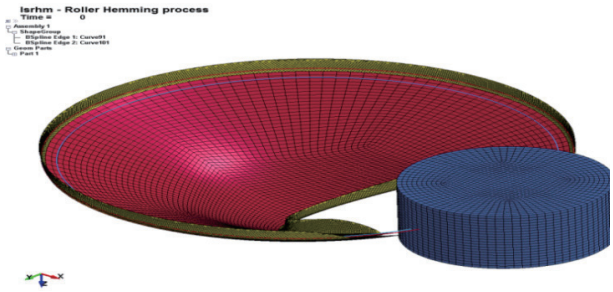


Figure 7. Roller hemming finite element model.

A full factorial design of experiments was conducted on the roller hemming model. Input parameters were:

- Roller speed
- Roller input angle
- Roller diameter
- Overhang
- Flange fillet

Output variables were:

- Roll In
- Hemming thickness
- Roller maximum force

Results

The reduction in thickness for the first step at 45 ° is shown in Figure 8a. The maximum value is obtained as 0.1252% and is located at a point where the contact with the roller begins.

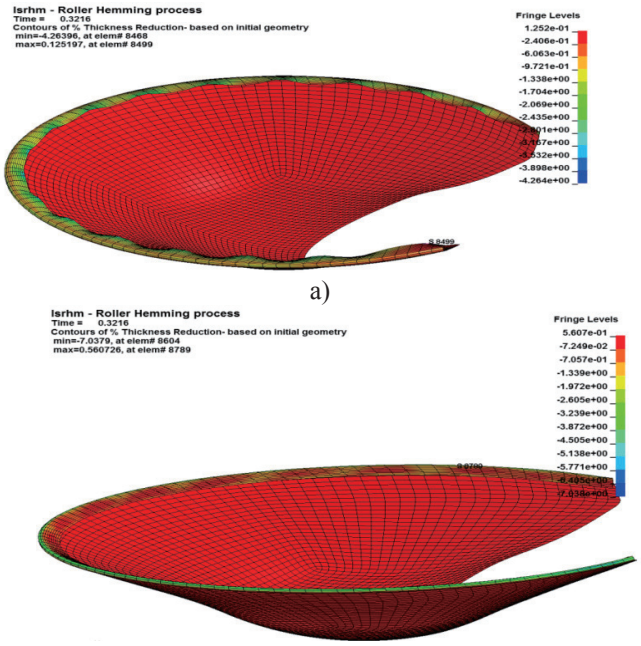


Figure 8. Thickness reduction a) 45º roller hemming step, b) 90º roller hemming step.

Thickness reduction on the 90º roller hemming steps is 0.5607% maximum, Figure 8b.

Plastic deformation for the first step at 45° on the periphery is shown in Figure 9a, where a maximum value of 0.1903 was obtained. While the second step to a maximum value of 0.4553 was obtained.

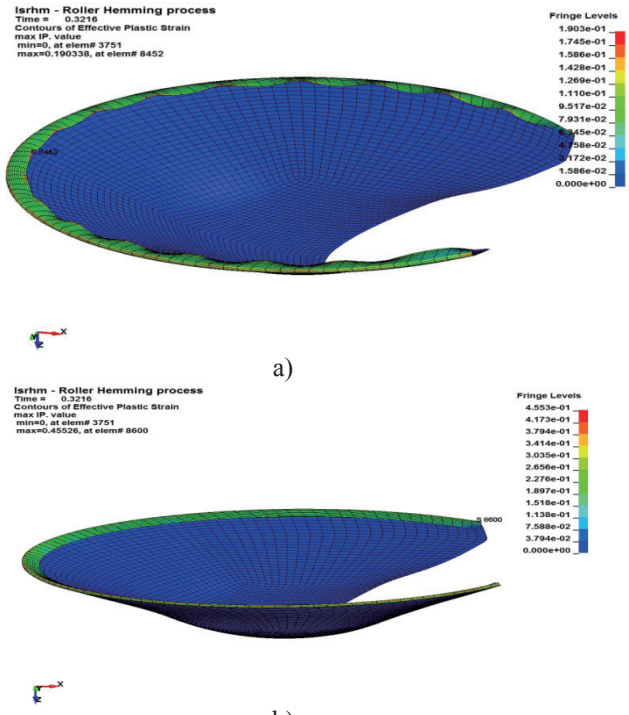


Figure 9. Plastic deformation a) at 45° step, b) at 90º step.

The graph of the force-time behavior between the roller and the flange to the first step was analyzed, getting a maximum value of 764.69 N. For the second step a maximum force was obtained equal to 17,776 N. Both

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graphs show a similar behavior although the range of values of strength is very different.

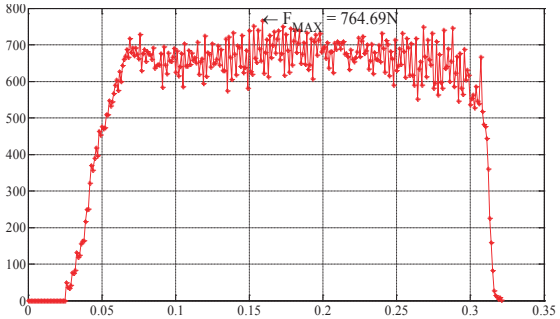


Figure 10. Roller force vs. time, 45º step.

Conclusions

In our simulations it can be seen that in the first step remains a tendency for non-uniform deformation in the inner hemming, right where the shape is the most radical change of curvature although it is noteworthy that the shape of the specimen and the trimming done on the specimen, the curvature changes at all times. In the last roller hemming step the problem with ripples and uneven deformation tends to be corrected, but in the specific case of the inner hemming a slight defect persists. Our results were verified with preliminary experimental analysis.

Design of experiments analysis

Roll in

It was found that the most influential parameters in obtaining the output variable roll in are first is the radius of flange fillet, followed by the roller angle.

Hemming thickness

For measuring the output variable *hemming thickness* it was found that the most influential parameters are, first; roller diameter, roller angle followed by influencing nearly as significantly as the roller diameter, subsequently it is the flange fillet radius and at least influence the roller speed.

Roller maximum force

The most important main effect comes from roller diameter.

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COLLABORATIVE TRAINING PROGRAMME BETWEEN NAGAOKA COLLEGE AND ADTEC MELAKA BASED ON THE SOLIDWORKS AND TETRIX ROBOTICS

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Abstract

Nagaoka College has entered into a collaboration with Advanced Technology Training Centre (ADTEC) Melaka in training robot skills. ADTEC Melaka was built in 1998 and one of four ADTECs developed under the 7th Malaysian Plan, which was officially opened on January 11, 2003. ADTEC Melaka is fully governed by Manpower Department (JTM) of the Ministry of Human Resources, Malaysia. ADTEC Melaka is a technical skills training centre that provides 70% hands-on training and 30% theoretical education for its trainees. JTM Robot Challenge is one of annual robot competitions organized by JTM since 2008. The main objective of the JTM Robot Challenge is to enhance the skills and innovations related to robotics on JTM instructors or students. ADTEC Melaka's team has participated in the JTM Robot Challenge every year. For 2015, the JTM Robot Challenge will be held in conjunction with JTM Technology Carnival at ADTEC Taiping on September 6 - 8, 2015. This year, they are aspired to form a formidable robotics team to win this competition by taking the collaborative training programme between Nagaoka College and ADTEC Melaka based on the SolidWorks and TETRIX robotics. The collaborative training programme was conducted by the Nagaoka College's lecturers using the college's facilities. The main purpose of the programme is to assist ADTEC Melaka lecturers in developing the robot using current technology. In ensuring the effectiveness of the training, approach to be used is project based which includes planning and developing the robot within four working weeks at Nagaoka College. This training programme covers a fundamental and hands-on experience on design, fabrication, programming and operation of a robot. At the end of the training, the trainees should be able to: 1. Design, simulate and analyze structure, drive train and gripper/weapon of the robot. 2. Select the suitable material for the robot. 3. Calculate and make decision on sensor, motor and power transmissions for the robot. 4. Perform robot fabricating, machining, and joining for each part of the robot. 5. Program and operate the robot.

Keywords: *Collaborative training, Design, Robot, SolidWorks, LEGO Mindstorms, TETRIX robotics*

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.

ADTEC Melaka was built in 1998 under the 7th Malaysian Plan and was officially opended by Malaysian Deputy Prime Minister, YAB Datuk Seri Abdullah Hj Ahmad Badawi, and Malacca Chief Minister YAB Datuk Seri Mohd Ali Hj Rustam on January 11, 2003. ADTEC Melaka is a technical skills training centre that provides 70% hands-on training and 30% theoretical education for its trainees. It is one of four ADTECs in Malaysia developed under 7th Malaysian Plan.

ADTEC Melaka offers five main programmes which are Manufacturing Technology, Automotive Technology, Computer System Technology, Telecommunication Technology and Mechatronic Technology. The aims of these programmes are to enhance and strengthen their teaching and learning procesess by taking various initiatives to accomplish its educational excellence. One of the strategies implemented by ADTEC is to have collaboration with other parties to enhance the quality of their graduates. ADTEC Melaka paves the way for those

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who aspire to become qualified skilled workers in any fields which involve the use of advanced technology in line with the rapid modernisation and global technological revolution. The ultimate vision of ADTEC Melaka is to churn out highly capable individuals in the quest to transform the country's manpower development in becoming more efficient.

National Institute of Technology, 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 (NIT), Japan. However, each college maintains its independent authority.

NIT, Nagaoka College is an established College of Engineering, focusing on Mechanical Engineering, Electrical and Electronic systems Engineering, Electronic Control Engineering, Material 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 signed an academic exchange programme on November 6, 2014. The first collaborative training programme between Nagaoka College and ADTEC Melaka based on the SolidWorks and TETRIX robotics was conducted from May 11 – June 5, 2015. The aim of this programme is to assist ADTEC Melaka lectures in developing the robot using current technology. In ensuring the effectiveness of the training, project based approach has been used which includes planning and developing the robot mechanism at Nagaoka College within four weeks. This training programme covers in designing using SolidWorks2014, prototyping with ink-jet and FDM type 3D printers, programming and controlling LEGO and TETRIX Robotics.

JTM Robot Challenge organized by the Manpower Department of the Ministry of Human Resources, Malaysia, is one of the annual robot competitions since 2008 [1]. JTM Robot Challenge serves as a platform to enhance the knowledge and skills level in robotics among the lecturers and students under the Manpower Department Institutions. ADTEC Melaka has participated in the JTM Robot Challenge every year without failure. For 2015, the JTM Robot Challenge will be held in conjunction with JTM Technology Carnival at ADTEC Taiping on September 6 - 8, 2015. This year, they are aspired to form a formidable robotics team to win this competition by taking the collaborative training programme between Nagaoka College and ADTEC Melaka based on the SolidWorks and TETRIX robotics.

2. JTM Green Earth 2015

This year, ATEC Melaka's team will take part in Green Earth 2015 competition which is one of the categories in JTM Robot Challenge. Figure 1 shows the playing field of JTM Green Earth 2015. The main rules of Green Earth competition are as follows:

1. Teams will compete on the playing field.
2. The playing field are divided into two teams, red and blue.
3. The size of playing field is 3000 mm x 3000 mm.
4. Each robot must remove the stump to the dump site of stump, take trees in nurseries and plant trees on the site.
5. Each team will be represented by four members, consist of three students, one instructor.
6. Robot weight should not exceed 15 kg.
7. At the starting point, the initial size of the cube robot cannot exceed 400 mm (W) x 400 mm (L) x 500 mm (H).
8. On the playing field, the size of the cube robot cannot exceed 500 mm (W) x 500 mm (L) x 500 mm (H).
9. The team must be able to put all the goods within 3 minutes and the fastest will be the winner.

