UTILIZATION OF UPPER ATMOSPHERE OBSERVATION FOR EDUCATION

A. Ikeda\textsuperscript{a,} H. Nozawa\textsuperscript{a} and M. Shinhara\textsuperscript{a}
\textsuperscript{a} Liberal Arts and Sciences, National Institute of Technology, Kagoshima College, Kirishima, Japan
*a-ikeda@kagoshima-ct.ac.jp

Abstract

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

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

Introduction

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

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

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

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

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

Upper atmosphere observation

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

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

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

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

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

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

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

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

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

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

Results and Discussion

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

We encouraged the students to improve their skills through the upper atmospheric data. They handled and analyzed the data by themselves. They also presented the obtained results at scientific symposiums. In our hearing investigation, the students thought that there are advantages to be exposed to science. Thus we
concluded that the scientific data can be utilized for student education at Kosen and improve students’ skills. We further plan to give opportunity to experience “observation” to students. Our new installation of the fluxgate magnetometer can give them such opportunity and provide us more information about the upper atmosphere.

Conclusions

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

Acknowledgements

A part of the upper atmospheric data was obtained in association with Dr. Kazuo Makita. We would like to thank Mr. Shinji Abematsu for correcting this paper.

References


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

Nanae Sato, Mitsuru Muramoto and Kanaho Matsuda  
National Institute of Technology, Tomakomai College,  
Department of Engineering for Innovation, Japan  
saton@tomakomai-ct.ac.jp

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

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

Introduction

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

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

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

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

Method

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

<table>
<thead>
<tr>
<th>Majors</th>
<th>3rd</th>
<th>4th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical Engineering</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Electrical and Electronic Engineering</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Computer Science and Engineering</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Science and Engineering for Materials</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Civil Engineering</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>15</td>
<td>2</td>
</tr>
</tbody>
</table>
2. Preparation for Science Demonstrations

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

(1) Deciding Experiments

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

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

Table 2 Contents of Science Demonstrations in 2015

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

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

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

(2) Writing Scripts in English

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

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

(3) Practicing Experiments in English

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

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

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

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

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

Figure 2 Demonstration of Moving Snake (Day1)

Figure 3 Demonstration of Kundt Tubes (Day2)

Results and Discussion

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

1. Fostering positive attitudes toward English communication

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

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

<table>
<thead>
<tr>
<th>JP-Q1. I had experience at using English to explain things to others before. (If yes, what was the context?)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No: 10 (67%)</td>
</tr>
<tr>
<td>Yes: 5 (33%)</td>
</tr>
<tr>
<td>* no context from one student</td>
</tr>
<tr>
<td>- In a English conversation school (3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>JP-Q2. It was difficult to prepare for Science Demonstrations in English.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree</td>
</tr>
<tr>
<td>2 (13%)</td>
</tr>
</tbody>
</table>

Despite their anxiety, however, the pupils who joined the demonstrations gave quite positive responses to a questionnaire which asked their reactions to the performance given by the Japanese students. As shown in Table 4, most of them answered that they enjoyed the demonstrations (NZ-Q1, NZ-Q2), and would like to have another opportunity to participate in such science events in the future (NZ-Q3). Moreover, regarding the intelligibility of the Japanese students’ English, over 85% of the pupils answered that it was clear enough to understand (NZ-Q4), and the result seems to indicate that their English helped the pupils understand the contents of the experiments.
From these results, it is suggested that the activity worked effectively for the development of the students’ positive attitudes toward English communication, and cultivated their self-confidence in their own English.

2. Improving motivation for English learning

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

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

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

Comments from the participants (authors’ translation)
- I found it very effective to speak English actively as I usually don’t have a chance to use English to explain things to others.
- I could improve my communication ability by thinking about the effective ways of speaking which can attract the audience’s attention.
- This activity improved my presentation skill with which I am careful of using English which is easy to understand for the audience.

