Topic 4

Educational Models and Approaches
ENHANCEMENT OF EDUCATIONAL AND RESEARCH ACTIVITIES BY “PRELAB” SYSTEM

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Abstract

The declining birth rate and aging population have caused decline of the national strength and international competitiveness in Japan. The Ministry of Education, Culture, Sports, Science, and Technology has been promoting “Regional revitalization strategy”, and the ministry has demanded educational institutes to nurture human resources who can solve various issues with local companies. To respond to these demands, we NIT, Nagaoka College established the System Design Innovation Center (SDIC) in 2015. The center has nurtured innovative human resources using various measures such as engineering design education, cross-department education program named JSCOOP; job search for local companies based on cooperative education, and Prelab (pre-laboratory) system, which supports exploratory educational research. This paper describes the detail of Prelab system (Prelab), and discuss the ripple effect on the education and research activities of ourKOSEN.

The basic philosophy of "Prelab" is to support faculty members' exploratory research and research activities for underclassmen who are equivalent to high school student. The Prelab consists of three major policies, which are "(A) Supporting exploratory research and realization of ideas", "(B) Holding various seminars", and "(C) Discussing new education methods". Also, all faculty members can propose any contents to all students and faculties. There have been 15 proposals raised in total since August 2015 in which the system was established. While there were only two research groups out of 15 proposals, the core member consisted of the third-year students and a technical personnel participated in the lab group. The questionnaires showed that the students' motivation was improved, and also research motivation of them was higher than we had expected. We will strongly promote this system.

Keywords: Project-Based Learning, Engineering education, High-school student, Prelab

Introduction

Recently, the declining birth rate and aging population have caused decline of the national strength and international competitiveness in Japan. The Ministry of Education, Culture, Sports, Science, and Technology has been promoting “Regional revitalization strategy”, and the ministry has demanded educational institutes to nurture human resources who can solve various issues with local companies (MEXT, 2015). Also, the Japanese government has been vigorously promoting the globalism in the field of education because of Japan’s policy of accepting international students and acceleration of overseas transfer of Japanese factories. Therefore, educational reforms are demanded fundamentally to the field of education.

We NIT, Nagaoka College had performed to nurture having the practical and innovative-minded human resources since its establishment. However, these policies were not at all satisfied with current social demands. Therefore, to respond to them, we established the System Design Innovation Center (SDIC) in 2015 (Fig. 1). The center has nurtured innovative human resources using various measures (Toyama, S., 2015). Especially, the SDIC consists of three major policies such as Engineering Design Education (EDE), JSCOOP (Job Search for Local Companies Based on Cooperative
Education, and Prelab (pre-laboratory) system. EDE is a cross-department education program. The students learn about system thinking, design thinking and facilitation skill, which seem to be required for innovative personnel. System thinking means paying attention to the connection between each element and interaction related to the behaviour of the whole of system. Design thinking is a technique to develop products and service for social themes and needs and to explain their value as a story (Maeno, T., 2014). Facilitation skill is one of leadership to activate organization and participants with the support of consensus building and mutual understanding in meetings (Oishi, K., 2011). JSCOOP program is to nurture students’ problem extracting and solving abilities with regional companies. The students go to regional companies to collect their information, and then they make public relations articles of the company. It is useful for nurturing abilities of carrier designing, collecting information, and information transmission. The Prelab system can support exploratory educational research of faculties and active research of underclassmen. This paper describes the detail of Prelab system (Prelab), and discuss the ripple effect on the education and research activities of our KOSEN.

**Outline of Prelab System**

The basic philosophy of "Prelab" is to support faculty members’ exploratory research and research activities for underclassmen who are equivalent to high school student. The Prelab consists of three major policies, which are "(A) Supporting exploratory research and realization of ideas", "(B) Holding various seminars", and "(C) Discussing new education methods" (Fig. 2). Also, all faculty members can propose any contents to all students and faculty members. When the proposers want to recruit the collaborators, they can announce it using a message board, email, and announcement by homeroom teachers. Usually, researchers who belong to general educational faculties and technical personnel are difficult to conduct research because of not having their laboratory and human resources in KOSEN so far, however, they can attempt to establish their own laboratory using this Prelab system. Also, all faculty members can discuss their ideas with all members. Therefore, it is expected that collaborative works and the number of grant application are increased by Prelab.

**Figure 2. Enhancing research and educational activities using three major policies**

On the other hand, underclassmen can participate in laboratory research using this system if they have an interest in research activity. Generally, KOSEN students like “monozukuri”, making something and experimental work (Fig. 3). However, underclassmen do not have a lot of experimental classes and opportunities for research activity. There are some reports that the study motivation of some students is to gradually decline for this reason (Yoshida, M., 2008). We have to make countermeasures against this rapidly. The missions of Prelab system are to prevent this issue and keep students’ motivation for monozukuri. Actually, there are some reports that underclassmen research activity can prevent declining their study motivation (Yoshida, M., 2008, Miki, K., 2010). If we can use Prelab system effectively, there are many possible merits for faculty members and students. The Prelab system is one of the suitable tools for enhancement of educational and research activities.

**Table 1. Detail of all Prelab proposals**

<table>
<thead>
<tr>
<th>Theme</th>
<th>Target person</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>GK seminar</td>
<td>All persons</td>
<td>B</td>
</tr>
<tr>
<td>Earthquake protective potential introduction of earthworms' functions and recruiting Prelab members</td>
<td>All persons</td>
<td>A</td>
</tr>
<tr>
<td>Investigation of volcanoes in Kagoshima etc.</td>
<td>Upper 3rd year students</td>
<td>A</td>
</tr>
<tr>
<td>Recruiting delivery lecture assistant of “Let’s enjoy using Robots!”</td>
<td>All persons</td>
<td>C</td>
</tr>
<tr>
<td>Recruiting delivery lecture assistant of “Let’s enjoy using Robots!”</td>
<td>All persons</td>
<td>A</td>
</tr>
<tr>
<td>PHE solar car project -Solar cell production practice (1st term)</td>
<td>All persons</td>
<td>A</td>
</tr>
<tr>
<td>Recruiting delivery lecture assistant of “Decode the optical signal of remote controlled toy”</td>
<td>All persons</td>
<td>C</td>
</tr>
<tr>
<td>Encouragement in electrical wiring for girls</td>
<td>Female students only</td>
<td>B</td>
</tr>
<tr>
<td>Class class “Mathematics using active learning”</td>
<td>Faculty and staff</td>
<td>C</td>
</tr>
<tr>
<td>Mathematics study meeting</td>
<td>Faculty and 2nd year students</td>
<td>B</td>
</tr>
<tr>
<td>Let’s make the only one object in the world</td>
<td>All persons</td>
<td>B</td>
</tr>
<tr>
<td>Practical learning of technology as a subject in junior high school</td>
<td>Faculty and staff</td>
<td>B</td>
</tr>
<tr>
<td>Regional construction activity using earthworms recruiting Prelab members</td>
<td>Upper 3rd year students</td>
<td>A</td>
</tr>
<tr>
<td>Class class “Mathematics for 4th grade” using active learning</td>
<td>Faculty and staff</td>
<td>C</td>
</tr>
<tr>
<td>Recruiting delivery lecture assistant of “Let’s enjoy using Robots!”</td>
<td>All persons</td>
<td>C</td>
</tr>
</tbody>
</table>
was roughly suitable. Furthermore, there were three limited themes for faculty members. It was revealed that Prelab was beneficial for sharing information among faculty members (Fig. 4). For other examples, there were recruitment of assistants for public lectures and monozukuri seminar announcement (Fig. 5).

While there were only two research groups out of 15 proposals, the core member consisted of under the third-year students. One laboratory group consisted of multiple department students and a technical personnel. Prelab actually contributed to activate the activities of education and research in our KOSEN.

**Figure 4.** The open class scenery of "Mathematics using active learning"

**Figure 5.** The monozukuri seminar: "Let's make the only one object in the world!"

### Detail of laboratory activity

#### 1. Research theme and participating motivation of students

There has been a concern underclassmen can research continuously. Here, we introduce one case of the Prelab activities and discuss its educational effect for underclassman.

The theme is a "Regional contribution activities using earthworms". The participants were 13 students; four 1st graders, two 2nd graders, six 3rd graders and one 4th graders on 5th Feb. 2016. In addition, one technical personnel, whose research field was not biology but electrical and electronic systems engineering, participated in the same lab. group. They were divided into four small research groups since there were a lot of participants.

#### 2. Actual activity

First-year students of our college start to take an experimental class from second semester, so we had to teach them how to take notes and use MS Office software before our research in order to start the activity at first semester. Since participants have a lot of classes and they belonged to various club activities as well, it was difficult to fix the research date. To encourage participants, we gave each group a small goal of research presentation, at an annual academic meeting for underclassmen and our college, for improving their research and presentation ability.

As a result, all research groups could summarize their research and present it at our College festival (Fig. 6). Furthermore, one of the groups presented their research at a high-school student category of annual academic conference (Fig. 7) (Saito, H., 2016). They explained their research to many people at the presentation diligently.

The students also attended at the symposium of novel prize winner. They listened to the lecture seriously and one of the students succeeded to get the

**Figure 6.** The poster display space at our college festival

**Figure 7.** The poster session at the 2016 annual conference of the Japan society for bioscience, biotechnology and agrochemistry
autograph of the winner.

The questionnaires after the conference showed that the students’ motivation was improved, and also their research motivation was higher than we had expected. Currently, we try to raise the research to the next stage.

Promotion of Prelab System

The current problem of Prelab is the low recognition because of the poor information system. We have to improve advertising method for all students and faculty members. The Prelab-system survey results showed that the way that proposers’ direct announcement got more participants than that by Prelab administrators. The number of proposal is two per month, and we must disseminate the system continuously to gain more recognition. We need to enhance the public relations and visualize various Prelab activities from now on.

Although Prelab has just begun, the system revealed that there were a lot of students who have an interest to research activities and monozukuri events. Furthermore, Prelab has contributed to encourage information exchange among faculty members. We strongly continue promoting this system for enhancing educational and research activities.

Conclusions

The basic philosophy of "Prelab" is to support all faculty members', including technical personnel members', exploratory research and research activities by underclassmen who are equivalent to high school student. Prelab can promote exploratory research and raise the study motivation of underclassmen. Also, the system can contribute to exchange information efficiently among faculty members. It was found that Prelab could promote the educational and research activities.

Acknowledgements

We thank all SDIC members, the president, and administrative officials of National Institute of Technology, Nagaoka College: they supported us to establish the Prelab system.

References


Project Based Learning: Case study in Chemical Engineering Plant Design

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Abstract

Chemical Engineering Plant Design is the last and one of the most important classes in Chemical Engineering degree program. In this class, students will work in a group of 5-6 to combine engineering knowledges learned in other courses in the general curriculum including economics, safety and environmental to design an integrated chemical process plant. At the beginning of class, small workshop in Leadership Compass (a Native American Indian–based practice): Appreciating Diverse Work Styles was introduced. This framework was designed to allow each student to dig deeper in their perceptions of self and team. The series of lectures such as principles of process design, selection of processes, material, and equipment, and cost estimation were given to provide fundamentals and techniques for students. The active learning tools such quiz game such as kahoot, group activities were used in class to enhance learning outcome. Students have to submit two progress reports and one final report. A preliminary report was including project title, objectives, market survey, process alternatives and selection, and simple profitability of each process. The second report was including a detailed process design and equipment and a result from process simulation program. The final report was including content in previous report, and economics evaluation as project and equipment cost, profitability. The three oral presentations were presented to a class and 4 of lecturers. During comments session, students was allowed and encouraged to comment and ask questions. After the oral presentation, the students have to make a correction and re-submit a report. From a series of lectures and oral presentation, students have developed their abilities to design an integrated chemical process plant. The comments from students were that they developed their abilities to work as a team, know their strength and weakness in each technical issue, and how to apply all knowledge to design an integrated chemical process plant.

Keywords: Project Based Learning, Active learning, Chemical Engineering, Plant Design, Team Work

Introduction

In the 21st century, the world has become more volatile, uncertainty, complexity, and ambiguity or VUCA. R. Berger (2016) explained about the trend compendium 2030 by such as demographics dynamics, globalization and future markets, scarcity of resources, climate change and ecosystem at risk, dynamics technology and innovation, global knowledge society, and sustainability and global responsibly are opportunities and also challenges for a new graduate in science and technology field especially chemical engineering. P21.org(2016) explained about Framework for 21st Century Learning The requirement for the 21st century skills such as Information, Media, and Technology skills, Critical thinking, communication, collaboration, and creativity, and life and career skills has to be well developed before graduation.

Chemical Engineering is one of seven disciplines of the Regulated Engineering Professions in Thailand under Council of Engineer, the Engineer Act, B.E. 2542(1999). Unlike the Accreditation Board for Engineering and Technology(2014) that established curriculum requirement for “(a) one year of a combination of college level mathematics and basic sciences (b) one and one-half years of engineering topics, consisting of engineering sciences and engineering design appropriate to the student's field of study, and (c) a general education component that complements the technical content of the curriculum”[2], The Council of Engineer(COE) in Thailand has established a very strict and detailed curriculum. The curriculum shall include at least 84 credits in fundamental and specific engineering, i.e, Fundamentals in science (18 credits), Fundamentals in Engineering (24 credits), and core course in chemical engineering (24 credits).

Chemical Engineering Plant Design, a one of required core course in chemical engineering curriculum from COE requirement. This projected based learning course is designed for the 4th year student to experience
a conceptual design, general design considerations and selection, process design project of a chemical plant.

Pedagogy

During the first year in chemical engineering program, students will learn fundamental course in science and engineering to gain basic knowledge. In second year, they will learn more sub-discipline in chemistry such as Organic Chemistry, Analytical Chemistry and fundamental course in chemical engineering such as Principle Calculation, Chemical Thermodynamics to gain deeper knowledge in chemistry and basic knowledge in chemical engineering. In third year, they will learn core course in chemical engineering such as Chemical Kinetics and Reactor Design, Unit Operations, Chemical Engineering Process to gain deeper knowledge in Chemical Engineering. During summer of third year, there is a 2 months industrial training class. Students will gain a hand on experience with staff in a real chemical plant. During a last year, they will learn the last three of chemical core courses; Process Dynamics and Control, Engineering Economics, and the last one, Chemical Engineering Plant Design.

Chemical Plant is an industrial scale plant that manufactures chemical/biochemical product via a series of process such feed preparation, reaction, separation, and etc. The project based learning was chosen for teaching in Chemical Engineering Plant Design for students to experience in a conceptual design for a complex chemical plant and to develop the higher cognitive skills (analyzing, creating, and evaluating) as well as communication and collaboration skills.

The strategies to teach Chemical Plant Design class were similar to build a model from a Lego block. Students will learn how to do a conceptual design of a chemical plant task by task till the end. Students were given an instruction to form a team of 5-6 persons to work on a project to design a chemical plant to produce chemicals of their choice. They need to submit three reports, i.e., preliminary report, progress report and final report at week 6, 10, and 15 during 18 weeks of the whole semester. In addition, the week after report was submitted, groups required to present their work in front of instructor’s panel.

The first stage: To help students to understand perception of team work, the small workshop in Leadership Compass (a Native American Indian–based practice): Appreciating Diverse Work Styles was introduced. This framework was designed to allow each student to dig deeper in their perceptions of self and team. Students learned about four work styles; North (Action preferred), South (Empathy preferred), East (Vision preferred) and West (Analytical preferred) from a team of instructors and performed a checklist to choose a work style that close to their style. After that they were participated in two round of 30 mins discussion among a group with the same work style and different work style to share and learn from individuals. Figure 1 shows a picture during group activities on leadership compass.

The second stage: The further steps was a series of lectures such as principles of process design, selection of processes, selection of plant location, and simple cost estimation were given to provide fundamentals and techniques for students to fulfill a requirement of a preliminary report. The requirement of preliminary report is including project title, objectives, market survey, process alternatives and selection, and simple profitability of each process. A team has to submit a report at the week 6 and make a presentation in front of instructor panel. After each presentation, the open discussions were conducted for students to learn from other successful and failure. The example of preliminary report presentation was show in figure 2. During this learning process, students developed the deeper cognitive skills such as remembering, understanding, applying, analyzing, and evaluating from completing the task as well as communication, collaboration skills.

![Figure 1](image1.png)

Figure 1 shows group activities on leadership compass.

![Figure 2](image2.png)

Figure 2 an example of preliminary report presentation of propylene glycol production team.
The third stage: After presentation, a series of lectures such as selection of materials, equipment design were selected to lay down fundamentals for students to finish their progress report. The requirement of progress report is including detailed process design, process diagram and results of process simulation. In this process, the knowledge that learned from the first three year and this class including the industrial training has been used to creating a new process that economical and sustainable. The all six of cognitive skills such as remembering understanding, applying, analysing, evaluating, and creating has been developed during this task. Again, team has to submit a report at the week 10 and make a presentation in front of instructor panel. The example of process diagram from a progress report presentation was show in figure 3.

![Figure 3. Process Diagram of propylene glycol production team.](image)

During comments and open discussion of the progress report, students have learned from failure and misunderstanding. They realized their technical capability and weakness. The public quiz game, Kahoot, was introduced to the class to check students’ core Chemical Engineering knowledge. Kahoot quiz game is a powerful that made students enjoy and more engaging. The example of kahoot quiz and score were shown in Figure 4 and 5.

![Figure 4 example of kahoot quiz that use in class](image)

![Figure 5 kahoot score of students.](image)

The Last stage: A series of lectures that related to cost estimation such as equipment cost estimation, project cost estimation were introduced to student. The requirement for the final report was including all material from the first two reports and investment cost, operating cost, manufacturing cost, and profitable. In addition, a plant layout also presented. The breakdown of cost estimation, economics analysis, summary of the project, and plant layout of student project were shown in Figure 6-9, respectively.

![Figure 6 breakdown cost estimation of the propylene glycolteam](image)

![Figure 7 Economics Analysis of the propylene glycol team.](image)
Summary

**Propylene Glycol Plant**

- **PG plant from Glycerol 80% feed grade**
- **Capacity**: 150,000 ton/year
- **Location**: Hemaraj eastern seaboard
- **Initial cost**: 1,472,920,387 Baht
- **Annual Operating cost**: 3,229,792,782 Baht/year
- **Payback period**: 5th year
- **Rate of return**: 31%
- **Break even point**: 31,165 ton/year

Figure 8 Summary project of the propylene glycol team.

Figure 9 Plant layout of the propylene glycol team.

The grading of the class were evaluated from score of 4 parts, 10% from class participation, 30% from reports, 30% from presentation, and 30% from final exam. The reports and presentation was graded by using rubric score. The final exam was intent to check individual knowledge of chemical plant design, their project and their involvement in the project.

**Results and Discussion**

The project based learning that have been implement for teaching Chemical Plant Design class for 20 years was an effective learning method. However, the new requirement for 21st century skills challenged the instructors to use additional tools and method of teaching such as quiz game and a leadership compass tools to help students to develop their cognitive skills to higher level. The comments from students during a leadership compass activities, were very positive. They learn and understand the different of work style and will behave differently to make others to be happy to work with them. The quiz game made the students feel more enjoys and relax. The project assignments that challenge them to find a new process that economical and sustainable help them to use their critical thinking and creating. The reports and presentation helps the students to develop their communication skills.

**Conclusions**

The project based learning in chemical engineering plant design is a power tools to let student experience in conceptual design of chemical plant. Throughout a series of assignments and lectures, students have finished all tasks step by step like build a model from Lego block. They have been developed their abilities to design an integrated chemical process plant from the beginning to the end and prepare their higher cognitive skills as well as the 21st century skills.

**Acknowledgements**

The authors would like to thank faculty of engineering, King Mongkut’s Institute of Technology Ladkrabang for providing an active learning course, training and lectures for all faculty member and all support.

**References**


Abstract

Project-based learning (PBL) is one of the most important methods of engineering education at institutions of higher education. Students who study engineering need to have skills to solve problems under given restrictions as well as generic skills. In order to make the students to acquire problem-soliving skills and to enhance creative ability, we carried out the education which we call "Instruction for Thinking." This program places great importance to each student’s experience of problem-finding and problem-solving. It also aims to enable the students to get communication skill, team work skill, and practical technical skill as well as creative ability.

The Department of Electrical and Computer Engineering of National Institute of Technology, Asahikawa College has developed the subject named "Exercises for Creative Engineering Design" for the fourth year students since 2009. The theme of 2015 was "Let's explain the mechanism of electric power generation to the general public.” The students worked in groups of 3 or 4 for a year. First they discussed which power generation to explain and selected four kinds of power generation: “Solar,” “Thermoelectric,” “Vibration,” “Water.” They designed and made original models to explain the principle of power generation by hands. The Instructors just pointed out some problems, but did not provide the students with any ideas. Finally the students made a presentation at a shopping mall after practicing many times.

As a result of our approach, most of the students who participated in this program improved their individual skills and felt great satisfaction. It was found that the education of "Instruction for Thinking" we conducted is an effective way to foster the students’ creative ability and generic skills.

Keywords: project based learning, presentation, power generation, engineering design, generic skill, creative ability

Introduction

Project-based learning (PBL) has been taking place in the past ten years in Japan. Projects are based on challenging questions and problems, which involve students in design. Also, PBL gives students opportunities of problem-finding, problem-solving. The central activities of the project involve the transformation and construction of knowledge (e.g. John W. Thomas, 2000).

Recently, PBL is one of the most important methods of engineering education at institutions of higher education. Students who study engineering need to have skills to solve problems under given restrictions as well as generic skills (e.g. In-sook Kim. 2009; Y. Utsumi, T. Yonamine and Y. Kikuchi 2010).

The mission of the National Institute of Technology (KOSEN) is to foster creative and practical technical engineers. The KOSEN is conducting positive activities. The variety of career courses after graduation creates many possibilities for their careers, and leads to the production of excellent talents such as practical and creative engineers, managers, and researchers (e.g. J. Watanabe, 2009).

The Department of Electrical and Computer Engineering of National Institute of Technology, Asahikawa College (Asahikawa KOSEN), developed the new subject named “Exercises for Creative Engineering Design”.

In this paper, we report an approach on PBL, i.e. the education called “Instruction for Thinking,” to make the students to acquire problem-solving skills and to enhance creative ability. The effects of our approach are also discussed.

“Instruction for thinking”

The education called “Instruction for Thinking” places great importance to each student’s experience of problem-finding and problem-solving. It also aims to enable the students to get communication skill, team work skill, and practical technical skill as well as creative ability. The key of “Instruction for Thinking” is that the instructors point out a few problems but do not provide the students with any ideas.
The Department of Electrical and Computer Engineering at Asahikawa Kosen has developed the subject named "Exercises for Creative Engineering Design" for the fourth year students since 2009. The theme of 2015 was "Let's explain the mechanism of electric power generation to the general public." The number of the students who took this course was 15.

In the beginning, the students discussed which power generation to explain. They were divided into four groups, each of which included three or four students, and worked for over two semesters. After discussion each group selected four kinds of power generation: "Solar," "Thermoelectric," "Vibration," "Water."

The students constructed a model which explained the principle of power generation in order to make a presentation. First, the students drew their own ideas on a sheet of A4 sized paper as shown in Fig.1. They discussed the details and the problems of the ideas with the instructors as shown in Fig.2. The instructors only pointed out a few significant problems. They did not provide the students with any ideas so that the students could think the matters over by themselves.

After their ideas took shape, the students made a presentation of their original model to the instructors and the students of other groups. Figure 3 shows the example of presentation by the "thermoelectric" power generation group. The instructors made students elaborate plans of the purchase of goods. The students made their original model by hands.

Then the students made a first presentation to the first year students of the Department of Electrical and Computer Engineering of Asahikawa Kosen at the end of the first semester. Figure 4 and 5 show presentations by the "vibration" and the "water" power generation groups, respectively. When the first presentation finished, instructors collected a questionnaire from the audience. In order to make the presentation better, following feedback or comments reflected as shown in Fig. 6.
Figure 5: First presentation of the original model to explain the principle of the “water” power generation to the first year students of the Department of Electrical and Computer Engineering.

Figure 6: Following feedback or comments from the questionnaire of the first presentation.

Figure 7: Students presenting their plan to improve their model.

Figure 8: Instructors and students discussing the submitted plan.

Figure 9: The “vibration” power generation group rehearsing the final presentation.

Figure 10: The “solar” power generation group rehearsing the final presentation.

In the second semester, the students made a plan to make their presentation better. In addition, the instructors made them to use the models which run on electricity. In the same way as the last time, the students made the ideas and discussed submitted plan documents to the instructors many times as shown in Fig.7 and 8. They also prepared three materials for a presentation: a revised model, a sheet of A0 sized paper and a handout, so that they could explain easily. Finally, they rehearsed the presentation again and again. Figure 9 and 10 show
the rehearsal by the “vibration” and the “solar” power generation groups, respectively.

At the end of second semester, the students made a presentation at a shopping mall as shown in Figure 11 and 12. A girl, her parent, and her friends, who are the general public, attended our presentation.

After they finished this course, we surveyed how their individual skills improved and how satisfied they were with the course.

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Results and Discussion

In our approach, the instructors did not provide the students with any ideas. Instead, they made various “devices” to guide the students to think by themselves. This is the most important point.

Our aim of this program was to get the students the following ability and skills: problem-finding skill, problem-solving skill, creative ability, writing skill, presentation skill, computer-using skill, teamwork, communication skill, spontaneity, professional knowledge, practical skill and thinking skill. Figure 13 shows a result of self-evaluation between before and after class on a scale of one to ten. The vertical axis of the graph is the students’ average point difference between before and after taking the course. All of their ability and skills were developed after they took this course.

From the questionnaire, 100% students showed positive satisfaction: very much 58%, rather 42%, not so much 0% and Not at all 0%.

Conclusion

As a result of our approach, most of the students who participated in this course improved their individual skills and felt great satisfaction. It was found that the education of "Instruction for Thinking" we conducted is an effective way to foster the students’ creative ability and generic skills.

References


A case study of the guidance for experiment with “Interactive Experiment Notebook” (II): Practical Training for Lower Graders of NIT and Improvement of Note-Taking Technique using Student's Self- and Peer Evaluation

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Abstract

In college or university, it has been made various student experiments in the region of Science and Technology. Evaluations of the student's efforts to experiments are made by mainly report that student wrote. On the other hand, even if it understands that the guidance of the “Experiment Notebook” is important for a student, it is the fact that the teacher cannot start experiment notebook guidance by many enormous quantity powers. In the previous report, an attempt for guidance for experiment with “Interactive Experiment Notebook” in the subject of “Experiments in Electrical Machiner” that was made for fourth grade students was reported. In that trial, Notebook guidance was tried mentioned blow. Namely, 1) to all students, notebooks were distributed. 2) Template seals were also distributed and on which the table templates were printed and students had to fill the blanks with basic contents of experiments. Students learned how of basic data description. 3) Student drew actual wire-diagram of electric circuits for accurate record and practical understanding. 4) Another seal for notebook was made on which “consideration and idea on experiment” should be described. Students were faced with the need to consider the awareness and idea on experiment. 5) Effective use of “Inheriting sheet concerning know-how and instructions”; prevenient experiment student team recorded about “the notes (especially for safety), “the idea”, and “the advice” for a follower team. In this report, in addition, an attempt of practical training of “Interactive Experiment Notebook” about “Applied Physics Experiment” for the 3rd grade students is reported. Firstly, to seize the trend of student's writing without preconceptions, the description of notebook without an indication of the format is allowed. Thereafter, the guidance of the description method is made to students; we examined the "change in the description of notebook" and "student of opinions and impressions."

In addition as a further attempt, students evaluate their notebook by themselves and do peer evaluation each other. So using obtained knowledge, it could be used effectively to further progress of the notebook description techniques. We can carry out the conversion of these attempts from "Passive Experiment" to "Active Experiment”.