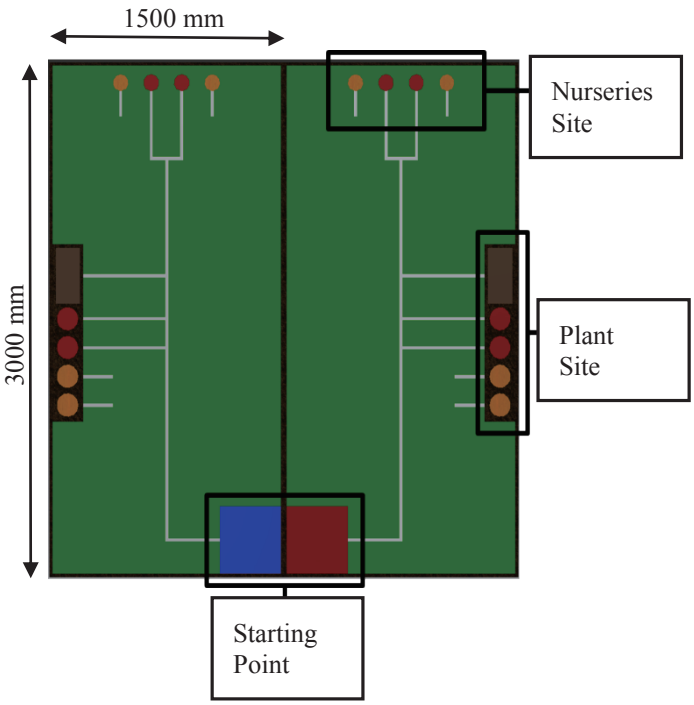


Figure 1 Playing field of JTM Green Earth 2015.

3. Collaborative training programme

The collaborative training programme between Nagaoka College and ADTEC Melaka based on the SolidWorks and TETRIX robotics was conducted from May 11 – June 5, 2015. The following describes the detail of the programme.

3.1 Modeling and prototyping a leg unit of KAWASAKI Robot

Basic operation of SolidWorks, making a part model and assembly model with SolidWorks, prototyping of robot parts with ink-jet and FDM type 3D printers and 3D modeling of a leg unit for KAWASAKI Robot Contest (KAWA-ROBO) were conducted for the first two weeks. Training schedule for the first two weeks from May 11 to May 22 is shown in Table 1.

Table 1 Training schedule for the first two weeks.

DATE	Programme
May 11 (Mon.)	1. Introduction of NIT, Nagaoka College 2. Basic operation of SolidWorks 3. Making a part model with SolidWorks 4. Using SolidWorks online tutorial
May 12 (Tues.)	5. Making assembly model with SolidWorks 6. Using SolidWorks online tutorial 7. Laboratory tour in the Department of Mechanical Engineering 8. Learning how to use 3D printer
May 13 (Weds.)	9. Practice of SolidWorks Motion 10. Using SolidWorks online tutorial 11. Introduction of KAWASAKI Robot contest 12. Planning of a robot for KAWASAKI Robot contest
May 14 (Thurs.)	13. Participate in School Hiking with Malaysian students
May 15 (Fri.)	14. Design of leg unit 15. Participate a class (Subject: Creative Design and Manufacture) 16. 3D printing (Model part)
May 18 (Mon.)	17. Checking of printed parts and temporary assembling 18. Design of leg unit 19. 3D printing (Model part)
May 19 (Tues.)	20. Checking of printed parts and temporary assembling 21. Design of leg unit 22. 3D printing (Model part)
May 20 (Weds.)	23. Checking of printed parts and temporary assembling 24. Modification modelling 25. 3D printing (Model part)
May 21 (Thurs.)	26. Completion of assembling of leg unit 27. 3D modelling of robot parts excepting a leg unit
May 22 (Fri.)	28. 3D modelling of robot parts excepting leg unit 29. Summary of the first two weeks

During the training programme, a leg unit of KAWA-ROBO was designed using Hecken link mechanism with 3D CAD, SolidWorks2014. SolidWorks is software program used for solid modeling computer-aided design (CAD) and computer-aided engineering (CAE). SolidWorks users can create sophisticated parts and assembly designs quickly and efficiently. Since SolidWorks is currently used by over 2 million engineers and designers at more than 165,000 companies worldwide, users can have quick access to people and resources to gain the knowledge and support they need when questions arise.

Figure 2 shows the leg unit using the Hecken link mechanism. Figure 3 shows training class of 3D model with SolidWorks. KAWASAKI Robot Contest is one of popular robot contests which has been held in Kawasaki city since 1994. Content of the contest is “robots battle”. The participating robots have to be driven by a walking mechanism. That means driving wheels and tires are not



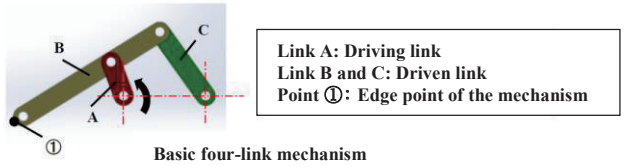
Figure 2 Leg unit using Hecken link.

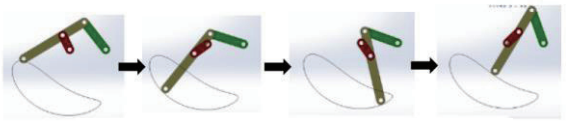


Figure 3 Making 3D model with SolidWorks.

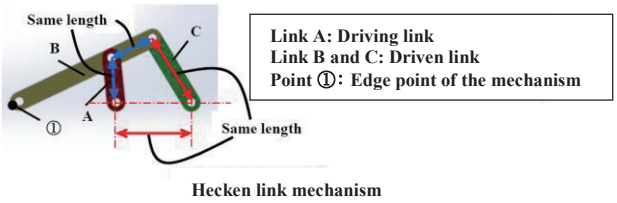
accepted in the regulation. To achieve this, several four-link mechanisms are commonly used for the robots.

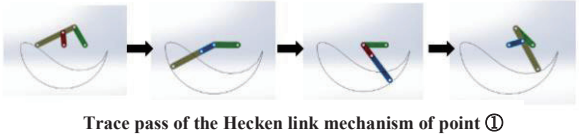
Four-link mechanism is the most basic mechanism and it consists of three-link. Schematic illustration of four-link mechanism is shown in Figure 4. Figure 4 (a) shows the normal four-link mechanism. A trace pass of edge point ① will not become an arc. The Hecken link mechanism is in a type of four-link mechanism and its schematic illustration is shown in Figure 4 (b). The mechanism has a particular length ratio. The Hecken link mechanism can get a smooth arc pass at over 180 degree. In this training programme, we designed the leg unit having the Hecken link mechanism.





(a) Normal four-link mechanism





(b) Hecken link mechanism

Figure 4 Schematic illustration of four-link mechanism.

In this training programme, two types of 3D printers were used for prototyping the leg unit of KAWA-ROBO which was designed by SolidWorks. The 3D printers normally require “*.STL style files” to read the 3D model.

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Most 3D CAD systems support the STL file as an output model. Figure 5 shows the parts of robot's leg formed by FDM type 3D printer.

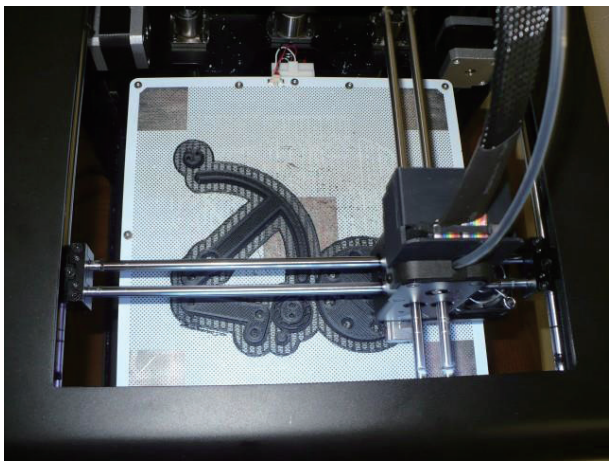


Figure 5 Prototyping of robot's leg parts with FDM type 3D printer.

3.2 Building LEGO robot and TETRIX robotics

In order to upgrade ADTEC Melaka lecturers' robot skills, LEGO robot (LEGO Mindstorms NXT 2.0) and TETRIX robotics (TETRIX® MAX Starter set) were used for the next two weeks from May 25 to June 5. Training schedule for the latter two weeks is shown in Table 2.

Table 2 Training schedule for the latter two weeks.

DATE	Programme
May 25 (Mon.)	1. Introduction of LEGO robot 2. Assembling of LEGO robot 3. Participate in a class of Experiments of Electrical Engineering I in the Department of Electrical and Electronic Systems Engineering
May 26 (Tues.)	4. Programming of instruction to motor using LEGO robot 5. Programming of instruction to sensor using LEGO robot
May 27 (Weds.)	6. LEGO robot programming 7. Participate in Experiments of Electrical Engineering II in the Department of Electrical and Electronic Systems Engineering 8. Participate in Experiments of Electrical Engineering III in the Department of Electrical and Electronic Systems Engineering
May 28 (Thurs.)	9. Practice of LEGO robot
May 29 (Fri.)	10. Practice of LEGO robot
June 1 (Mon.)	11. Introduction of TETRIX robotics 12. Assembling of TETRIX robotics 13. TETRIX programming
June 2 (Tues.)	14. TETRIX programming
June 3 (Weds.)	15. Practice of TETRIX
June 4 (Thurs.)	16. Final presentation
June 5 (Fri.)	17. Courtesy visit to Tokyo College 18. Study tour of Tokyo College (Embedded system)

LEGO Mindstorms is a robotics kit which allows anyone, including children, to build robots that do what they want. The LEGO Mindstorms NXT 2.0 was launched in early August 2009. It is a very popular product line in the area of robotics education. It contains 619 pieces (includes sensors and motors), two touch sensors, an ultrasonic sensor, and introduced a new colour sensor. The main component in the LEGO Mindstorms NXT 2.0 kit is an intelligent brick computer which enables it to execute user-written programs based on feedback from a variety of sensors. It can take input from up to four sensors and control up to three motors, via a modified version of RJ12 cables. The brick computer has a 100×60 pixel monochrome LCD display and four buttons that can be used to navigate a user interface using hierarchical menus. It has a 32-bit ARM7TDMI-core Atmel AT91SAM7S256 microcontroller with 256KB of flash memory and 64kB of RAM, plus an 8-bit Atmel AVR ATmega48 microcontroller, and bluetooth support. Power is supplied by 6 AA (1.5 V each) batteries in the consumer version of the kit and by a Li-Ion rechargeable battery and charger in the educational version.

In programming for the brick computer, a variety of unofficial languages exist, such as NXC, NBC, leJOS NXJ, RobotC and BricxCC. BrixCC is the integrated development environment (IDE) used to write, compile, and edit NBC and NXC programs for the NXT. In this training programme, we used BricxCC because it has many utilities such as NeXTExplorer (upload/download files, defragment the NXT, use file hex viewer) and NeXTScreen (view what's on the NXT's LCD display, and capture images and video). Figure 6 shows that ADTEC Melaka lectures are building the LEGO robot.



Figure 6 Building LEGO robot.

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TETRIX is a robotics building system that was created by Pitsco, Inc. The main structural TETRIX pieces are aluminium channel with a trademarked hole pattern that enables connections at multiples of 45°. The pieces are attached using bolts. Other building elements such as gears, wheels, motors and servos are included in the package. The TETRIX system is intended for use in educational settings for hands-on explorations of mechanisms and robotics. It is also designed for use in robotic competitions, such as the FIRST Tech Challenge, a team-oriented contest for high school students [2].

The TETRIX robotics system is designed to allow users to create stronger, heavier-duty robots while leveraging the programming of NXT software and the autonomy of the intelligent brick computer. Robots built from TETRIX components may also be controlled via radio control equipment - hand-held radio transmitters like those manufactured by Futaba, and receivers mounted on the robot chassis. This enables a human operator to control the robot's movements from a remote location.

Features of the TETRIX robotics are as follows [3]:

- Uses elements made from heavy-duty, aircraft-grade aluminum to maximize stability and reliability.
- Uses powerful drive motors that drastically increase the capabilities of Mindstorms with TETRIX robots.
- Can be combined with LEGO Mindstorms and either National Instruments LabVIEW for LEGO Mindstorms or RobotC to build sophisticated, versatile robots that are able to handle complicated tasks autonomously.
- Offers flexibility in build design and can be expanded using additional materials.
- Gives users the opportunity to master the concepts of wiring, motor control, and much more.
- Fosters creativity and ingenuity amongst students.
- Develops engineering and problem-solving skills.

Figure 7 shows a prototype machine for JTM Green Earth 2015 competition. This machine is a four-wheel drive using TETRIX robotics and the intelligent NXT brick computers. Two NXT brick computers are used to use three photo sensors to detect a line and one ultrasonic sensor to detect obstruction.