Table 5 Questionnaire Results (NZ pupils: N=45)

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

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

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

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

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

| JP-Q7. I found that the experience of using English with the purpose of explaining things to others is an effective way of learning and improving English. |
|-----------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |
| ________________ | __________ | __________ | __________ | ________________ |
| 11 (73%) | 4 (27%) | 0 (0%) | 0 (0%) | 0 (0%) |

Comments from the participants (authors’ translation)
- I was disappointed of myself for having limited vocabulary. I felt that I need to learn more vocabulary, especially verbs and nouns.
- Because of my limited vocabulary, I sometimes gave the audience roundabout explanations. So I felt the need to improve my vocabulary.
- I found it important to pay attention to not only the meanings but also the pronunciations of the words when I learn new English words.
- I need to practice speaking, focusing on pronunciations and intonations.
- I want to improve my speaking ability which enables me to make myself understood to others.

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

Table 6 Questionnaire Results (NZ pupils: N=45)

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

Table 5 Questionnaire Results (NZ pupils: N=45)

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

Table 6 Questionnaire Results (NZ pupils: N=45)

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

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

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

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

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

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

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

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

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

I want to improve my speaking ability which enables me to make myself understood to others.
that they felt the positive effect of the activity on their English learning, especially on the development of their communication abilities (JP-Q7), and 14 of them answered that the activity helped them to discover new objectives for their future English learning (JP-Q8) as indicated in Table 6. Some of their comments given to each question are also shown in the table.

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

3. Developing autonomous attitudes for learning

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

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

![Figure 5 Instruction for Moving Snake](image)

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

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

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

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

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

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

References


Abstract

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

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

Introduction

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

In our institution the student population comes from families where both parents working all day. For this reason, students have a poor academic support that directly impact their educational level. There are numerous studies that talk about the factors that influence academic achievement of students. All of them are agree that the nature of the problem associated with low academic performance is multifactorial. Duron and Oropeza (1999) established the presence of four main factors, Figure 1, which are:

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

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

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

d) **Sociological factors.** They are associated with socioeconomic characteristics such as economic status, education level and occupation of parents and the quality of the environment surrounding the student.
transformation and social renewal. We believe that a more integral citizens that become agents of change, with a greater participation and a greater degree of understanding by students thank to this experience generate knowledge more durable and meaningful. Finally, the solving process motivates students to build their own systems of learning and understanding. In the case of teachers this project represents a direct invitation to the renewal of teaching practice and the improvement of a teaching-learning process.

Materials and Methods or pedagogy

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

1) Knowledge. This level is associated with universal information and specific methods related with processes, structures and models. It gives greater emphasis to the psychological processes of remembrance, involving organization and reorganization of a problem, to provide signs and clues associated to useful information.

2) Understanding. This level represents the lowest level of understanding. It refers to a kind of understanding such that the individual knows what he is communicating and can use the material or idea without necessarily relating it to other material, or without the need to know their full implications.

3) Application. This level implies the use of abstractions into concrete situations. Abstractions can be in the form of general ideas, rules of procedure or generalized methods. The abstractions may also consist in technical principles, ideas and theories which must be remembered and applied. For example: the application of terms and concepts used in scientific research work to the phenomenon discussed in another investigation or the ability to predict the effect of a change in a biological factor or situation that is in equilibrium. In the level associated with the application we can recognized four different kinds of problems such as: a) problems associated with a fictional situation, b) Problems associated with materials focused to simplify a complex situation, c) Problems that demand the generation of several solutions associated with ordinary situations and d) Figure out new ways of looking ordinary phenomena.
Besides, we can recognize two kinds of conduct when people have to solve a problem. These conducts are: a) The student select the correct principle and he show how it applies to the problem. The student understands the full application process and explain the concepts involved and b) the student shows the solution and we can infer if the principles applied in the solution are corrects.

4) Analysis. This level is associated with the separation of a communication into its elements or components in order to clarify the relationship between the ideas expressed.

5) Summary. This level is associated with the ability to unite different parties and form a new element. This may involve the production of an essay or speech, a plan of operations (research proposal) or a set of abstract relations (schemes for classifying information).