Keywords: Experiment Notebook, PBL, Student’s Self Evaluation, Student's Peer Evaluation, Interactivity, Technology Literacy

Introduction

Following previous report (Koshiji, 2015), this paper also reports the effectiveness of guidance of experiment notebook, especially about student’s self- and peer evaluation. Many Student experiments are performed at university and institute of technology etc. Usually, most of aims of student experiments were to understand of the theories and to learn experimental techniques. And most of evaluations of student’s achievement are made by reports written by students. For paying attention to various aspects of experiment notebook such as “recording tools”, “thinking tools” and “cultivation tools for science literacy”, actual and intelligible Note-Taking trainings are very important for students belonging to the educational course of science and technology. As the first step of this attempt, analyses for state of student research were made by questionnaires for teachers belonging to NIT of Kyushu region. As a result, it was found that little guidance for experiment Note-Taking is made. In previous report (Koshiji, 2015), at the subject of “experiments in machine experiment”, for 4th grade student of our department, guidance of experiment that mainly situated notebook training was tried and reported. In this report, the subject of “Applied Physics experiment” for 3rd grade students was added to this Note-book guidance trial. Further, in addition as a further attempt, students evaluate their notebook by themselves and do peer evaluation each other.

Methods

Then, in our school at the class subject of “Experiments in Electrical Machinery” for 4th grade students (Figure 1), and “Applied Physics experiment” for 3rd grade students (Figure 2), the guidance of
experiment that mainly situated notebook training were tried.

The methods used in this attempt will be described in detail below. Especially for 3rd grade student, to understand the student’s idea about notebook without prejudice, at the start-up of this trial, there were no suggestions for note-taking method and we were allowed to students to freely note description. As a result, students were not carried out description of the organized laboratory notebook. In particular, no student has been described the figure and picture for explaining a state of the experiment. Moreover, by using the camera such as a smartphone, some students took photos of the described notes of their co-workers without their original note description.

Then, we tried to the attempt mentioned below (since the start of subject for 4th grade student and since after student’s free note-writing trial mentioned above for 3rd grade student).

(A) Common attempt for two class subjects:

1) Using commercial-available laboratory notebook: Commercial-available laboratory notebook that had adopted at many research laboratories and universities in Japan were distributed to all students (Figure 3).

2) Using “Table-type template seal” and “Subject title seal” : As shown in Figure 4, Table-type template seal was employed to learn how to record basic information about experiments (i.e. Date, Title, Collaborators, Experimental equipment’s details and so on).

Students cut the seals and attach them to notebook and fill in the blanks (Figure 5). It was possible to learn the contents of the format to be referred to the notebook through this work. In addition, there were “Subject title seal” and it’s items of “Awareness and Discussion” in the seal and gimmicks such as students should wrote “Thinking” and “Awareness” in the notebook spontaneously. This allows the students began to actively description of “Awareness of the experiment”
and “Attention and advice from the education staff” (Figure 6).

Figure 5 Student filled in the blanks of table and cut and pasted the seal on notebook.

Figure 6 Student cut and pasted the “Subject-title seal”.

3) Sketch of practical wiring diagram or the arrangement of the experimental device: For the student’s specific understanding about electric circuits and the arrangement of the experimental device, students had to draw freehand drawing (Figure 7&8).

Figure 7 Examples of “Sketch of practical wiring diagram” which written by freehand. (by 4th grade student at the subject of “Experiments in Electrical Machinery”). Drawing situation (above) and an example of sketch (below).

Figure 8 Examples of “Sketch of experimental situations” which written by freehand. (by 3rd grade student at the subject of “Applied physics”). It was drawn about the experiment of “Measurement of Young's modulus” that shown in Fig. 2.

(B) Specialized attempt in relation to the subject of “Experiments in Electrical Machinery” for 4th grade student

1) Prewriting an experiment report before experiments: The contents written in a report are “Subject”, “Date”, “Collaborators”, “Aim”, “Method”, “Data analysis”, and “Discussions”. Students should be written in report until “Method” before doing experiment. Students can understand the details of experiment in advance throughout description of experimental report.

2) Using “The hand-off memo about technical know-how and knowledge”: In this subject, fourth-
grade student are learn and perform experiments with transformer, synchronous machine, induction machine and so-on. Four or Five students formed a group and conducted different experimental theme in every week and finally carry out twenty themes of experiment for one year. At the most of the conventional student experiment, there was little transition from predecessor team. As mentioned before in this paper, students recorded “Precaution”, “Awareness of the experiment” and “Attention and advice from the education staff” on notebook and student team reproduced “technical know-how and knowledge” to next team. By using this approach, education staff now need not performed by repeating the same attention and guidance to each team. By reading this memo at the beginning of the experiment, Students also were able to obtain in advance a wide variety of knowledge (especially about safety) regarding the experiment (Figure 9&10).

3) Additions: For teaching staff and students, it adopted the cover that has been different color-coded for each experiment type in order to facilitate the sorting work (Figure 11).

Figure 11 Color-coded cover sheets of report

Results and Discussion

Conventional, “Experiment Notebook” for students was “A Personal Memorandum Existence”. Under the influence of this idea, the contents that described in the experiment notebook are a good thing as long as it only students themselves can understand. Then, in addition as a further attempt, students evaluate their notebook by themselves and do peer evaluation each other. So using obtained knowledge, it could be used effectively to further progress of the notebook description techniques.

1) Self-evaluation of notebook by themselves: After the end of each of the experiments, student did self-evaluation about their notebook description using a check sheet shown in Figure 12.

Through these efforts, students did objectively evaluate the descriptive content of their own experiment notebook, and was able to take advantage of the result to the next of the experimental notebook description.
Contents. Although many of the students felt that it was possible to objectively evaluate their laboratory notebook, there were also students who feel the difficulty of objectively evaluate their own notes. Then, as the first attempt, students check the experiment notebook of one another, began to Peer Evaluation to evaluate and confirm the good points and the required improvements.

2) Peer-evaluation of notebook: These experimental subjects are carried out in half of the schedule of the one-year academic calendar. In the middle of the half a year of the experimental period, the students attempted to peer-evaluation of each other to check the experimental notebook of one another. As mentioned above, the conventional notes are those that belong to the individual students as a reminder of the individual students. Student didn’t have an idea and chance that the peer-evaluation each other’s notes to share the know-how of how to write. Therefore, although this attempt was a challenging one for students, on the other hand, it was also seen slightly bewildered student.

This is a future task as will be described later. Actually peer-evaluation will be described below : As shown in Fig. 13, each experiment notebook placed on each table and students checked one by one, and filled out the results in the peer-evaluation check sheet shown in Fig. 14. Students write improvement and enhancement point to “Improvement and enhancement Sheet (shown in Fig.15)” and it was used as a guideline for the future of notebook description.
Although the reason for the difference is a need for further comparison, it is mentioned that the higher grade students already had more knowledge about the laboratory notebook. In this time of the questionnaire, we used the keyword “helpful” as a keyword in question. However, taking into account the purpose of this initiative is better to using the “there is educational effect” is thought that it was good. Finally, the questionnaire results about “Overall for this trial” were shown in Figure 22. Most of the students responded that this attempt was helpful for them.

Attempts of this self-evaluation and peer-evaluation had the implications of the trial. So, at the next trial, there are going to perform in mind the following points like as “Description of adequate purpose before trial” and “careful selection of words with respect to the questionnaire”, etc.

**Conclusions**

To student experiment, by using the interactive approach, it was possible to stimulate a positive attitude and awareness of students. Also it was possible to carry out the cultivation of science literacy through these attempts. On the other hands, for the purpose of achievement, Self and Peer-Evaluations are unfamiliar for students, it is important to explain its purpose and meaning, etc. We can carry out the conversion of these attempts from "Passive Experiment" to "Active Experiment".

**Acknowledgements**

I am particularly grateful for the assistance given by the co guidance staff for this student experiment. This work was supported by JSPS KAKENHI Grant Numbers 23650521, 25560096 and 15K12401 (Grant-in-Aid for Challenging Exploratory Research).

**References**

INFUSING ENGINEERING DESIGN THINKING & DESIGN PRACTICE MODULES IN ME DIPLOMA

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Abstract

The 21st century, marked by technological revolutions, has significantly shifted the type of skills required in the engineering workplace. Future engineers will need to be equipped with 21st century skills and have abilities to innovate with user-centric designs. To develop these competencies in students, Ngee Ann Polytechnic, School of Engineering, Mechanical Engineering (ME) Division infused Engineering Design Thinking (EDT) and Design Practice (DP) modules into the ME Diploma curriculums in order to:

a. Introduce design thinking processes and opportunities for the students to develop empathy for real world issues and to practice design earlier in their courses.
b. Strengthen students’ understanding of basic principles and concepts by relating to real world applications.
c. Scaffold and stack the design curriculum to create connections to other modules and put together a complete picture of design to the students.

Based on the learning theory of constructivism (Gagnon, Jr & Collay, 2008) (Keller, 2011), EDT and DP were introduced with the objectives of developing student’s engineering design and design thinking skills. Together with the use of project-based approach (Moalosi, Molokwane, & Mothibedi, 2012), the two design modules enable the transfer of design and engineering content knowledge into practice with an emphasis on engineering design.

In the EDT module, students work in teams and use a five-stage engineering design thinking process to solve course-related design problems. Critique from lecturers and peers, during the design and mock-up stages, provide constructive feedback for the project teams to improve on their projects. Students translate their conceptual designs into working prototypes, and apply iterative improvements to their prototypes to meet the design criterions.

The DP modules introduce enhanced or more complex design problems, which further deepen the students’ design and hands-on skills. Students are assessed using a mixture of assessment activities like course level competitions, showcases, poster presentations and viva voce examinations. These activities further hone their interpersonal skills, teamwork and competitive skills.

Keywords: design thinking, engineering design, constructivism, active learning, experiential learning, project-based learning

Introduction

As part of the annual course review in 2012, Ngee Ann Polytechnic School of Engineering, Mechanical Engineering (ME) Division reviewed their ME diploma courses against the skills required in the 21st century engineering workplaces, which are marked by technological revolutions and evolving demands of skills (National Academy of Engineering, 2004). The four ME diploma reviewed in 2012 were:

a. Automation and Mechatronic Systems (AMS)
b. Aerospace Technology (AT)
c. Mechanical Engineering (ME)
d. Marine & Offshore Technology (MOT)

The review examined the relevance of the teaching and learning pedagogies used in developing engineering students, against a backdrop of issues like decreasing level of interest and motivation in engineering courses and wide variations of academic abilities in larger cohort courses like ME and AMS.

The review identified the following areas that required strengthening:

(1) “Scaffolding” and “stacking” of the design curriculum is weak. While all the four courses have aspects of “Design” in the curricula, the scaffolding of the design modules was not strong for all the three-year courses. The core engineering modules also have weak or no connections to the design modules; which cause students to have fragmented ideas about how engineering principles can be applied into design applications.
Lack of design thinking process and opportunities for students to encounter practice design earlier. Another finding from the review indicated that there was a lack of user-centred engineering design thinking process. Typically, integrative design projects only occur during the final years, where students create engineering designs with their technical skills and knowledge, rather than in the earlier years, where students can have more time to hone their creativity and engineering design thinking skills. There were also limited opportunities for students to practice and develop critical thinking earlier in their courses, which can enhance students’ design thinking experience.

Student’s inability to see relevance of concepts in real world applications.

Many students’ understanding of engineering principles and concepts were weak and many could not see the relevance of what they learnt in the classroom to the real world. Students were learning in a surface manner which resulted in weak retention of knowledge and skills and inability to apply concepts practically.

The result of this 2012 course review prompted a design-centric curriculum recalibration and the introduction of two new design modules in 2013, namely Engineering Design Thinking (EDT) and Design Practice (DP) modules.

This paper describes the design and implementation of the EDT and DP modules to provide early and additional opportunities for students to practice engineering design thinking. This paper also describes the implementation of Design Thinking as a Teaching and Learning (T&L) strategy that is useful in driving engagement and deeper learning amongst the engineering students.

Infusing Engineering Design Thinking & Design Practice Modules – An Initial Experience

Design is embedded in the engineering curricula of AMS, AT, ME and MOT in ME Division. Design knowledge is scaffolded and the complexity of problems students have to work through is increased as they progress through their years in the course (Table 1).

<table>
<thead>
<tr>
<th>Yr</th>
<th>Modules</th>
<th>Competency</th>
</tr>
</thead>
</table>
| 1  | Innovation Toolkits 1 & 2 | • Innovative mind-sets and creative thinking  
                             • User-centric approach in general applications |
| 2  | Engineering Design Thinking & Design Practice | • Engineering design  
                             • Engineering focus  
                             • Domain applications |
| 3  | Final Year Project / Internship | • Capstone projects in real world context  
                             • Professional development |

Table 1. Scaffold of design curriculum in three-year diploma courses

Figure 1. Overview of EDT-DP modules in the second academic year

At the beginning of the second academic year, the entire cohort of students goes through the Induction Week programme. The week-long programme provides students with community-based learning situations, where students will experience issues and challenges faced by certain groups in the community. This creates the opportunities for students to encounter the “needs of the user” and develop “empathy” for them. This initial encounter with “Empathy” will also set the foundation for students as they embarked on their design projects in EDT and DP and other domain-focused modules. The students will then seek to solve the issues with design applications and engineering solutions.

During the Induction week in 2015, ME Division students were committed to the community service of beach cleaning along the recreational beaches of Singapore in 2015 (Figure 2).

Figure 2. Community service of beach cleaning

Through research, cleaning activities and interactions with community partners and members of public, students experience and understand the problems of coastal pollutions that affects islands like Singapore. This understanding of the problems and the users allows students to work towards designing course-related solutions using their engineering knowledge learnt in their first and second years’ modules with an additional dimension of “user” in mind.
For example, AMS students were required to design and build autonomous machines to retrieve objects from the beach (Figure 3). They were required to apply foundation mechanical engineering knowledge (e.g. Applied Mechanics, Engineering Materials, Strength of Materials, Electrical Technologies and Electronics, Fabrication and Manufacturing skills) and mechatronics domain specific knowledge (e.g. Arduino microcontroller, sensors and computer programming) into their design projects, with consideration for how the machines would be practical to the users.

Figure 3. Autonomous machines to carry out missions of retrieving objects on the beach by AMS students

Engineering Design Thinking & Design Practice Modules – Design & Prototype

With the design problems and context defined through the Induction Week activities, the students commence their design activities in the EDT module, where students are introduced to a five-stage engineering design thinking process (Table 2) which helps the students conceptualise and find solutions to the design projects. Students are required to build physical mock-ups and prototypes to demonstrate the working principles of their designs in this module.

<table>
<thead>
<tr>
<th>Stages</th>
<th>Description of Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empathy</td>
<td>To analysis and understand the roots and needs of the problem.</td>
</tr>
<tr>
<td>Discover</td>
<td>Discover feasible solutions to address the needs and find opportunities for ideas creation.</td>
</tr>
<tr>
<td>Ideate</td>
<td>Ideas are formulated and analyzed. Chosen ideas are developed into the final conceptual product.</td>
</tr>
<tr>
<td>Create</td>
<td>Resources and processes are planned and prepared for mock-up and prototype making.</td>
</tr>
</tbody>
</table>

Table 2. Five stages engineering design thinking process

Realize Physical development of working prototypes. Iterative testing, evaluation and modification are used to realize the designs successfully.

Measurable design criteria are given to the students along with the design problems. During the engineering design process, students will have opportunities to design and develop solutions that would meet the needs of the problems (including those of the users) against the measureable criteria. These criteria allow the students to strategize their design approaches and validate the effectiveness of their prototypes.

For example, three measurable criteria are used to assess the capabilities of load-carrying vehicles of the ME course, namely Load, Timing and Accuracy (Figure 4). These criterions serves as goals for design teams to validate and optimize their vehicle designs.

Figure 4. Design criterions for ME in EDT module

Throughout the engineering design thinking process, students will also learn how to manage their own resources and time to ensure that they are able to present their best prototype to be assessed at the end of the semester. Feedback provided by their lecturers and sharing among the peers allow students to refine their design and rework their prototype.

Upon completion of the design and prototype development in EDT, students will proceed to the DP module where they will be expected to do further refine their design and manage more complex design criterions.

Engineering Design Thinking & Design Practice Modules – Deepening of Learning

The DP modules build upon the EDT design thinking process to solve enhanced engineering design objectives (Figure 5), which are more complex and challenging. These enhanced objectives further stretch the students to deepen the design, technical and hands-on skills. Students will continue to refine and improve their prototypes, but with more constraints and considerations.
Materials, Electrical Technologies and Electronics into their design projects, with consideration for how the machines would be practical to the users.

Stages

Discover feasible solutions to address the needs of the problem.

Design & Prototype

Ideas are formulated and analyzed.

Create

Resources and processes are planned and conceptual product.

Determine

Honed ideas are developed into the final design and rework their prototype.

Deepening of Learning

For example, AMS students were required to design autonomous machines to carry out missions and find solutions to the design projects. Students are engaged with practical and hands-on skills which are essential for their final year capstone projects and industry attachments.

The DP module ends with Creativity and Innovation (C&I) Week, where students are immersed in course level competitions (Figure 6). The students will compete against their peers for class rankings – corresponding to marks added to their assessments. The course level completion and class rankings gamify the assessment process which aims to motivate the students to collaborate and work closely with their teammates and peers from their own classes. The students’ projects are also reviewed in viva voce examinations, as well as demonstrations to their peers in poster showcase and exhibition. (Figure 7). These activities enable students to further hone their interpersonal skills, teamwork and competitive skills which are essential for their final year capstone projects and industry attachments.

The 10th International Symposium on Advances in Technology Education (ISATE) 2016

Transactions of ISATE 2016

The 10th International Symposium on Advances in Technology Education

13-16 September 2016, ISATE Sendai

(1) From Teaching to Facilitation

The teaching staff moved from traditional teaching to facilitation of learning. The facilitation approach enables greater interaction and engagement with the students. The lecturers’ role now is to facilitate the learning process by getting students to think through the issues themselves rather than just teach content and giving answers. They serve as design critiques and mentors, guiding and assisting students to seek their own solutions and methods. By doing so, the lecturers are also giving students more space to explore, learn, and apply their knowledge in a practical and useful manner.

(2) Creating more Opportunities for Student Engagement with Content

In the DP module, students can put their designs through iterative prototyping, testing, analyzing and refining to achieving their desired design goals. By testing their prototypes against the design criterion, they get immediate feedback on how well their designs are. Every failed attempt in achieving the goal becomes an opportunity for students to reflect on their designs, in terms of what they have learnt and how they can improve on their shortcomings. When faced with contradictions, students have to analyze alternative solutions, make decisions and trade-offs all while ensuring that the design and users requirements are met.

(3) Development of 21st Century Skills : Critical Thinking & Collaboration Skills

Students are stretched in their inquiry and critical thinking skills through the engineering design thinking process. Using pen and paper, sketching, making mock-ups and prototypes, students are engaged with practical hands-on experiences used in design thinking methodologies.
Collaboration and working in teams enable students to learn from one another (Figure 8) and develop critical 21st century workplace skills, such as teamwork, communication and interpersonal skills. As the student groups take ownership of their designs and project timelines, they become active and independent learners in the process of finding and achieving their own project goals.

Students welcome the opportunities to make design decisions and develop the prototypes on their own. Students were more engaged and take greater ownership of their own learning, skills developments and project deliverables as a result of these opportunities. Some of the students furthered their involvements by incorporating what they did in their EDT-DP modules into their final year projects, where they continue to develop user-centered projects that are technologically more diverse and complex.

Conclusion

The revision of the ME diplomas towards more design-centric curricula by infusing Engineering Design Thinking and Design Practices modules has changed the way teaching and learning takes place within ME. The alignment between engineering modules that are used in the design projects has enabled ME to better prepare their students for 21st Century innovation-driven workplaces (Design Masterplan Committee, 2016). The students are more engaged with the learning and during the design thinking process, they are also developing critical skills that are essential for their future work. Lecturers are also engaging students in a different manner and have created more opportunities for the development of students’ higher order thinking skills in addition to exchanging content knowledge.

The different pedagogical approaches to teaching and learning engineering have obtained positive feedback from both lecturers and students:

“I like that we are actually building our ideas. It is really awesome that we are putting all of the things we learned into practice.” - AMS Student.

“The building of the glider was the highlight in this module, we have the freedom to think out of the box for the design of the glider it was very interesting as a student to apply what we have a learned in the past years to build the glider.” - AT Student.

“We get to create structures for the first lesson which enhanced our thinking ability and through the weeks of presentation, our communication skills increased!” - ME Student.

“I enjoy the process of building a ship. The hands on approach is fantastic as it is not boring. The greatest form of success for this module comes when my team’s ship floats and is able to carry out tasks assigned by the lecturer.” - MOT Student.

The EDT and DP module development team will continue to review and improve the modules and design projects so that the diplomas are able to develop students that are both competent in their engineering design and knowledge, as well as being relevant to the needs of the community and industry.
Acknowledgements

This paper and project was competed with the strong support from Ngee Ann Polytechnic. We are thankful to our Mechanical Engineering Division colleagues who had provided expertise that greatly assisted the development and operations of the EDT and DP modules. We are also grateful to the Teaching & Learning Centre colleagues who had shared their wisdom with us during the course of preparing and moderating this paper.

References


Attempts of the Project Based Learning in the technology development program for the decommissioning of Fukushima Daiichi nuclear power station

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Abstract

One of the most severe technological issues of the recovery from the damages by the Great East Japan Earthquake in 2011 is the decommissioning of the Fukushima Daiichi nuclear power station, including the restoration of contaminated environment.

NIT Fukushima College (one of the most closely located national engineering and technology colleges), therefore, started an education and technology development program funded by MEXT contributing to the decommissioning project under the collaboration of the nationwide NIT colleges, universities, national institutes and local private companies. The program (started last December) contains the activities for the development of (i) Physical and chemical probes to estimate the damages of the reactor buildings and the in-vessel components, (ii) Methods and devices for sampling and analysis of the “debris”, for the storage of heat-generating nuclear wastes, and (iii) Social science approach to reduce the labor accident risks focusing on the motivation of the employees. Also, (iv) Education course to introduce the decommissioning technology, such as “Reactor decommissioning engineering” and “Decommissioning and the society”, including “the students’ competition on the decommissioning robotics” is a vital part of the program for the development of students with visions. The course also includes international internships.

A variety of technologies are required to be developed in the program. Some of the targets are the development of prototypic ones so far, and are rather suitable for the subjects of the “Project Based Learning”; for example, the basic technologies for the sampling and analysis of the “debris”. Attempts and the prospects of these PBLs are introduced.

The education program contains lectures and internship on nuclear safety and decommissioning. In addition, the Creative Robot Contest for Decommissioning as part of the expansion of interest of students in research and development activities. An overview of these progress and future developments will be presented.

Keywords: Educational program, Decommissioning, Nuclear power, Basic research program

Introduction

Decommissioning of Fukushima Daiichi nuclear power station is a national challenge. Mid-level engineer training from a medium- to long-term perspective on to proceed with decommissioning is a pressing issue. A training of practical engineer is the theme of technical college as institution of higher education of the National. In particular, National Institute of Technology, Fukushima College (NIT, Fukushima College) is located in the most close to the Fukushima Daiichi nuclear power station in the higher education of the National. Therefore in NIT, Fukushima College, a position to lead the national colleges across the country in the field of decommissioning education has been required.

Students of NIT Fukushima College have an interest in decommissioning technology. Some students choose nuclear power-related companies in place of employment. In order to meet the medium- and long-term theme of the region, incorporate the decommissioning basic research in graduate research and special studies carried out human resource development through research.

The establishment of decommissioning human resource development consortium

NIT, Fukushima College had been submitted as a business representative on the public offering of Education, Culture, Sports, Science and Technology Ministry. As a result, our application has been adopted by the business for one year as a feasibility study. Application title was "Human resources training on the decommissioning of nuclear power plant, based on study for graduation --- interdisciplinary challenge from Fukushima".

In the wake of this adoption, "Decommissioning human resource development consortium" was established in 2015 March 17 by NIT, Fukushima College. In this council, the nationwide technical colleges, universities and research institutions pursue together human resource training in the medium-
long-term perspective. Place the Council of the Secretariat in the Fukushima College, Takayuki Nakamura Fukushima College president was appointed first chairman, and Tetsuji Choji Kagoshima college president was appointed vice chairman. 2016 April at 34 technical colleges, 9 universities, 3 local government relationship, 6 private companies have joined.

Education program on decommissioning

This educational program is designed to correspond with the "human resource development and cooperation between higher education and research institutes in the medium-and-long term viewpoint" which is related to a governmental medium-and-long term roadmap for TEPCO’s Fukushima Daichi Nuclear Power Plant. This education program is constituted by three pillars; research and development, education and the facilities available (Japan Atomic Energy Agency Naraha Remote Technology Development Center).

In 2015, classes on decommissioning have been offered in two subjects new.

Classes are "decommissioning and Society" of the 3-year target, a "decommissioning engineering" of the 4-year target, any one credit, was carried out in the intensive course format.

In 2016, internship programs for decommissioning and the two new lectures have been started. At the same time, the Technical College has promoted the cooperation in graduate research and special research.

In 2017, by starting classes on decommissioning in first grade and fifth grade, education program on decommissioning will be completed.

Internship is carried out complexly at two locations of companies and municipalities. In the company learn the decommissioning technology. In the municipalities understand the duties as a government on decommissioning.

Overview of "Decommissioning Engineering" and "Decommissioning and Society"

"Decommissioning and Society" will learn the basic knowledge that is required, including social aspects towards the decommissioning of the Fukushima Daichi nuclear power station.

It shows the syllabus in Table 1. Prior to the decommissioning, it was also with the contents to think about radiation, decontamination and the interim storage facility. In addition, it was carried out basic lectures, such as history of the earth atmosphere formation, uranium resources formation, biology, physics, robots and waste management. Work group for understanding the communication techniques with the local residents towards decommissioning was also carried out.

Table 1 Syllabus of "Decommissioning and Society"

<table>
<thead>
<tr>
<th>Period</th>
<th>Course content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Overview of nuclear fission reactor</td>
</tr>
<tr>
<td>2</td>
<td>Decommissioning overview of the nuclear power station</td>
</tr>
<tr>
<td>3</td>
<td>Social infrastructure of modern society</td>
</tr>
<tr>
<td>4</td>
<td>Nuclear power generation and nuclear fuel cycle</td>
</tr>
<tr>
<td>5</td>
<td>Radioactivity and radiation</td>
</tr>
<tr>
<td>6</td>
<td>The Earth's history, the global environment and the formation of iron and uranium resources</td>
</tr>
<tr>
<td>7</td>
<td>Selection of global warming and global warming countermeasures</td>
</tr>
<tr>
<td>8</td>
<td>Decommissioning and biology</td>
</tr>
<tr>
<td>9</td>
<td>Decommissioning and physics</td>
</tr>
<tr>
<td>10</td>
<td>Decommissioning and public communication</td>
</tr>
<tr>
<td>11</td>
<td>Decommissioning and robot</td>
</tr>
<tr>
<td>12</td>
<td>Decommissioning and sociology</td>
</tr>
<tr>
<td>13</td>
<td>Decommissioning and waste</td>
</tr>
<tr>
<td>14</td>
<td>Decommissioning and decontamination technology, interim storage facility</td>
</tr>
<tr>
<td>15</td>
<td>Overview of the Fukushima Daichi nuclear power plant decommissioning</td>
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</table>

Lecture on decommissioning of the nuclear power station, the structure of light-water reactors and the nuclear accident of Chernobyl and TMI in the "decommissioning engineering" had been carried out.

In 2016, to start the "Introduction to Radioactivity and Radiation" for the second year and the "Introduction to Decommissioning robot" for the third year. In addition " Creative Robot contest for Decommissioning " is started.

Overview of Creative Robot Contest for Decommissioning

In order to get interested in the decommissioning to the young generation believes that education through the robot is effective. In addition, a variety of practices, such as PBL education and active learning lesson can be seen in each technical college. This Robocon also carried out by such PBL and active learning. It is the purpose to have an interest in decommissioning to the student through the manufacturing of robot. At the same time, it aims to cultivate the contributing to the "creativity education" "problem-solving ability" and "ability to identify challenges" students.
Overview of the competition challenges are as follows.

1) Field
To select the playing field in each team from the two fields of the following assumes the reactor building.
   a) Mock-up stairs
   b) Standard step field

2) Field environment
   a) Mock-up stairs and b) standard test field have a common environment for the following.
      a) It is no darkness lighting
      b) Not be able to face up to the body to operate the robot by remote
      c) Radio wave does not reach because there is a thick wall of concrete

3) Challenges of robot
   a) Mock-up stairs
      - Carry the luggage of weight 5kg to the second floor from the first floor. And come back to its original location by placing the luggage.
      - Examine the thing that is put on the second floor. It should be noted that the location is undefined.
      - Other issues related to decommissioning.
   b) Standard step field
      - Examine the field of shape (such as area and irregularities).
      - Check things that are located in the field. It should be noted that the location is undefined.
      - Other issues related to decommissioning.