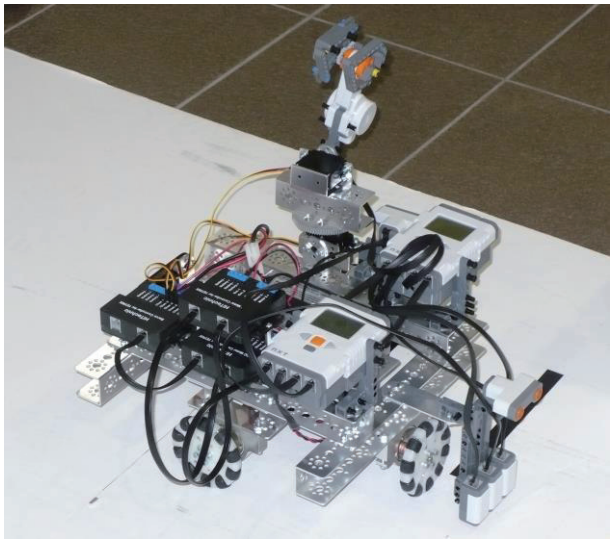


Figure 7 Machine having four-wheel drive using TETRIX robotics and NXT brick computers.

4. Conclusions

In order to upgrade ADTEC Melaka lecturers' robot skills, the collaborative training programme between Nagaoka College and ADTEC Melaka based on the SolidWorks and TETRIX robotics was conducted by the Nagaoka College's lecturers using the college's facilities. This training programme covered a fundamental and hands-on experience on design, fabrication, programming and operation of the robot.

This programme is the first step to develop strong relationship between Nagaoka College and ADTEC Melaka. We are planning to send 15 students of Nagaoka College to ADTEC Melaka this August for one week and have cooperative programme using LEGO robot.

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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ENVIRONMENTAL CRITICAL THINKING DEBATE AND PRESENTATION WORKSHOPS ON SUSTAINABILITY ISSUES TO NURTURE FUTURE GLOBAL TECHNICAL LEADERSHIP

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Abstract

This paper highlights effective speaking skills development in students. This development includes critical thinking through debates and presentations in classes specializing on current environmental crisis and sustainability issues for nurturing future global technical leadership. Hundreds of engineering students of the National Institute of Technology (NIT), Sendai College and international students from the International Post-Graduate Program in Human Security at Tohoku University, have participated in the two-year multicultural classes since the academic collaboration was initiated and designed in 2010. This innovative curriculum and the intercultural communicative teaching methods were designed for enhancing critical thinking and global leadership skills through focus on thematic topics such as climate change, natural disaster, refugee camp conditions, desertification, large-scale water pollution, and lack of natural resources. Targeted leadership skills were; (1) identifying a problem, (2) debating, (3) problem solving, (4) decision making or (5) doing dynamic presentations over global controversial issues such as various noticeable challenges in science, technology and engineering toward environmental protection.

The methods of English education at NIT vary, but have mostly focused on performance on English achievement tests as in other Japanese secondary schools; mid-term exams and finals based on grammar, reading comprehension and translation questions. Furthermore, some tertiary school level classes have set their goals for scores or accomplishment on listening and reading to prepare for tests such as TOEIC or EIKEN respectively. Naturally, most non-native speakers have difficulty achieving sufficient communicative skills with only these types of test preparation. However, these results do not necessarily improve effective verbal communication or debate skills in student's respective areas.

This study aims to create one of the most effective teaching methods providing strong incentives in the students. This can lead towards remarkable improvement in English communicative skills by giving tasks of multinational debates and presentations based on global sustainability issues. This curriculum and the joint support of NIT and the Graduate School of International Cultural Studies, Tohoku University develop; 1) the blueprint of a successful global technical leader training program to create better intercultural understanding, and 2) richer human resources contributing to academic achievement and international cooperation of the next generation.

Keywords: *intercultural understanding, critical thinking debate, sustainability issues, English communicative skill, competitive advantage*

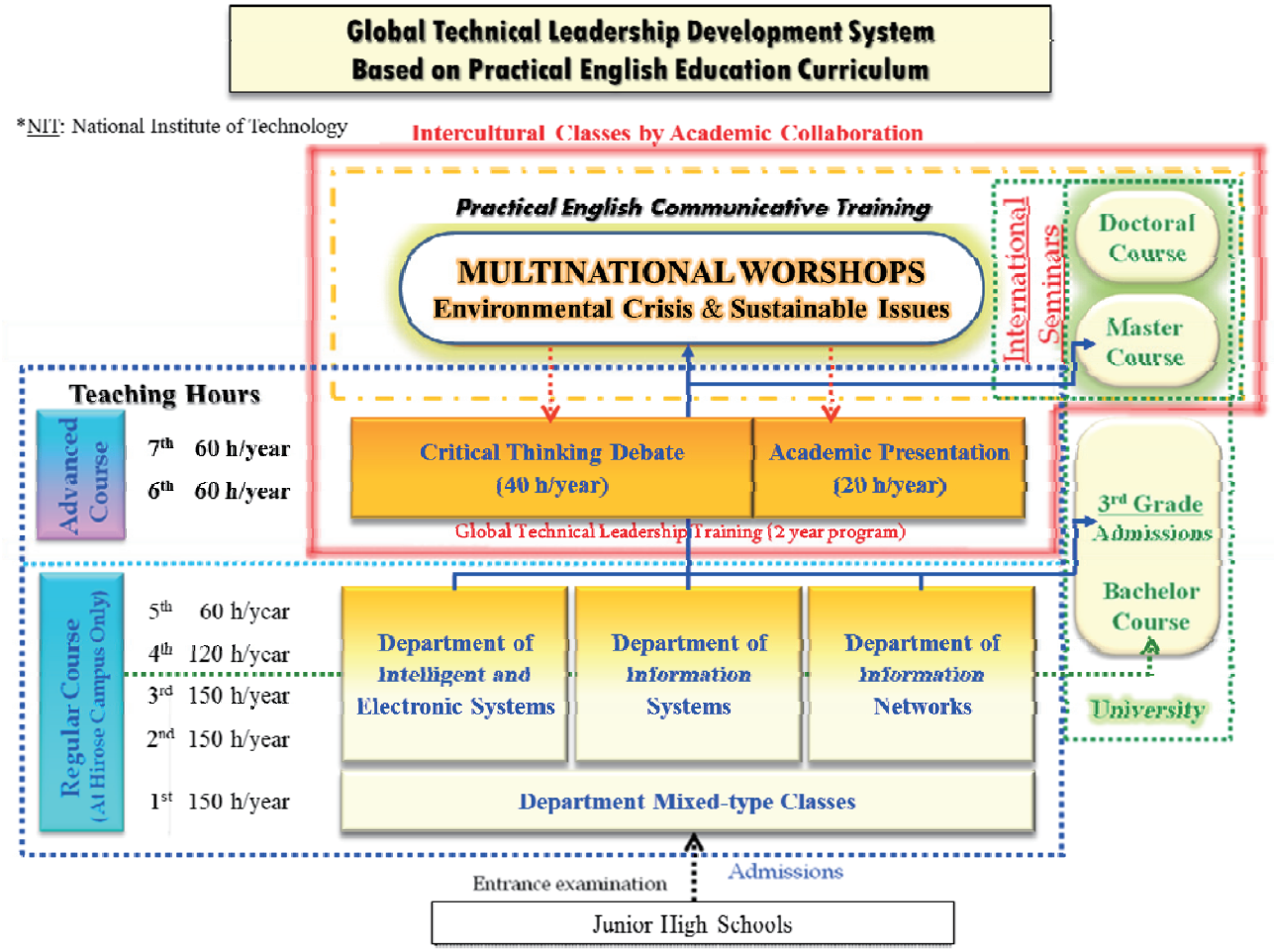


Fig.1. Educational system of NIT, Sendai College and global technical leader development curriculum

Introduction

The majority of Japanese English instructors in public secondary and tertiary schools are focusing on vocabulary building, grammar, translation, reading or preparation for TOEIC or EIKEN tests which are designed to better evaluate listening and understanding of readings. As English instructors emphasize grammar and translation teaching methods in their classes in their mother language, it doesn't effectively improve speaking skills development, however, too many grammar exercises on error corrections are virtually possible to be one of the main factors of disturbing students' motivation in speaking English. Furthermore, to nurture active verbal anilities in specific purposes require more practical and professional training with fluent English speakers.

On the other hand, Japanese National Institute of Technology (NIT) has very clear educational purposes to nurture practical and well-trained engineers in from 5 years to a maximum of 7 years. It is therefore possible to work effectively in an industrial company right after graduation. Since the educational goals of NIT are mainly set on practical technical knowledge, the students should learn special core curriculums which are very different from other high schools or universities.

We were focused on specific knowledge and English communication abilities required for the 21st century in fostering intrinsic student motivation and tried to create the most competitive English learning activities through academic collaborative intercultural workshops.

Materials and Methods or pedagogy

For the most effective communicative skill development, we have invited totally over fifty international graduate students as tutors to join the intercultural workshops since 2010 and have set up common interesting discussion topics on environmental and sustainable issues such as climate change, natural disaster, refugee camp conditions, desertification, large-scale water pollution, and lack of natural resources.

The majority of foreign tutors from the International Post-Graduate Program in Human Security at Tohoku University have handled their group discussions successfully, and maximized student concentration amazingly in cross-cultural communication studies as well as global technical leadership training as shown in Fig.2. The main purpose of intercultural discussion was to nurture practical communicative skills on identifying a problem, debating, problem solving, decision-making or giving a presentation over sustainability issues toward environmental protection.

The intercultural critical thinking debate and presentation workshops followed the steps listed below.

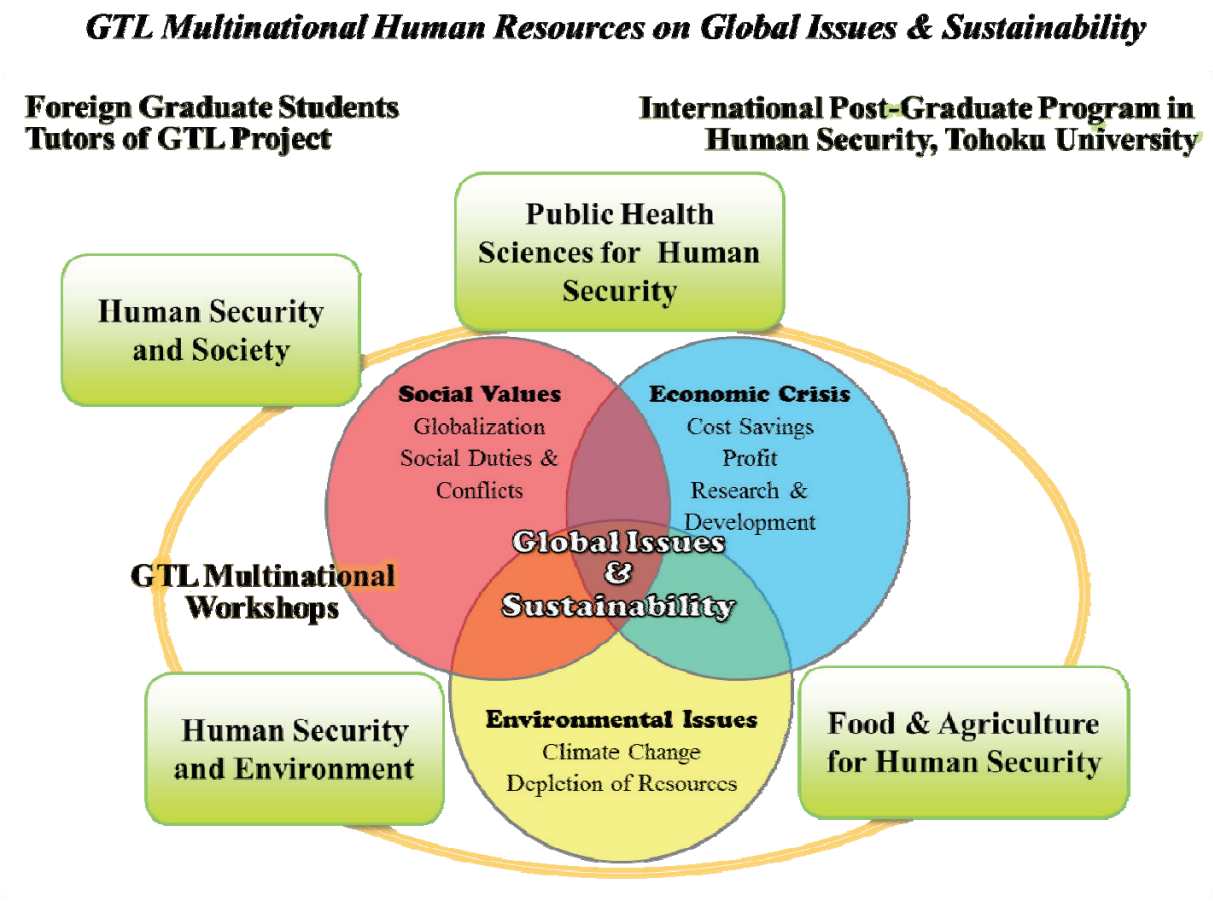


Fig.2. Intercultural discussion topics on global environmental and sustainable issues

①Pre-task Session; The instructor introduces the debate or presentation topic and gives the students clear instructions on what they will have to discuss at the task stage and might help the students to recall some vocabularies and expressions that may be useful for the task. The pre-task stage can also often include watching tutors model presentations and their debates on specific purposes. This gives the students a clear model of what will be expected of them. ②Task (Group Discussion) Session; The students complete a task in groups using the language resources that they have as the teacher monitors and offers encouragement. ③ Planning Session; The students prepare a technical presentation or debate with several Power Point slides on the topic of their group discussions. Meanwhile the tutors are available for the students to ask for advice to clear up English questions they may have. ④Presentation or Debate Session; Students give a presentation or participate in a panel debate in the class. The teacher and tutors evaluate student presentation or debate individually. ⑤Question & Answer Session; Finally, the student presenters answer various critical thinking questions from instructor, tutors and other students. The teacher and tutors evaluate student feedback about the questions individually.