6) Evaluation. This level is associated with the ability to judge the value of materials such as declarations, novels, poems or research reports for a particular purpose. The judgment should be based on defined criteria. These criteria may be internal (organization) or external (relevance or purpose). The student can determine the criterion or he can receive it from others. The outcomes obtained in this area are the highest in the cognitive hierarchy because they contain elements of all other categories.

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

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

a) To choose a parameter (level of Bloom’s Taxonomy to be evaluated) with the desired confidence level. A parameter is an element that is considered essential and guidance to achieve assess or evaluate a given situation.

b) Detecting a particular difference, if it really exists, between the study groups with a minimum guarantee.

c) Establish a balance between feasibility, costs and speed the study.

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

Table 1. Structure of test.

<table>
<thead>
<tr>
<th>Process of Solving problems</th>
<th>What is evaluated?</th>
</tr>
</thead>
<tbody>
<tr>
<td>I) Understanding the Problem</td>
<td>Reading-Comprehension</td>
</tr>
<tr>
<td>II) Analysis of the information</td>
<td>Identification Highlights</td>
</tr>
<tr>
<td>III) Design of a plan</td>
<td>Identification Algorithm</td>
</tr>
<tr>
<td>IV) Implementation of the plan</td>
<td>Operations and Mathematical Manipulation</td>
</tr>
<tr>
<td>V) Examination of the solution obtained.</td>
<td>Validation</td>
</tr>
</tbody>
</table>

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

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

a) Index of difficulty. All questions have a specific difficulty level. A question with a low frequency of success is more difficult than another with a high frequency. The index of difficulty is the frequency of responses obtained on the total number of people.

b) Index discrimination. The discrimination index allows us to determine if a question is answered most often by students with high academic performance or by student with a low academic performance.

c) Validity. The validity of an instrument is associated with the possibility of measure what we want to measure.
d) Reliability. It refers to the accuracy with which we can get the same measurement under different conditions. In some cases, the condition will be associated with the temporal stability. In these cases, the element measured at two different times should give the same answers to the instrument. Using these indicators, we were able to measure the quality of the questions.

Results and Discussion

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

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

<table>
<thead>
<tr>
<th>Bloom’s Taxonomy*</th>
<th>Levels</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Questions</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td></td>
<td>21</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Total Students</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>202</td>
<td>44%</td>
<td>56%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Average Age</th>
<th>15-16 years old</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of education</td>
<td>High School (Grade 10-11)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Question</th>
<th>*Scale of degrees of Certainty/ (%students)</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is a problem?</td>
<td>1</td>
</tr>
<tr>
<td>An exercise which the teacher proposes in order to know if the student has learned a definition, a formula or procedure.</td>
<td>9.2</td>
</tr>
<tr>
<td>An exercise in which we can apply a procedure to a real situation</td>
<td>15.5</td>
</tr>
<tr>
<td>A situation that motivates students to learn new definitions, formulas or procedures.</td>
<td>8.3</td>
</tr>
<tr>
<td>A situation that allows students to develop new skills.</td>
<td>4.8</td>
</tr>
<tr>
<td>A situation that motivates students to learn new concepts, plan activities, develop strategies and propose solutions to real situations.</td>
<td>20.4</td>
</tr>
<tr>
<td>A situation which connects knowledge from different areas.</td>
<td>20.4</td>
</tr>
<tr>
<td>A situation that involves the development of competencies (knowledge, skills and attitudes).</td>
<td>5.6</td>
</tr>
</tbody>
</table>
Finally, we identify benefits about the development of projects associated with solving problems from surveys and evaluation reports. These benefits are included in Table 6.

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

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

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

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

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

Conclusions

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

Acknowledgements

I would like to express my appreciation for the support extended by the University of Guanajuato for doing the research work.

References


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

Lee Foon Yee and Jason Chui
School of Information Technology, Nanyang Polytechnic, Singapore

LEE_Foon_Yee@nyp.edu.sg, Jason_CHUI@nyp.edu.sg

Abstract

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

Exploration on the relationship between students’ learning styles and their engagement can help instructors understand students’ learning preferences and hence design more engaging videos for differentiated learning in the future.