There were submitted from all over the country in the national and public technical colleges of the 13 colleges 15 team in this contest. Results of document screening, was observed participation of 15 teams.

Introduction of Research

Considering that educational institutions such as Technical Colleges can accommodate, the development of large-scale equipment for melting and solidification fuel removal is difficult. Therefore, it considered appropriate to be centered on the fundamental issues regarding the construction of remote technology. Research themes, such as the following has been set.

1) Development of remote control equipment in a nuclear reactor towards such sampling techniques for the situational awareness in the nuclear reactor
2) Development of remote control equipment related to the analytical technique of radioactive material
3) Waste treatment and disposal research for the safe storage technologies for heat-generating waste.
4) Property analysis and development of remote control infrastructure technology.
5) Estimation of product material in nuclear reactor.
6) Analysis of the relationship between work safety and motivation.

Conclusions

Last year, in the first year of this program, it was carried out basic research and development. We were able to build a research network between the National Institute of Technology. The education program was lectured as "decommissioning and Society" of "decommissioning engineering" to about 150 students. In the future, At the same time increasing the students with an interest in decommissioning, we want to nurture students who can compound eye thinking by composite type internship.
AN ATTEMPT TO IMPROVE OF UNDERSTANDING IN ENGINEERING LECTURES BY ACTIVE LEARNING APPROACH

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Abstract

This report describes an attempt to deepen understanding of mechanical engineering education, especially tribology lectures by active learning approach.

Various teaching methods were used in tribology lectures in Yuge College since 2010. For example, group discussions, video/presentation media or handouts were used to make interactive lectures and to control classroom.

CompTIA CTT+ techniques were applied to activate and to control classroom since 2014 in tribology lectures. In the presentation skills in the CTT+ techniques, the talking accents, intonations, speeds and eye contacts were intended to present in the lectures.

In the communication skills, open and closed questions were used according to the needs. And in the instruction skills, the pair and group discussions were applied.

When the students said their opinions or answered some questions in the classroom, sometimes they speak with a quiet voice before implements of the CTT+ techniques. This causes no problem in the lecture because every student was copying the blackboard and they kept quiet in the lectures. More I used to talk something small stories to change of the feelings in the classroom frequently.

From questionnaires for five years, before and after the implements of the CTT+ techniques, the students become busy and they have to concentrate their work in the lectures after the techniques. And they have to speak with a larger voice when they answered the questions in the classroom. More, the results of the regular examination are slightly better than before the implements of the CTT+. In particular, the students who marked bad results are decreased.

Keywords: mechanical engineering education, active learning, lecture method, education effect, tribology education, CompTIA CTT+

Introduction

The improvement of the education by the active learning approach becomes more common. Technique of the active learning is carried out in many universities and technical colleges. And the active learning method is carried out not only in problem based learning or in creative engineering class but also in good old style lectures.

Mizokami (2007) investigated actions of the improvements of learning in the universities in Japan according to discipline. He reported that many improvements for the good old style lectures are reported, problem solving types are popular in the seminar classes and the improvements are for the contents and the qualities.

Students works the lectures actively and higher learning effect of the lectures are obtained by the active learning.

There are many reports that an understanding of the student deepened by the active learning. In addition, it is analysed about an effect and the problems of the active learning by various point of view.

Sunaga (2010) analysed the aim and the concepts of active learning and he points importance of the management of the curriculum.

Ohashi (2010) analysed the effects and the problems based on the Mizokami's report, and he mentioned the need of the consciousness change of the teachers and connection with the other subjects.

Oyama (2013) classified into six types according to the active learning styles, and she noticed the importance of the pre/post tasks of the students.

There are various understandings for "Active". For example, some students regard the copy of the blackboard is active job enough.

An affirmation for lectures and the tasks are important to lead the activate the students and to control of atmosphere in classes is also important for the activeness.

CTT+ technique have been introduced as one of the style of the active learning on "Tribology" lectures in Mechanical Electronics Engineering Department, National Institute Technology, Yuge College since 2014. Questionnaires were conducted before/after the introducing the CTT+ technique to evaluate the atmosphere in the classes.
Questions:
(1) I laughed frequently in this class.
(2) I felt a cheerful atmosphere in this class.
(3) I asked questions in friendly atmosphere.
(4) I remember that teacher said “Face forward”
(5) I remember that teacher said “Speak louder”
(6) I could take a mental break with teacher’s idle talk or chat.
(7) I remarked my opinions actively.
(8) Do you recommend that this class keeps this atmosphere?

It is important to be make the brightly atmosphere that is easy to participate for students to get their higher activity.

Therefore, the questions mainly ask the atmospheres and easiness to participate to the works in class.

Results and Discussion

Figure 1 to Figure 3 are results obtained from the questionnaires before introduction of CTT+ technique to the tribology lectures.

The Figure 1 shows the results obtained from the questionnaire in tribology lecture in 2010. From the question 1, 2 in Figure 1, it can be seen the class could keep brightly atmosphere. From the question 3, no students have the sense of psychological resistance with ask questions to teachers or their friends in the class. From the question 4, just some students were warned to look at the teacher.

From the question 5, they do not have to speak louder when they answer something questions because the
And sometimes a teacher had to cause them to become active in order to maintain their concentration for the students who are scatterbrain before the class started. We can see from the question 4, 5 and 6 in the Figure 4 that the students frequently make sounds in the classroom, and sometimes they have to speak louder from the question 5 and the chat is important from the question 6 as same as Figure 1. It can be seen that the management of the class is important and the students do not have to speak louder from the question 5 and the chat is important from the question 6 as same as Figure 1 and Figure 2.

Figure 4 shows the results obtained from the questionnaire in 2014. Since this year, the CTT+ technique was introduced in the tribology lecture. The CTT+ technique was introduced in the tribology lecture. The CTT+ technique was  introduced after the implements of the CTT+ techniques.

It can be seen that the management of the class is going well and many students have favorable reviews to the lecture from the question 8. Figure 2 shows the results obtained from the same questionnaire in 2011. It has a similar tendency with Figure 1.

Also, Figure 3 shows the results in 2012. The students do not have to speak louder from the question 5 and the chat is important from the question 6 as same as Figure 1 and Figure 2.

Figure 4 shows the results obtained from the questionnaire in 2014. Since this year, the CTT+ technique was introduced in the tribology lecture. The tendencies in the question 4, 5 and 6 in the Figure 4 are different from the Figure 1, 2 and 3.

The question 4 is an instruction to look at the teacher or a blackboard. It is also an attention to be quiet for the students who talked with the friends or to make their concentration for the students who are scatterbrain before the CTT+ technique was introduced. However, after the CTT+ technique was introduced, it is an instruction to make an end of pair works or group works, so that many students answer for the question 4 with Yes.

From the question 5, they make discussions within the groups and make sounds in the classroom. They have to answer to the questions something with louder voice. And sometimes a teacher had to cause them to become active in order to maintain their concentration for the students who are scatterbrain before the class started.
aware that their voice is not louder enough to inform their opinions to the whole of classroom.

The question 6 is about the teacher's chat to change their mood or to lead next theme. It was important to change their mood and remake their concentration to the next theme for the students before the CTT+ technique was introduced. However, the numbers of students become decrease who answered with "Very much" after introducing of the CTT+ technique. It seems that a part of the chat to change their mood is decreased. This is because that they are changing their concentrations to pair works, group works, open/closed questions and so on in turn frequently.

The Figure 5 is the results obtained in 2015 and it shows similar tendency with the Figure 4.

The Figure 6 shows the results obtained from the similar questionnaire from Figure 1 to Figure 5 for the "Applied physics" lecture. Where, seven questions were conducted except the question 4. It can be seen the similar tendency with the tribology lectures for the question 5 and 6.

Table 1 shows the results of the average and minimum marks of examinations in the tribology lectures.

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<tbody>
<tr>
<td>Average</td>
<td>80.6</td>
<td>82.1</td>
<td>84.7</td>
<td>84.4</td>
<td>89.0</td>
</tr>
<tr>
<td>Minimum</td>
<td>58</td>
<td>60.5</td>
<td>47</td>
<td>62</td>
<td>67</td>
</tr>
</tbody>
</table>

The average marks in 2015 is slightly better than that before the introducing the CTT+ technique. And the minimum marks after the CTT+ technique was introduced is better than that before the CTT+ technique was introduced. It is assumed that the students who have passive attitude become to be interested in the lectures more, after the introducing the CTT+ technique.

Conclusions

CTT+ technique have been introduced as one of the style of the active learning on "Tribology" lectures in Mechanical Electronics Engineering Department, National Institute Technology, Yuge College since 2014.

Questionnaires were conducted before/after the introducing the CTT+ technique to evaluate the atmosphere in the classes. The conclusions are as follows:

1. The students copied the blackboard during the lecture and keep silent before the introducing the CTT+ technique. And the teacher's chat is important to change their mood and to re-concentrate next theme for students.

2. The students have to speak louder to inform their opinions to whole of classroom. And the role of the chat becomes not so important because they change their concentrations frequently to pair works, group works and so on.

3. To control the atmosphere in the class is also important, especially, the students who have passive attitude become to be interested in the lectures more.

References


A CASE STUDY ON THEME-BASED APPROACH IN HEALTH TECHNOLOGY ENGINEERING EDUCATION: PHYSIOLOGICAL MEASUREMENT TECHNOLOGY

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Abstract

There were radical curriculum changes in Metropolia University of Applied Sciences (MUAS) Information Technology Programs including Health Technology in 2014. This paper introduces the curriculum changes and experiences especially from student perspective. Instead of having fragmented curriculum including dozens of courses, the new curriculum has formed around larger thematic parts. In Health Technology, students learn not only technology but also business, operating environment and users, related to health technology utilization. Broad area of the curriculum magnifies the importance of integrated curriculum, for example, because teachers are from not only ICT but also from social and healthcare sectors. After the curriculum change, the core of Health Technology is based on three 30 ECTS themes: Physiological Measurement Technology, Customer Oriented Software Applications, and Health Technology Devices and Solutions. Themes are one semester in length and they have a common operating principles, integrated timetable and tools. Students have three simultaneous tightly integrated courses. Weekly timetable includes slots for lectures, assignments, independent and guided group work. Students work in small groups. Student centred approach is a vital in new curriculum to enable learning and fulfill needs of working life. The key is that students work actively and take responsibility of their own learning. Lectures and introductions are kept short and the focus is on guided practical assignments and projects done mainly in small groups. Teachers carefully plan and have weekly meetings to enable synchronization between different courses inside the themes. This paper focuses on Physiological Measurement Technology theme that was implemented first time in autumn 2015. Student feedback related to timing, synchronization, workload, and pros and cons is presented in this paper. Results were good. The goal is to provide students an integrated learning experience where they can deepen their knowledge and skills related to specific theme for the whole semester. Results imply that we are on the right track.

Keywords: engineering education, integrated curriculum, learning methods, learning experience, teaching methods

Introduction

Student centred learning is a significant issue in modern engineering education. Working life is changing to ever faster paced and work is done mostly in various projects. Tasks, employers, industry and teams are changing between the projects and during a career many times. Working life expects professionals who can solve problems, work in challenging projects and operate successfully with different kinds of people. Geven and Attard (2012) presents that students have to take responsibility and fully participate for their own learning to be able success in their later career.

Based on the Confederation of Finnish industries (2011) working life expects that future education will focus on skills in addition to knowledge and working in groups instead of working in isolation. Report also predict that fragmented curriculums are replaced by problem and phenomena based learning.

Attard, Di Iorio, Geven, and Santa (2010) define student centred learning: “Student-Centred Learning represents both a mindset and a culture within a given higher education institution and is a learning approach which is broadly related to, and supported by, constructivist theories of learning. It is characterised by innovative methods of teaching which aim to promote learning in communication with teachers and other learners and which take students seriously as active participants in their own learning, fostering transferable skills such as problem-solving, critical thinking and reflective thinking.”

Student centred learning is key in Metropolia University of Applied Sciences’ (MUAS) Health Technology engineering education. Health Technology is one of the major’s in Information Technology Degree Programme. To enable student centred learning pedagogical choices and curriculum development are needed. Based on Attard, Di Iorio, Geven, and Santa (2010) students’ different learning styles, needs, backgrounds, interests and choices have to be taken into consideration as well as communication between
students and staff, ongoing reflection on learning and teacher’s role as an enabler of learning.

Project based learning is one of the methods that is used in student centred learning. In project based learning, projects are typically quite long, problems are solved in small groups, and themes are multidisciplinary and broad. Learning is active, diverse and student centred. Goal-oriented and systematic work with deadlines and different tasks is important in project based learning. Students manage their projects by themselves, and agree with their individual tasks, phases and roles inside the project. The results are shared with others and evaluated by students themselves and others.

According to David (2008), the basic idea of project based learning is that real problems from real world capture students’ interest, motivates and causes serious thinking as the students acquire and apply new knowledge in a problem-solving context. Larmer and Mergendoller (2010) list the following seven building blocks in project based learning: need to know, driving real world question, student voice and choice, 21st century skills, inquiry and innovation, feedback and revision, and a publicly presented product.

Pucher and Lehner (2011) stress that challenges in project based learning are students’ ability to manage projects, students’ variable motivation, communication between students and teachers, and authenticity of the project. According to Fincher and Petre (1998), the amount of teacher’s resources for materials and guiding projects, and complexity of multidisciplinary implementations are challenges of project based learning in engineering education.

In addition to pedagogical choices, curriculum development is important to enable student centred learning. A fragmented curriculum including dozens of courses distributed to study path can be challenging. The main issue is how these courses can be integrated from student, planning and implementation point of views. In MUAS Health Technology, students learn issues related to technology, business, health and social care environment, and users and customers. This broad curriculum emphasise the importance of integrated curriculum, for example, because teachers have multidisciplinary background.

There were radical curriculum changes in MUAS in 2014. Previously, there were tens of 3 ECTS (European Credit Transfer and Accumulation System) courses along student 4-year study path. ECTS is a standard of higher education in the European Union; 60 ECTS credits (1600 hours) corresponds one academic year. 4-year study path include 240 ECTS in 8 semesters; one semester is divided into two periods. Earlier, there were courses that ran whole semester or one 8-week period. Student had 5 to 10 simultaneous courses. 3 ECTS equals to 80 hours of work and thus time per course was 5-10 hours including 2-4 hours of contact per week.

After the curriculum change, discussed thoroughly in Björn and Soini (2015) the core of Health Technology Major is based on three 30 ECTS theme-based semesters: Physiological Measurement Technology, Customer Oriented Software Applications and Health Technology Devices and Solutions.

Table 1 presents the structure and content of Health Technology Major at MUAS. Each Block is one period (8 weeks) in length and 15 ECTS in size. Each theme includes two one period modules and each theme module includes three 5 ECTS courses.

Table 1: MUAS Health Technology curriculum.

<table>
<thead>
<tr>
<th>1st year</th>
<th>2nd year</th>
<th>3rd year</th>
<th>4th year</th>
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<tbody>
<tr>
<td>1st period</td>
<td>2nd period</td>
<td>3rd period</td>
<td>4th period</td>
</tr>
<tr>
<td>1st year</td>
<td>2nd year</td>
<td>Theme 1</td>
<td>Theme 2</td>
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<tr>
<td>Objects Module</td>
<td>Devices Module</td>
<td>Physiological Measurement Technology</td>
<td>Physiological Measurement Technology</td>
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Even after curriculum changes, MUAS Information Technology Programs are still 4-year and 240 ECTS programs. First year includes four 15 ECTS modules (Objects, Devices, Networks and Games) that all last one period. After the first year students choose their major. This paper focuses on Health Technology Major and especially on the theme 1 Physiological Measurement Technology.

Theme 1: Physiological Measurement Technology

Health and wellbeing can be measured with various methods. Applications measuring human functionality and living environment are developing and becoming more common. These applications are essential part in disease cure and prevention, and in health and wellbeing promotion. When utilizing measurement technology it is important to take issues related to human body and functionality into consideration - what can be measured and how this measured information can be utilized. There is an extensive set of sensors that can be used to gather data from a human body and functionality. To be able to use this data, it must be processed and analysed, in other words transformed into information. Health related information is necessary when building solutions to various customers and users.

The goal of Physiological Measurement Technology theme is that student knows products, applications and business related to human functionality and living environment measurements. Student knows phenomena measured from human body and their utilization opportunities. Student recognizes main physical principles of biomechanics and solves problems requiring mathematical skills, and performs practical measurement and analysis. Student understands physiological signals and uses physiological signal measurement devices and methods, and understands principles of digital signal processing. Student
understands wireless communication principles. Student builds simple measurement system, connects sensors to measurement system, understands sensor operation and manages measurement data processing and storage. Student knows basics of team and project work, and applies these skills and the knowledge and skills learned in this theme to the project.

Theme 1 include six 5 ECTS courses. Courses and their main content are as follows:

**Physiological Measurement Technology I (PMT I)**

- Intelligent Environments and Applications (5 ECTS)
  - Measurement applications and business environment
  - Products, services and applications related to measurements
  - Intelligent living environment measurements
  - Wireless communication
  - Wireless sensors and sensor networks

- Applied Anatomy and Physiology (5 ECTS)
  - Basic structure and functions of musculoskeletal system
  - Structure and functions of cardiovascular system
  - Structure and functions of respiratory system
  - Basic functions of nervous system and sensory system
  - Practical measurements and analysis

- Biomechanics and Motion Measurement (5 ECTS)
  - Statics and equilibrium
  - Rigid body dynamics
  - Equipment for motion measurement
  - Principles of motion analysis
  - Senses and motion

**Physiological Measurement Technology II (PMT II)**

- Physiological Measurements and Sensors (5 ECTS)
  - Measurement of physiological signals
  - Physiological signal measurement methods and devices
  - Sensors
  - Signal amplification and noise filtering
  - Digital signal processing

- Data Collection and Processing (5 ECTS)
  - Labview programming
  - Development of graphical measurement application
  - Connecting sensors to system
  - Data processing, analysis and presentation
  - Storing data to database

- Health Technology Project 1 (5 ECTS)
  - Practice-oriented project
  - Product and service development
  - Team and project work
  - Project management
  - Project documentation

Implementation of Theme Based Curriculum

In this new thematic approach the themes are one semester in length and they have common operating principles, integrated timetable and tools. For example, each course inside the themes has similar structure including weekly schedule and goals, assignments and returns, and basis for evaluation and grading in Tuubi workspace (Metropolia’s e-learning platform). Tuubi workspace is also utilized for course level communication and assignment returns.

Students have three simultaneous tightly integrated courses, time per course is around 16 hours including 7 hours of contact per week. Weekly timetable includes slots for lectures, assignments, independent and guided group work. Each students work in one small group, and the groups are re-assigned between semesters. The main idea is that students work actively and take responsibility of their own learning. Different learning methodologies are utilized such as project based learning presented earlier. It is essential that the students participate actively on their learning and therefore lecturer centred learning is reduced significantly compared to previous curricula. Lectures and introductions are kept short and the main focus is practical assignments done mainly in small groups. Students also widely evaluate their own and the group work during the themes.

Careful planning and weekly meetings are the tools to enable synchronization between different courses inside the themes. For example, biomechanics and motion lab measurements are tightly integrated to each other which enable student to understand the connections between practical human motion measurements and theoretical physical phenomena.

Feedback from the first implementation

It is important to gather feedback to enable continuous development. Physiological Measurement Technology theme was implemented first time in August-December 2015. This section presents the survey used to gather student feedback. Feedback was gathered at the end periods one and two of the theme. Similar survey is also executed after each period/module in the future. Obviously this survey in only one method to collect feedback. Feedback is also gathered during the courses, tutor discussions etc. The survey included following questions.

1) Assignments and timing of returns
2) How good timing and synchronization was in this period
3) How different courses supported each other
4) Amount of work: a) could have been more, b) suitable, c) too much
5) I worked: a) <30 hours, b) 30-40 hours, c) 40-50 hours, d) > 50 hours per week
6) What was good in this period?
7) What should be developed in this period?
Feedback Results: PMT I

This section presents the results from the student feedback survey gathered at the end of the first module of the theme 1. Results are divided into workload, what was good and what should be developed.

Workload (questions 4 and 5)

Figure 1 presents answers to survey question 4 related to amount of work. It can be seen that 85.7% (N=24 out of 28) of the students estimated that the amount of work was suitable (option b), 8.9% (N=2.5) of the students thought that there was too much work (option c) and 5.4% (N=1.5) of the students answered that there could have been more work (option a) during the first module of the theme 1.

![Figure 1: Amount of work in PMT I.](image)

What was good (questions 1, 2, 3 and 6)

Practically all students were satisfied with timing of the assignment returns. Most of the students that is 67% (N=18 out of 27) wanted assignments to be spread out to the whole period instead 33% (N=9) of the end of the period. Most of the students, that is 93% (N=25 out of 27) were satisfied how different courses supported each other.

Students were especially satisfied to practical assignments and research. Examples from these were practical measurements at the motion lab, personal ECG measurements and analysis, visits to the companies and also practical assignments done at the physics related to the motion lab measurements. Also versatility of the period was appreciated. This module included anatomy, physiology, wireless communication and biomechanics. High level of the teaching was highlighted in the feedback.

What should be developed (questions 1, 2, 3 and 7)

Students would like to have even more practical assignments instead of theory. Based on the survey more emphasis should be put to the instructions of assignments. Group sizes were 4 to 5 in the theme 1, students would have preferred smaller group sizes than these.

Feedback Results: PMT II

This section presents the results from the student feedback survey gathered at the end of the second module of the theme 1. Results are divided into workload, what was good and what should be developed.

Workload (questions 4 and 5)

Figure 3 presents answers to survey question 4 related to amount of work. It can be seen that 87.5% (N=17.5 out of 20) of the students found the amount of work suitable (option b), 7.5% (N=1.5) of the students answered that there was too much work (option c) and 5% (N=1) of the students thought that there could have been more work (option a) during the second module of the theme 1.

![Figure 3: Amount of work in PMT II.](image)
Figure 4 presents answers to survey question 5, how much students worked on weekly basis. It can be seen that 52.9 % (N=9 out of 17) of the students worked 30 to 40 hours (option b), 20.6 % (N=3.5) of the students worked under 30 hours (option a), 17.6 % (N=3) of the students worked 40-50 hours (option c) and 8.8 % (N=1.5) of the students worked over 50 hours per week. Thus 79 % of the students self-estimated that they worked over 30 hours on weekly basis.

![Figure 4: Working hours per week in PMT II.](image)

**What was good (questions 1, 2, 3 and 6)**

Students were satisfied for timing of the assignment returns. They were also pleased versatility of the theme. Students were especially satisfied to practical assignments also in this second module of the theme 1. Based on the feedback there were less theory in the second module that satisfied students. Students also liked project and project based learning.

**What should be developed (questions 1, 2, 3 and 7)**

Students hoped for more materials from the teachers and more practical examples about subjects discussed. They also wanted clearer articulation related to course evaluation and how the grades are formed. They also pointed out the importance of distinct instructions the different course assignments. One practical example is that students were little confused the use of different learning platforms used in different courses.

**Conclusions**

Previous sections presented the feedback from the students. This section discusses the results and how they have been and will be used in the following implementation in 2016.

It is quite difficult to estimate weekly hours without precise documentation but it can concluded that workload in the first implementation was good, there might be possibility to increase the workload slightly.

Students were satisfied for timing of the assignment returns. From teachers’ perspective there are some adjustments to be done in the next implementation. Students were pleased with practical assignments and measurements and these should be developed even more. Theory lessons are important and they cannot be omitted but rather they should be developed and matched even better to practical assignments. Versatility of the period was appreciated which was nice to notice because this is one of the building blocks of the theme-based curriculum. Students were ready and eager to work in groups and in project based manner, this was also important because this was another building block of the new curriculum.

In the following implementations the small group size is three and groups are decided by the teachers. This was also students’ preference. More emphasis will be put to the homogenous instructions of assignments and grading in different courses. Tuubi e-learning platform will be utilized. Teaching materials will be developed for the coming implementations.

The goal of theme based integrated curriculum with student centred learning is to provide students an integrated learning experience where they can deepen their knowledge and skills related to specific theme for the whole semester. Based on the results presented and multiple discussions with teachers we are on the right track.

**References**


Introducing Active Learning into Social Studies for Engineering Education

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Abstract

This paper aims to show the effects of introducing active learning into social studies for Engineering Education and to reconsider the possibility and the implication of social studies in Engineering Education.

For this purpose this paper reports some class examples which introduced the method of Oral History and Gamification.

Through these cases, this paper discusses effectiveness of introducing active learning into social studies.

First, the method of interviews or oral history is effective in a point to be able to realize the multi-faceted aspects of working and the important qualities of an engineer.

Second, the method of Gamification is effective at improving the learning motivation of the students.

Third, social studies can be as a part of the classes teaching communication skills.

Fourth, the developing the class in collaboration with teachers of other fields is significant.

Fifth, it is enable to provide opportunity when student oneself notices importance of the knowledge of history.

Keywords: Active Learning, Oral History, Engineering Education, Social Science

Introduction

Generally, social studies in the College of Technology is not high in importance in comparison with engineering subjects.

The consciousness of the students is similar. For example, self-evaluations regarding Humanities and Social Sciences of graduates is low according to the results of questionnaires of the National Institute of Technology (NIT, 2012).

I heard things such as "I am weak in Social Studies” often from students. But according to this questionnaire of graduates, many of them answered that the subjects of Law and Economics will be necessary in the future for Engineering Education (NIT, 2012).

The results of this survey indicate that the teacher of social studies must devise classes so that students can be interested in this subject. And then, the teacher must think about educational policy and method.

Active learning is the method of learning in which the teacher provides his/her students lessons which are more interesting by providing contents that are easier to understand. It is the general term for the teaching method that incorporates the participation of the students who learn actively, in contrast to the form of teaching by one-sided lecturing from the teacher. (Central Council of Education, 2012). Specifically, it includes such learning as learning by discovery, problem-solving learning, learning by experience, and learning by investigation, etc., but group discussions, debates and group work in class are also effective methods of active learning. As active learning promotes the subjectivity and the participation of the students in this manner, it is considered an effective form of teaching. (Central Education Council, 2012).

However, in the contents of social studies subjects, such as civics, geography and history, there are a few themes for which questions with more than one answer can be given. For these themes, rather than teaching the answers to the relevant problems, teaching that focuses on the process, such as relying on the discussion of problems by the learners is often done.

Having such a background, social studies education had a great deal of teaching materials and teaching methods that included the elements of active learning, before the appearance of the term, "active learning”. Therefore, the environment of the teachers of social studies is easier to introduce the method of active learning compared to that of other subjects.

In such situations, I have been trying to introduce the method of active learning in social studies for the purpose of enabling students to take greater interest in class.

In this paper, I report some class examples which introduced the method of Oral History and Gamification in the social studies.

Through these case studies, this paper discusses and considers the possibility of introducing the method of active learning and the implication of social studies in Engineering Education.
Methods

1. Learning Oral History

Oral history is interviewing individuals about important events or everyday life and using the material which was collected with interviews for the study of history (Sakurai, 2010). Oral history is opened and used widely, for example sociology, psychology, political science etc. It is evaluated that through the interview, experiencing an another person's career indirectly is effective as higher education or career education (Umezaki, 2010).

In this section, I will report two examples as the trials that introduced oral history into social studies education.

Thinking about “working” through interviews

In the class of politics and economics, I introduced the method of interview. I gave students an assignment for summer holidays. In this assignment, students had to interview people who have work experience and to hear how he works, what does he get by working, what does he work for. Further, students had to consider what his way of thinking and his values about his career were. In this assignment students often interview their parents or relatives during summer holidays. In some cases, they also go to their workplace to observe them at work. After interview students wrote a report, summing up what they have learned.

After the summer holidays, in the class students engaged in group work. First, students presented their reports which they prepared with each group. After presentation each group engaged in brainstorming about career or working by using a tag. Finally students summarized in one sentence or one phrase the meaning of “working” and presented it to the class. For example, “working” means “living”, “enriching one's life”, “brining comfort to one's family”, etc.

Through this group work students came to know the meaning and the significance of “working”.