This intercultural workshop is truly strong communicative approach where students must spend the most of their class time for communicating.

Results and Discussion

Evaluation methodology of delivery and Q&A

These intercultural workshops as the most effective communicative English teaching methods have provided strong incentives in the student participants. These educational methods could lead towards remarkable improvement in English communicative skills by giving tasks of presentations and critical thinking debates focused on global sustainability issues. We aimed at evaluating the main elements of presentation delivery and the feedback in the question and answer session. The evaluation parameters for presentation delivery consisted of following fifteen contents; “Avoided fillers”, “Spoke loudly enough to be heard in the room”, “Pronounced words clearly”, “Spoke without noticeable pauses in mid-sentence”, “Used falling intonation at the end of sentences”, “Varied rate of delivery”, “Changed pitch for emphasis”, “Looked at entire audience”, “Spoke key points, intro, and concluding remarks without reading”, “Did not read to audience much from screen”, “Used concept-related gestures to show relationships”, “Avoided nervous hand movements”, “Stood straight”, “Planted feet” and “Appeared confident and enthusiastic”. All students made the thematic technical presentations and the

evaluation results on deliveries of the 1st and the 4th presentation are shown in Fig. 3 and Fig. 4.

At the final presentations, the student evaluation results on delivery were improved dramatically compared with the first evaluation scores. The majority of student presenters raised their scores on delivery a lot, especially for the content of "Spoke loudly enough to be heard in the room" of which average score was raised from 5.5 to 9.0. It means their voice clear to listen to and it can be a strong evidence of self-confidence improvement. The average score rising on the other contents such as "Avoided nervous hand movements", "Stood straight", "Planted feet" and "Appeared confident and enthusiastic" has also supported these positive results. For the expression ability using body language, "Used concept-related gestures to show relationships", even it is naturally weak point for Japanese due to their cultural background, the average score shows a great improvement from 3.4 to 7.2.

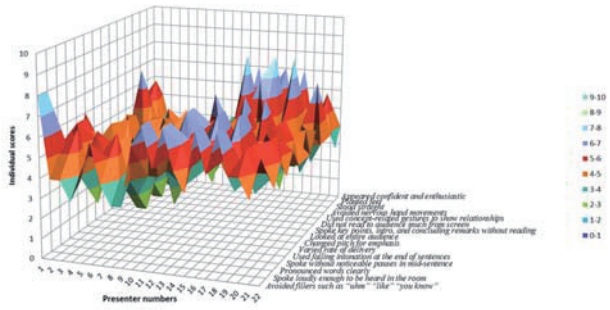


Fig.3 The 1st evaluation scores on deliveries

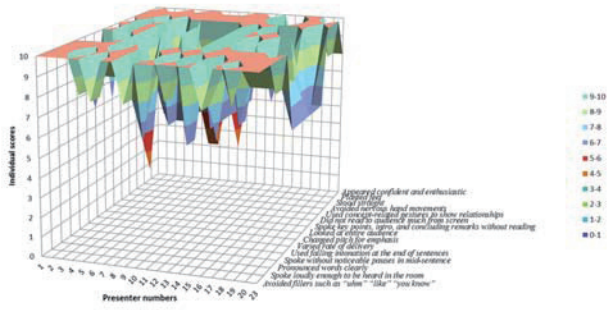


Fig.4 The 4th evaluation scores on deliveries

The evaluation parameters for handling a question and answer session consisted of following 6 evaluation contents; "Listened to question without interrupting", "Repeated or rephrased question", "Addressed response to everyone", "Began with general answer and then followed up with details", "Stood ground or stepped toward questioner" and "Avoided cover-up gestures (fig leaf, behind back, arms crossed)". As the evaluation results on deliveries, the most of students got much better scores for their 4th Q&A session handling as shown in Fig.5 and Fig.6.

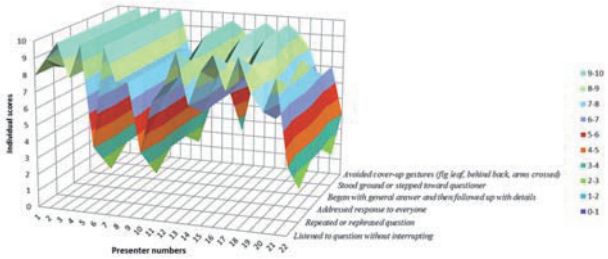


Fig.5 The 2nd evaluation scores on Q&A session

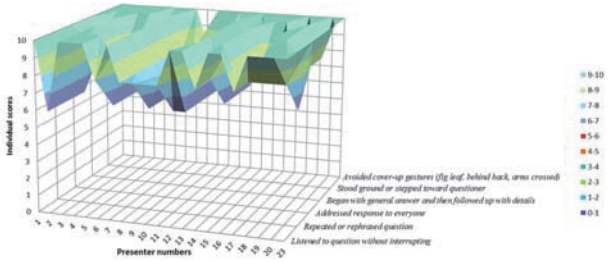


Fig.6 The 4th evaluation scores on Q&A session

At the final presentations, the student evaluation results on Q&A session handling were also improved compared with the previous evaluation scores. The average score of Q&A session handling were raised from 7.5 at the 2nd presentations to 8.9 at the final presentations and it shows that the students had improved their listening levels to understand the questions as well as answering abilities towards powerful critical thinking communicative skills.

The evaluation results shows that these types of classes can lead towards remarkable improvement in English communicative skills by giving tasks of intercultural debates and presentations focused on global sustainability issues.

Conclusions

All Japanese NIT students deserve a chance to be successful in their practical English studies to create better intercultural understanding and responsible NIT must respond to their student needs towards well-educated students of the highest global standard, now in the future.

To conclude, through these innovative cross-cultural critical thinking debate and presentation workshops on sustainability issues, the students can dramatically improve their verbal communication skills for specific purposes, as well as future global technical leadership. Furthermore, the abilities will lead them not only to make a high-value technical presentation effectively, but also to debate more actively in the case for topic discussions that require negotiation over global controversial issues.

Acknowledgements

This dissertation would not have been possible without the guidance and the help of many individuals who in one way or another contributed and extended their valuable assistance in the preparation and completion of this study. My utmost gratitude to Dr. Motomu Takeshige, Vice President of NIT, Sendai College whose steadfast encouragement and endless support I will never forget.

The international graduate students from Tohoku University also have been my inspiration about intercultural leadership training curriculum based on academic collaborations for this research work.

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Cultural and technological exchange through industrial program "ICT Project in TOBA"

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Abstract

In March 2014, the engineering-based cross-cultural exchange program called "ICT project in Toba" was launched in National institute of technology, Toba College (NIT, Toba). The purpose of this program for oversea students is cultural exchange through the practice of technical projects using ICT technology. The project has been held once every year for a period of six weeks, and undertaken in the Ise-Shima region listed as an international tourist destination in Japan.
This program is not only for recieving oversea students industrial department in NIT Toba, but also for local students from Japan to encourage international minds. In every year, support students joined this program were more than 20 which is equivalent to 10 % of the industrial related department in NIT, Toba. Those local students helps and work together with oversea students to conduct the technical project. They planned and visited at regional tourist facilities and accommodations, and ate local food with the cooperation of the local community,.
As a result of the technical project, exchange students created tourist support system, such as a sightseeing map which automatically collects information from websites and desplays places of significant activity. In the case of other group, a prototype of a real-time communication system using a hands-on device was developed. Thanks to this program, the most of support students gained opportunities to learn the cultural and technological differences between Japan and overseas. In addition they were able to think about their identity and the global perspective.
In this paper, we will report on technical outcomes, ways to encourage the local support students and the schedules of the project including preparation before foreign participants' arrival.

Keywords: *Keywords Student Dispatch, Cultural Exchange, Support Students, Information, Electrical, SNS group, technical projects, English Convesation,*

1.Introduction

In Recent years, Japanese government encouraged to further globalisation of Japanese higher education. Japanese Prime Minister has announced to launch an ambitious scheme to attract 300,000 international students over the next six years, to enrol in its universities in 2014. The plan also includes that strengthening English-language proficiency among Japanese students.

On the other hand, according to the 2012 statistics compiled by Organisation for Economic Co-operation and Development, there were 60,138 Japanese nationals studying overseas which is an increase of 2,637 (5%) compared with the previous year.

While the above tread was taking place, National Institute of Technology, Toba College established short term student research and cultural exchange program "ICT project in Toba" with overseas engineering universities to promote student global engineering competencies based upon 6 weeks with academic research in laboratory and field work experiences in the local comunity.

The program was started in March 2014, supported by JASSO. In this program, we have set different goals and objectives to short-term international students and acceptance side of the Japanese students (Support students), respectively.

1.1 Overview of Students and Calendar

NIT,Toba has approximately 600 students and 25 advanced course students. Approximately 1 % of the students are international students. National Institute of Technology, Toba College has been 134 years since Toba Mercantile School, as it was originally known, was founded in 1881. NIT, Toba has set the following three educational goals, (1) students should keep in mind while training to be high-level, (2) practical engineers with a rich senses of humanity, (3) creativity and internationality.

The institute's mission is to educate person with a liberal spirit, to be an engineer with a creative mind and to be a person with good international sense. The final year of the undergraduate student is devoted to laboratory research and graduation thesis.

The academic calendar of NIT, Toba follows the Japanese fiscal year, class starts in April and ends in March. It is consisted 15-week semesters which the one is from April to August, and the other one is from September to February. This unique calendar makes difficult to exchange students for semesters since it does not match most overseas academic institutions' calendar.

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However, we have 1 month of long holiday from the end of February to beginning of April, it allows for overseas exchange students to interact with NIT, Toba students.

Several exchange model of receiving exchange students at department of maritime engineering was conceived to accommodate partner college and polytechnics with NIT,Toba. However, there were no experience for the engineering department to receive short-term exchange students. Therefore, the project was set up and managed by engineering department.

2 Technical project

2.1 Model of the Project

Figure 1 shows a model of the technical exchange program ICT project in Toba which composed of field activity and technical tasks conducted by students.

ICT project in Toba was developed to practice technical training using ICT technology and mechatronics at industry-based department as well as cultural training at Ise-Shima region listed the international tourist city. Students from abroad to stay over a period of six weeks among local support students.

For the field activity, both side of the participants went for field activity which is to visit regional tourist facilities, accommodation, restraint, and engineering factory to learn cultural background and manufacturing technology of Japan.

Technical project is a task for the students from oversea. The project to establish the system or device support many foreign tourists visit at Toba city where NIT, Toba is. The students should be able to summarize their opinions from the field activities from the point of view of foreigners

On the other hand, local support students, belong to NIT Toba, is possible to experience communication using foreign language and cross-cultural understanding to enrich their practical skill as an international person.

As a summary of the program to perform a joint presentation of the participating students and support students. Those projects and activities create an opportunity to faces the differences between own culture built by historical and technological background to all the participants.