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

Introduction

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

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

Literature Review

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

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

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

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

Methods

Research Study Participants

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

Research Study Treatment

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

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

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

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

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

Data Collection

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

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

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

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

Results and Discussion

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

Insights on Student’s SDL Participation

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

<table>
<thead>
<tr>
<th>Learning Style</th>
<th>Part 1</th>
<th>Part 2</th>
<th>Part 3</th>
<th>Part 4</th>
<th>Part 5</th>
<th>Part 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diverging</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Assimilating</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Converging</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>98.2%</td>
<td>98.2%</td>
</tr>
<tr>
<td>Accommodating</td>
<td>100%</td>
<td>100%</td>
<td>96.4%</td>
<td>94.6%</td>
<td>91.1%</td>
<td>89.3%</td>
</tr>
</tbody>
</table>

From this table, we could see that all students started their learning in SDL mode, with 87.5% of them participated in all the six parts. One student with “Converging” learning style stopped learning after part 2. Among students with “Accommodating” learning style, two stopped after part 2, three stopped after part 3, five stopped after part 4 and six stopped after part 5. This result was not surprising as students with “Accommodating” learning style generally prefer more ‘hands-on’ with feeling and doing rather than watching videos and completing reflection exercises.
Next, we would like to examine how the students had actually used the interactive videos to learn the content in SDL mode. Using the data downloaded from Zaption platform, we managed to summarise the students’ usage patterns according to their learning styles in Table 2 below:

Table 2: Students’ SDL Usage Patterns by Learning Styles

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

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

Learning Effectiveness

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

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

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

From the Pre-test results in this table, it showed that the students did learn some module content before attending the face-to-face flipped classroom session, where students with “Assimilating” and “Converging” learning styles scored slightly better than the others. From the Post-test results, we could see that the mean scores improved by about 50 marks across all the four learning styles. The effect size of the mean score (Cohen’s d) for measuring the magnitude of difference in mean between the pre- and post-test is computed to be 2.6462, indicating a large effect. From Chart 1 below:

Chart 1: Comparing students’ mid-term test mean score

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

Learning Satisfaction

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

Chart 2: Students’ satisfaction on Face-to-Face lecture and SDL with interactive videos
From this chart, we could see an affirmative answer with 90% of the students surveyed found the use of interactive videos as a learning platform in SDL mode satisfactory and 72% had rated it good and above. According to the qualitative responses given, the two top cited reasons were “the ability to replay the videos” and “enhanced understanding gained from clear and well-structured videos”.

Conclusions and Recommendations

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

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

Acknowledgements

The authors would like thank the management of the School of Information Technology and Nanyang Polytechnic for their support in this research.

References


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

Osami Yanagisawa a, Jane D. Magallonb Tomo Murakamia, Seiji Simizuc, Hiroyuki Sakauchia and Jongdoc Parkc

a Maritime Technology Department, National Institute of Technology, Yuge College, Japan
b Maritime Academy of Asia and the Pacific, Philippines
c Shipping Technology Department, National Institute of Technology, Oshima College, Japan

* park@oshima-k.ac.jp

Abstract

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

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

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

Introduction

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

To develop a new international internship program, Maritime Academy of Asia and the Pacific (MAAP) in Bataan and K Line Maritime Academy Philippines (KLMAP) in Central Manila were surveyed in February 2013 (2014). Unfortunately, we could not get an understanding and cooperation for this program at colleges due to the security condition of the Philippines. MAAP held “the maritime English instructors' training course”, for instructors from Japan, Indonesia, Thailand, Myanmar and Vietnam sponsored by the Japanese non-government organization in September 2013 (2012). This seminar gave a basic idea to "Professional maritime English instructor's training seminar" and “Professional student’s onboard ship training” for five NIT maritime colleges.