The description to be seen in their reports frequently is “until I conducted my interview, I had thought that 'working' was only to 'earn money' or ‘to persevere', etc. But after the interview, I learned that ‘working’ was not merely to earn money, but to also engage in one's work, while enjoying what one is doing at times, thinking of one's family, as well as perceiving the purpose of life. I came to realize how limited my thinking had been.”

The objectives of this assignment and group work are to enable the students to acquire communication skills, writing skills, interviewing, logical thinking, and brainstorming. However, the most important things are that the students cultivate a positive awareness on careers and realize the multi-faceted aspects of "working".

Learning the oral history of a sailor for Engineering Education.

In the subject: Modern Society and Law, which was held in the advanced course after the college of technology, we introduced the method of oral history (Takehara & Hino 2014). This class was conducted in cooperation with a teacher of material science, Dr. Takenori Hino. In this class, students learned the oral history of “Seikan” Train Ferries, Yotei Maru which ran between Aomori and Hakodate in 1965-1988, and recorded this oral history in cooperation with students from other departments. They made a DVD by creating a script and editing the video.

They wrote an impressive essay about the process of this class at the time of the semester test. From these essays we found that, consequently, students learned important qualities for engineers such as safety awareness, teamwork, and mastering skills. Moreover, they came to recognize the importance of knowledge based on experience and history.

I carried out a questionnaire after this class. It revealed that the satisfaction of the students was high from this survey (table 1).

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>N/A</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q6 Whether it is devising a means and method of teaching?</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Q7 Did teacher go with a serious and passion?</td>
<td>9</td>
<td>1</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Q8 Are you interested in the course content?</td>
<td>9</td>
<td>1</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Q9 Did you understand the lecture?</td>
<td>7</td>
<td>3</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 1: the questionnaire after class (excerpt)

Moreover, the script and edited video became an important material for labor history and engineering history.

2. Gamification into Social Studies Education

High motivation of students toward class and study is essential for active learning in education. Gamification is one of the ways to increase the motivation of students. Gamification is to apply a game concept to non-gaming contents.

In this section, I report two examples of Gamification in social studies education.

Quiz with ranking for student’s motivation

In this case I collaborated with the teacher of computer science, Dr. Hidetake Uwano and a student of the advanced electronics and information course in NIT Nara College, Yuki Tanaka. We introduced the element of Gamification into the class of social studies and summarized the result in an article (Tanaka, Uwano, Ichinose, Takehara 2016).

In the lecture of “Politics and Economics” we carried out the quiz to check the students’ degree of understanding. At that time, we used the ranking for the
student’s motivation. The ranking is often used in Gamification.

In this quiz we used Moodle, a web-based open source platform for education as an e-Learning system.

The quiz was carried out on a Moodle quiz module at the beginning of one lecture. The quiz consisted of 15 four-choice questions with an eight-minute time limit.

After finishing the quiz, the ranking was displayed on the system with each student’s ID. Each ID was given as a well-known person in Japanese history for the student’s privacy.

Some students made comments such as “I want to get a high score worthy of my user ID.” When displaying the ranking to the students, they talk about the name and their rank, especially about two clan masters who fought in a historical battle. The user ID was treated like the real name on the e-Learning system. Therefore, appropriate user IDs were an impetus for student’s motivation.

After the quiz we carried out the questionnaire. The results revealed that many students answered in the affirmative about the quiz and ranking (table2).

<table>
<thead>
<tr>
<th>Question</th>
<th>NO</th>
<th>YES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Q7: Do you think you want to do a quiz with ranking next time?</td>
<td>6 (21%)</td>
<td>18 (55%)</td>
</tr>
</tbody>
</table>

Table 2: the questionnaire about the quiz and ranking (excerpt)

We also measured the effect of the ranking on the motivation toward preparation and the quiz score. We defined three classes (104 students) as a ranking group, and the other two classes (82 students) as non-ranking group. Both groups were informed that the quiz would be performed two weeks later. In addition, the ranking group was informed that the quiz score would be open to other students with their ID through an e-Learning system.

As the result of the experiment, 44% of the students answered in the questionnaire that their motivation toward the preparation for the quiz had increased. There was no significant difference between the quiz score of the ranking and non-ranking groups. Analysis of the relation between a competitive-mind and motivation for quiz preparation shows that less competitive-minded students tend to have low motivation and scores (Tanaka, Uwano, Ichinose, Takehara 2016).

General Conversation in Trading Game

In this section, I will report the cases that I have developed social studies lessons for the purpose of improving the students’ communication skills.

Specifically, by using the teaching materials that took advantage of the existing game-type materials, we devised a situation in which the students were compelled to speak English. The materials I used were called “trading games.” This is a game that simulates trading, one in which the students are divided into multiple groups (representing countries) and vie with each other, having been given an unequal quantity of paper, (representing resources) and equipment (representing technologies). It was created as a teaching material for developmental education in Britain. Its translation in Japanese has been published and is being used in Japan

Before starting the game, the students are divided into 6 to 8 groups, each of which is given its resources and raw materials. By using them, each group creates products and sells them in the market for making profit. In this game, the group that acquires most profit is the winner.

When the students are divided into groups, unequal initial conditions are established from the beginning, reflecting the realities of advanced countries and developing countries.

Through the experience of real-like trading, the students became to understand how economic disparities are being increased.

Generally, the learning of English in Japanese schools is centered around lecture classes where students learn English grammar and get training in listening comprehension. Therefore, they receive few opportunities to practice conversation. By using these teaching materials and with the collaboration of English instructors Dr. Sachiyu Nisikawa, I devised the lessons to supplement the training in communication in English for learners, by preparing the environment in which they were compelled to speak English.

In this game, its “facilitator” could, in the middle of the game, change the rules to provide changes in the situations. In the middle of the lesson I decided to implement the rule that players had to speak English, when going to the market to sell the products. I prepared in advance a set of English examples, consisting of the questions and the answers that will be needed by the person in charge of the market. The learners would then try to somehow speak in English, but no words would come out of their mouths. They found out how difficult it was to communicate in English. They realized the necessity of learning English actively, rather than passively.

Summary and Conclusions

To conclusion, I will summarize the results and consider the effectiveness of introducing active learning into social studies for Engineering Education.

First, the method of interviews or oral history is effective in a point to be able to realize the multi-faceted aspects of working, for example, “working was not merely to earn money, but was also the means to enrich their lives” and the important qualities of an engineer, such as being aware of safety, of teamwork and of mastering the skills in his field.
Second, the method of Gamification is effective at improving the learning motivation of the students. Many students answered in the affirmative in the questionnaire after the quiz with ranking. From the analysis of the questionnaire data, it was revealed that the students who were highly motivated in their studies and had higher competitive spirit became even more so, as their ranking was shown.

Third, having created situations in which communication in English was required can be as a part of the classes teaching communication skills.

Fourth, the developing the class in collaboration with teachers of other fields is significant in recognizing each other's education method or object rather than taking advantage of the professional knowledge of the experts in the respective fields.

Fifth, active learning brings the positive influence for social studies education itself. Because it enables to provide the opportunity when student oneself notices importance of the knowledge of history. And if the script and edited video became an important material for labor history and engineering history, the students may come to be interested in social science.

In a conventional way, social studies education in college of technology is centered on teaching knowledge which is provided by an individual subject such as History, Politics and Economics, Ethics and Geography etc.

In contrast, introducing the method of active learning into social studies education provide the opportunity when the students oneself notice the importance of learning social science.

In other words, through the experience such as interviewing people who have work experience or ship sailor, trying to sell the products they made in English, the students oneself become aware of safety, teamwork, mastering skills in their fields and importance of communication.

So introducing active learning into social studies education is effective for Engineering Education in a point to be able to earn ability for self-study and become aware of the important qualities of an engineer.

References


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IS A FLIPPED LEARNING APPROACH SUITABLE FOR PART-TIME ENGINEERING STUDENTS AT TERTIARY LEVEL EDUCATION?

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Abstract

In a flipped learning model, teachers shift traditional educational arrangement outside the classroom and make teacher-driven instruction to student-centered learning. Meanwhile, students are the agents of their own learning and typical lecture and homework elements of a course are reversed. Very often, flipped classrooms are designed for secondary schools and for full-time courses and programs. As there has been growing interest in incorporating flipped learning into higher education, this calls for more high quality researches to inform practitioners on the use of flipped learning in different study modes. Rarely have they been examined in tandem with part-time study mode, this paper provides information on previous research studies and outlines benefits and major challenges of flipped learning particularly for this study mode. An investigation of a part-time higher diploma engineering course at Hong Kong Institute of Vocational Education (Tuen Mun) has been conducted. It reveals the learning needs in which flipped learning approach would have benefited their studies somewhat. The results of this investigation have been used as the basis for developing the course to allow a more effective flipped style. Pedagogical implications are drawn from the analysis and the way forward.

Keywords: flipped learning, part-time, engineering study, tertiary education, vocational education

Introduction

Pedagogical approaches such as Problem Based Learning (Kelly and Lesh, 2000), Model-Eliciting Activities (H. A. Diefes-Dux et al., 2004) and Peer Learning (H. A. Diefes-Dux and M. A. Verleger, 2009) have been introduced for teaching engineering students at tertiary level education. Recently, flipped learning approach has been the subject of much popular attention, however, very little research has been undertaken into these approaches.

In a flipped classroom, the information transmission component of a traditional face-to-face lecture is moved out of class time and in its place are active, student-centered and collaborative tasks. Before class, students have to prepare for class by engaging with resources that cover what would have been in a traditional lecture. After class, they could follow up and consolidate their knowledge. Notably, flipped learning has proven to be effective in secondary schools and in freshman engineering level (Yelamarthi et al., 2015). While past research studies have addressed many benefits of implementing flipped learning in full-time study mode, the flipped classroom approach in part-time study mode is under-evaluated, under-theorized and under-researched in general. Despite popular enthusiasm and a somewhat reasonable rationale, flipped classroom approach could not yet be considered an evidence-based (Pawson, 2006) approach, especially in consideration of different level of commitment by part-time students.

Vocational Training Council (VTC) is the largest vocational and professional education and training provider in Hong Kong. In academic year 2015/16, VTC has offered about 44,900 full-time and 21,500 part-time study places through its member institutions. Aiming for high quality researches to inform practitioners on the use of flipped learning in part-time study modes, the purpose of this study can be defined as the followings: 1) To provides information on previous research studies; 2) To address benefits and challenges of flipped learning for part-time students; 3) To propose best practices to design and implement flipped learning.

Research Questions

Part-time programs have a very different level of commitment than full-time programs do. Full-time students are expected to treat their studies as the main focus while part-time students might take one class a week, requiring only a couple hours of out-of-class study time.

From a cognitive load perspective, self-paced preparatory work might better manage working memory than traditional lectures (Clark, Nguyen, & Sweller, 2005). According to Andrews, Leonard, Colgrove, and
Kalinowski (2011), many of the learning difficulties experienced by students in higher education courses can be attributed to the passive role played by them during traditional lectures.

Flipped classroom approach wagers the success of in-class activities on the likelihood of students completing their pre-class assigned work and this leads to the perennial problems of student preparation. More troubling are issues of student motivation and imagine a flipped classroom where none of the students have completed their pre-class work. Based on such circumstances, how do teachers ensure students have prepared, and if the preparation in a flipped learning approach is useful for part-time engineering students at tertiary level education?

Research Methods

In academic year 2015/16, flipped learning approach was introduced to two compulsory engineering science modules, namely ENG3012 Engineering Science B and CON3301 Engineering Science for Construction A. The class of former one was in full-time mode of 28 students, while another was in part-time mode of 20 students. Both modules were foundational modules in the engineering curriculum and similar flipped learning approach was adopted in both classes such as the progress, the implementation, the physical setting, and the interface with Moodle-based resources.

Two study modes distinguish the two modules with different curriculum hours. Given the same qualifications framework level 3, ENG3012 has 45 hours including 25 hours of lecture, 15 hours of tutorial and 5 hours of laboratory, while CON3301 has 26 hours including 13 hours of lecture, 9 hours of tutorial and 4 hours of laboratory. Video lectures in English were available on Moodle platform and ENG3012 was considered as a control for gauging the discrepancies between both groups of students about flipped learning approach. A questionnaire survey was done in both classes to collect students’ feedback, problems encountered, and the way forward.

There are five key questions to collect students’ valuable views on the implementation of flipped learning approach. Key question 1 asks whether students watch the video lectures before the class or not. If students have watched the videos, the questionnaire asks whether the videos helpful for them to understand the topics in key question 2. If students have not watched the videos, the reasons of why they do not watch the videos are asked in key question 3. Key question 4 asks the students’ opinions on the effectiveness of flipped learning approach than that of traditional lecture. Last key questions addresses what are the possible activities in the class session. The students’ feedback is analyzed for the comparison of impacts on flipped learning approach towards students in different study modes. However academic result is not used as an indicator because of different learning contents. Minor changes will be made to ensure equivalence between other factors.

Results and Discussion

A big difference is found between part-time and full-time students on the actual preview rate of video lectures in a flipped learning approach. Almost no part-time students watched the video lectures while around three quarter of full-time students watched that. Key question 3 also shows the same situation in which part-time students considered there was no enough time to watch the video lectures, in contrast to full-time students who did not view the video lectures may be activated by modification of video lectures.

The results echo with previous research findings that level of commitment and motivation are two important factors that drive the effectiveness of flipped learning approaches. Among these two factors, level of commitment was more applicable to part-time students and motivation was more applicable to full-time students in this survey. For all students who watched the video lectures, majority of them agreed that the video lectures were helpful in understanding the topics.

Comparing traditional lectures, both classes agreed the flipped learning approaches were more effective while full-time class yielded a clear result. If flipped learning approaches were adopted, most of the students would prefer to have game-based activities in its place. Small-group and large-group discussion were second and third preferable options in their point of views. The summary of results is tabulated in Table 1.

The move from a traditional lecture to presenting that same lecture online is unlikely to result in learning differences if nothing else changes. Comparing full-time students, part-time students have more difficulties in finding time to watch video lectures because of their works. In this study, although part-time students also recognize the benefits and effectiveness of flipped learning approaches such as manipulating the pace of learning by pausing, rewinding, fast forwarding or skipping any parts of lecture videos, the constraint of tight study schedule is the largest hurdle in applying flipped learning approaches for part-time students.

The information-transmission component of a traditional lecture is moved out of class time if possible and replaced by a range of interactive activities designed to entice active learning. However, in most cases, engineering subjects are not solely information-transmission but require deeper understanding of concepts and skilfully practice of calculation. Unless a lecture has the sole goal of transmitting information, flipped learning is probably not the best approach (Bligh, 2000). Further researches should be done in order to identify the content to be delivered.

A Call For Further Research

There are many factors that play key roles in the effective use of flipped learning approaches. Only time and further researches will tell if flipped learning approach yield predictable, repeatable increased performance. A limiting factor in this study was its small sample size of 48 participants. A larger sample size and perhaps a same modules study would be
informative. A same modules survey would also be helpful to identify any disparities that are not affected by subject contents. In general, it is important to ensure teachers have the skills and pedagogical understanding required to embed constructively aligned active learning within the approach. In particular, future efforts will focus on how to modify the current flipped approaches to suit the needs of part-time students. Perhaps shorter videos will be used and incentives should be added to attract students to preview the videos.

Conclusions

Flipped learning approach are being adopted with much enthusiasm despite the paucity of specific evidence about their efficacy. In the absence of evidence of the efficacy of flipped classroom in general, the findings should encourage the practice of flipped learning approaches in the future, and support future research into exploring the adaptation and development of flipped classroom as an innovation educational pedagogy.

This paper outlines a study of the flipped learning approach with part-time and full-time engineering students at tertiary level education. The flipped classroom is a new pedagogical method, which employs video lectures, and interactive activities in the classroom. The results between part-time and full-time students are very different in some senses. Using full-time class as a control point, a survey was conducted in two engineering science courses at Hong Kong Institute of Vocational Education (Tuen Mun) during the spring semester of academic year 2015/2016. All students were asked to complete video lectures outside the classroom and full time students were considered as a gauge against part-time students. The two groups were compared using a same questionnaire addressing 5 key questions.

In conclusion, part-time students found it difficult in fitting flipped learning structure due to different level of commitment than that of full-time students. The biggest hurdles to achieve full effectiveness of flipped learning approaches for part-time and full-time students were busy work-study schedule and motivation respectively. Despite the difference in programme nature, both part-time and full-time students agreed that flipped learning approaches would have benefited their studies somewhat. If flipped learning approaches are adopted, game-based learning activities and small-group discussion should be in its place of the class session.

Three implications should also be highlighted in this study during applying flipped learning approaches including 1) to move most information-transmission teaching out of class, 2) to use class time for learning activities that are active and social and 3) to adjust the length and language of video lectures whenever appropriate.

References


PRACTICE OF LECTURE COURSE "APPLICATION OF ELECTRICAL AND ELECTRONIC"

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Abstract

The authors have conducted a lecture course “Application of Electrical and Electronic” by adopting active learning (AL) methods from FY2015 in National Institute of Technology (NIT), Nagano College. This course is an optional course of half-year to learn by utilizing knowledge of electrical and electronic engineering which students have learned at college in the past. In this course, students will learn photovoltaic power generation system, lighting design, electric heating equipment, air-conditioning equipment, electric railway, application of motors, electrochemistry, and smart grid and micro-grid. Also, in this course, we have partially adopted flipped classroom and conducted a test to confirm learning level at the beginning of a course. During school hours, students are doing the exercises on basic matters and designing electrical equipment by utilizing basic matters.

In the lecture course, students designed the photovoltaic power generation system of 10kW, and LED lighting equipment to be used in the classroom. In addition, students were exercises computational problems of the amount of heat generated from the electric heating equipment, capacity of air-conditioning equipment, output power of motor for elevator, and current efficiency in electrochemical, and so on. These designs and exercises were carried out in individual learning and group learning. In addition, students listened to lectures about the construction of the Shinkansen (bullet train lines) and conventional lines, and the configuration of the smart grid and micro-grid. Students who are interested in power engineering was the state that are working actively in home learning.

We conducted a questionnaire at the end of a lecture course. From the contents of the free description column, evaluation of students is likely that it was good. In this paper, we describe the course content and questionnaire results of a lecture course “Application of Electrical and Electronic”.

Keywords: Active learning, flipped classroom, applications of electrical and electronic, photovoltaic power generation system, lighting design

Introduction

In recent years, active learning has been incorporated into courses in many college (example, Ogawa, N., et al. (2015)). Also, teaching examples incorporating the flipped classroom have also been reported (example, Inoue, H. (2014)).

In NIT, Nagano College, there were only a few courses that incorporated active learning seriously. The authors conducted a lecture course by using a teaching method that has gained experience in the experiment to nurture creativity (Watanabe, S., et al. (2005), (2008), (2011)). Therefore, we conducted a lecture course that incorporates active learning in order to have a deep understanding of the electrical equipments to the students. In this paper, we describe the course contents and questionnaire results of lecture course.

Contents of a lecture course

In this course, students will learn photovoltaic power generation system, lighting design, electrothermal equipment, air-conditioning equipment, electric railway, application of motors, electrochemistry, and smart grid and micro-grid. The contents that this course dealt with aimed at the technology close to that which is actually used in designing electrical equipments. This course was intended to be a course in which students actively collect information and learn on their own. This course is an optional course intended for the fifth grade, 26 out of 34 applicable students (76.5%) took it. In the end, it passed students of 25 (96.2%) in this course. Contents handled are as follows:

(1) Photovoltaic power generation system

The assignment about solar power generation equipment is to create a proposal to build a solar power plant of the total output 10kW at any location. The model of the power-conditioner used for the power conversion was specified in advance, but the students were required to choose solar panels and platforms, etc. Students were also required to predict the yearly amount of power generated by their proposed equipment, using the information from weather stations, etc. In a lecture course, only devices that constitute the solar power generation equipment and fundamentals of power
generation characteristics were explained. For the students, it was instructed to investigate their own detailed matters necessary for the design. Students wrote a report by investigating the specifications of devices such as solar panels on the Internet and literature (figure 1 and figure 2). It is observed that interested students were actively gathering information.

(2) Lighting design of classroom

In lighting design, students were asked to calculate the number of light emitting diode (LED) lamps to illuminate the classroom used for this course if LED lamps are used to light the classroom. They were also instructed to calculate the illuminance on the desks in the case that LED lighting was used.

(3) Electric heating equipment and air-conditioning equipment

In electric heating equipment, students learned the principles of heat pumps and solved heat calculation problems. As for the calculation of the capacity of the air-conditioning equipment, students solved an example problem which asked for the heat needed for the room and chose what capacity air-conditioners are appropriate for the room (figure 3). For the results of solving were asked to describe in the blackboard to a representative of the students (figure 4).

(4) Electrochemistry, application of motors, and electric railways

In electrochemistry, students learned the principles of the primary battery and secondary battery, and went through the exercise of basic calculation problems. In the application of motors, students solved exercise problems about hoisting elevators. In the electric railway, it handled for the technology in Hokkaido Shinkansen which opened in March 26, 2016.

(5) Smart grid and micro-grid

Finally, we discussed about the smart grid and micro-grid that has been attracting attention as a power transport technology. After that, students studied the relationship between power demand and frequency variation and the problem of voltage rise due to the reverse power flow.

Figure 1. Appearance of students who are to search for articles about photovoltaic power generation system.

Figure 2. Report on the design of photovoltaic power generation system.

Figure 3. Appearance of students who are practicing in groups or pairs.
State of a lecture course and questionnaire results

This lecture course was half carried out. Interested students were observed to actively collect information and design equipment, but there were also students studying passively. The submission of assignments went well. At first, the contents in electrical equipment design by students was scheduled to provide the opportunity to present, but could not be carried out by poor health of the instructor. However, in FY2016, this plan is going to be put into practice.

The authors have conducted a questionnaire survey on tuition to students on March 1, 2016, and obtained answers from 22 out of 26 attendants (84.6%). Questionnaire results are as follows: 19 students (86.4%) were almost satisfied with the contents of this course (figure 5(a)). Also, although 11 students (50.0%) were almost satisfied with the methods of this course, rest of students answered “Neither” or “Somewhat bad” (figure 5(b)). Students are considered to be not familiar with the flipped classroom. As for the efforts of problem, 19 students (86.4%) answered that they were able to make moderate efforts (figure 5(c)). As for flipped classroom, 6 students (27.3%) answered that they were able to do it a little, but 16 students (72.7%) answered “Neither”, “Unable to do much,” and “Unable to do it” (figure 5(d)). As for the amount of homework and reports, 14 students (63.6%) answered “Appropriate” (figure 5(e)). As for the knowledge about electric power engineering, 19 students (86.4%) answered “Somewhat master” (figure 5(f)). Students because it has mastered the basic knowledge of power engineering before taking this course, it is considered a degree of understanding has been improved.

(a) Satisfied with the contents of this course

(b) Teaching style

(c) Efforts to problem

(d) Approach to flipped classroom

(e) Amount of homework and reports

(f) Knowledge of electric power engineering

Figure 5. Results of the questionnaire survey.
In the free comment area, favourable comments like “The course was useful because I was able to learn electrical applications and practical things” were observed. On the other hand, there were opinions that there were too many handouts and that it was difficult to understand the content of the course, because the course dealt with various themes. It was also found that there were students who had difficulty preparing for the test because the range of topics for the test is wide. Some students were critical of the idea of flipped classroom itself, and some said that they could not learn deeply because the content of the course is wide. This year is the first year for this course. We will try to improve the method as to how to handle the class in the future.

Conclusions

In this paper, we describe the course contents and questionnaire results of a lecture course “Application of Electrical and Electronic” being implemented from FY2015. We conducted a questionnaire to students at the end of a lecture course. 86.4% of the students were almost satisfied with the contents of this course. Also, although 50.0% of the students were almost satisfied with the methods of this course, rest of students answered “Neither” or “Somewhat bad”.

From questionnaire results, students in this lecture course is considered a heightened awareness to learn aggressively electrical and electronic engineering. However, since most flipped classroom not carried out in this college, students are considered not familiar with the flipped classroom and exercises. In the future, we need to devise the contents of a lecture course. In addition, it is important to increase the lecture that incorporates active learning and flipped classroom.

References


TECHNOLOGY EDUCATION IN HONG KONG – TRENDS, CHALLENGES AND POTENTIALS

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Abstract

While education promotes technological changes, it also responds to technological changes. Technology education, with the concept of applying technology to solve problems and satisfy needs and wants, aims to develop individuals’ knowledge, skills, attitudes and values in order to maximizing their adaptability and flexibility for future employment. As a field of study, technology education was internationally recognized in the 1980s, but the history of teaching craft-based and skill-oriented subjects in secondary schools in Hong Kong began in the 1920s. Students at that time were simply needed to acquire basic technical skills and gain practical experience to prepare for earning a living. Not until the mid-1970s was the higher order design element integrated into the curriculum of the local technology education to provide students with opportunities to practise problem-solving skills. Now, technology education is a part of general education in Hong Kong. In alignment with the global education trend, by combining science, technology, engineering and mathematics education, STEM education is currently being highly promoted in local schools. Besides, sustainability is a global issue of immense importance. Hong Kong, like many other cities in the world, has implemented various strategic measures to achieve sustainability. Theoretical perspectives on sustainable development under three topics, namely value position, nature of the proposed responses and structure of the proposed responses to this issue, as suggested in the literature, revealed that technology education can effectively contribute to education for sustainable development (ESD). A coherent and cross-curricular approach across all STEM subjects can be adopted in local secondary schools for ESD. This paper reviews the trends and challenges of technology education and STEM education in Hong Kong, discusses overseas experiences on integrating ESD through technology education into the school curricula, and describes case studies in the context of STEM education for introducing green design and green products as recommended in the literature to be beneficial to the future ESD.

Keywords: technology education, STEM education, values, problem-solving skills, trends and challenges, sustainability, education for sustainable development

Introduction

According to ITEA (2000), technology is defined as human innovation in action that involves the generation of knowledge and processes to develop systems for solving problems and extending capabilities. Technology education is a part of general education that is designed to develop technological literacy among students. The ultimate goal of technology education is to produce students with conceptual understanding of technology and its place in the society and thus grasp and evaluate new bits of technology that they may never have seen before. The definition of technological literacy is given as what every person requires to become an informed and contributing citizen for the present and the future. The scope and nature of technology education however vary in different places. In Hong Kong, technology education since 2015 has officially been integrated into STEM education, which is an acronym that stands for the academic disciplines of science, technology, engineering and mathematics collectively. This paper reviews the trends and challenges of technology education as well as STEM education in Hong Kong.

The concept of sustainability has sparked intense international debates since the early 1980s. Governments and non-government organizations all over the world have become aware of and expressed concern about the future of the mankind. The discourse took a pause when a common description of sustainable development was agreed: sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. The discussions about how sustainability can be achieved across a community however never stop.

Different cities empathize different areas and set out different ways for approaching sustainable development. In consideration of the strategic direction of Hong Kong, three areas were identified to exert impacts on the city’s sustainable development. They are namely solid waste management, renewable energy and urban living space. Extra efforts are paid on these three areas in order to achieve sustainable development in the city.

One of the most crucial meanings of education is to empower people to contribute to environmentally sound sustainable development through their lives and careers. Whatever sustainable development is conceptualized, there is always a general agreement that education plays an essential role in this issue. As reported in the literature,
STEM education for introducing green design and cross-curricular approach across all STEM subjects education can effectively contribute to education for sustainable development suggested in the literature, revealed that technology education is highly preferred because it has the particular capabilities for developing a moral value and solving authentic problems by using practical solutions and innovation designs. This paper discusses overseas experiences on establishing ESD based on technology education, and describes two case studies in the context of STEM education about promoting green design and green products which were suggested in the literature that they are highly effective to the future ESD.

Trends of Technology Education in Hong Kong

Technology education as a field of study was widely recognized by the end of the 1980s but the inclusion of technology education in the secondary school curriculum began much earlier. The teaching of traditional technical subjects in schools in Hong Kong can be traced back to as early as the 1920s (Feng, 2012). As a British colony at that time, the local education system was primarily modelled on that of the United Kingdom. Technology education at that time was mainly, formally offered at the secondary level. The title of these technical subjects, e.g. woodwork and metalwork, revealed that students at that time were only required to acquire simple technical skills and gain basic work experience for the preparation of earning for their own. Besides, the curricula of most traditional technical subjects in Hong Kong were copied directly from those used in the earlier days in the British schools, and had not been revised for many years. In the late 1970s, Hong Kong economy undertook a major transformation, from manufacturing industry to services industry. To adapt to the changed economy, in the education system, a subject of different nature called Design and Technology (D&T) was introduced at that time to the junior secondary level as an attempt to get out of the traditional craft-based and skill-oriented subjects. This subject incorporates higher order design element into the local technology education curriculum, focuses on the thinking process and involves more design and problem solving components than any traditional technical subjects did. The intended learning outcome of this subject is that by the end, students should be able to obtain technological literacy through the development of design and technological understanding, knowledge and capacity, communication and problem-solving skills, and awareness of the relationship among design, technology and the society (CDC, 2015).