2.2 Admission of oversea and local students

A summary of the students from abroad involved in ICT project in Toba is shown in Table 1. We approached several universities, colleges and polytechnics. For the exchange students, development of a tourist support system, such as information display system and electrical device for foreign travellers, was set as a goal. While the short-term foreign students to stay, they visit around the tourist destination with support students to discover what the attractive points of the Ise-Shima area are. Thanks to the experience they had from the tourist spot, exchange students work on the ICT project with understandings the information what should be and how to distribute to foreign travellers. Druing the project, problem-solving ability of ICT skills, and cross-cultural understanding was trained.

Table 2 shows number and attribute of the local support students. Task of the support students imposed a planning and guidance of the field activity taken a place at Ise-shima region. In each year, more than 20 support students were able to interact with students. In addition, for the support students in to introduce their local place, where they grow up and well known, in English. Goals was set to achieve the development of cross-cultural understanding and communication skills.

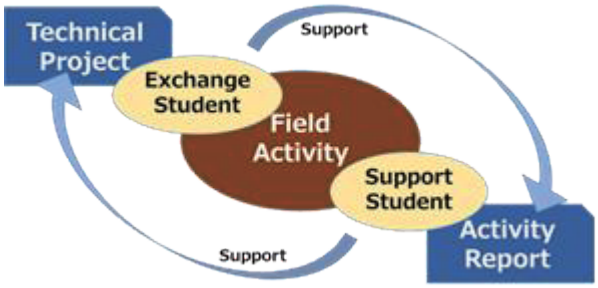


Figure 1 Modelling of the ICT project in Toba

Table 1 Summary of the students from abroad involved in ICT project in Toba

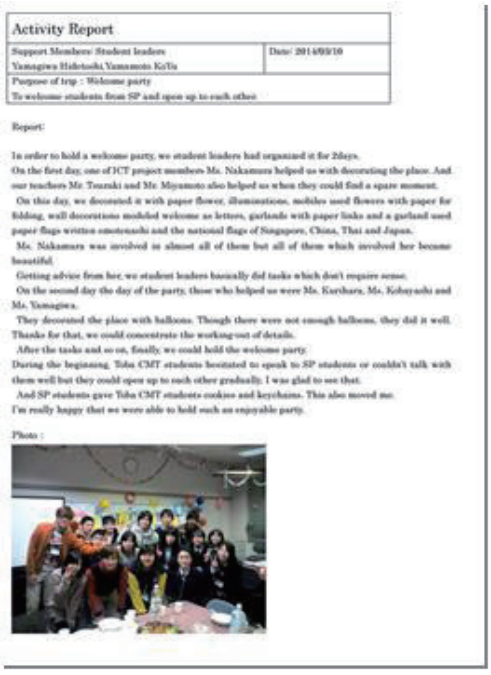
Year	Department	Gender	Institute
2015	Electrical and Electronic Engineering	F	Singapore polytechnic
	Computer Engineering	M	Singapore polytechnic
	Computer Engineering	M	Singapore polytechnic
	Fundamental year	F	Institute of Technology of Cambodia
2014	Computer Engineering	M	Singapore polytechnic
	Info-Communication Engineering & Design	M	Singapore polytechnic
	Info-Communication Engineering & Design	F	Singapore polytechnic

Table 2 Number and attribute of the local support students

Year	Gender	Info.	Mech.	Mari.	Adv.	Total
2015	Male	13	5	1	2	19
	Female	2	0	0	1	3
2014	Male	3	5	1	2	11
	Female	12	2	0	0	14



Figure 2 Communication on group page: Closed group page on the internet worked to communicate for exchange information about activity, share the electrical files



Activity Report

Support Members: Student leaders
Yamagiwa Hidetoshi,Yamamoto KoYu

Date: 2014/03/10

Purpose of trip : Welcome party
To welcome students from SP and open up to each other

Report:

In order to hold a welcome party, we student leaders had organized it for 2days.
On the first day, one of ICT project members Ms. Nakamura helped us with decorating the place. And our teachers Mr. Tsuzuki and Mr. Miyamoto also helped us when they could find a spare moment.
On this day, we decorated it with paper flower, illuminations, mobiles used flowers with paper for folding, wall decorations modeled welcome as letters, garlands with paper links and a garland used paper flags written omotenashi and the national flags of Singapore, China, Thai and Japan.
Ms. Nakamura was involved in almost all of them but all of them which involved her become beautiful.
Getting advice from her, we student leaders basically did tasks which don't require sense.
On the second day the day of the party, those who helped us were Ms. Kurihara, Ms. Kobayashi and Ms. Yamagiwa.
They decorated the place with balloons. Though there were not enough balloons, they did it well.
Thanks for that, we could concentrate the working out of details.
After the tasks and so on, finally, we could hold the welcome party.
During the beginning, Toba CMT students hesitated to speak to SP students or couldn't talk with them well but they could open up to each other gradually. I was glad to see that.
And SP students gave Toba CMT students cookies and keychains. This also moved me.
I'm really happy that we were able to hold such an enjoyable party.

Photo :

Figure 3 Example of activity report: Summary of the activity is written by Japanese students and reviewed by oversea students



Figure 4 Photos taken during cultural exchange and field work program:
(Right) Welcome Party planned by local students
(Left) Field trip at Aquarium to find attractive facts

2.2 Laboratory, Research and Cross-Cultural Experience

Before the project starts, election for both of the dispatch student from foreign institution and local support students belongs NIT, Toba was performed.

Participant students from oversea fill the format and send their information about their topic in application admission form prior to arrival propose a research plan. This helps to authorize the topic of the project.

Support students were also selected as motivated students by announcement to the whole college. Because Toba is located the country side of Japan there were few case to talk in foreign language.

Usually Japanese students need to participate dispatch program to the outside of their country by spending much cost if the students desired to talk in other language. However, this program produces good opportunity for the elemental English speakers to communicate deeply without paying a lot of money.

As shown in Figure 2, communication by using web-based group page was created to start communication through network following the selection of the exchange student and support students. It makes possible for local students and staff to catch the prior information before the oversea students arrive. Exchange students and support the students were able to take the contact to teachers including dispatched institution which gives closer relation between members of the project. Also, during their stay in Toba, the students from the oversea uploaded the photo at the nightly 22 o'clock at accommodation for organizing staff to be sure for their return.

As shown in Figure 3, Japanese students created activity report in English, and then oversea student checked their report. Students from oversea and local support students from NIT Toba were well communicated by working together on field trip to research problems at tourist spot and creating their activity reports.

To encourage smooth communication between students, there were no sufficient rules to strict the activity of the students for this group page. Therefore, students started to share their activity by uploading daily photo during the project as shown in Figure 4.



Figure 6 FY2014:Presentation of the work at hall of Chamber of Commerce and Industry in Toba



Figure 7 FY2015:Presentation of the work at hall of NIT, Toba

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3. Technical research program

During the technical program, common working room which 5th grade and advanced course stay for graduation thesis is able for exchange students to use freely among with the Japanese students. Therefore, foreign students were able to touch to support students and a lot of Japanese students at laboratory. On the other hand, private room accommodation was prepared to ensure privacy.

As shown in Figure 6 and Figure 7, summary of the program including a presentation and a demonstration of the products was given not only to the students at Toba College but also to the community members.

In the case of the project titled "Tourist information display system for foreign travellers", basis of the webpage was developed in cooperation with the Chamber of Commerce and Industry of Toba. Before students from oversea arrive in Japan, they were asked to investigate the location where you want to sightseeing in Ise-Shima region and reported on the survey methods. As a result, Web sites that the information for foreign tourists was found not to be browsed. Creating mechanisms to work with the Web site of Chamber of Commerce and Industry to launch basic information of Toba.

Those results gives that exchange students and support students to be not only loaded with valuable experience but also given a good stimulus for the local area. For international students was able to learn specific ICT technology through system development (PHP, MySQL, various API) as well as the charm of Ise-Shima region through among with a lot of Japanese students.

4. Conclusions

Since FY2014, NIT Toba launched technological exchange based on engineering training program ITC project in Toba.

Students from oversea and local support students from NIT Toba were well communicated by working together on field trip to research problems at tourist spot and creating their activity reports.

Launch of a Web-based group page for the project was carried out to enhance the communication between exchange student, support student and teachers and staff. It helped a lot to understand each other and share the information even before and after the project taking place in Japan.

Oversea students successfully gave a presentation and demonstration about their outcome to share with local students and community. After the project, Japanese students recognized the need of English communication in English through the activity which spend the time together with exchange students, motivation to English learning was grown up. Also, it is successfully offered chances to be aware of the differences between the cultures of other countries.

Acknowledgements

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DEVELOPMENT OF INTERNATIONAL COLLABORATIVE PROJECT IN MECHANCIAL ENGINEERING BETWEEN IVE (HONG KONG) AND KOSEN (JAPAN)

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Abstract

Industry-based student project (IBSP) is a mandatory curriculum requirement for all Engineering Discipline Higher Diploma programmes under the Hong Kong Institute of Vocational Education (IVE). Since 2013, students from IVE have conducted Mechanical Engineering related semester based IBSP in National Institute of Technology, Kagoshima College (KNIT). The paper reported two IVE(Chai Wan) students completed their collaborative IBSP in KNIT in 2015 adopting problem based learning approach.

The main objective of the IBSP is to design and control of an air floating ball mechanism, then, the mechanism will be used as key component of a game station for secondary school students to demonstrate the fundamental fluid mechanics principle to promote engineering programmes. The project involved problem based approach to select power source and actuator to support and control the height of a floating ball. Air flow equation is the key concept to control a floating ball; students studied the flow equation carefully and finally confined the control parameter as air flow velocity through theoretical study and experimental verification. Correlation between simulation result and an experiment work is an important step for applied research study, students in this project conducted a number of computer simulation using fluid flow simulation package in the Solidwork software. Students also conducted experiments using pitot-tube setup to verify the simulation result. It comes to conclusion that the simulation results matched with experimental work. Based on the problem based learning approach, in order to reduce the rotating air flow effect in axial fan and to increase air flow velocity, design of a stator in axial fan and design of centrifugal fan are required respectively in this project. Apart from the mechanical design, the microcontroller control of the actuator, extend to Android based smart phone and tablet control is also included.

The paper reported a successful case of collaborative project supervision between IVE and KNIT for good practice sharing in various aspects. Also, it will address key points to setup general framework for semester based international exchange collaborative project between Hong Kong and Japan.

Keywords: *International Multiple Institutions Collaboration, Technology Exchange for Teacher and Student, MechanicalEngineering, Problem Based Learning*.

Introduction

Students studying the Higher Diploma programmes in the Hong Kong Institute of Vocational Education (IVE) are required to complete a module of industry-based student project (IBSP) in their fifth semester. In order to enhance cross country learning experience, students will be arranged to conduct their IBSP module outside Hong Kong.

Since 2013, students have been arranged to conduct their IBSP module in the Department of Mechanical Engineering, National Institute of Technology (Kagoshima College), Japan. The key procedures and arrangements are well established, which are including recruitment of suitable students, discussion of topic, compromising of the study period, negotiation of accommodation and sourcing of subsidisation.

Two students studying Higher Diploma in Mechanical Engineering from IVE (Chai Wan) were arranged to conduct their IBSP module in Kagoshima NIT from March to May of 2015. Their project is related to fluid flow problem. They adopted the problem based learning approach to finish their project. In the following sections, a successful case of collaborative project supervision between IVE and KNIT is presented for a good practice sharing.

Problem Based Learning

Problem-based learning (PBL) is a student-centered pedagogy in which students gain knowledge through their own research and application of findings to solving open-ended problems. Students learn both thinking strategies and domain knowledge. The goals of PBL are to help students develop flexible knowledge, effective problem solving skills, self-directed learning, effective collaboration skills and intrinsic motivation [Hmelo-Silver, Cindy E. (2004)].

This learning method is very suitable for the IBSP module. Students will be assigned a specific problem. They identify what they already know, what they need to know, and how and where to access new information that may lead to the resolution of the problem. The role of the supervisors (known as the facilitator in PBL) is to facilitate learning by supporting, guiding, and monitoring the project progress [Schmidt, Henk G; Rotgans, Jerome I; Yew, Elaine HJ (2011)]. Two IVE students from Hong Kong conducted their IBSP module in Japan which is a different cultural environment. They adopted the PBL approach to finish their IBSP module.

Student Project Introduction

In order to promote engineering programme in Hong Kong, a game station based on an air floating ball mechanism is going to be design, e.g. children grabbing balls game or ball shooting game, for secondary school students to demonstrate the fundamental of fluid mechanics principle. The aim of this project is to design and make an air floating ball mechanism. The air floating ball mechanism needs to float up a ball to a height around 300 mm and the height is controllable. The mechanism will be used as the key component of the game station.