Class and evaluation

Yuge College invited two English instructors, Jane MAGALLON and Ma. Celeste ORBE, from MAAP and requested them to conduct the seminars for two weeks sponsored by “Maritime human resources developing project” in November 2013. Subsequently, Oshima, Hiroshima and Yuge College invited Jane MAGALLON from MAAP again in 2014 and 2015. This time, the seminar was performed for instructors and for students at the same time for one each week. New teaching style, discussion learning, role play active learning, U shape seat arrangement, among others were first introduced to Japanese instructors and then applied in the classes (see Photo 1).
On board ship training were provided in English with school training ship, Yuge Maru at Yuge College and Oshima Maru at Oshima College. Yuge Maru travelled from Yuge port to Matuyama port through Kurushima channel for 2nd grade students in common course before separating into Navigation and Engineering course for 2 days in November 2013. Kurushima channel is very famous rapid and strong current in very narrow channel and have special navigating rule. Role playing of “starting main diesel engine”, “starting diesel electric generator”, “departing port procedure”, “arriving port procedure”, etc. were done in this on board ship training (see Photo 2).

On board role playing of fire-fighting and trouble shooting for deck winch were conducted at Oshima Maru for instructors in November 2014. Before role playing, the scenario were made in detail based on IMO Standard Marine Communication Phrases (SMCP), and discussed each other. Movies were taken and reviewed and discussed after the role playing. Photo 3 shows the active learning of fire-fighting training on board.

Questionnaire for how much students can enhance their motivation to be seaman through the seminar was sent out at the end of the seminar. Next shows a list of questionnaire about it.

**Questionnaire for MAAP Maritime English seminar.** Just choose one number from listed below for each question. 1: Very false 2:False 3:Neither true and false 4:True 5:Very True

Q.1 Do you understand teacher’s instruction in English? Q.2 Do you like this seminar style (presentation, roll play, workshop and etc.)? Q.3 Can you join the seminar proactively? Q.4 Can you enhance your motivation to communicate with foreigner through the seminar? Q.5 Can you enhance your motivation to study maritime English through the seminar? Q.6 Can you understand what kind of maritime English is needed as seaman? Q.7 Is the seminar useful for passing seaman license examination? Q.8 Can you enhance your motivation to be international ship officer and ship manager at oversea through the seminar?

The pretest and posttest were conducted before and after the seminar to evaluate the educational effect of the seminar. Next shows example questions for 3rd grade in the engineering course at Oshima and Hiroshima College. Pretest and posttest are composed with same question set. They differ with grade and college depending on the content of the seminar.

**MARITIME ENGLISH Pretest and Posttest**

Read the questions carefully and choose the best answer. Circle the letter of your answer.

1. Where do you see the graphic panel? (A. control room B. engine room C. bridge) 2. What is the purpose of the generator? (A. source of heat B. gives electric power C. makes fuel) 3. The _____ controls the flow of the liquid in any pipe. (A. steering B. pump C. valve) 4. What is the main component of the valve? (A. body B. stem C. bonnet) 5. What do you call the book in the engine department that has all the information of the engine room? (A. bellbook B. logbook C. manifest) 6. What machinery in the engine room that has combustion to make power stroke? (A. generator B. purifier C. main
engine) 7. What is the first event in a four-stroke engine? (A. compression  B. power stroke  C. suction) 8. What connects the piston and the crankshaft? (A. piston rod B. crank C. cylinder)

Result and discussion

Figure 1 to 4 show statistical results of the questionnaire survey of motivation enhancement in percentage at each grade at Yuge College in the seminar of November 2015. All sectors show gain of motivation through the seminar. The motivation increases with increasing grade which was similar behaviour among other maritime colleges. It is because of the increased level of understanding of English as its grade level increases. We conclude that the seminar is successful to enhance their motivation to be seaman.

Table 1 and 2 show statistics result of score gain between pretest and posttest at each grade in engineering course at Hiroshima and Oshima College in the seminar of November 2015. They checked true or false at each question, give a score 1 for true and 0 for false and input into Microsoft Excel files. Score for each question is added and gain score for each student is computed by subtracting pretest score from posttest score. The score is totalled in the class and normalized with number of total students in the class.