D&T provides a new direction in learning and a new learning environment for students such that they can have more chances to practise problem-solving skills. The reinforced subject of D&T, called Design and Applied Technology (DAT), was later made available for the senior secondary students. The success in developing D&T and DAT triggered the reconstruction of the other traditional technical subjects and the development of new technical subjects containing more design and problem-solving elements in the early 1980s. However, there was no more major modification in the local technology education over the following 20 years.

Challenges of Technology Education in Hong Kong

Before the year of 2000, all the technical subjects in the local technology education curriculum still remained using outdated teaching materials and teaching methods. The situation had a change in 2000. In order to match up to another economic transformation towards a financial centre, the “Reform Proposal for the Education System in Hong Kong” prepared by the Education Commission of the Hong Kong Government proposed that all the subjects in the curriculum should be reorganized and categorized into Key Learning Areas (KLAs) (CDC, 2015). Technology education is one of the KLAs.

Table 1 shows the existing technical subjects in the technology education curriculum at the secondary level in Hong Kong.

Table 1. Technology education at the secondary level in Hong Kong (CDC, 2015)

| Junior secondary (Secondary 1-3) | \- Automobile Technology  
| \- Business Fundamentals  
| \- Catering Services  
| \- Computer Literacy  
| \- Design & Technology  
| \- Design & Technology (Alternative Syllabus)  
| \- Design Fundamentals  
| \- Desktop Publishing  
| \- Electronics & Electricity  
| \- Fashion Design  
| \- Graphical Communication  
| \- Home Economics/ Technology and Living  
| \- Retail Merchandising  
| \- Technology Fundamentals |

| Senior secondary (Secondary 4-6) | \- Business, Accounting and Financial Studies  
| \- Design & Applied Technology  
| \- Health Management and Social Care  
| \- Information and Communication Technology  
| \- Technology and Living |

For junior secondary level, the latest curricula of the technical subjects in the local technology education were released in 2000 and implemented in the same year while those of the senior secondary level were released in 2007 and implemented in 2009, with minor updates in 2015. It is worthwhile to note that for D&T, the schools have a high degree of freedom to follow the curriculum of the 1983 version or that introduced in 2000. The objectives of the latest D&T curriculum at the junior secondary level are to help students to develop technological awareness, literacy, capability and lifelong learning patterns (CDC, 2015). The curriculum can broadly be divided into four areas of learning: nature and impact of...
technology for yesterday, today and tomorrow, tools and machines of technology, resources of technology, and design and communication. As for DAT at the senior secondary level, the objectives of its latest curriculum issued in 2015 are to provide students with fundamental knowledge and skills in design and technology and to cultivate them the attributes of innovation and entrepreneurship necessary to face the rapid social, economic and technological changes in a knowledge-based economy (CDC, 2015).

Over the past 30 years, technology education in Hong Kong has changed from skill-based teaching to teaching and learning for a balanced development of technological capability, understanding and awareness. Technology education provides broader chances to cultivate students’ initiative, creativity, problem-solving skills and practical design competence. Technology education has developed to a high level between 1970s and 2000s in Hong Kong (Volk, 2003), but in the recent decade, the shift of the economy to finance and banking has caused technology education to struggle in a difficult situation. Besides, technology education is not officially offered as an independent curriculum at the secondary level in Hong Kong. Neither D&T at the junior level or DAT at the senior level nor any other technical subjects in the current technology education curriculum is recommended to be compulsory in the local secondary education system. Technology education in some local secondary schools has started to be cut back, suspended or closed, which leads to a significant decline in the number of students studied in the technical subjects. Today, only half of the local secondary schools offer D&T and less than 40 schools offer DAT (Feng, 2012). A comprehensive review of technology education in the local curriculum is therefore in great need.

STEM Education in Hong Kong

In Hong Kong, currently, there are eight KLAs in the school curriculum, namely Chinese language, English language, mathematics, science, technology, personal, social and humanities, arts and physical education. Every student should gain a balanced exposure in all these eight KLAs (CDC, 2015). However, when an educational system cannot satisfactorily achieve its goals, government and citizen groups will call for an educational reform.

In order to maintain the international competitiveness of and create opportunities for Hong Kong in national developments, the Hong Kong government is currently actively promoting innovation and technology across the city (CDC, 2015). Talents with different capabilities, at different levels are required to fulfill and contribute to the economic, scientific and technological developments of the city and the country. Although Hong Kong students perform well in science, technology and mathematics in international competitions, it has been criticized that they may focus only on individual disciplinary studies but not evenly participate in hands-on activities in schools. On the one hand, the current education curriculum may have failed to arouse all the abilities of students to solve daily life problems. On the other hand, it is widely agreed that knowledge learnt through the school subjects of science, technology, engineering and mathematics are most useful for people to live their everyday lives. Thus, a pedagogy, developed based on technology education and combined with science, mathematics and engineering education, is currently in need to strengthen the abilities of students in integrating and applying their knowledge and skills that they have learnt from different academic disciplines to provide practical solutions and innovation designs for their daily life challenges (CDC, 2015).

In 2015, when the school curriculum is under review, STEM education is notably introduced. The promotion of STEM education in Hong Kong is in alignment with the worldwide education trend. STEM refers to four subject disciplines, namely science, technology, engineering and mathematics. The differences between STEM education reform and other educational reforms rest upon three key factors: (i) STEM education responds to the worldwide economic challenges that many nations face; (ii) STEM education recognizes the demand for STEM literacy for solving the worldwide technological and environmental problems; and (iii) STEM education gives emphasis to the necessary knowledge and workforce skills required in the 21st century (Bybee, 2013).

The main objective of STEM education is to nurture students to equip with necessary knowledge, generic skills, values and attitudes in order to meet the increasing changes and challenges, and become effective lifelong learners. STEM education in Hong Kong is specifically intended to promote students’ interest and develop their capacities to innovate by enhancing their creativity and problem-solving skills, through integrating and applying knowledge and skills across disciplines in solving real problems and promoting good citizenship. It also assists students’ further studies and career plans, and allow teachers of different KLAs to work closely to enhance the overall learning and teaching effectiveness together. It is hoped that by adopting STEM education in local schools to nurture diversified talents of different capabilities can enhance the international competitiveness and social and economic development of Hong Kong.

STEM education is currently being highly promoted among schools in Hong Kong in a holistic and coherent manner through a variety of strategies, such as renewing the KLAs in the existing curricula of science, technology and mathematics education, enriching students’ learning activities, strengthening project and experiential learning, providing teaching and learning resources, enhancing the teachers’ professional development, partnering with key players in the community, and conducting reviews while disseminating good practices.

Besides, when promoting STEM education, five basic principles were identified by the Government for schools to follow. The ideas of these principles are summarized as follows: Each school is directed to build up on its own strength to provide students with STEM-related learning activities, diversified learning, teaching and assessment strategies in the way of continuous development process to answer students’ needs and interest, where the learning activities and teaching strategies are most appreciable if they can balance the purposes, views and interests of the students and teachers and provide learning opportunities
Beyond classroom to the students so as to form a part of the essential student learning experiences (CDC, 2015b).

While STEM education is going to be adopted in local schools, five common confusions about STEM education must be highlighted: (i) it is not equal to a single scientific investigation; (ii) it is not equal to a single mathematics, science or technology competition; (iii) it is not equal to simply applying technology in the teaching of science or mathematics; (iv) it is not only suitable for a small group of elite science or mathematics students; and (v) it should be taught in an integrated, cross-circular manner, not just within the individual STEM subjects (Dugger, 2010).

The promotion of STEM education in Hong Kong started in 2015. It should take longer period of time to observe whether the outcomes of this new pedagogy can be effectively achieved.

**Technology Education and Sustainable Development**

Technology education is suggested to be an effective method of vocationalizing schooling. It is understood as developing an individual’s capabilities and competences to empower the individual for his/her future employment. One of the key features that appears to be common across technology education is the emphasis on problem solving.

Human has been living beyond the carrying capacity of the planet. Continuous degradation of the environment is adversely affecting the growth and development of our world. The future of the mankind and the quality of life for future generations are under threat. The concept of sustainable development emerged in the early 1980s as an attempt to bridge the gap between environmental concerns about the increasingly evident ecological consequences of human activities and socio-political concerns about the persistence of human development (Robinson, 2004). Measures are required to deal with this immensely important problem.

Education can make a significant contribution to the promotion of sustainable development. Sustainability is often described in curriculum documents as an issue that is intended to be integrated within design projects and activities, rather than being a lesson topic in a classroom (Middleton, 2009). Owing to the particular emphasis on problem-solving skills, in the recent decade, the issue of sustainability has been linked with technology education.

Pavlova (2009) studied the theoretical perspectives on sustainable development under three key areas: value position, nature and structure of the proposed responses towards the sustainable development issues.

When interpreting sustainable development comes to value position, the first question is often whether human should put more emphasis on human or the nature. There are frequent debates on philosophical and moral concepts of appropriate methods to conceive of the relationship between human and the nature. Huckle (2005) criticized that ecocentrism, i.e. the environmental ethics that human should live with reference to the nature, romanticizes the nature outside the society and fails to recognize that only human can value things; while if anthropocentrism, i.e. the environmental ethics that the nature should be used and managed, is too strong, it will allow the exploitation and oppression of the nature by treating it instrumentally or only as a means to human. Pavlova (2009) suggested that a weak anthropocentric approach that promotes mutual flourishing of human and the nature should be adopted as the value position to conceptualize sustainable development in order to provide a basis for education for sustainable development (ESD) via technology education.

As for the nature of the proposed responses towards sustainable development, Robinson (2004) identified two major approaches, i.e. technical fix and value change. It was highlighted that these two approaches of responses should be conducted in parallel. One major reason is that although technology has plenty of positive features for achieving sustainability, technological advancement is a subject of profitability. In economics, the Jevons Paradox teaches us when technologies increases the efficiency with which a resource is used, reducing the amount necessary for anyone use, but the consumption rate of that resource rises due to the increasing demand. It is easily understood that achieving reductions in the environmental impacts of an economic activity does not necessarily translate into improvements in human living quality. The major goal of the responses to sustainable development is to achieve optimal performance by using the technological problem-solving skills with a change of the value learnt from technology education.

The responses towards sustainable development may contain several common goals or themes. With regard to the structure of the proposed responses, Pavlova (2009) responded to the three key areas of concepts for ESD, as identified in the International Implementation Scheme for the United Nations Decade of ESD, which are society, environment and economy. The three concepts establish the framework of ESD. Since these elements comprise an ongoing and long-term process of change in knowledge, skills, moral values, attitudinal progress, it is worthwhile to remark that achieving sustainable development is a dynamic action.

Theoretical perspectives that include value position, nature and structure of the proposed responses provide a clear interpretation of sustainable development. A weak anthropocentric approach together with an emphasis on value change and the issues on the ever-changing society, environment and economy build up the nature of ESD. Technology education which has the particular value and design and problem-solving components can effectively contribute to ESD. Currently as technology education is fused into the STEM education in Hong Kong, a coherent and cross-curricular approach across all STEM subjects can be adopted in local secondary schools for ESD.

**Overseas Experience on ESD**

The need to integrate ESD into technology education has taken on a new priority internationally in recent years. Governments of many countries in the world are working hard to include ESD in their curriculum documents. This paper overviews the experiences of the governments in Australia, Ireland and Sweden on promoting sustainable development through technology education.

Currently, there are two syllabuses about technology being used in Queensland, Australia (QSA, 2007). Both syllabuses have the requirements of delivering some ESD
elements to the students. The junior students are required to work technologically and consider appropriateness in the social, environment and economic aspects before adjudicating on the sustainability of their design ideas, the processes and the products as well as their possible impacts on the users or the environment. During the process, appropriate knowledge, practices and attitudes can be developed in the students. This syllabus provides teachers with an opportunity to introduce the basic ideas of sustainable development. However, no guidelines on the concept about appropriateness leads to no mechanism to evaluate the education effectiveness of the teachers and students on ESD. This situation was criticized that in the context of the outcome-based education, the majority of teachers would not pay much attention to the sustainability aspect of the syllabus (Pavlova, 2009).

In the Irish education system (IESD, 2006), younger students study in the Junior Certificate programme, in which four technical subjects are elective. Material Technology, Technical Graphics and Metalwork do not have any element about technology and society. The remaining technical subject Technology was developed as a combination of the other three technical subjects but having a strong emphasis on the design and problem solving skills. The concern on the relationship between technology and society also features the syllabus. As for the senior level, the technical subject Technology and Society provides a context in which students can explore and appreciate the impact of past, present and future technologies on the economy, society and environment. Critiques however appeared around the Irish technology education. It was argued that although the focus of the technical subjects has moved from a craft-based model to a design-based model, simple passing-on of traditional knowledge and skills to students remains. Students are not required to understand the content (Owen-Jackson, 2000). While Technology and Society shows awareness of the environmental issues, the other subjects appear to operate without a real understanding about the complex economic and social effects that shape the technological development. The absence of a focus on these effects of technology on sustainable development across the suite of the Irish technology education also highlights a significant failure in ESD (McGarr, 2010).

In the current Swedish school curriculum, ESD is a requirement (SNAE, 2011). It is highlighted that every person working in the school should encourage respect for the intrinsic value of each person and the environment. In the Swedish education system, environment is one of the four perspectives, which states that teaching should illuminate how the functions of society and our ways of living and working can best be adapted in order to create sustainable development. Three goals in the curriculum are sustainability or a sustainable development approach. It is mentioned that the school is responsible for ensuring that each student on completing compulsory school has obtained knowledge about the prerequisites for a good environment and sustainable development. Sustainable development is explicitly written out as an important element in the syllabuses of eight subjects. In the subject of Technology, for example, its goal is clearly related to sustainable development: students should be given the preconditions to develop confidence in their own ability to assess technical solutions and relate these solutions to sustainable development. However, this curriculum of ESD also has shortcomings. It was criticized that knowledge about sustainability in the Swedish technology education is vague and teachers are mainly aware of the ecological and environmental aspects of sustainability but less on the social or economic parts (Inga-Britt, Gumaelius and Geschwind, 2013). Besides, the implementation process of ESD was complained since decisions and directives of ESD is taken at the organizational level with few chances for teachers to influence the what, when and why of ESD.

In looking back at the experience of integrating ESD into the school curricula in Australia, Ireland, and Sweden, four strategies for developing ESD successfully in Hong Kong are proposed, (i) an audit should be conducted on the syllabuses of all the technological subjects to avoid sustainability blind spots; (ii) the assessment methods should align constructively with the intended learning outcome and the nature of the learning activities to enrich ESD learning experience; (iii) professional development opportunities should be offered to teachers for ESD; and (iv) a constant evaluation mechanism for ESD is needed (McGarr, 2010).

Suggested Learning Strategies in the Context of ESD

The importance of ESD can be addressed via STEM education in Hong Kong. Case studies are usually good starting points for students to understand, analyse and brainstorm solutions for a daily life problem. Learning activities in ESD suggested in the literature for realizing green strategies and technologies are described.

Various problem-solving strategies can be used in the green design. Advanced Systematic Inventive Thinking (ASIT) is one of the strategies, which contains five tools: unification, multiplication, division, breaking symmetry and object removal.

A case study was proposed about a management company requiring a sustainable design to solve the problem of disposing sewage. Students can propose their own solutions to the above challenges with the basis of the knowledge they have learnt from the STEM subjects. For example, students can combine the knowledge learnt from Science with the ASIT tools of unification and division to assign worms a new use to break the sewage down to become humus. Students can combine the knowledge learnt from Technology with multiplication tool to slightly modify the existing worm farm technology to minimize the use of energy consuming power machines or probably toxic chemicals but deal with the sewage naturally. They can use the knowledge learnt from Engineering to speed up the rate of natural transformation. They can also use the knowledge learnt from Mathematics to determine the reduction of daily running costs, the negative costs to the environment as well as the ongoing maintenance costs. This ESD of green strategies in this way will create a win situation for all the parties, customers, students and the environment.

Different criteria for green product design have been developed all over the world, such as Datschewski’s five principles of designing sustainable products, which
require: (i) the products are made from organic materials and is recyclable or compostable; (ii) the products should use solar energy or other forms of renewable energy during manufacture and use; (iii) the products must be non-toxic in making, use and disposal; (iv) the products should consume less materials, energy or water; and (v) the products should be made under fair and just operating conditions for the workers and the communities involved.

A case study was proposed about an industry which recognizes the challenges posed by energy shortages, climate change and the necessity for energy efficiency in buildings. A green product is needed to reduce the energy consumption of the industry. Similarly, students can propose their own solutions to the above challenges with the basis of the knowledge they have learnt from the STEM subjects. For example, students can use the knowledge learnt from Science to identify, source and use new and more efficient materials for the green product to reduce energy consumption. They can use the knowledge learnt from Technology to design the green product to consume renewable energy instead of fossil fuel energy and consume less materials and water. They can use the knowledge learnt from Engineering to improve the energy efficiency of the green product. They can also use the knowledge learnt from Mathematics to evaluate the effectiveness of energy saving by using their green product across the industry.

At the end of the ESD class, teachers can introduce more methodologies of assessing environmental impacts of the existing and new products, e.g., Life Cycle Analysis (LCA). When LCA is applied in the ESD teaching, issues such as energy and water consumption, toxic emissions, transport problems and the health and safety of users and workers can be further discussed (Pavlova, 2009).

Conclusion

There are three aims of this paper: (i) to review the development and challenges of technology education and STEM education in Hong Kong; (ii) to study the overseas experience in integrating ESD via technology education into their school curriculum; and (iii) to describe some case studies that were proposed in the literature about the adoption of STEM education in promoting ESD.

Technology education began in the 1920s in Hong Kong. By integrating higher order design element into the curriculum, technology education becomes a part of general education for our students. In alignment with the global education trend, the local Government is pushing STEM education. Besides, sustainability calls for the global concern. Hong Kong has established a strategy direction for mitigating a number of environmental problems. Human resources with different capabilities at different levels are required to help to achieve sustainability in Hong Kong. Literature reveals the support of theoretical perspectives on sustainable development under value position, nature and structure of the proposed responses on technology education for its contribution to ESD as it provides a set of clear priorities for teaching and learning. Therefore, a coherent and cross-curricular approach across all STEM subjects can be adopted in local secondary schools for ESD.

References


EVALUATION OF PROBLEM-BASED LEARNING TO SELF-MOTIVATION USING CUSTOMER SATISFACTION ANALYSIS

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Abstract

One-way type classes have long been emphasized in Japanese educational practice. To promote voluntary learning among students, problem-based learning (PBL), an active learning method, is regarded as being more educational than conventional classes. Several lecturers have adopted PBL-based assignments recently. Nevertheless, the outcomes of such approaches for PBLs apparently depend on both the lecturer and the class. It remains unclear whether all PBLs are educational and effective for students. Methods for quantitative evaluation of the educational value of PBL are also poorly established.

This study assessed the effects of a PBL-based assignment on students’ motivation and outcomes by sampling a PBL-based assignment in a Food Engineering class at the National Institute of Technology, Miyakonojo College. This PBL-based food engineering assignment for groups (3-4 individuals per group) was conducted as one of the learning content. The assignment included studies of interesting food processing, preparation of a presentation about that food processing, and presentation in a class workshop. In addition to hearing other presentations in the workshop, students were instructed to evaluate other presentations according to certain evaluation criteria. This evaluation was intended to foster students’ critical thinking through critical assessment of other presentations. After the workshop, a questionnaire survey was administered to elicit responses related to the challenge and meaningfulness of this assignment for students. To evaluate the effects of the assignment statistically, data from the questionnaire were subjected to customer satisfaction (CS) multivariate analyses.

Questionnaire analyses reveal that most students have experienced presentation-based classes several times in years 4–5 at this college. Results also indicate that they regarded other presentations as beneficial for themselves for future presentations and that they expected comprehensive classes including PBL-based assignments rather than one-way type classes. Although presentation-based assignments yielded qualitatively demonstrative benefits to students, the CS analysis clearly reveals that having the opportunity for a presentation itself was more important for students’ effort and motivation than anything else. Considering questionnaire survey results, CS analysis is useful for quantitative evaluation of the PBL assignments. It can provide statistical verification of them.

Keywords: educational style, active learning, presentation, critical thinking, statistical analysis, multivariate analysis

Introduction

One-way type classes, during which students passively receive information from a teacher (Prince, 2004) via traditional lectures, have long been emphasized in Japanese education practice. Unfortunately, student learning retention rates by lecture are only 5%: far less than active learning methods such as discussion and practice by doing (Lalley & Miller, 2007) (Fig. 1A). Active learning has received adequate attention recently because it is regarded as being more educational than traditional classes (Yamaji, 2014) (Fig. 1B). To promote voluntary learning among students, several active learning methods including flipped classroom using e-learning (Hayashi et al., 2013), problem-based learning (PBL) (Ishi et al., 2011; Kawajiku, 2011), and project-based learning have been tried (Sumino et al., 2011; Ohnaka, 2012). Actually, PBL-based assignments have been adopted in several classes. In practice, the outcomes of such approaches for PBLs apparently depend on both the lecturer and the class. Moreover, it remains unclear whether all PBLs are educational and effective for students and how the educational values of PBLs are evaluated quantitatively.

The author conducted a PBL-based assignment in a Food Engineering class at the National Institute of Technology, Miyakonojo College. The assignment included studies of interesting food processing, preparation of a presentation about that food processing, and presentation in a class workshop. This study investigated the effects of a PBL-based assignments on
student motivation and outcomes by sampling the PBL-based assignment in a Food Engineering class. After the workshop, a questionnaire survey was administered to elicit responses related to the challenge and to assess meaningfulness of this assignment for students. To evaluate the effects of the assignment statistically, customer satisfaction (CS) multivariate analyses were applied to questionnaire survey data. Results reveal that students expected comprehensive classes including PBL-based assignments rather than traditionally one-way type classes. Moreover, CS analysis is useful for the quantitative evaluation of PBL assignments.

**Pedagogy and Methods**

**PBL-based assignment:** A PLB-based assignment was given to students of the Food Engineering class, taught by the author, at the National Institute of Technology, Miyakonojo College in 2014 and 2015 academic years. The numbers of students who took the class in 2014 and 2015 academic years were respectively 19 and 29. This assignment for groups (3-4 individuals per group) was conducted as learning contents of this class. The assignment included (1) studies of interesting food processing, (2) preparation of a presentation about that food processing, and (3) a presentation in a class workshop.

**Critiquing other presentations in the workshop:** In addition to hearing other presentations in the workshop, students were instructed to evaluate other presentations according to the following evaluation criteria: 1, abstract format of a presentation abstract (including figures and tables); 2, abstract contents; 3, quality of figures and tables; 4, presentation technique toward audiences; 5, visibility of their presentation slides such as font size and quality of figures and tables; 6, clear presentation and explanation; 7, punctuality of presentation time; and 8, adequate responses to questions from the audience.

**Questionnaire survey after the workshop:** After the workshop, a questionnaire survey was administered to elicit responses related to the meaningfulness and challenge of this assignment for students. The questionnaire survey asked students the following questions: 1 (designated as Q1), their experience of presentation-based classes at this College; 2 (Q2), their experience of reviewing other presentations; 3 (Q3), a question about whether students regarded other presentations as beneficial for themselves for future presentations; 4 (Q4), their preference for comprehensive classes including PBL-based assignments relative to one-way type classes; and 5 (Q5), the necessity of critiquing other presentations. Students responded to Q1-2 with “yes” or “no”, while they did Q3 with 3-grade evaluation or Q4-5 with 4-grade evaluation. Here, the answers for Q3 were “no benefit”, “beneficial for themselves”, and “beneficial as a negative example”. Moreover, this questionnaire survey allowed students multiple answers to the decision branch for Q3. Those decision branches for Q4-5 referred to Figure 3.

**CS analysis for statistical evaluation of the questionnaire survey results:** To evaluate the effects of the assignment statistically, data from the questionnaire survey were subjected to CS multivariate analysis, a data analysis method used to assess customer satisfaction using a several-point scale for store operation, business management, and product development in a marketing field. Data from Q3–5 above of the questionnaire survey were used for CS analysis in this study. Each answer for Q3, for instance, was categorized into three types: 0 points for the answer “no benefit”, 1 for that “beneficial as a negative example”, 2 for that “beneficial for themselves” and 3 for both “beneficial as a negative example” and “beneficial for themselves”. Each answer for Q4-5 was also categorized into four types: 0 points for the answer “strongly disagree”, 1 for that “disagree”, 2 for that “agree”, and 3 for that “strongly agree”. Scores 2-3 were regarded as positive answers in this CS analysis.
The student scores for Q3-5 were calculated. The degree of importance and satisfaction derived from each question item was evaluated. It is shown graphically in Fig. 4.

Results and Discussion

Although active learning has received adequate attention for promoting voluntary learning among students, it is difficult to assess educational outcomes. This study was conducted to evaluate the educational values of PBLs for students using the questionnaire survey qualitatively and CS analysis method quantitatively. The questionnaire analysis (Q1) reveals that most Food Engineering class students had already experienced presentation-based classes several times during years 4–5 at this college (Fig. 2). In addition to their presentation in the workshop, students critiqued other presentations. This was intended to foster students’ critical thinking through critical assessment of other presentations. The questionnaire survey results (Q2) reveal that students had experienced evaluation of other presentations (data not shown). Questionnaire survey results (Q3) also indicate that they regarded other presentations as beneficial for themselves for future presentations including a presentation for their graduation work (data not shown). Some students considered others’ presentation styles and methods of presenting figures as good references. For others, for instance, presenters speaking from their notes gave a bad impression. Consequently, the behaviour was regarded as a negative example for other students. Moreover, the results (Q4) show that they clearly expected comprehensive classes including PBL-based assignments rather than just a traditional lecture (Fig. 3). Students, more than 80% of them, tended to respond positively about the necessity to critique other presentations (Q5) (data not shown).

Voluntary learning among students is apparently related with student satisfaction level to each educational method. To elicit responses related to the challenge and meaningfulness of this PBL-assignment for students, results from Q3-5 were subjected to the CS analysis (Fig. 4). The degree of satisfaction of the PBL assignment and the importance, which were correlation factors between each student’s total scores and each factor from the questionnaire survey, were estimated...
respectively. Factors related to both Q3 and Q4 have a high rating for both the satisfaction and the importance of the PBL assignment. In contrast to the results from Q3 and Q4, the factor related to Q5 was split on both evaluations, particularly the importance (correlation coefficient) rather than the satisfaction, from students in the 2014 and those in 2015 (Q5 in Fig. 4). In addition to that presentation-based assignments yielded qualitatively demonstrative benefits to students (Q3 in Fig. 4), the CS analysis clearly reveals that merely having the opportunity for a presentation itself was more important for student effort and motivation than anything else (Q4 in Fig. 4).

A flipped class (Hayashi et al., 2013; Shigeta, 2014) has received more attention than other active learning typed-classes including PBL. The flipped class demands preparation using e-learning such as web schooling to students. The flipped class spends regular classroom time on related practice or higher-level education such as case studies and PBL. Consequently, the flipped class no longer spends classroom time on lecturing. Seeing the flipped class from other viewpoints, the class requires an educational situation in which both the teacher and all students become fully conscious of learning, irrespective of the student’s habits of study in advance for the next lesson. The presence of students, who fail to prepare for the class and forget to do so, might trigger the flipped class to fail. Moreover, those students eventually fall behind others in the class. In contrast to the flipped class, a PBL-type class, which this study also adopted, must spend some regular classroom time on lecturing and the remainder on PBL. Even if some students maintain a low level of consciousness related to learning, a teacher can manage a PBL-type class and also teach in flexible ways.