The drag equation applied to float a ball is

$$F_D = \frac{1}{2}\rho v^2 C_o A$$

This machine will be operated in the atmosphere environment, thus the fluid density (ρ) is 1.2 kg/m^3 for air. The drag coefficient (C_o) is 0.4 for a sphere shape. Where (A) is the cross sectional area of the ball. All of them are constants. The air flow velocity (v) is the most important parameter to affect the drag force. Different balls have been tried. Table 1 shows the air flow velocity required for different balls.

Table 1 – Air Flow Velocity Requirement for Different Ball

	Diameter (mm)	Mass (g)	Velocity (m/s)
Table-tennis ball	39.4	2.45	9.06
Styrofoam ball	49.4	1.97	6.48
Hollow styrofoam ball	49.4	1.1	4.84

Preliminary Experiment

Students used cardboard paper, plastic bottle and a 24 V axial fan to build an initial setup to perform a test to obtain the preliminary result.

Although the nozzle velocity was about 7.42 m/s, only the hollow styrofoam ball can be floated up to a height of 280 mm. A higher air flow velocity is required to float a heavier ball. At the same time, it was found that the high speed (5000 rpm) axial fan generated spinning flow (as shown in Figure 1) to cause unstable movement of the ball.

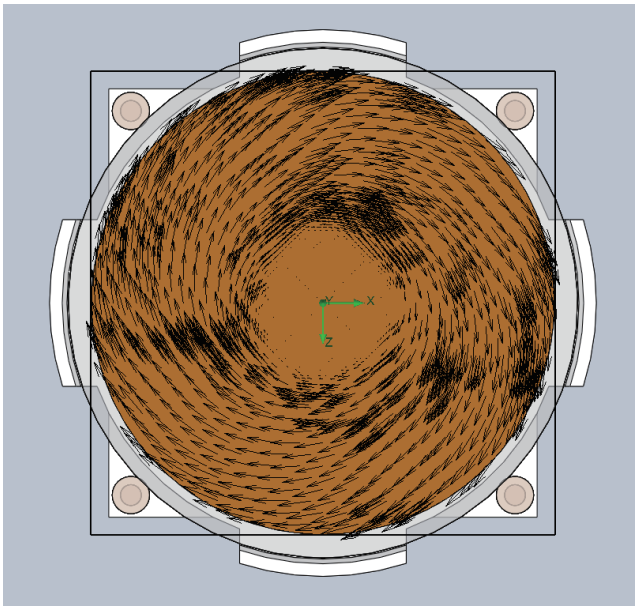


Figure 1 – Software Simulation Top Veiw of the Nozzle to Show the Spinning Flow

The two students compared the air flow generated by axial fan and centrifugal fan as shown in Table 2. They was divided their work load to concentrate on one source. That means one student worked in axial fan and the other worked in centrifugal fan.

Table 2 – The Comparisons of Axial Fan and Centrifugal Fan

	Axial Fan	Centrifugal Fan
Flow rate	Low	High
Pressure	Low	High
Noise	Low	High
Availability	Commercial market	Tailor-make
Cost	Low	High

The following sections report their works and results of their design.

Axial Fan Solution

After some initial studies, the student decided to use a stator to solve the spinning flow problem. He started the design with the shape of the stator. Stators can be straight or curved as shown in Figure 2 and Figure 3.

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Figure 2 – Straight Stator



Figure 3 – Curved Stator

The student then applied the fluid flow simulation package in the Solidwork software to obtain the results of different stators. According to the result as shown in Figure 4, the straight stator cannot reduce the spinning problem very much. However, from Figure 5, it was found that the curved stator is better than the straight stator in solving the spinning problem.

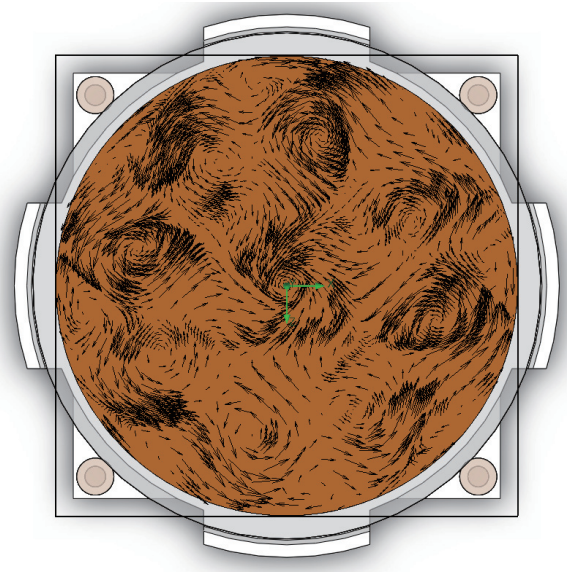


Figure 4 – Software Simulation Top Veiw of the Nozzle with a Straight Stator

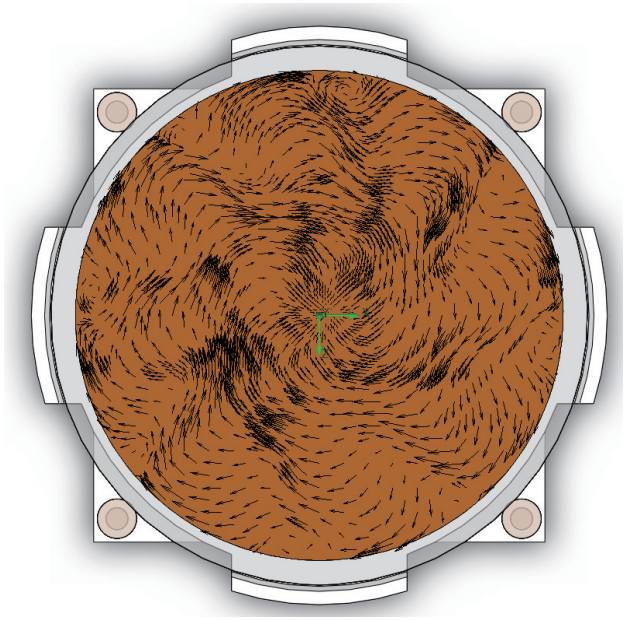


Figure 5 – Software Simulation Top Veiw of the Nozzle with a Curved Stator

The following design is about the number of blade. Student used the software simulation again to obtain the best design. After comparison of the simulation results as shown in Figure 6, Figure 7 and Figure 8, the 7-blade stator provides a more stable flow than 8-blade stator and it can provide about 0.4 m/s faster velocity than that of 6-blade stator. Therefore, the final design is 7-blade curved stator.

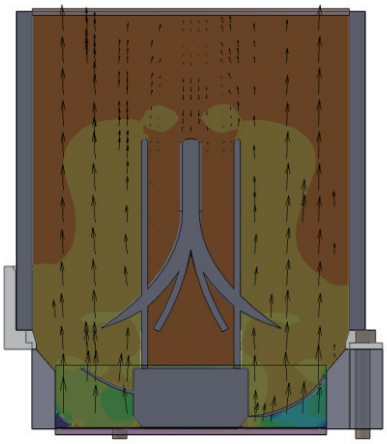


Figure 6 – Software Simulation View of Flow with 8-blade Stator

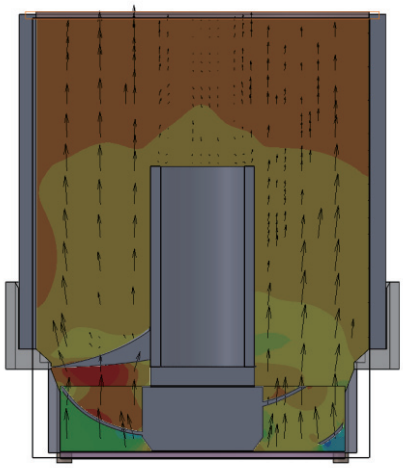


Figure 7 – Software Simulation View of Flow with 7-blade Stator

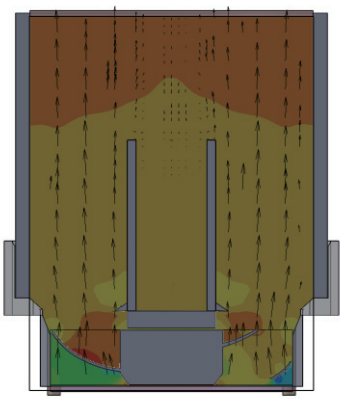


Figure 8 – Software Simulation View of Flow with 6-blade Stator

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From the simulation, it was found that there is a low pressure zone in the middle of the tube just above the stator as shown in Figure 9. In order to improve the stability of the air flow, the student re-designed the stator with a cone shape to reduce the pressure drop as shown in Figure 10. Figure 11 shows the final design of the stator.

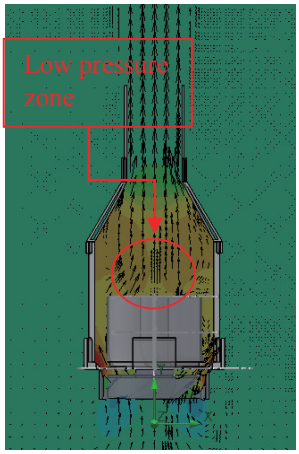


Figure 9 – Software Simulation of the Pressure Distribution Without Cone

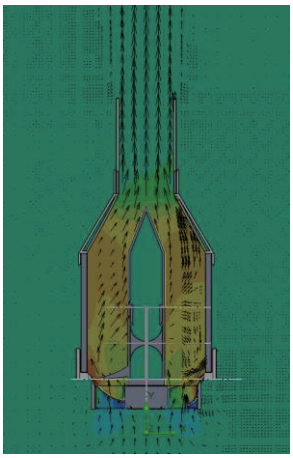


Figure 10 – Software Simulation of the Pressure Distribution With Cone

The final design was constructed in the Solidwork drawing and produced by a 3D printer. The product was then tested experimentally by measuring the velocity with a pitot tube setup. The ball can be floated stably above the nozzle with desirable height. Figure 12 shows the assembly of the design.

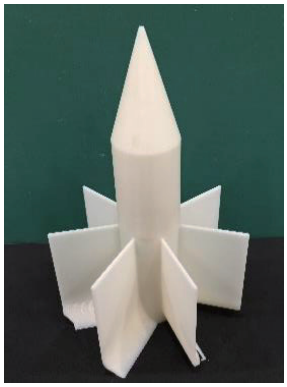


Figure 11 – The 7-blade Stator with Cone



Figure 12 – The final assembly of the air floating ball mechanism

Centrifugal Fan Solution

Another student tried to design and make a centrifugal fan to produce a more powerful air flow source. He studied the parameters of design a centrifugal fan with the reference of Malcolm J. McPherson (1993), *Fan*. Retrieved from https://www.mvsengineering.com/files/Subsurface-Book/MVS-SVE_Chapter10.pdf. Figure 13 shows some important parameters. There are two types of blade: backward-curved blade and forward-curved blade as shown in Figure 14 and Figure 15.

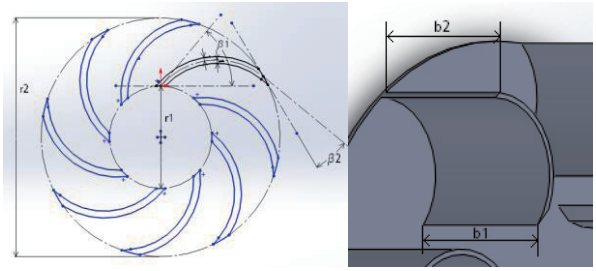


Figure 13 – Design Parameters of a Centrifugal Fan

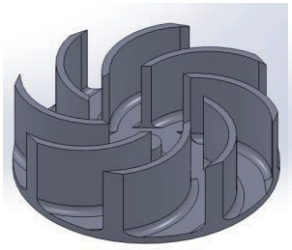


Figure 14 – Backward-curved Blade

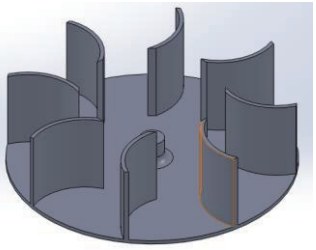


Figure 15 – Forkward-curved Blade

Some prototypes are made by 3D printing. Experimental test was conducted to check the performance of the prototypes. Some of them were broken during the test due to weak strength of 3D printing product. Table 3 shows the two successful final tests.