Even if a teacher decides what kind of educational method to use, it is important to evaluate the effects of the selected method and to perceive student’s satisfaction level with the method. Although we can vaguely understand each student’s behaviour and tendency from questionnaire surveys, which are a classical and standard approach, it is difficult to quantitatively ascertain the students’ satisfaction level solely from questionnaire approaches. As a result of the application of CS analysis to this PBL-based assignment and the questionnaire survey, this study has demonstrated that CS analysis is useful for quantitative evaluation of the PBL assignments and that CS analysis can provide statistical verification of them.

This study adopted CS analysis to evaluate the effects of the PBL-based assignment. This study, however, included no plan to conduct CS analysis at the beginning of this study. For this reason, limited question items (Q3-5) in the questionnaire survey were subjected to CS analysis because other items were unsuitable for CS analysis. Therefore, the number of evaluation items might be insufficient for CS analysis. Adequate question items for CS analysis are also needed. At any rate, more evidence is necessary to validate the potential benefits of CS analysis properly to evaluate educational methods including active learning methods.

**Conclusions**

The PBL-based assignment as one of active learning methods was conducted in the Food Engineering class. This study evaluated the educational effects of the PBL-based assignment on students using the questionnaire survey and the CS analysis. This study reveals that students expected comprehensive classes including PBL-based assignments rather than one-way type classes. In addition to understanding student’s behaviour and tendency qualitatively from the questionnaire approach, CS analysis is a workable method to quantitative evaluation of the PBL assignments. Thus, CS analysis can provide statistical verification of them.

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This study conducted the questionnaire survey to students, which attended the Food Engineering class at the National Institute of Technology, Miyakonojo College in the 2014 and 2015 years. The author thanks the students for willingly consent to answer the questionnaire survey.

**References**


EXPERIENCES OF TEACHING ENGINEERING AND ENGLISH IN COLLABORATION

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Abstract

The purpose of this paper is to study how the change in pedagogical principles has influenced the teaching methods of engineering studies and English communication with respect to first and second year IT students. Information Technology Degree Programme at Helsinki Metropolia UAS adopted a curriculum reform in 2014 and introduced team learning and student collaboration as well as team teaching in order to improve learning outcomes. Several studies have argued that foreign language communication skills, especially English skills, play a more significant role in today’s working life. For example, an increasing number of technology companies use English as their working language and employees are expected to be able to not only read complex professional texts but also analyse them with insight.

The data for this study was gathered by analysing video recordings of team teaching and observing students’ project presentations and writing process. Academic writing outcomes as well as other written assignments were evaluated from both language and content point of view by the teacher team. Students were also asked to give feedback on the English lessons.

Although the focus on English courses has already for years been on communicative competence and skills needed in working life, the change in the pedagogical approach was noticeable. The preliminary results suggest that the team-based approach to teaching engineering and English communication resulted in improved learning outcomes. Especially the students with weaker English skills succeeded better in their learning assignments than they did with conventional teaching arrangements due to the support of their team members and the teacher team. The presence of a multi-disciplinary teacher team clearly motivated the students to work harder on the assignments. Especially project presentations, practicing formal meetings and focused customer communication as well as the job application process were taken more seriously. Since feedback was received from the teacher team, the structure and content of the presentations and the reports clearly improved. Another significant finding was that not only did the students benefit from team teaching but team teaching provided an opportunity for the teachers to learn from one another.

Keywords: Curriculum reform, team teaching, engineering, English communication

Introduction

Although team teaching as a pedagogical method has been used for decades in Finnish comprehensive schools, it is not very common at university level. In 2014 Finnish Ministry of Education declared that team teaching should be used systematically throughout comprehensive school classes 1-9 from the beginning of 2016, because as a method it provides a pedagogically flexible, versatile and efficient learning environment (Opetushallitus 2014). In 2014 Metropolia UAS Information Technology Degree Programme adopted a curriculum reform and introduced team teaching in order to improve learning outcomes. The new curriculum was made quite flexible and teachers were given resources to enable joint teaching sessions.

This study aims at analysing how teaching engineering and English in collaboration and integrating language studies with professional ICT studies such as software development and web design, affect student performance. The study describes two team teaching implementations and compares team teaching with the more traditional way of teaching where a teacher is alone in the classroom with students. We also discuss the benefits of team teaching from teacher point of view and reflect on how team teaching has affected our way to plan the lessons, teach and evaluate student assignments. The research was conducted among first and second-year international and Finnish students at Helsinki Metropolia UAS.

Background

Because foreign languages are an essential part of working life competence for engineers (Charles and Marchan-Piekkari 2002; Huhta et al. 2006; Kantelinen and Airola 2009), they have traditionally been included in Finnish curricula in higher education. At university level students are taught that they should be able to communicate in English globally (cf. the goals for
The curriculum reform at Helsinki Metropolia UAS in Finland which started in 2014 has meant significant changes for teaching English and all other subjects as well. Previously the starting point was that each teacher is solely responsible for his/her courses. Teachers taught their courses and evaluated student work mostly alone. After the curriculum reform, there can be 4-6 teachers working and teaching in collaboration during an 8-week module. Also, the structure of the whole course module is different than before. In the old system, English courses were 3 credit units whereas now they are integrated into a 15 credit unit module. One module consists of engineering studies and so called general subjects such as mathematics, physics, Finnish and English. The teachers who are responsible for the module share responsibility for planning the module, monitoring student progress and evaluating student work. (For a more detailed discussion on the reform, see Hjort et al. 2015; Lukkarinen et al. 2015 and Vesikivi et al. 2015).

The new modules as well as student and teacher reactions have been described at least in three studies. Vesikivi et al. (2015) found out that significantly more students had completed 30 ECTS credits or more by the end of the first term of their studies. Hjort et al. (2015) and Lukkarinen et al. (2015) suggest that students were quick to adopt teamwork skills. Also, the students became quickly independent and were able to meet new challenges without much teacher intervention.

Material and Methods

This paper discusses two implementations of team teaching. In the first one, two English teachers analyse their experiences of teaching English together. In the second study teachers of engineering and English discuss their collaboration when English was integrated with two engineering courses, Application Development Methods and Software Structures. In both studies we wanted to focus on how the new pedagogical principles of Metropolia UAS have influenced the teaching methods.

We decided to use ethnography as a research method. Hammersley and Atkinson (2007) describe the key features of ethnography as follows:

1. Ethnography studies real rather than experimental social situations / events.
2. According to the ethnographic method, data may come from various sources such as participant observation, informal conversations and documentary evidence.

3. In ethnographic methodology, what will be studied has not been decided beforehand. Whatever catches the researcher’s interest, is worth studying.
4. In an ethnographic study, there does not have to be a large amount of data because the purpose is in-depth study of a certain group.
5. Ethnographic study does neither focus on quantitative nor statistical analysis. The data is typically interpreted and explained by the researchers.

The joint sessions of the English teachers were video recorded to observe teacher collaboration and student response. The analyses of all the other joint sessions are based on field notes and student feedback. The findings presented in subsequent chapters are based on what we noted about our own behaviour as well as student behaviour in the data.

Research: Teaching English in Collaboration

In the first study two English teachers experimented with teaching together during an 8-week module called IT Orientation in September 2015. The course is intended for first year international students of Information Technology at Metropolia UAS. The purpose was to investigate the curriculum reform at Metropolia UAS just as Hjort et al. (2015), Lukkarinen et al. (2015) and Vesikivi et al. (2015) but from a language and communication point of view.

The module yields 15 credit units for students and the topics included English, Finnish, mathematics, photo-editing and software programming languages. Our students came from over 12 countries such as Nepal, Vietnam and Russia. All of them had completed secondary education and some also had university level studies. All students had studied English for several years but their skills varied a lot.

At the Metropolia UAS we have agreed on dealing with the following topics during the English classes with the first-year ICT students: presentation skills, job application documents and academic writing. The topics that we chose for our joint English sessions were important for an international group of first-year students: integrity and honesty in academic writing and the job application process in Finland and Europe. The joint sessions were video-recorded by another member of the teacher team.

Videos: For this study two English teachers analysed their collaboration during two joint English lessons. The topics of the lessons were academic integrity and applying for a job. We started the lesson about academic honesty by asking the students how they understood plagiarism. The discussion showed that different practices exist and many students were eager to tell what is considered as acceptable in their home countries. Since we had students from so many different cultures, the discussion was very interesting. After that
We went through the conventions of our university which are similar to the practices commonly adopted in Europe (Swales and Feak 2004). We also had a workshop on a plagiarism prevention service called Turnitin used at Metropolia UAS and many other Finnish universities (Turnitin 2015).

The second lesson dealt with writing a CV and a cover letter for a job application. The students were divided into groups of 3-6 based on their nationality and linguistic background. We wanted to have students with as similar background as possible in the same group. This was important because we asked the students to demonstrate how a proper job application is written in their home countries. After each group presentation there was a lively discussion about the different ways of contacting an employer. It was interesting for all of us to see how different we are in terms of formality/informality and power distance. For example, according the Vietnamese students, a job applicant should not mention that he/she knows more about something than the employer. In contrast, the European students emphasised the importance of being self-assertive. The student presentations were followed by our lecture on Finnish and European conventions.

Discussion

For us these two lessons were the first were have ever held together with another English teacher. Even though we planned the lessons carefully beforehand, we still needed to learn in practice how to work together in front of the students. What added to our nervousness was the fact that the lessons were being video-recorded by a third member of the teacher team and later shared with all the teachers and students of this module.

In addition to describing our observations of the lessons we held together, we decided to analyse our collaboration through the recordings. We noticed that at the beginning of the lesson we kept to the roles and work division we had previously agreed on and although we established plenty of eye contact, there was little dialogue between us. Towards the end of the lesson when we were starting to feel more relaxed, there was a lot more dialogue. Another observation was that first both of us mainly communicated with the students but gradually we began to interact with each other and we even started to complete other’s speaking turns. The third teacher in charge of the video recording also began to participate in the conversation and we began to involve him. As a consequence, the students had a chance to hear three teachers’ views on the same topic such as plagiarism. In hindsight, there could have been more dialogue from the beginning between the teachers.

Research: Teaching Engineering and English in Collaboration

The purpose of the second study was to find out how two second-year engineering courses, Application Development Methods and Software Structures and Models, could be integrated with an English course on Project Writing and Presentation Skills. The teacher team consisted of two English teachers and six engineering teachers. The implementation was carried out during two 8-week study periods in spring term 2016. Both international (23) and Finnish (13) IT-students participated in these courses and English was the language of instruction.

The course content and assignments for the both 8-week implementations were planned together with the engineering teachers and the English teachers. The idea was to have one joint 4-hour session once a week. The topics chosen for team teaching on the first course were project presentations, practicing formal meetings and writing formal emails. The second course focused on writing an academic report based on professional technical articles selected by the teacher team. The students were reminded that all these assignments would be evaluated by the whole teacher team.

Project plan: The purpose of the Application Development Methods course was to expose students to a typical process of designing and implementing an application that has a web user interface. For this purpose students worked both on individual assignments and, more importantly, on a small project in teams of three. Each group had to come up with a clear and concise project plan.

Each group made several project phase products, such as user persona descriptions, project plan, project presentations, and a final report which were evaluated from both language and content point of view. The evaluation of the phase products took place in a meeting room where two project groups gathered simultaneously with the English teacher and the engineering teacher. Altogether there were 6-8 students and 3 teachers present during the evaluation and feedback sessions.

The project plans and user persona descriptions were assessed during two team teaching sessions. Each session lasted for 45 minutes. The first drafts of the assignments varied a lot in quality. Some groups had almost finalised their work and produced thorough project plans written in good report style. However, some groups failed to produce any kind of written plan mostly due to poor team working and communication skills.

These were the first joint sessions for us teachers and we were all eager to contribute. As a teacher team, we were able to give effective feedback to
each group from several points of view. When the project plans and user persona descriptions were shown on a large screen, all the teachers immediately started to correct errors both in language and content. Consequently, students were able to sort out multiple errors in a short time. There was a lot of dialogue and interaction between us, for example we debated about the structure and content of the assignments. Based on our experience we would like to argue that academic debate between teachers in the classroom can be a positive thing; it encourages students to participate in discussions and learn how to argue for their opinions.

Presentations:  When evaluating student presentations, the engineering teacher’s long experience of giving and listening to presentations in working life proved valuable. He was able to spot weaknesses in the structure of the presentations and point out how to sound more convincing. In other words, he gave quite honest and pointed feedback on how a real client would react to each group’s presentation and what should be done to improve content, delivery, and engaging the listeners.

The English teacher paid more attention to language use, but also delivery. Since presenting in front of an audience is quite stressful for many students, we all shared our experiences of feeling nervous during presentations and gave tips how to feel more calm and confident.

Business writing:  Students practised writing formal style business letters such as a letter of apology for different recipients. They also practised negotiation skills and having formal project meetings. The purpose of these exercises was to prepare the students for working life and also pay attention to cultural differences in business writing conventions. Once again, it was interesting to discuss together how different we are in terms of formality/informality and directness/indirectness, for example in greetings and salutations. We also talked a lot about power distance which can be seen as an important cultural concept.

Written assignment:  academic report:  The final project in engineering studies is a written thesis. In order to prepare students for academic writing conventions well in advance, we required them to study one selected article each. Moreover, the students were instructed to search for at least three additional reliable sources and write a 3000 word formal style report based on the source material. We told the students that the teacher of engineering would grade the content and the English teacher the language of the reports. The students were instructed to upload their reports on the plagiarism checking service Turnitin which was already introduced to them during their first English course at Metropolia UAS (Turnitin 2015).

The students varied a lot in their English skills and were, therefore, given several opportunities for extra tutoring by both teachers. Some students took the opportunity to learn how to improve the grammar and style in their reports. Quite a few needed help with paraphrasing, in-text referencing and how to indicate sources in the list of references.

We decided that both the engineering teacher and the English teacher would read and grade the reports together because we wanted to discuss their content, style and grammar simultaneously. The reports were clearly better than expected; in several reports the language, structure and conventions of an academic report as well as content were of excellent quality. We were pleased to see that none of the students had plagiarised their text; all reports were properly paraphrased from source material. In other words, the students had absorbed the reference material and done their own thinking.

Results and Discussion

It seems that the presence of a multi-disciplinary teacher team which has expertise in both content and language made students work harder on the assignments. Also, the new curriculum offers possibilities for team teaching because of its flexibility.

Integrating English with engineering studies:  In addition to analysing collaboration between English teachers, we found the collaboration between the teachers of engineering subjects and the integration of English into engineering subjects fruitful. As already pointed out, the IT Orientation course, its English lessons and course tasks were planned together. The students were told from the beginning that each task will be reviewed by the whole teacher team and that there is a common goal. To give an example, the students were asked to compile their up-to-date CV. The English teachers were interested in how well the students could communicate about their background and skills. The students were also asked to upload the CV to their homepage which they created with one of the professional teachers using HTML. What is more, each student included in the CV his/her portrait photo that had been taken and photo edited with the professional teachers. From a language point of view, this collaboration paid off. The students provided better quality CVs. The same phenomenon could be seen with other tasks that were assessed by several teachers.

Another benefit turned out to be an increased student retention rate. During the old curriculum sometimes only half of the students had completed all their English assignments by the end of the course. Several students used to submit the compulsory tasks even 2-3 years late. During the new curriculum only a few students had not completed all their assignments by the end of the English course. Also, no student failed to submit the remaining assignments by the end of the term. This finding clearly suggests that students take their tasks more seriously and engage themselves better when there are several teachers dedicated to one course. This
finding is in line with Hjort et al. (2015), Lukkarinen et al. (2015), and Vesikivi et al.’s (2015) observations.

Conclusion

The purpose of this study was to analyse and describe our experiences of teacher collaboration and the integration of English and professional studies during a module aimed at first and second-year ICT students at Helsinki UAS in Finland. This was important because Metropolia UAS has undergone a major curricular reform in order to, among other reasons, increase the number of students who complete their studies and graduate with a Bachelor’s degree. Because the reform meant substantial pedagogical changes for teachers and students alike, it has been important to evaluate the outcome.

First we analysed sessions which the two English teachers taught together and which a third member of the teacher team recorded. The analysis was based on video recordings of the sessions and our field notes. One difference with a traditional classroom setting with one teacher was that now we could provide the students with multiple views on the same topic. We believe this benefitted our students who have various cultural backgrounds and different learning styles. This was interesting as we have different teaching styles and typically emphasise slightly different angles. These joint sessions gave us all fresh ideas and served as a learning experience.

Secondly this study described collaboration between English teachers and teachers of ICT subjects. The course tasks we gave to the students were planned and evaluated together. Compared to our previous experiences of separate tasks for separate subjects, it was evident that the students now took the combined tasks more seriously. We were quite pleased to see that none of the second-year students had resorted to plagiarism when writing the academic reports. What is also noteworthy is that apart from one or two exceptions all the students submitted all tasks and passed the module by the end of the term. This is quite an achievement keeping in mind that the students had very different English proficiency levels.

In conclusion it can be argued that team teaching improves student motivation and learning outcomes. Because the students worked harder, the content and structure of their presentations and reports were clearly better compared with those before the curriculum reform. Finally, team teaching as a method has allowed us teachers to learn substantially from each other.

References


EDUCATION OF PRACTICAL ENGINEERING SKILLS AIMING FOR SOLVING REAL PROBLEMS RELATED TO LOCAL AREA

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Abstract

The Department of Electrical and Computer Engineering in National Institute of Technology (NIT), Maizuru College offers practical engineering education that teaches how to utilize skills to contribute to local area in cooperation with local society. Based on investigation of real society, the students propose solutions to problems related to local area by fabricating prototypes using their electrical and information engineering skills in the lecture. For example, the students have developed a special controller for electric wheel chair with support from Maizuru Rehabilitation Center for Crippled Children. The prototypes fabricated by them actually contribute to solving the problems related to local area because the five-year course education system of NIT makes it possible for the students to develop advanced electronic devices and software for practical use. The involvement of the students in activities with local institution and city government has encouraged them to learn more diligently, and taught actual development process of devices and software related to regional contribution.

Keywords: engineering education, practical skill, regional contribution, welfare, tourism

Introduction

National Institute of Technology (NIT) is a higher education facility in Japan which fosters engineers with advanced practical skills and creative ability through a five-year course starting after graduation from junior high school. The five-year course makes it possible to design an effective curriculum which includes a wide range of engineering education from basic to advanced level. For example, in the department of electrical and computer engineering in Maizuru College, which is one of 51 colleges of NIT, the subjects of electrical engineering and those accompanying experiments and practical training are introduced in the first year in addition to liberal arts. The engineering education begins with very basic contents assuming low level mathematical skills of first year students. In the five-year course, the students achieve learning of advanced contents such as design and manufacture of electronic control system, measurement of properties of electric devices, producing of computer programs for various purposes, and so on. After completing the five-year course, the students acquire an ability to work as electrical engineers in a company.

The department of electrical and computer engineering in Maizuru College educates the students about the manufacturing skills in the subject “Creative Engineering” (Fukumura and Tange, 2009; Funaki, Tange, and Mihara, 2012). The subject requires the students to develop prototypes of electrical devices and/or software which propose a solution to a problem presented by a teacher. The students incorporate their creative ideas in the prototype with originality and ingenuity. Until three years ago, problems which the students addressed were chosen from general engineering or scientific issues. For example, the students assembled the inexpensive parallel computer while taking into account the budget to solve the problem with calculation speed of numerical simulation. One of the most important points in the lecture is the choice of the problems by the teacher. Although certain results were achieved by the lecture, further consideration to choice of problems is thought to be important in ensuring the students more interest in manufacturing.

NIT has 51 colleges which are located in various parts of Japan. One important mission of NIT is to provide the education/research results which is closely connected with the location of each college. There are a lot of examples of research which contribute to local area by solving the problems related to local area (Hama, Kobayashi, 2009; Satake, Tsukayama, Kamisato, and Noguchi, 2010). However, it is very difficult to contribute to local area directly by educational activity. The department of electrical and computer engineering in Maizuru College has been developing relationships with the local governmental agency, some local institutions and companies to provide the students with the opportunities for effective lecture in practical skills. In the lecture of the subject “Creative Engineering”, the problems which are solved by the students have been changed to those which are related to those agencies, institutions or companies so that the problems are more concrete than former ones. In the subject "Creative
Engineering", the students aim for solving real problems related to local area by fabricating prototypes which contribute to solving the problems using their practical engineering skills. The students can investigate the real problems related to local area by visiting those agencies, institutions or companies. In the development process of prototypes which are fabricated to propose the solution, the students can also investigate the feedback of real users to improve their prototypes. The student’s proposal contributes actually to solve the problems related to local area because the students have advanced electrical and information engineering skills by the five-year course education of NIT. We provide very effective education of practical skills by making the students concern with real society.

This article reports the details of effective education of practical skills via the lecture of the subject “Creative Engineering” which is taught at the department of electrical and computer engineering in Maizuru College. The disability aid and the vitalization of local area (Maizuru-city) were chosen as the problems which the students addressed. The students developed the prototypes of support devices for disability person and the prototypes of electronic devices for vitalization of local area to propose the solutions to the problems. In the development process, the students visited Maizuru Rehabilitation Center for Crippled Children and Maizuru city government to investigate the problems and to obtain the feedback. The students have acquired the practical skills effectively by being contact with the local society, and have contributed to solve the problems related to local area.

Learning goals of the subject “Creative Engineering”

In the lecture of the subject “Creative Engineering”, the students learn how their engineering skills contribute to local society. The small-group teams, each of which consists of four or five students selected at random, propose the solution to the problems related to local area. The significance and unique feature of the lecture is that the students are involved with real local society and collaborate with those. The students develop prototypes of electronic devices and/or software using their advanced engineering skills to solve the problems. The five-year course curriculum of NIT, starting after graduation from junior high school, allows the students to develop the advanced and practicable devices and/or software. The lecture is also effective for the contribution to local area as well as for the education. The details of the learning goals of the subject “Creative Engineering” are as follows.

< Educational goals >
1. The students are able to understand the development process (planning, design, prototype, survey, improvement, evaluation), which is started from investigation of the problems and is ended by completion of the devices and/or software, through involvement in local society.
2. The students are able to contribute to local society using their engineering skills.
3. The students are able to integrate their broad knowledge of electricity and information and to utilize those to fabricate devices and/or software.
4. The students are able to communicate and cooperate with group members to achieve project.

< Contribution to local society >
1. The proposals to solve the problems related to local area are advanced after the lecture by continuing the development of devices and/or software in the graduation work, and the achievement contributes to local area.
2. The development of collaborative relationships with local governmental agency, some local institutions and some companies contributes to the establishment of technological assistance system for local society.

Learning structure of the subject “Creative Engineering”

- Lecture plan
The subject “Creative Engineering” is designed for the fourth year students of the five-year course. The classes are scheduled once a week. There are 15 classes in half a year.

< 1st, 2nd week > Explanation of the problems related to local area. Group discussion.
< 3rd week > Presentation of the proposals to solve the problems.
< 4th to 12th week > Fabrication of devices and/or software.
< 13th week > Poster presentation. Demonstration of devices and/or software.
< 14th, 15th week > Report writing.

The teachers also give the students guidance about activities outside of school hours. The students visit local governmental agency, some local institutions and companies to investigate the details of problems related to local area after class or at convenient time for the destinations. The preparations for each classes by the voluntary effort of the students are required to proceed with the fabrication and their activities smoothly.

Although two or three teachers of the department of electrical and computer engineering in Maizuru College mainly teach the students, all teachers instruct the students in engineering technique in their respective specialized fields. In the fabrication process the students seek technical advice from the teacher familiar with the problem which they face.

- Field investigation and proposal to solve the problem
The students address the problems related to local area based on the investigation in real society. The students visited Maizuru city government and Maizuru Rehabilitation Center for Crippled Children. Maizuru Rehabilitation Center for Crippled Children is a public institute which teaches the skills required for independent living to the children with disabilities, such
as cerebral palsy, spinal cord injury and hip joint disorder. The students investigated the problems related to sightseeing and public park in the visit to Maizuru city government. They also investigated the problems related to electric wheel chair for children in the visit to Maizuru Rehabilitation Center for Crippled Children. The investigation in real society encourages the students to learn the method to utilize their engineering skills for contribution to local society.

The students identify the problems based on the investigation, and make a presentation on how to solve the problems related to local area by fabrication of electronic devices and/or software. All student teams and teachers discuss about the proposals which solve the problems. After the review of the proposals by the teachers, the students can set a goal properly with consideration of their skills, the budget and the fabrication period, and can begin design of electronic devices and software.

Fabrication of the prototype
The budget and fabrication period are restricted to make the students consider a schedule for fabrication. The budget is restricted to ¥5,000 (about $48) because the students are only required to fabricate simple prototypes to show their ideas. Actual fabrication is restricted to being executed at the laboratory so that the students fabricate the prototypes for just the time the laboratory is available. The students have to consider their plans of development. Some teachers teach practical fabrication skills in the laboratory in addition to giving advice outside the laboratory.

Poster presentation of proposal and prototype
The students make poster presentations on the results of fabrication of prototypes, and explain details of their proposals to solve the problems related to local area in addition to the details of their activity. As shown in Figure 1, the students demonstrate how their prototypes solve the problems related to local area. The examples of posters are shown in Figure 2. The students prepare two A1 size posters for the presentation.

Grading of the subject “Creative Engineering”
The activity in the fabrication process, the poster presentation and the report are graded. The students are evaluated with a focus on group activity except for the report.

The students are required to show their proposal and target achievement in the poster presentation. Although the high quality prototypes are not required, those have to be able to demonstrate how those work to solve the problems related to local area, and have to have functions enough to explain their proposal and their target achievement. The students are graded with a focus on their proposal because the development of the prototypes is taken over by fifth year students of the five-year course to work toward practical use of the prototypes in the subject “Graduation Work”.

Grading for fabrication (group activity)
In addition to giving technical guidance, all teachers grade the group activities of the students in the laboratory in which the students fabricate the prototypes. Cooperativeness, role and responsibility, positive attitude, planning, comprehension, originality, technical skills, and so on are graded.

Grading for poster presentation
In the poster presentation the teachers ask the students from many different perspectives about their proposal. The teachers grade the posters (format, content, intelligibly), the prototypes (technical skill,
originality, accomplishment) and the presentation skills (comprehension, clarity, attitude).

- **Grading for report**
  All students are required to submit the report individually after the poster presentation. Some teachers grade the reports based on content (intelligibly, clarity), organization (proposal, planning, achievement, explanation of prototype, test results, future tasks), format, and observance of deadline.

**Educational results of the subject “Creative Engineering”**

- **Examples of prototypes**
  In 2014 and 2015 the students proposed 11 solutions to Maizuru city government and seven solutions to Maizuru Rehabilitation Center for Crippled Children. The examples of the proposals which solve the problem related to the regional tourism and the electric wheel chair for handicapped children are reported below.

< The proposal solving the problem related to regional tourism >

“Decorative illumination placed in public space”

Maizuru city government needed a huge display which is placed in front of Higashi-Maizuru station and which illuminate night town. As shown in Figure 3, the students made the huge decorative illumination which illuminate about 20-square-meter of land. They had to take into account snow because it is installed in winter and it snows in our area.

Figure 3 Decorative illumination placed in front of Higashi-Maizuru station

“The Stamp Rally using NFC”

One of the problems related to regional tourism in Maizuru-city is that many sightseeing places are not introduced sufficiently. If many tourists would visit many sightseeing places in Maizuru-city, Maizuru city government could expect benefits from tourism. The students developed the “Stamp Rally” system for a smartphone to resolve the problem. The “Stamp Rally” is a Japanese game which participants collect stamps placed at various spots. Examples of the stamps are shown in Figure 4. Usually “Stamp Rally” uses special paper sheets to collect stamps but preparation and management of sheets and stamps are bothersome. The students replaced sheets and stamps with smartphones and Near Field Communication (NFC) tags. Participants collect stamp images stored in NFC tags by touching their smartphone to NFC tags. Figure 5 shows the screen of smartphone which the application program is executed. The stamp image (Figure 4(c)) is displayed at the location of the tag on the map of application program.

(a) (b) (c)

Figure 4 Stamps for “Stamp Rally”

< The proposal solving the problem related to electric wheel chair for handicapped children >

“Swipe Controller for Electric Wheel Chair”

“Swipe Controller for Electric Wheel Chair” is the controller for the children who cannot use usual joystick controller because of the trouble in hand. Figure 6 shows the “Swipe Controller for Electric Wheel Chair”. Even if children have a trouble in hand, they can use the “Swipe Controller for Electric Wheel Chair” because they can control an electric wheel chair only by putting their hand above the surface of the “Swipe Controller”.

Figure 6 Swipe Controller for Electric Wheel Chair

The controller consists of a single-board computer (Arduino), magnetic sensors, and so on. Some magnetic sensors are arranged under the surface cover. As shown in Figure 7, we can control the electric wheel chair by putting the magnet above the surface of the “Swipe Controller”. In the figure he puts the magnet on left side of the controller so that the electric wheel chair turns to the left.
Demonstration Outside Campus

In 2014 the prototype of electric wheel chair controller was shown at “Kids Barrier-free Festival” and “Welfare Festival in Maizuru” by the students. Those exhibitions were held in Maizuru city under the cooperation of many related organizations and companies. Many handicapped people, their families and welfare service workers attended the festivals, so the students were able to collect valuable information for practical use of their prototypes. As shown in Figure 8, the students were interviewed by local newspaper.

As shown in Figure 9, many prototypes were shown also in open campus (open house) of our college by the students. Many junior high school students and their parents attended the open campus (open house). The students got a good opportunity for describing the prototypes from engineering view point because the participants in the open campus (open house) have a strong interest in engineering. The participants were able to know our education about practical engineering skills specifically by talking directly with the students educated in our college.

Table 1  Evaluation of achievement by students

<table>
<thead>
<tr>
<th>Evaluation items</th>
<th>satisfied</th>
<th>neutral</th>
<th>dissatisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>problem-solving skills</td>
<td>58.6%</td>
<td>42.4%</td>
<td>0.0%</td>
</tr>
<tr>
<td>problem analysis ability</td>
<td>42.4%</td>
<td>57.6%</td>
<td>0.0%</td>
</tr>
<tr>
<td>planning skills</td>
<td>66.7%</td>
<td>27.3%</td>
<td>6.0%</td>
</tr>
<tr>
<td>ability to utilize knowledge</td>
<td>54.6%</td>
<td>42.4%</td>
<td>0.0%</td>
</tr>
<tr>
<td>presentation skills</td>
<td>57.6%</td>
<td>33.3%</td>
<td>9.1%</td>
</tr>
</tbody>
</table>

Review of the subject “Creative Engineering”

Relationships with local society

Cooperation of local governmental agency, some local institutions and companies is essential for the lecture. They offered the students valuable opportunities to relate to real society, so the students were able to propose practical solution to the problems related to local area through learning the method to utilize their engineering skills for contribution to local society. The proposals by the students in the lecture need further discussion so that local governmental agency, some local institutions and companies adopt those as practical idea. Some students should continue the development of prototypes in the subject.
“Graduation Work” to contribute to resolving the problems related to local area.

- **Budget for lecture**
  Electric wheel chairs were needed to develop controller. Two electric wheel chairs were provided by Kami Electric Corporation which is located near our college, and the others were purchased by the grant of “KYOTO KOSEN COC Project”. If we developed more practical devices and/or software, the more budget would be required.

- **Grading**
  Group activities, poster presentation and report were graded based on our evaluation sheets. The sheets have enough items to grade each skill but Rubric has not yet been introduced.

**Conclusions**

The department of electrical and computer engineering in Maizuru College educates the students about manufacturing skills in the subject “Creative Engineering” aiming for solving real problems related to local area. In the lecture the students learn how to contribute to local society using their engineering skills. They propose solutions to the problems by developing the prototypes of devices and/or software using their expertise in electrical and information engineering. The development, which is executed in cooperation with local society, teaches process (planning, design, prototyping, feedback, improvement, demonstration) to the students. The collaboration with local governmental agencies, local institutions and companies is effective for the education of regional contribution and practical skills. It is a very valuable experiences for the students to visit local governmental agency, some local institutions and companies to investigate the real problems related to local area, to collaborate with them to solve the problems, and to realize significance of regional contribution.

Some student’s proposals to solve the problems are advanced to put prototypes to practical use by continuing the development of devices and/or software in the graduation work, and their achievement will actually contribute to solving the problems. The education also plays an important role in regional contribution because all colleges in NIT aim to contribute to local area where each college is located.

**Acknowledgements**

The education has been provided through partnership with Maizuru city government and Maizuru Rehabilitation Center for Crippled Children. The members of the department of electrical and computer engineering in National Institute of Technology (NIT), Maizuru College express our sincere gratitude for their gracious support.

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**References**


DEVELOPMENT OF PROFESSIONAL COMPETENCIES IN POLYTECHNIC STUDENTS USING AN AUTHENTIC LEARNING STRATEGY IN THE HUMAN RESOURCE IN ACTION MODULE

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Abstract

To prepare students for the workplace, the polytechnics have to design curricula and adopt innovative teaching and learning strategies to make a difference to student learning outcomes. One of these is authentic learning. This paper describes how authentic learning was applied in the design of the Human Resource in Action (HRA) module to prepare students for work when they graduate from the polytechnic. In this module, students worked in groups of 5 to 6 to complete a real HR-related project for a company (also known as “the client”), which had specific deliverables determined by the client and students. The tutor and the client took on a coaching role to provide guidance and feedback throughout the semester to support student learning and to achieve the project outcomes. Students were assessed using defined criteria on the final deliverables and professional competencies by the tutor and the client. These together with the students’ reflection journals showed that professional competencies, such as planning and organising skills, communication skills, collaboration, result orientation, analytical thinking and creativity, can be imparted and their importance emphasised through an authentic project that allowed students to be actively involved in their learning. Their involvement in a real-world project also led them to develop an interest in the subject matter and be responsible for their learning journey.

However, the development and implementation of this authentic learning experience does have its challenges. These included issues relating to assessment reliability, the client’s readiness to coach, the tutor’s workload and time pressure for the students to complete the tasks that met the client’s expectations.

To further enhance the authentic learning experience for the students in the HRA module, there are plans to include deeper engagement with the industry partners in coaching and assessing the students and a review of the teaching load or tutor-student ratio to achieve optimal learning for the students.

Keywords: authentic learning, real-world project, and professional competencies

Introduction

Twenty-first century organisations are becoming more demanding places to work in because business is not always stable and sustainable, and jobs are becoming less defined and the workplace is constantly presented with uncertainty. To remain employable and appealing to multiple employers, employees have to possess 21st century skills that will enable them to engage in jobs that emphasise expert thinking or complex communication. These 21st century skills also include cross-disciplinary skills and competencies, such as communication, problem-solving, co-ordination skills, interpersonal skills (Garrick and Clegg, 2000) that will enable employees to collaborate with colleagues, not only with those in the same office location but also with peers who may be half way across the globe.

Confronted with a demanding workplace and uncertainty in the global market, the pressure is on higher education institutions to prepare students for work. A set of discipline-specific skills will not be sufficient because they get obsolete quickly in an increasingly knowledge-driven economy. The role of higher education institutions has to focus on students’ employability and to kick-start their work readiness when they graduate. This is because employers expect the work-ready graduates to be competent in their specific discipline and be able to operate in ambiguous situations (Barrie, 2006; Bowen, Hart, King, Trigwell and Watts, 2000).

Business schools have to redefine their curricula to enhance student learning and adopt pedagogical methods, which will enable students to master the 21st century skills faster and allow for improved quality of learning. Learning activities must also allow students to transfer their learning to real world situations and measure their ability to interpret, analyse and synthesise information.
Purpose of Paper

This paper describes how authentic learning was applied in the Human Resource in Action (HRA) module at the School of Business and Accounting (BA) at Ngee Ann Polytechnic (NP) to prepare students for work when they graduate from the Polytechnic, and the professional competencies that they had acquired in performing authentic tasks that reflected the real world.

Literature Review on Authentic Learning

Authentic learning is a pedagogy that focuses on real-world issues where students are introduced to tasks that reflect genuine problems faced by experienced professionals at the workplace (Lombardi, 2007). It is a strategy that enables students to make connections of their classroom learning to real-world situations. This pedagogical approach provides a platform for students to acquire knowledge in the classroom and apply it to real-life tasks related to their professional fields (Donovan, Bransford, and Pellegrino, 1999).

Many educational researchers have advocated the use of authentic learning in higher education to develop students’ competencies through the integration of knowledge into real-life issues. The pedagogy has been used in many disciplines, including physics (Murphy, Lunn, & Jones, 2006), and product development (Hey et al, 2007). Adopting the authentic learning approach provides powerful learning environments for students to interact with rich contexts and authentic tasks, engage them in active, deep, independent and collaborative learning. Such an approach supports knowledge construction as students are required to construct knowledge rather than reproduce information that is taught to them in the classroom.

To maximise the benefits of authentic learning, Reeves et al (2004) suggested that the learning tasks must have real-world relevance, are ill-defined and include a number of sub tasks and complexity. The learning experience should also provide students the opportunity to investigate the tasks from different perspectives, allow students to collaborate and reflect, yield an end product that includes more than one iteration, and allow for competing answers or solutions, integrate across different subject areas, and include integrated assessment.

When adopting authentic learning, the role of the tutor has to change to that of a coach who will act as a sounding board, a facilitator, a counsellor and an awareness raiser to assist the students to deepen their learning and confidence. This practice is acknowledged as important for enhancing learning and the development of learners. Metzler (2000) argued that coaching will “promote more student thinking and creative exploration by posing questions and problems to students rather than telling (or showing) students how to move in a certain way”. Coaching is also an effective instructional strategy in developing problem solving, creativity and critical thinking skills (Entwistle, 2000).

Design of an Integrated Curriculum in HRA

The HRA module is taken by Year 3 students who specialise in the Human Resource Management Option in the Diploma in Business Studies. The pre-requisite for students is that they must have successfully completed four core HR modules, namely Compensation Management, International Employment, Industrial Relations and Training & Development before they are enrolled for HRA.

HRA is designed with the aim of providing students with an authentic learning experience to develop critical professional competencies and essential HR functional skills in a real-world setting.

The HRA curriculum incorporates a combination of Dewy’s cognitive processes orientation and Bruner’s self-actualisation orientation curriculum development principles. The cognitive processes orientation allows students to process and apply HR content into a real-world project and in so doing, they are able to use problem-solving and decision-making strategies to find solutions to address the issues on hand as well as develop their critical thinking skills. These cognitive skills are essential in one’s career because they are transferable in a wide variety of settings. Bruner’s self-actualisation orientation curriculum principle provides students with rewarding experiences to enhance their personal development because they are required to reflect how they have developed their professional competencies. It also aims to increase students’ awareness of workplace expectations. A curriculum that emphasises on practical application of concepts engages the students in deep analysis and critical thinking (Chonko, 1993).

The curriculum development is done in consultation with staff in the HRM section of BA, analysing feedback data from students, as well as learning from colleagues’ experiences in conducting an experiential module. There is also close engagement with employers and professional bodies to ensure current professional competencies and desired personal attributes are included into the curriculum. The competencies include planning and organising, communication, collaboration, analytical thinking, result-orientation, job-focused learning, creativity, and conflict management. These competencies are critical for a 21st century education, and educators are expected to develop students who can manage complexity, uncertainty and value conflicts (Dehler, Welsh and Lewis, 2001).

Authentic learning and coaching strategies are used to develop the professional competencies and HR functional skills by having students work on HR-related projects, such as recruitment and selection, training and development, manpower planning, and employee benefits. The tasks are self-directed, reflective and relevant to the students because students apply what they have learnt in the classroom to a real-world assignment in a company. The assessments in HRA focused on the “how to”, as well as the “what” and the “why”. The assessments help students build their confidence and
interest in learning because the entire process emphasises the relevance of their learning to their employability rather than assessing on memorised theories and concepts.

**Teaching Approach in HRA**

There are no lectures and prescribed textbooks for the students in this module. Students are assigned four hours each week in their timetable to work on the project, which can include meeting the company or consultation with the tutor. An estimate of another two hours per week is required outside the timetabled hours for students to work on the project. The students are given 12 weeks to complete the project.

Students work in groups comprising 5 to 6 members each to complete a project of their choice from a list, which has been prepared by the tutor who has secured these projects from the industry. The tutor will also ensure that the project scope is manageable to be completed within the given timeframe and the assessment requirements meet the academic rigour and learning outcomes of the module.

In addition to the project work, students are also required to attend workshops, which are used to facilitate discussions on students’ development and progress on the project. These workshops are less formal and encourage dialogue between the tutor and the students where the tutor takes on the role of a coach, a facilitator and an expert resource to guide and support each group as they progress with the project. During these dialogue sessions, the tutor promotes creativity and self-discovery among the students, and gets students to reflect on their development of their professional competencies.

**Methodology**

A study was undertaken to review the use of authentic learning in HRA to evaluate its effectiveness of learning and the development of critical professional competencies.

This study involved 17 students who took the HRA module. The 17 students were divided into three groups, comprising 5 – 6 students in each group. Each group worked on a different project for 3 different companies. Each group worked with the company (also known as “the client”) to agree on the final deliverables and timeline. The students were assessed on an individual basis as well as a group by the tutor and the client on the final deliverables and the professional competencies.

For the purpose of this study, the tutor worked with the client in each company to observe and record observations of the students’ behaviours at all the interactions. Students’ reflection journals were also used as data points to validate the tutor and the clients’ observations.

The qualitative data analysis was performed using thematic analysis. The analysis began by a coding phase to identify emergent themes and to search for commonalities and uniqueness (Tesch, 1990). After the coding phase, information with similar meanings was organised into more comprehensive themes.

**Outcomes of Authentic Learning**

After examining the data from the students’ reflection journals, comments from the tutor and client’s records, four themes related to authentic learning emerged. They were deep learning, enhanced collaboration skills, improved communication skills, and greater emphasis on professionalism through real-world experiences.

**1) Deep Learning**

Deep learning was achieved through the project because the students participated actively at every stage of the learning process. The active learning process motivated students to learn and be interested in their own development because they were mentally challenged, and they were able to learn from various parties (the client, the tutor and their group members). Permanent learning can be achieved when students learn by doing the tasks and draw on their knowledge in other modules to support their learning outcomes.

The study showed that 14 students (out of 17) mentioned that the project had helped them apply their HR knowledge to a real-world situation and this had motivated them to think in depth about the practical application of concepts learned in the classroom. They also learned to set standards and measured them against the expected standards of the clients which drove them to take ownership of the project to make improvements if the standards were not met. This aspect of learning allowed them to hone the Result-Oriented competency which the module aimed to develop in the students.

The real-world project also gave students the ability to intelligently apply their functional knowledge to practice. At every stage of the project, students were assessed on their higher-order thinking skills because they were required to analyse and evaluate the suitability of the information to the issue on hand. At times, they were also required to create solutions by combining different pieces of information to present a coherent option to address a specific need in the project. Throughout the process, the students were able to hone their Planning and Organising competency, and develop their Analytical Thinking competency.

The following statements illustrate that the students were able to make connection with their learning to the real world:

- *I can see a connection between what I have been taught by my tutors and what is required in an organisation. My tutors always reminded us that HR is no longer just a department responsible for settling employee-related matters. They are also partners of the business.*
• Dealing with a real client for this project had taught me to be more flexible in order to adapt quickly. It allowed me to think deeper to what I already knew.

(2) Enhanced Collaboration

Collaboration is another outcome from authentic learning, particularly when students are required to work in a small group (Brown, Murphy, Nanny, 2003; Choo, 2007). As a group, the students practised problem-solving skills and learned how to collaborate to complete the project to meet the client’s expectations. The students were able to develop strong and meaningful bonds with each other through their “substantive conversations” while creating solutions (Newmann and Wehlage, 1993).

All 17 students reflected that collaboration skills were critical to their professional growth. The following statements demonstrated the value of working in a team.

• The team learned to work with people with different strengths and capabilities. None of the team members knew each other at the start of the project. It was only after a few project meetings, team members knew what their own personal strengths and weaknesses were and started leveraging on each other’s strengths to complete the project.
• I have also learnt that cooperation within a team is important. Each member played a part in delivering quality work and our combined effort is the result.
• In a group, I was able to solve an issue from different angles.

When students are involved in authentic tasks, they learn the importance of collaboration to achieve a shared goal and they are able to strengthen their communication skills to apply in a business situation. Business partners, colleagues and customers often come together to discuss their perspectives on business issues (Lombardi, 2007; Soslau & Yost, 2007).

It is also essential for students to learn how to leverage on the collective wisdom in a team-based setting to arrive at an agreed decision through critical thinking and negotiating processes. It also fosters responsibility and commitment as a group member because everyone is required to share and contribute to the final outcome of the project. Working in collaboration, students are able to sharpen their problem-solving skill and Analytical Thinking competency by considering and synthesising multiple perspectives.

(3) Improved Communication

Thirteen students mentioned that the project had enabled them to improve their communication skills. They realised that communication style and language used in a business setting was different from their day-to-day communication with their friends. Students also learned how to communicate effectively in a professional business manner, paying attention to body language and how to engage the audience appropriately. The students’ reflections on communication were as follows:

• I learned how to conduct myself appropriately in official meetings with the client. This will help me in the near future when I enter the workforce because I will have to face clients on a daily basis. It has taught me the ability to adapt to different client’s expectations and to act accordingly to suit their demands.
• It taught me the importance of communicating my ideas, opinions and thoughts clearly to my client.
• Communication is extremely crucial especially when working in a team because any miscommunication may snowball dangerously into something unconceivable and out-of-hand.

Communication skills are critical in the current fast-paced global workplace because such skills have an important place in ensuring a more efficient process to reach effective solutions and strengthen teamwork. Being able to communicate effectively and knowing the nuances is crucial for HR professionals because they have to present HR initiatives and policies to the management and employees regularly. In today’s workplace, HR professionals need good communication skills to interact with colleagues from diverse backgrounds within the location and across boundaries. Therefore, real-world projects provide students a good opportunity to learn valuable business communication skills and to develop their confidence in communicating with various stakeholders.

(4) Professionalism

The authentic learning experience through the project provided an effective way for developing professional competencies because the students were allowed to discover and develop these competencies through exploration within their learning context (Biggs, 1999).

In addition, authentic learning environment allows the development of certain personal attributes that are often referred to attitudes and values. Barnett (2006) refers to them as “certain kinds of human dispositions and qualities”. In education, these personal attributes can be demonstrated as: (a) self-awareness and confidence, and an increasing motivation to learn and succeed; (b) an active, self-managed approach to life and work; (c) focus on achieving.

Employers and community value these personal attributes because they demonstrate professionalism in a person. Employers value employees who are focused and have the drive to achieve because it shows an employee’s motivation and engagement on the job. Employees who have self-awareness and are confident tend to be more proactive in their learning and are more willing to apply their learning in different work situations.
Personal attributes, unlike skills and knowledge, cannot be taught as a subject but they can be learned when students are given the right support and learning environment. In authentic learning, the role of the tutor and the client play a critical role in helping the students to develop positive personal attributes.

The students’ reflections on their learning about professionalism:

- The team learned to conduct ourselves professionally in business meetings with the client. The team dressed appropriately and spoke in a polite and respectful tone so as to gain the client’s respect and trust. This had helped us to build rapport with the client too.
- The first learning experience for the team was working with an actual company. Working on a real-world project required the team to adjust their working style in order to meet the needs of the company, for example in communication and planning the workshop.
- Despite the difficulties working with the client, I had to maintain my professionalism. It was new learning for me and it was important that we learned it as a student.

Feedback for Learning

One of the key strengths in the module was the constructive feedback that students received from the tutor and the client. The four hours allocated in the students’ timetable were meaningfully used for feedback and coaching. The sessions helped to build confidence when the students were told that they had done well. At the same time, these same sessions were also used to coach students to develop their professional competencies so that they can be ready for work. The client was also involved in providing formative feedback to the students. The clients’ feedback gave a different perspective on the students’ performance and this dimension added richness to the authentic learning approach. The students became more aware of the critical skills that would make a difference to work performance, and it helped to reinforce the importance of professionalism at the workplace.

Challenges in Adopting Authentic Learning

There were several challenges in adopting the authentic learning approach. Students faced time pressure to complete the project because they had to manage multiple projects from other modules simultaneously. As a result, work quality was compromised because they did not have the capacity to fine-tune their work. Some students also reflected that they had difficulty providing workable solutions to their client because they lacked experience and business knowledge. The ability to translate theoretical concepts to practical solutions took time and deeper understanding of a company’s working norms and culture. It was also time intensive for the tutor because of the diverse requirements and expectations of each project. Depending on the readiness of each group to handle the client, the tutor had to spend time coaching the groups so that they felt a little more confident meeting up with the client.

As each project requirements differed, the learning from diversity and unpredictable events made it difficult to assess every student in a reliable manner. The knowledge gained from authentic learning may not necessarily match exactly the educational objectives of the planned curriculum. In many situations, the tutor and the client were not present to validate the learning. As a result, the tutor had to rely on the reflection journals as evidences of learning.

Another challenge was finding companies who were willing to partner with the Polytechnic to create the learning platform for the students. There were varying degrees of commitment from the companies to coach and provide constructive feedback to the students. There was also a fine balance between meeting the needs of the company and maintaining academic standards for high quality learning. The tutor had to keep an active industry network and this required time and effort to continuously engage industry partners in order to build a strong pipeline of projects.

Conclusion

This study showed that authentic learning was an effective pedagogical approach to enable polytechnic students to acquire skills and develop professional competencies. The real-world project provided an effective vehicle for the students to apply their HR knowledge to address specific HR issues and had enabled them to take greater responsibility for their learning and development. They became more confident in integrating learning to specific situations and through the process, they became active learners, strengthened their collaboration and communication competencies to be in sync with workplace expectations on professionalism. Their engagement in complex tasks and higher-order thinking skills helped them to develop a broader understanding of the role of HR practitioners in an organisation.

The students valued the coaching and feedback given by the tutor and the client because it provided guidance and a means of determining their areas for improvement. Therefore, it is important to build in space for feedback in assessment. Like collaboration and communication, feedback is integral in the real world, which is critical to successful performance in modern work environments.

The findings in this study may be limited as the sample size was small. It also did not consider other pedagogical approaches as a comparison to develop professional competencies. The projects which the students were involved in were scaled down to allow them to complete the tasks within the limited timeframe and hence, the complexity of the tasks may not accurately
reflect the complex patterns and partnerships that HR practitioners are involved in the industry.

The analysis of the curriculum design showed that there were some areas for improvement and these included: (a) deeper engagement with industry partners in coaching the students, and in coping with the authentic tasks to align with the academic rigour; (b) the development of a criterion-reference assessment rubric to enhance assessment reliability and enable students to aspire to higher performance standards; (c) reviewing the teaching load or tutor-student ratio so that there is optimal learning for the students and to give the tutor time to build a strong network with the industry partners.

References


Effects of intermediate research presentation on the graduation study

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Abstract

For most students, the graduation-research presentation is one of the most difficult challenges of their college life. For their presentation to be successful, students must be well prepared to explain the significance of their project, give the rationale for their approach, and provide a clear interpretation of their results. In this sense, the graduation-research presentation itself functions as a powerful active learning tool. The problem is, however, that the opportunity to experience this presentation process is typically limited to only once a year, at the end of the second semester. Because of this restriction, students sometimes conduct their experiments without truly understanding the importance of their research project, ultimately resulting in a poor final presentation. In the worst case, students fail to manage their schedule and end up spending most of their time merely assembling their experimental data without a comprehensive understanding of the value of their research. To make student graduation research more effective, our department decided to hold an intermediate poster-presentation at the mid-point of each student's graduation research. Participating in the process were faculty members of the department, fourth-year students, and representatives from other departments. Time in the poster session was divided between two groups; fifth-year students in each group gave an approximately one-hour presentation. The faculty evaluated each presentation and engaged the students in discussion. The intermediate presentation had several notable effects: First, students performed more experiments in the first semester in order to produce results to discuss at the presentation. Second, students were encouraged to carefully consider the purpose of their study, their principal experimental methods, their analysis and interpretation of results, and their future direction. Third, students engaged more actively in their research during the second semester, as they were able to grasp the importance of their research. Fourth, students were better able to prepare for the final presentation, having sufficient time to prepare for a proper presentation and discussion, and thus significantly improve the quality of their presentation. As a result, a number of students won Society Awards. Fifth, in addition to the merits for fifth year students, the intermediate presentation helped fourth year students learn about the department's laboratories.

Keywords: Intermediate presentation, research project, poster presentation, graduation research, presentation skills

Introduction

For many students, the graduation-research presentation is one of the most difficult challenges of their student life. For their presentation to be effective, students are required to explain the significance of their project, give the rationale for the approach they have chosen, and provide a clear interpretation of their results. Because it is a project-driven learning process, the graduation-research presentation itself functions as an active learning device. However, the opportunity for students to go through this presentation process is normally limited to only once a year, at the end of the second semester. Because of this, many students continue their experiments without understanding the importance of their project, which ultimately results in a poor presentation. In the worst case, students fail to manage their schedule and end up spending most of their time simply assembling experimental data without having a comprehensive understanding of the value of the research. To make graduation research more effective and productive, our department introduced an intermediate poster-presentation requirement.

Materials and Methods or Pedagogy

Role of participants

The Chairman of the Department of Chemical and Biological Engineering proposed the intermediate
research presentation. A teacher in charge of academic issues in the department organized the presentation plan. One teacher of fifth year students and another teacher of fourth year students worked with their students. Faculty in our department conducting research with fifth year students evaluated the presentations (Syllabus 2015). All fifth year students prepared a presentation and presented their work, while fourth year students set up the presentation location and attended the poster presentation.

Planning
Following the department Chairman’s proposal, the department changed the syllabus so that the intermediate presentation would be a part of the final evaluation. The intermediate presentation was included in Experiments in Chemical Reaction Engineering and Experiments in Biochemical Reaction Engineering for fifth year students (syllabus 2014 and 2015). Our department evaluated student achievement based on their reports, posters, presentation and attitude in their graduation research (Table.1). To obtain more effective feedback for students, it was determined that discussion time should be long enough to discuss the details of the research. Accordingly, we deemed that a poster presentation was superior to a strictly oral presentation. A supervisor, along with two other faculty members from our department, evaluated the presentations.

Preparation before presentation
A meeting room with a seating capacity of 100 attendees was used for the poster presentation. A faculty member in charge of the presentation (organizer) along with two other faculty members, one from the fourth year and the other from fifth year held several meetings to create the schedule for the presentation. The organizer managed the setup of the presentation room (Fig.1), checking the poster boards, the legs of the boards, and providing push pins and tape. The organizer and fourth year faculty member directed fourth year students to set up the room. The organizer assigned two faculty members to perform the evaluations. The fourth year faculty member assigned his students to each presentation and distributed documents with a questionnaire for the presenter, along with comment sheets. In advance of the presentation, the fifth year faculty member described the presentation process to her students (Fig.2).

Table 1 Evaluation of Achievement

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<th>Evaluation of Achievement (%)</th>
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<td>Experimental Achievement and Preparation of Reports</td>
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Intermediate Graduation Research Presentation of Chemical and Biological Engineering Department, 2015
15th July, 2015 (Wed) 13:00-15:00
Multi media room, Library Building 2nd Floor

Program
13:00~13:05 Opening Speech by Chairman of Department
13:05~13:45 Poster Presentation of Odd Number
13:55~14:35 Poster Presentation of Even Number
14:35~14:50 Judgement by Teacher
14:50~15:00 Comment by Chairman of Department

Fig. 2 Time table of Intermediate Research Presentation

Result and Discussion
Pre-study for fifth year students
A supervisor helped each student plan his/her experiment schedule, obtain experimental data, and organize results for the intermediate graduation study. Students were motivated to plan and implement their experiments in anticipation of their intermediate presentation. They had the opportunity to carefully consider their project and ask appropriate questions regarding such matters as the aim of the project, how best to design the experiments, the principles behind the methods used, and how to draw conclusions from the data. As a result, the students were able to learn more
about their project, producing positive effects on their graduation research.

The poster presentation

At the presentation, fifth year students used posters to present their study. They discussed their achievements with faculty members and fourth year students (Fig. 3). Faculty members evaluated six or seven student presentations as vice judges. In those cases in which students were unable to answer every question put to them, they had the opportunity to seek out the appropriate answers from their supervisors after their presentation. Through the poster presentation, participating students were able to rethink important aspects of their research such as the purpose of their project, the principles behind the methods used, their analysis and interpretation of results, and the future direction of their research.

The effect of poster presentation

After their presentation, students showed increased motivation and became more actively engaged in their research during the second semester, as they were able to grasp the importance of their work. Because they learned how to organize their presentation, they understood what they would need to do and what was most important in their research. In general, they were better able to plan their experiment schedule according to appropriate experiment priorities.