Table 3 – Test Results of Two Prototypes

	8 forward-curve blades	12 backward-curve blades
Flow velocity at nozzle	30 m/s	31 m/s
Rotational speed	8200 rpm	9400 rpm
Voltage	7.2 V	7.2
Current	4.6 A	3.6 A

Based on the test result, 8 forward-curved blades was selected as the centrifugal fan as the air flow source. The reason is that it can provide the similar air flow velocity in a lower rotational speed. Lower rotational speed can keep the noise low.

Spinning flow also occurred in the centrifugal fan. Therefore, stator is also added to improve the stability of the flow. Figure 16 and Figure 17 show the different between without stator and using stator.

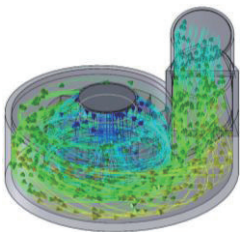


Figure 16 – Flow Simulation Without Stator

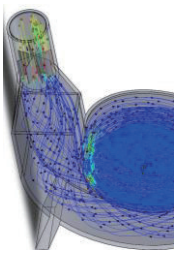


Figure 17 – Flow Simulation Using Stator

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One more problem was also found during the test. The rotor moved out along the rotation axis. It is due to the pressure difference between the rotor blade and back plate as shown in Figure 18. To solve the problem, the student re-designed the rotor with holes on the back plate (as shown in Figure 19) to reduce the pressure difference. Figure 20 is the assembly of the centrifugal fan.

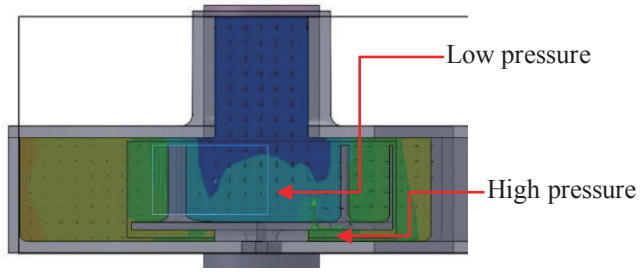


Figure 18 – Software Simulation of Pressure Distribution

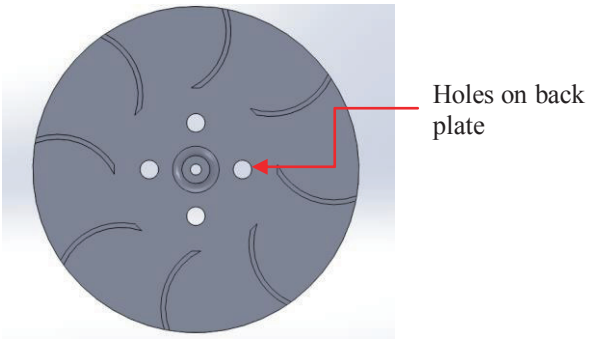


Figure 19 – New Design with Holes on Back Plate to Reduce Pressure Difference

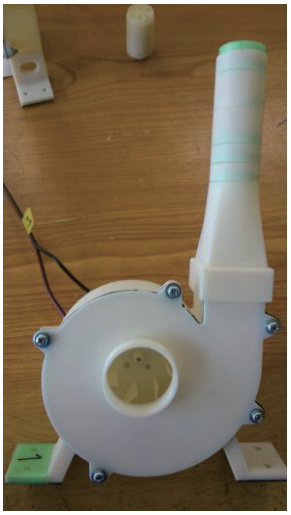


Figure 20 – The Assembly of the Centrifugal Fan

The student also determined experimentally the minimum distance between two parallel fans, which are not interference each other. He used a series of ribbons to visualise the flow as shown in Figure 21. The minimum distance between two parallel fans without interference is 200 mm as shown in Figure 22.

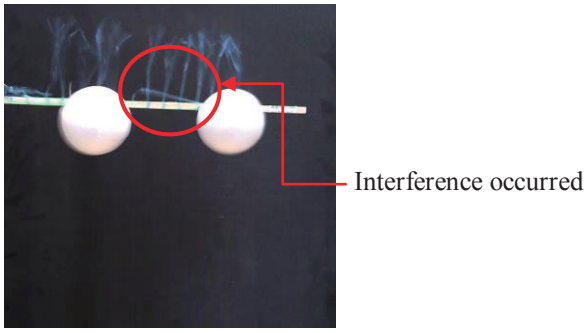


Figure 21 – Ribbons Showing the Interference

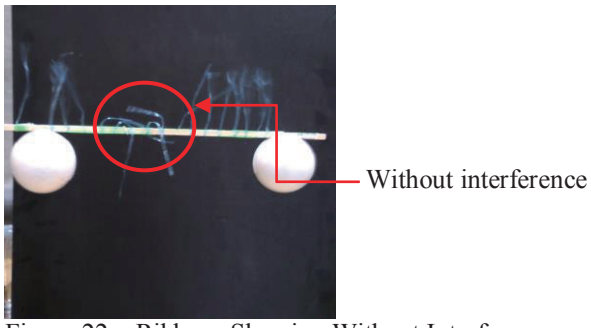


Figure 22 – Ribbons Showing Without Interference

Control of Motor Speed

Controlling the motor speed can change the air flow velocity, and hence, adjust the height of the ball. Both solutions are using the Arduino to control the motor speed. Using a bluetooth module, a mobile phone application was also developed to control the motor speed through an Android based smart phone.

Conclusions

Under the well arrangement between IVE and KNIT, the students performed very well during the learning process in Japan, although they conducted their IBSP module in an unfamiliar environment. The students designed and made the air floating ball mechanisms, which will be an important component of a game station. The outcomes of the students demonstrated that the goals of PBL are achieved in the aspects of develop flexible knowledge, effective problem solving skills, self-directed learning, effective collaboration skills and intrinsic motivation. The results proved that the collaboration between IVE and KNIT is beneficial to students. A framework of semester based international exchange collaborative project between Hong Kong and Japan is successfully built.

Acknowledgements

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Joint-Nanyang Polytechnic-National Institute of Technology Nara College Enhanced Student Exchange Programme: Planning, Observation and Evaluation using the Community of Inquiry Framework

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Abstract

The Community of Inquiry framework describes how learning takes place in an online learning environment through the educational transaction that occurs at the intersection of social, teaching and cognitive presence (Garrison, Anderson and Archer, 2000). Social presence is the ability of participants to communicate purposefully in a trusting environment, develop inter-personal relationships and establish group cohesion. Cognitive presence is the extent to which learners are able to construct and confirm meaning through sustained reflection and discourse. Teaching presence is the design, facilitation, and instructions by the teacher to enhance the educational experience.

A typical Student Exchange Programme involves students from both countries meeting-up for one or two days mainly for cultural exchange. This newly introduced Enhanced Student Exchange Programme, started in the year 2014 , involved a total of 53 Nanyang Polytechnic (hereafter NYP) and 44 National Institute of Technology Nara College (hereafter NITNC) students (inclusive of the one conducted this year) divided into groups of five to six students. They had collaborative online discussion six weeks ahead of their face-to-face discussion on a chosen project. Project of global interest like, how to reduce food waste, how to reduce plastic waste, propose a healthy daily diet to promote healthier living and how to prepare the community to face the aging population were given to them. During this six-week duration, they exercised and experienced the social and cognitive presence via social media such as email, LINE, Skype and Facebook in learning, studying and finding the solutions to their chosen project. NYP and NITNC staff were present to monitor the communications and developed the teaching presence with the students. Finally the NITNC students came to NYP for a three-day face-to-face discussion with NYP students and jointly presented their findings to a panel of NYP and NITNC staff. This paper shares the authors' experience in using the Community of Inquiry framework to plan, observe and evaluate the whole programme.

The method used to collect data and feedback were observation notes by the teachers, self-reflective notes and end-project survey by the students. A total of 13 end-project survey questions on social, cognitive and teaching presence were designed and given to the students to pen their feedback and comments. The majority of them felt that this was an excellent programme. The authors share the experiences, student feedback and observations made in this Enhance Student Exchange Programme.

Keywords: *Community of Inquiry, ICT enabled learning, exchange programme*

Introduction

NYP and NITNC started this Joint NYP-NITNC Enhanced Student Exchange Programme in the year 2014 where an equal number of NYP and NITNC students formed groups to discuss their chosen projects online for six weeks. After that the NITNC students came to NYP, met NYP students for a three-day face-to-face meeting, discussed and presented their findings and solutions to the teachers. Topics on aging population, food waste, plastic waste and healthier diet to promote healthier living were given to the students to prepare them for globalization and to raise their awareness of global issues. Around mid-January (2 months before the actual event on the NYP campus), briefing was given to all NYP and NITNC students to give them a better insight of this project. The teachers explained to them the programme objectives, the design of the programme, evaluation criteria for the project and presentation.

This programme required the students to discuss via online communication (such as Skype, e-mail, LINE.) six weeks before the NITNC students came over to Singapore to do project presentation together. There were eight groups in total and each group consists of five to six NYP and NITNC students. Through online discussions, students decided on matters such as the role

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of each member, work allocation of each side, how to do research together, etc. When NITNC students came to NYP from 11- 13 March 2015, they were given time again to continue discussion and to prepare presentation material. On 13 March 2015, each team was given 15 minutes to present. The presentation was in English and all members had to present. Gold, Silver and Bronze Awards were given to winning teams based on their creativity, content and presentation skills.

Two groups were selected as focus group which their Skype and other online discussions were closely monitored by the teachers. However, the teachers would not actively participate in their discussion. NYP and NITNC students had to independently initiate the discussion time, come up with meeting agenda, "to-do" list and more. They were asked to fill up self-reflective note each time after they finished the Skype discussion.

The Community of Inquiry framework (CoI)

The Community of Inquiry (CoI) was first introduced by C.S. Peirce and John Dewey to articulate the nature of knowledge formation and the process of scientific inquiry. It was later widely applied by several academic scholars such as Garrison R., Anderson T., Archer W. to analyse the use of computer-mediated communication in supporting an education experience (Garrison and Anderson, 2003, Garrison, Anderson, Archer, 2000).

CoI consists of three elements namely, Social Presence, Teaching Presence and Cognitive Presence.

Social Presence: It emphasizes the engagement with participants and to what extent the learners feel connected to one another. According to Garrison et. al. (2000), they described social presence as the projection of learners' personal characteristics into a community of inquiry through use of emotional expression, open communication, and various means to establish group cohesion.

Cognitive Presence: It emphasizes on the extent learners are able to construct and confirm meaning through sustained reflection, discourse and application. Through the process of exploration (exchange of information), integration (connect ideas through reflection) and resolution (apply new ideas), learners can achieve better communication skills to enhance the education experience.

Teaching Presence: It emphasizes the design of the programme, facilitation and instructions given by the teacher. In order to enhance the education experience, teachers should design the programme carefully with clear guidelines and instructions given to the participants. Also, the teacher, as a facilitator, has to engage and encourage the participants to take part actively in the activities and programme.

Figure 1 illustrates how these three elements overlap with each other to form the educational experience. Some examples of the three elements reported by Garrison in 2007 are summarized in Table 1.

Figure 1: Elements of an educational experience (Garrison, Anderson, Archer, 2001)

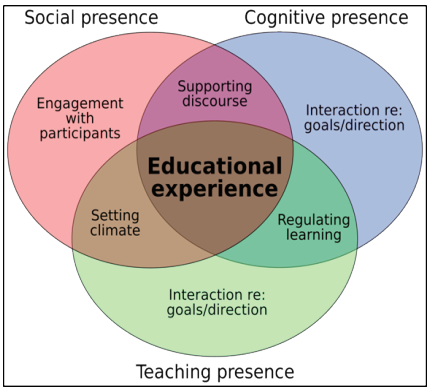


Table 1: Some examples of Social, Cognitive and Teaching presence (Garrison 2007)

Elements	Categories	Indicators
Social Presence	**Effective Expression**	**Emoticons**
	Opening Communication	Risk-free Expression
	Group Cohesion	Encourage Collaboration
Cognitive Presence	**Triggering Event**	**Sense of Puzzlement**
	Exploration	Information Exchange
	Integration	Connecting Ideas
	Resolution	Apply New Ideas
Teaching Presence	**Design & Organization**	**Settling Curriculum & Methods**
	Facilitating Discourse	Sharing Personal Meaning
	Direct Instruction	Focusing Discussion

Methodology

Both NYP and NITNC teachers used the following methods to collect data from students:

Observation Note

Teachers observed their Skype discussion and noted down the comments, student participations, improvement areas and etc.