The effect of the poster presentation on the graduation presentation

Because they had the experience of preparing their documents and slides for the intermediate graduation research presentation, students were much more prepared for their final presentation. They had sufficient time and direction to prepare for their graduation presentations and discussions so that the quality of their final presentation became significantly better. Before the introduction of the intermediate presentation, some fraction of the presenting students answered faculty questions poorly at the final graduation-research presentation. However, following the introduction of the intermediate presentation, many of them were able answer faculty questions much more competently. This was the result of a deeper understanding of their research and the extended time they had to ponder their work. Because of the improvement in their final presentations, some of the students earned Society Awards—including awards from the Free Radical School in 2015, the annual meeting of The Japan Association for the College of Technology in 2015, and the student presentation meeting of the Society of Chemical Engineers in Japan (2015).

The effect on the fourth year students with regard to their introduction to laboratories

In addition to the positive effects on fifth year students, the intermediate presentation helped fourth year students learn more about department laboratories. Fourth year students normally join laboratories during their second semester (College Bulletin 2015). We took advantage of the intermediate presentation to introduce laboratory alternatives to fourth year students who were to decide which laboratory they wanted to join. Before the intermediate presentation requirement became part of the curriculum, the department would hold a short introduction to its laboratories at the beginning of the second semester. Each laboratory had five minutes to introduce itself to the students, which seemed far too short a time to provide sufficient information. With the intermediate presentation, fourth year students are now much more able to choose a laboratory that fits their interest, resulting in a noticeable increase in student motivation.

Faculty burden

We did not find that the intermediate presentation increased the burden on faculty. In the short term, faculty members spent more time with their students to help them prepare for the intermediate research presentation. However, through the intermediate presentation students acquired a better understanding of their research and developed the ability to push their research forward independently, which saved a substantial amount of faculty time.

Future direction

Our department has decided to continue the intermediate presentation requirement. Our model has brought a new education style to the college, as another department—the department of business management—has, with our support, begun to require intermediate presentations (Syllabus of Department of Business Administration 2016). We plan to support the introduction of intermediate presentations in other departments as well. We also intend to report the positive effects of introducing intermediate presentations at professional meetings, as a reference for other institutions.

Conclusion
The introduction of an intermediate student presentation has brought several positive effects to the entire graduation research process. First, students have conducted more experiments in the first semester in order to produce results to discuss at their presentation. Second, students now have a chance to think more carefully about their research, including the purpose of their study, the principles underpinning their experimental methods, the analysis and interpretation of results, and their future direction. Third, students have more actively engaged in their research during the second semester, as they are better able to grasp the importance of their research. Fourth, students are more able to prepare for their final presentation, so that the quality of their presentation has become significantly better. A number of students have won Society Awards as a result. Fifth, in addition to the merits for fifth year students, intermediate presentations have helped fourth year students gain a greater understanding of the various department laboratories.

Acknowledgements

We are deeply grateful for the support of the faculty members in Department of Chemical and Biological Engineering to conduct the intermediate graduation-research presentation.

References

2015 College Bulletin, National Institute of Technology, Ube College

Syllabus 2015, Department of Chemical and Biological Engineering, National Institute of Technology, Ube College

Syllabus 2014 Department of Chemical and Biological Engineering, National Institute of Technology, Ube College

Syllabus 2016, Department of Business Administration, National Institute of Technology, Ube College

21st Annual meeting of The Japan Association for College of Technology, National Institute of Technology, Tokuyama College, 29th Aug, 2015

Free Radical School in 2015, University of Tsukuba, Tateyama 8th-9th Aug, 2015

18th Students’ presentation meeting, The Society of Chemical Engineers, in Japan 5th Mar, 2016
AUTHENTIC ASSESSMENT IN ENGINEERING – A REVIEW OF CURRENT IMPLEMENTATIONS

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Abstract

Authentic assessment is increasingly being recognized for the benefits it brings to students’ learning. Assessment as a motivator to learning, development of soft skills and reducing students’ motivation to cheat are but some of the benefits that this alternative form of assessment can bring about. This paper reviewed implementations of authentic assessments in engineering courses in three universities from Australia and Portugal. All of them shared commonalities such as having report-writing, and presentations contributing to part of the course grade. The paper also identifies some common challenges to overcome when designing such assessments. If the intention is to experiment with alternative assessment modes in a program, it might appear that implementing such changes in the first-year curriculum and allocating sufficient resources to conduct the assessment can make the difference between success and failure in the implementation.

Keywords: authentic assessment, authentic learning, formative assessment

Introduction

Over the years, incorporating authenticity in assessments has gained importance for educators around the world. It is now generally agreed that asking students to write an essay on a topic such as the engineering design process might not be the best way to assess their understanding of the topic. Similarly, there is no guarantee that a student who is able to convert a differential equation from the time-domain into its s-domain equivalent using Laplace Transform will be able to use the knowledge to analyze electrical circuits such as the one in Figure 1.

Figure 1 Circuit analysis using Laplace Transform

Traditional exams assess students’ mastery of knowledge and skills by examining their response to unambiguous and yet decontextualized test questions. In comparison, the questions or challenges given in an authentic assessment are often ambiguous, ill-defined or open-ended. Authentic assessment comes into its own when the objective is to assess students’ ability to apply their knowledge to real-world situations (Wellington, Thomas, Powell, & Clark, 2002).

Providing a context is the key to incorporating authenticity in assessments. The learning value in getting students to sit down for a 2-hour exam on circuit analysis is very different from getting them to explain a circuit that they have designed and built themselves, even though the same set of knowledge and skills may be required for both.

Therefore the techniques employed to conduct authentic assessments are very different from those in traditional assessments. Whereas traditional assessments typically make use of essays, short-answer questions and multiple-choice questions in the form of a pen-and-paper test to assess the outcomes of students’ learning, authentic assessments may utilize methods such as presentations, peer evaluation and journal entries to achieve the assessment objectives.

Students are reportedly more motivated and engaged academically when such assessment methods are used. They are also less likely to plagiarize or cheat because the nature of the assessment is such that copying from existing pieces of work will not lead to a good grade (MacAndrew, S.B.G., & Edwards, K., 2002). The following section provides a brief review of how authentic assessments may look like in engineering courses.

Authentic assessment in engineering courses

Monash University, Australia Third-year undergraduate students from Industrial Engineering, Accounting, Marketing and Industrial Design courses are grouped into multidisciplinary teams of 8 to 10 to solve a problem that originates from participating companies. This initiative was brought about to solve the problem of engineering graduates lacking the necessary skills in teamwork, communication and solving problems that are ambiguous in nature.

The project module lasts for 15 weeks and culminates with a presentation to the management of the
sponsoring company. Since one of the objectives of this project module was to hone students’ teamwork and communication skills, the team of academics who had developed it did not rely on a final exam to assess students. Instead, the deliverables for the project consist of two interim reports, one final report, three peer assessments and one reflective journal. All deliverables form part of the assessment together with the team supervisor’s observations (Wellington, Thomas, Powell, & Clark, 2002).

*University of Minho, Portugal* The term coined by this university to describe their project-based pedagogy is “project-led education” (PLE). First-year engineering students work in teams of 6 to 8 on multidisciplinary projects that encompass the learning objectives of 4 courses, namely Introduction to industrial engineering, Calculus, Computer programming and General chemistry. The motivation for this course to adopt this method of teaching is similar to that of Monash University, which is to enhance teamwork and develop competencies in communication and project management.

Deliverables that are assessed include project reports, presentations, peer assessments and a written test to assess students’ understanding of the subject matter. The written test differs from a regular pen-and-paper test in that it is customized for each team based on its project solution (Fernandes, Flores, & Lima, 2012). A post-implementation study conducted by the university found that students had mixed responses to this mode of assessment. There exists a group of students who prefer the traditional method of assessment because they felt traditional assessments are easier to do well, where a student’s performance does not depend on how the entire team performed, and there is no need to worry about applying or linking the concepts to real-life situations.

*Deakin University, Australia:* Several engineering programs ranging from Bachelor to Doctoral levels in the Deakin University School of Engineering and Technology adopt a flexible delivery mode and consequently utilize alternative methods to assess students (Palmer, 2004). In a subject known as “Strategic Issues in Engineering”, authenticity, fairness and practicality are some of the criteria that are important to the administrator of this subject. Because the students who are taking this subject are in their final year of study, the emphasis of the assessment is to check the students for the necessary skills that they will require in the near future when they graduate and move on to professional practice. Table 1 presents the written assessment components of this subject:

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<td>Reflective journal</td>
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<tr>
<td>Technological forecasting and assessment</td>
<td>10</td>
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<tr>
<td>Policy design in engineering organizations</td>
<td>10</td>
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<tr>
<td>Major report</td>
<td>20</td>
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<tr>
<td>Examination</td>
<td>50</td>
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Table 1 Written assessment components

In all of these items, apart from the examination, students are working in groups of three to study existing practices of real organizations and conduct interviews with professionals in the industry. Other than the written assessment components, there is also a 20-minute oral presentation as part of the assessment, during which the groups will present the findings documented in their major report.

**Characteristics of authentic assessments**

Based on the review of the various reports on authentic assessments implemented, there are certain traits that appear to be common across all implementations. First of all, assessment in all the case studies that we have presented did not occur as a one-off event. There are assessment activities conducted at various points throughout the semester in the form of report submissions, peer assessments and presentations. Due to the nature of the assessment activities, authentic assessments are mostly adopted by student-centric pedagogies which emphasize collaboration and learning through solving real-world problems.

The second characteristic of authentic assessments is that the assessments do not rely on the results of traditional tests, often conducted closed-book, to measure students' learning. Such pen-and-paper tests require the questions to be kept secret until the moment of assessment. If students get to know of the questions in advance, the test is no longer valid (Wiggins, 1990). In contrast, the challenges given in an authentic assessment are often made known to students in advance of the assessment for them to prepare and rehearse.

Authentic assessments require a different approach in determining their validity. The validity of traditional pen-and-paper tests is measured by comparing the test questions with the curriculum content. If the “correct answer” to the questions comes from the curriculum content, the test is deemed to be a valid one. Once again, the underlying assumption in traditional tests is that there is one correct answer to every test question. The validity of authentic assessments, on the other hand, has to be dependent on whether the assessment simulates real-world scenarios. Instead of asking “Are the students supposed to have learned this?”, the test of validity for authentic assessments is “Will the students be doing this when they go out to work after graduation?”

**Benefits of authentic assessment**

One clear advantage that authentic assessment has over traditional exam is the reduction in the number of cheating cases. There is no point for a student to copy from another student when both are working on different projects. As students work on their projects under the guidance of their supervisors, they would come to know exactly what knowledge they are supposed to acquire and what they would be tested on during the final assessment. Hence there is no need for spotting of exam questions. Having the assessment
activities spread over the entire semester also reduces the chances of a student scoring badly for a subject due to poor performance in a single, high-stake final exam. Thus the grade that a student obtains for a subject is more reflective of his level of mastery in that subject if authentic assessment were used.

Another benefit of requiring students to present before a panel of assessors is that students are more motivated to understand the subject matter because they know that they will be cross-examined on the concepts involved during their presentation. Compared to asking students to respond to a 5-mark question on “Explain the first law of thermodynamics” in a pen-and-paper test, listening to a student answering the exact same question verbally during a presentation session allows the assessor to have a better gauge of whether the student truly understands the first law of thermodynamics.

Incorporating teamwork, report writing and presentations into the assessment also drives students to work on these skills which are no less important than mastery of the subject matter.

Challenges

The amount of time and resources required for authentic assessment is the first challenge that institutions have to grapple with. The time and manpower that was previously allocated to marking exam papers are now required for grading reports and journal entries which make the task less straightforward. Reports and journals by their nature are open-ended with no single “correct answer” and hence there is no definite marking scheme for the assessors to fall back on in their marking.

Allocating sufficient time for project presentations is also a challenge. For example in the Aerodynamics course at Republic Polytechnic where presentations form part of the assessment, assessors found that in order to properly examine each student’s understanding of the subject matter, they often had to overrun the time limit given to each team.

The issue of reliability is always present in all tests, traditional or otherwise. However this issue is amplified in the case of authentic assessments where the assessors may comprise of different faculty members. In cases where peer evaluation is used, students play a part in the assessment as well. With only a set of grading rubrics to work with, assessors have to be properly trained on the use of the assessment rubrics in order for the assessment to have high inter-rater reliability.

It takes time to acclimatize not only the assessors, but also the ones being assessed to alternative methods of assessment. It can be a challenge to manage students’ negative responses to the change in the mode of assessment, which can be expected whenever there are any changes from what they have been accustomed to, as can be seen from the experience of the University of Minho. This is especially so if the change takes place in their final year of study before they graduate.

Conclusion

Some common benefits and challenges were shared among courses that had experienced using authentic assessment in place of traditional pen-and-paper tests. Students achieve deeper learning and find meaning in the assessment activities when the subject matter is learned in the process of solving a real-world problem. On the flip side, more resources have to be expended in the conduct of authentic assessment compared to traditional exams. This however should only be construed as a challenge, and not a disadvantage. If the benefits of authentic assessments are truly worthwhile to pursue, then sufficient time and manpower should be allocated to do it properly. We hope this review inspires more engineering schools to experiment with authentic assessments and give heart to those who are already doing so.

References


Practical English Exercise and Curriculum Design

aDepartment of Creative Engineering, National Institute of Technology, Kitakyushu College, Japan
bAcademic Center for Creative Education and Support Service, National Institute of Technology, Kitakyushu College, Japan

Abstract
Curriculum design is very important to achieve educational goals. The curriculum should contain the knowledge, skills as well as competencies that are required for the student's future success. The advanced engineering school of the National Institute of Technology, Kitakyushu College was reformed to aim at cultivating students to be creative engineers with multiple engineering viewpoints, problem-solving skills and global mind. In order to achieve these educational goals, the curriculum consists of thesis research, lab-work and exercise subjects, fundamental science subjects, liberal arts subjects, social science and foreign language as global/local study subjects. In this curriculum, there are 4 compulsory modules designed to connect directly each other and to deepen the students’ understanding of engineering and English communication skills for the global Engineer. The students prepare and practice their English presentation on their project done in the previous modules. Thus, the students have to learn effective ways to explain and present their own idea: customized learning contents. This constructively aligned module structure with clear learning activities and outcomes is essential to achieve the educational goals, especially for school reform initiative. Moreover, short/long-term international exchange students are welcome to join these modules as international collaborative learning activities. It seems that the international educational collaboration in the curriculum provides ideal circumstances to foster the global mind/awareness.

Keywords: Global mind, English study, Group work, Presentation skills, PBL, CDIO

1. Introduction
There is no doubt that we are facing with the rapidly changing world of “Globalization.” In order to improve the preparation of our students to meet high demands in rapidly globalizing world, we have to improve the curriculum as well as our educational approach. The 21st century skills shown in Figure 1, a set of essential abilities, are what our students need for their future; these skills should be recognized as one of the most important outcomes of teaching and learning through the curriculum.

Fig. 1 The 21st Century Skills

According to a blueprint for education reform in Japan, globally competitive talent of students has been a top priority on the agendas. Thus, collaborative problem-solving skills and intercultural communication skills for globalization, especially English language skills, are very important for our students. Although typical lecture plays an important role in English education, the intercultural communication skills can be also fostered effectively through a variety of international activities.

Based on these requests for educational institutes, the advanced engineering school of the National Institute of Technology, Kitakyushu College was reformed in 2015. Former three courses, Production Engineering Advanced Course, Control Engineering Advanced Course, and Material Science & Chemical Engineering Advanced Course have been consolidated into one course named “Creative Engineering” course. It aims at cultivating students to be creative engineers who are specialists of their engineering expertise and other related engineering fields with multiple engineering viewpoints, problem-solving skills and global mind; the curriculum was designed to achieve these educational goals effectively. Figure 2 shows the organization of reformed Kitakyushu College: 5-year college and 2-year advanced engineering course. The college part was also reformed and former 5 departments were consolidated in to “Creative Engineering” department. The Creative Engineering department provides 5-course.
In this paper, the curriculum design adopted in the advanced engineering school of Kitakyushu College is reported. The curriculum taking into account further international collaboration and exchange (e.g. short/long term student exchange programme) is discussed from the viewpoint of global education as well as practical English exercise.

2. Advanced School and Curriculum
The advanced school provides an additional 2-year multidisciplinary engineering education for graduates of colleges of technology (KOSEN) or junior colleges. Figure 3 shows the position of the advanced school in the school system of Japan.

In the Advanced School of Creative Engineering, in order to foster the multiple engineers’ viewpoints, the students study technologies from the stages of materials/resources to final products with addition of recycling process for the sustainable/recycling-based society. The curriculum consists of thesis research, lab-work and exercise subjects, fundamental science subjects, social science and foreign language as global/local study subjects, elective specialized subjects and subjects for three compulsory elective major fields based on demands for engineering and technology as well as regional needs of Kitakyushu district.

2.1. Curriculum Design for Practical English Exercise
In this curriculum, there are four compulsory modules designed to be linked each other and to deepen the students’ understanding of engineering and English skills for the global Engineer: “Lecture for Creative Engineering Design and Production”, “Production Design Engineering Practice”, “Advanced Experiments for Creative Engineering”, and “Practical English for engineers I.” The students broaden and deepen their knowledge about manufacturing technologies in Lecture for Creative Engineering Design and Production, and these knowledge and ideas will be applied to their project as Problem Based Learning (PBL) in Production Design Engineering Practice. The students design, manufacture and evaluate devices in Experiments for Creative Engineering as summary of the learning outcomes as Project Based Learning. In Practical English for engineers I, the students prepare and practice their English presentation on their PBL works.

2.1.1. Lecture for Creative Engineering Design and Production
The main topic of this module is technologies in “Production.” As the first Japanese government-managed steelworks/steel blast furnaces registered as World Heritage were constructed in Kitakyushu in 1901, “Steel manufacturing” is chosen to be the main topic (Fig. 4a). This module is an omnibus style lecture (90 min. × 15) consisting of 5 sub-topics: Mechanical engineering, Electrical engineering, Information technology, Control engineering, and Material Science & Chemical engineering corresponding to the former 5 departments. “Production” in the steel manufacturing is explained and discussed from different engineering points of view as total engineering. Figure 4(b) shows an example of application of Electrical engineering in steel manufacturing. The students learn their engineering expertise and other related engineering fields with multiple engineering viewpoints. This module also aims to foster local identity of Kitakyushu.

2.1.2. Production Design Engineering Practice
This module is designed as PBL and starts from the following trigger question.

You are a member of Research & Development team of Kitakyushu-Kosen Company located in Kitakyushu. You have to suggest a new product utilizing technologies of at least two different engineering fields. Please propose your product plan to the board of directors!

Fig. 5 A trigger problem for PBL.
The students are required to think and act as company researchers to propose new products as play roles. The students are divided into groups of 4 to 6 members with different major engineering fields as shown in Figure 6. After the instructions of PBL, they started to develop their products basing on their already learned knowledge and the investigation.

Fig. 6 A picture of students in Production Design Engineering Practice Class.

2.1.2. Advanced Experiments for Creative Engineering

The students try to design, manufacture and evaluate devices in Experiments for Creative Engineering as summary of the learning outcomes. The students are again divided into groups of 4 to 6 members with different major fields. This module provides 5 short experiments relating to 5 engineering fields mentioned above and one long-term project (3 hr. x 10). Therefore, this module is a mixture of conventional lab-work and Project-based learning. The topic of the project is chosen to be a chemical reactor system: a microreactor. A microreactor is a micro-channel reactor in which chemical reactions are designed to take place in a confinement with typical lateral dimensions less than 1 mm (Fig. 7). Microreactors possess many advantages over conventional large scale (bulk) chemical reactors, because of high energy efficiency, reliability, and a superior degree of process controllability. It should be noted that the fabrication, operation and evaluation of the microreactor requires knowledge and skills of all 5 engineering fields.

Fig. 7 An example of flow in a microreactor(left) and a microreactor designed by students (right).

2.1.4. Practical English for engineers I

In this module, the students work with the same group members from previous “Production Design Engineering Practice”. The students prepare and practice their English presentation on their PBL project done in the semester 1. Again, it starts from a scenario continuing from the R & D team story. Thus, this module is supposed to be a sort of PBL for effective English presentation. It should be noted that their suggested products relate their major engineering field, but are quite different from their thesis research. Therefore, English terms and expressions used for the presentation are ones that they are not familiar with. The scenario for this module is that the member of R & D team received an invitation letter shown in figure 8. Figure 9 shows a picture of students’ English presentation.

Dear Sir or Madam,

We are pleased to invite your company, considering its innovative experience and great idea of products, to take part in the WORLD INNOVATIVE EXPO 2015 and International New Products Conference that will be held on 19-21 December 2015 in USA.

We would like to invite you to present your product at an exhibition stand, and also to take an active part in the conferences accompanying the exhibition, including the possibility of giving presentations in details. We are very confident you will find this proposal worthy of consideration and that any business talks held at the conference will be beneficial to your company in a number of ways.

We are looking forward to hearing from you at your earliest convenience.

Yours sincerely,
Project Manager

Fig. 8 An invitation letter for students (e-mail).

Fig. 9 A picture of students’ English presentation.

2.2. International Educational Collaboration in Classroom

It should be noted that International Symposium on Advances of Technology Education (ISATE) is one of good examples of the institutional collaboration. Many faculties of educational institutes have exchanged and shared their pedagogy and future visions, as well as established international educator networks. Through ISATE, Kitakyushu College has been developed international/global education programs with several Polytechnics in Singapore and other Universities.

Figure 10 shows examples of short term exchange program at Kitakyushu College in 2014. The short or long term research projects, such as joint Final Year Project (FYP), are typical exchange programs. Durations of program are typically from one month up to about 3 months. Although these collaborative research projects are very effective way to foster the
global mind of students, their activities tend to be limited within the research laboratory.

Fig. 10 Examples of short term exchange program at Kitakyushu College in 2014.

It is ideal that the short/long term exchange students join some modules with our students and learn collaboratively to achieve international learning environment, which also motivates other students who are not involved in the projects directly. It is important to establish the international collaborative learning environment for the globalization of education. However, as a small size of the advanced school (Annual admission: 35 students), there are not enough number of modules suitable for this purpose. The four modules mentioned in the previous section is designed to provide the short/long term exchange students opportunities to join and to learn collaboratively with our students. In 2015, two Singapore students joined “Advanced Experiments for Creative Engineering.” As their final year project was also the development of microreactor, they presented the research results as well as conducted short experiments (Fig. 11).

The same two Singapore students partially attend Practical English for engineers I and another Indonesian student joined the final presentation. They gave the comments and asked questions after the presentation.

Fig. 11 Pictures of the students in Production Design Engineering Practice Class. Joining the short-term experiments (above) and Giving a presentation in the class (bottom).

3. Results and Discussion

It is shown that modules mentioned above are linked each other to develop competency for the global engineer: collaborative problem-solving skills and intercultural communication skills. Figure 12 shows the structure of these modules. The concept of this curriculum structure is basically the same as the integrated curriculum design of CDIO. In order to develop the students’ competency, these modules make explicit connections among learning outcomes and supporting and complementing contents.

International Student (Short/Long term)

![Curriculum Design of the four modules.](image)

3.1. As Modules Design

Three engineering modules are a core part of curriculum for learning “Production” from an engineering point of view. “Lecture for Creative Engineering Design and Production” provides basic knowledge of production technologies and multiple engineering viewpoints. At the same time, the students challenges to propose new products as Problem-Based Learning in “Production Design Engineering Practice”. Then, the students are requested to draw on their previous experience in “Advanced Experiments for Creative Engineering” as Project-Based Learning.

Regarding practical English exercise, basing on previous engineering practice activities, “Production Design Engineering Practice” and Practical English for engineers I “ are linked strongly together. Since the students try to figure out how to present and explain their original works in English, this activity is a simulation of real-world problem solving as English study. Different from teacher prepared hand-on topics, the customized learning contents (i.e. students’ PBL works) let them be closely involved in thinking things as well as in making decisions.

3.2. International Educational Collaboration in the Classroom

In addition to the curriculum design, international educational collaboration in the classroom is also an important factor for the global engineering education. Participation of new international students to the classroom seems to simulate students’ curiosity and interest. Especially in English class, the international students really endorse whether their English is
understood or not. Moreover, they can teach us intercultural difference that is important, but is rarely taught. Here is a good example of intercultural difference which the students recognized during the presentation. When a group presented their IT controlled umbrella management system (holder) for home-use, the international students questioned a possibility of umbrella theft, and Japanese students could not understand the reason why they worry about theft. Japanese students believed that umbrella should be kept inside home (entrance hall), that is common in Japan, but the international students thought it should be outside. This is simply due to the life-style difference, and they found it through questioning and answering. It is noted that this type of experience show the students’ English proficiency is not only important for communication as an engineer. Understanding cultural orientations and differences is important for successful communication.

Fig. 13 A picture of group presentation of IT controlled umbrella management system.

Candid opinion from the international students are very important for the practical English exercise. Figure 14 shows the result of students’ peer evaluation regarding understandability of their presentation. Even for the good score group, the international students point out the problems from the viewpoint different from ones of Japanese lecturers and students. Their comments are very persuasive and are quite meaningful to improve our students’ English presentation including English skills itself and intercultural communication skills.

3.3. Follow-up Survey Results

As this module is for the students’ practical English presentation exercise, we are not considering the direct influence on English examination score such as TOEIC and TOEFL at this moment. However, a follow up survey is conducted so as to consider the students’ perspective after their class experience. Table 1 shows results of follow-up survey conducted after 5 months. The Questions #1 and #2 ask the students English skills that will likely be required in the future. The Question #3 is about the importance of cultural understanding in the communication. The Question #4 and #5 concerns participation of short-term international students in English class. The number of opportunities they give English presentations is also asked in the Question #6.

It should be noted that low negative response rates ≤ 10 % are obtained for all questions. It is shown that a high positive response rate of 83 % is achieved for both Q 1 and Q 2. These results indicate the students recognize the importance of practical English skills in their future career. A high positive response rate of 69 % is obtained for Q3 regarding cultural understanding in the communication. For Q4, the students give a positive response rate of 65 % for effectiveness of the participation of international students. Although the students give a positive response rate of 62 % for Q 5 about promotion of participation of international students in English class, the highest negative response rate of 10 % is also obtained. This result seems to relate to Q 6. It is found that 34 % of the students had no chance to give an English presentation except this module; only 10 % of the students are well experienced regarding English presentation. Due to the lack of experience, the students feel anxiety in their English performance in front of international students. In fact, some students mentioned that they concern about the gap between ideal and real performance when they talk with international students. These results shows that it is important to encourage the students not to hesitate to use English even if they might make mistakes and to provide the students opportunities to use English.

<table>
<thead>
<tr>
<th>Questions</th>
<th>(N=30)</th>
<th>Disagree » Neutral » Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Do you think you will need higher English skills after graduation?</td>
<td>3 3 10 31 52</td>
<td></td>
</tr>
<tr>
<td>2. The required English skills will be of practical use such as for presentation?</td>
<td>0 7 10 31 52</td>
<td></td>
</tr>
<tr>
<td>3. Cultural understanding is particularly important in communication?</td>
<td>0 3 28 41 28</td>
<td></td>
</tr>
<tr>
<td>4. Short-term international students’ participation in English class is very meaningful to learn practical English.</td>
<td>0 3 31 31 34</td>
<td></td>
</tr>
<tr>
<td>5. Do you hope to have more opportunities to communicate with international students in English class to learn practical English?</td>
<td>0 10 28 31 31</td>
<td></td>
</tr>
<tr>
<td>6. How many presentations have you done in English except this module?</td>
<td>34 48 7 0 10</td>
<td></td>
</tr>
</tbody>
</table>
4. Conclusions

In this paper, the curriculum design of the advanced engineering school of Kitakyushu College is presented. Simulation of real-world engineering context were used for both engineering and language education. The constructively aligned and integrated module structure with clear learning activities and outcomes seems to be essential to foster the global engineering. In addition to the curriculum, participation of short/long term international exchange students to the classroom is very effective for the practical English exercise. It is shown that the international educational collaboration provides ideal circumstances to foster the global mind/awareness in the classroom.

Since the 1st ISATE held at 2007, many faculties of educational institutes have promoted the international collaboration. We hope that ISATE continues to be a platform to promote further international collaboration among institutes for the globalization of education.

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References