Self-reflective Note

Students were asked to fill up a self-reflective note each time after they finished the Skype discussion. The note was used to check on each CoI element during the online communication. In the note, there were questions such as problems the students had noticed during the discussion and how they tackled with the problems (Cognitive presence). They were also asked if they felt the discussion became smoother and if they had better bonding over time (Social presence). Also, there were questions to ask students if the instruction given by teachers were adequate (Teaching presence).

End-project Survey

At the last day of the project (13 March 2015), students were asked to give feedback. Similar to "Self-reflective note", the questions in the End-project survey were meant to check on each CoI element during the online communication.

Results and Discussion

The results collated were based on the 13 End-project Survey questions and observations made. Eight of the 13 questions are quantitative questions (tabulated in table 2) with score from 1 to 5 (1= Poor; 5= Excellent). The other five questions are open ended questions.

	Quantitative Feedback Questions	Average Score		Difference
		NYP	NITNC	
1	Instructions given about the programme and project were clear and sufficient	4.32	3.90	0.42
2	Objectives of the projects were well-explained	4.00	3.60	0.40
3	Online communications get smoother and fruitful after the first few sessions	3.80	3.95	0.15
4	Team bonding gets stronger over time	4.08	3.95	0.13
5	Better and more confident in communicating with teammates over time	3.96	3.95	0.01
6	More aware of the cultural differences in Japan and Singapore	4.16	4.00	0.16
7	Have improvements in language ability (Japanese for NYP students and English for NITNC students)	3.24	3.50	0.26
8	Are you satisfied with the project outcome	3.92	3.95	0.03
	Overall Average Score	3.94	3.85	0.195

Table 2: Results of Quantitative Feedback Questions

The overall average score for NYP and NITNC are 3.94 and 3.85 respectively. This shows that the students find that this is a good and beneficial programme. The difference in the average score for the NYP and NITNC students were pretty close for most of the eight questions except for question one and two. This was attributed to the different method of explaining the instructions and project objectives to the students from both sides. One way to improve this is to have a common set of briefing materials and/or brief both the NYP and NITNC students via teleconferencing at the same time.

Question seven has the lowest score of 3.25 for NYP and 3.50 for NITNC. This is due to the fact that it takes time to see significant improvements in learning a foreign language. NYP students gave a lower score because they used English to communicate most of the time during the online and face-to-face discussions. Hence, they have slightly lesser chance to practise their Japanese Language during this programme.

The discussion of the results from NYP side and NITNC side are as follows:

NYP Side

Teaching Presence

Design and Organization

The objectives of the project are to prepare our students for globalization, increase their awareness of global issues, improved their communication skills and deepen cultural understanding of both Japan and Singapore. In order to achieve these objectives, each team was given topics such as aging population, food waste, and plastic waste and healthier diet to promote healthier living. The topics required them to explain the current situation of their countries, make comparison and suggestions to improve the situation. As mentioned earlier, they had to discuss via online means for six weeks before NITNC students come over to Singapore to meet up with their NYP teammates for a 3-day exchange programme. Students were given time to continue discussion and prepare their presentation material. A briefing of this programme was conducted by the teachers.

Most of the student feedback in the end-project survey that the objectives and design of the programme were well-explained and an average rating of 4.00 was recorded.

Direct Instruction

Most of the NYP participants have taken the module "Advance Japanese" at NYP. Hence, they are able to engage in daily conversation in Japanese with their NITNC teammates. To further smoothen the discussion process, some useful Japanese phrases were introduced to them by the teachers. Students were also asked to prepare meeting agenda and "to-do" list. Students were asked to speak slowly, be more articulate and avoid using Singlish. According to the End-project survey, most of the students agreed that the instructions given by the teachers were clear and sufficient, with an average rating of 4.32.

Facilitating Discourse

During online communication, there was no direct intervention by the teachers. It was mainly led by the students. The teachers acted as facilitator and observed their discussion. Students had to initiate discussion and tackle problems by themselves. Comments from the teachers were given to the students only after the discussion ended.

Social Presence

Open Communication

It refers to how our students express themselves freely without reservation. From the self-reflective notes, there were comments such as "I felt that both NYP and NITNC students were more comfortable with each other", "we were more relax and not that awkward compared to the first time", "… open minded and humorous which made us happy". It shows our students became more comfortable with their counterparts over time and developed trust. Besides, according to the End-project survey, students agreed that they became better and more confident in communicating with their teammates over time. The average rating was 3.96.

Group Cohesion

We received positive feedbacks from participants with regards to group cohesion. They agreed that "it is a good chance to bond", "I am really looking forward to the next meeting and hope to see them in Singapore

soon". The overall rating from the End-project survey was quite high (4.08). It shows that students agreed that the group bonding became stronger over time.

Cognitive Presence

Triggering Event

The teams identified a few challenges during the Skype discussion such as communication due to language barrier, cultural differences and different ways of expressing ideas on the selected project. This has led to a little bit of awkward silence during the first few video call sessions.

Exploration

To tackle the problems and turn the awkward silence to productive outcome (Information exchange), the teams came up with some ideas such as "we have tried speaking in Japanese, using hand gestures as well as simple hand written English words", "speak slower and with more clarity". They also used paper to write down English or Japanese to show the other side and "google document" to help carrying out their discussion. All these helped them to smoothen the process of information exchange. The team also commented that "they did well to respond to the problems by tackling them systematically and finding effective ways to solve these problems".

Integration

The average rating for awareness of cultural differences in the End-project survey was 4.16, which was quite high. It was observed that the six weeks of online communications has helped to bridge the cultural barriers prior to the face-to-face meeting in NYP. Hence, the teams were able to understand each other reasonably well during the face-to-face discussion and integration of ideas.

Resolution

After a few rounds of discussion, the groups were more certain of what they had to do. They came up with ideas such as making prototypes, conceptual drawings, and video in their project presentations.

NITNC Side

Teaching Presence

Design and Organization

The objectives of the programme were: to provide the students with opportunities to communicate in their target language, to improve their international communication skills through discussion on issues common to both countries, and to increase their awareness of cross-cultural understanding. The students were asked to report on the progress of their group project twice. In the first report, two weeks after the discussions, each group filled in a project progress report sheet on five categories: roles, research content, discussion (exchange of opinions), structure of a presentation, and conclusions. The project progress report sheet was used to guide the students in understanding how to proceed with the project with their group members. The second report on the progress of the project was given verbally by each group leader to all members of the exchange programme one week before they departed for Singapore. Most of the students thought the objectives and design of this project were reasonably clear, as shown in the End-project survey form with an average rating of 3.60.

Direct Instruction

The teachers provided a list of useful expressions to the students in order to help them discuss their topic in a logical way with NYP students. According to the End-project survey, some students appreciated the fact that when they attended the exchange programme on NYP campus, the NYP teachers gave clear instructions in English, and only used Japanese if NITNC students failed to understand. One student, who had some experience of giving a presentation, remarked that the goal of the project was not clear and gave a relatively low rating (fair 2). Those who participated in the Skype meetings tended to think that the instructions given by the teachers were fairly sufficient. In the Self-reflective notes, one student who engaged in the second Skype meeting said, "I felt it was important to solve issues by myself, without being afraid of making mistakes." The average results of the End-project survey was 3.90.

Facilitating Discourse

For the project, the students generally talked to NYP students online (mostly LINE and Skype) without intervention from teachers, with the exception of the two groups who participated in two Skype meetings. Some students reported that it was hard to understand the spoken accent (i.e. pronunciation), the slang and abbreviations used by the Singaporeans. In the Self-reflective notes written by participants of the Skype meetings, one group commented on the difficulty of listening to NYP students in the first meeting because of a poor Skype connection. To make up for the poor connection, NYP students wrote down questions on a piece of paper and held it up to the screen to NITNC students as a visual aid. In the second Skype meeting, the NYP students used Google documents as a supplemental tool for online communication. The NITNC students in the group remarked that this Google document was helpful, and they had no difficulty during the second Skype meeting.

Social Presence

Open Communication

In the Self-reflective notes, one student remarked that he was able to express his thoughts better than on the first meeting because his group used Google documents for the second discussion. A small number of students reported that they thought they could not express themselves well enough because they were shy. Two groups commented that they had difficulty setting up a meeting time for an online discussion that suited all group members. The End-project survey showed that

students generally became more confident about talking with their teammates. The average rating was 3.95.

Group Cohesion

It was observed that the group cohesion improved over time. After the first Skype meeting, they showed a clear interest in setting up a second one. During the discussion, one of the students said, "It is really fun." Although the two focus groups were officially asked to engage in two Skype meetings, one of the two groups decided to set up the third one voluntarily during the second Skype meeting. The result of the End-project survey showed that most of the students thought the bonding within the group became stronger. The average rating was 3.95.

Cognitive Presence

Triggering Event

The students who engaged in the Skype discussions reported that a bad Skype connection caused difficulties in online discussion. This technical issue led them to use paper and Google documents as alternatives. In the Self-reflection notes, some students reported that they became aware of their insufficient English vocabulary knowledge and low English proficiency. In the End-project survey, some students commented that they did not have enough time for online discussion due to the pressure of the final-term exams.

Exploration

Some students intelligently bridged the communication gap by using dictionary and web-based translation services during online and face-to-face discussions. Students participated in the Skype meetings reported that they used Google documents, diagrams, and gestures to communicate smoothly. One student in the focus group reported that valuable advices from a teacher in the exchange programme was sought regarding statistics on the aging population in the two nations he had compiled in preparation for the group discussion of the second Skype meeting. One student said that since he did not have enough time for online discussion before visiting Singapore, he tried to use the time in NYP efficiently.

Integration

In the End-project survey, most of the NITNC students reported that they became more aware of cultural differences between them and their Singaporean counterparts. They gave an average rating of 4.00. One student reflected that the topic he worked on was difficult to discuss, and suggested that it would be better to discuss an issue common to Japan and Singapore in terms of statistical information.

Resolution

Through online discussions before visiting Singapore, and subsequent face-to-face talks on the NYP campus, students shared their researched findings on the chosen topic, exchanged opinions, and sharpened their ideas before doing their presentation. In the presentation, most groups compared the research they had carried out on domestic issues of both nations, and offered suggestions for the future, including practical solutions. Some groups created a prototype and demonstrated how it could be used and applied.

Conclusions

The NYP and NITNC students had a better understanding of cultural differences as a result of participating in the project. Since they had to discuss many issues for the project, they have learnt to gather information and exchanged their findings. The project activities seemed to help them become more aware of differences and similarities between the two nations.

It was observed that the language improvement was less significant among NYP and NITNC students since the event period was short. It was a challenge for the students to communicate as they had to toss between Japanese and English Language. However, with the common goal of working towards the completion of their projects, it motivated them to find all possible means to integrate and finalise their project ideas.

As discussed in a previous study (Arnold and Ducate, 2006), at the exploration and integration phases, all students worked collaboratively to share their ideas and information on their chosen topics. At the resolution phase, the presentation induced the students to apply their newly-obtained knowledge to the creation of prototypes and to put on some skits for the audience.

All participants went through a series of project procedures: online pre-meetings, face-to-face discussions on the NYP campus, and a group presentation. In each phase, the students in the respective groups had good opportunities of interacting with each other for communication purposes. This eventually helped them strengthen group cohesion and bonding.

The two focus groups had the advantage of being assisted by the teachers in the setting up the two Skype meetings. Students who had technical support began to communicate with their counterparts quicker than groups without assistance. The teachers' presence also facilitated their online communications and enabled the students to engage in dynamic discussions. The smooth start to online pre-meetings seemed to provide more opportunities for the focus groups to communicate with each other, and they bonded in friendship more easily, compared to the rest of the groups.

To conclude, through observations by the teachers and comments collected from the students, this Joint-NYP-NITNC Student Exchange Programme has proven to be a good platform to prepare the students well in bridging the gap in communication in this increasing globalized world. It enhanced the student learning experience and gave the students the first-hand experience in facing the challenges of working online with overseas counterpart of different culture and language. The CoI was a good framework used to guide, plan and assess this programme. It helps support the complete educational experience for the students. However, students gave feedback that six weeks of discussion was too short and some groups were not able

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to fix a Skype meeting due to exams and tight schedule. Therefore, as an area of improvement, we will extend the discussion period to two months. Also, each group will be asked to fix Skype discussion at least two times prior to the event.

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