Table 3 show statistics results of score gain between pretest and posttest at each grade in common, navigation and engineering course at Hiroshima and Oshima College in the seminar of November 2015. All results show score gain after the seminar. However, it is a little bit small because the seminar is very short in time, seven hours each for Oshima and four hours each for Hiroshima. The seminar needs a longer time span such as a month or a semester. We conclude that the seminar successfully enhances professional English communication ability for future seaman.

Table 1 Statistics result of score gain between pretest and posttest at 3rd grade in engineering course at Hiroshima College in the seminar of November 2015.
Table 2 Statistics result of score gain between pretest and posttest at 3rd grade in engineering course at Oshima College in the seminar of November 2015.

<table>
<thead>
<tr>
<th>Student No.</th>
<th>Pre Test 1</th>
<th>Pre Test 2</th>
<th>Pre Test 3</th>
<th>Pre Test 4</th>
<th>Pre Test 5</th>
<th>Pre Test 6</th>
<th>Pre Test 7</th>
<th>Pre Test 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3 Statistics result of score gain between pretest and posttest at each grade in common, navigation and engineering course at Hiroshima and Oshima College in the seminar of November 2015.

<table>
<thead>
<tr>
<th></th>
<th>1st Common</th>
<th>2nd Common</th>
<th>3rd Navigation</th>
<th>4th Engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hiroshima</td>
<td>22.02</td>
<td>22.02</td>
<td>22.02</td>
<td>22.02</td>
</tr>
<tr>
<td>Oshima</td>
<td>22.02</td>
<td>22.02</td>
<td>22.02</td>
<td>22.02</td>
</tr>
</tbody>
</table>

Summary

The content of program has already been edited and published into the textbook entitled “Let’s Enjoy Maritime English” (2016). Then it will be introduced to the common curriculum in five NIT maritime colleges (2017). Now, we suggest that the English training combined with the internship program in the Philippines should be affordable for every student in maritime colleges.

In the future, the international internship program in Manila or Cebu areas will be encouraging that maritime college students can put in practice the English training smoothly in the Philippines. It could be expected as one of the countries in Southeast Asia for the international exchange, where is affordable cost and security.

Acknowledgment

This program is sponsored by “Maritime human resources developing project” from the Japanese government. The authors would like to express gratitude to all Japan Seamen’s Union (JSU), International Mariners Management Association of Japan (IMMAJ).

References


Makoto Endou, (2013) “An approach to study method easy to understand and to fix in maritime department - all maritime college study method improvement project”, Proceedings of “Education forum for all college in Japan”, AP4 3 2.

Makoto Endou and et al., (2012) “Development of human resources training system with corporation between college and industry in maritime area”, Annual report of “Inter-university cooperation joint education promotion project”.


THE FIRST SEMESTER OF THE MEXICAN KOSEN AT THE UNIVERSITY OF GUANAJUATO

O.A. Flores*\textsuperscript{a} and J.S. Galván\textsuperscript{b}

\textsuperscript{a} University of Guanajuato/Guanajuato High School, Professor, Mexico
\textsuperscript{b} University of Guanajuato/Guanajuato High School, Professor, Mexico

* oflores@ugto.mx

Abstract

The University of Guanajuato offered the Technological High School with an International Profile Program, best known as Mexican Kosen, in August 2015 for the first time. The results of the first semester from the first generation of students are now available. The purpose of this paper is to analyze and show these results as well as to compare them with the results of the General High School Program students in the same institution, referring only to Guanajuato city high school. The reason to compare both programs is because they had the same admission instrument, so all students had the same starting point. As with all new projects or programs, it’s very important to take a step back to evaluate every stage of the process. I consider this information as necessary to help determine the direction of the next semesters and to identify the key elements to focus on. I obtained all the information used in this paper from the Integral System of Administrative Information (SIIA by its initials in Spanish) of the University of Guanajuato. I had access to the final grades of the semester of students from both programs, as well as statistical information by program, generation and subject. I found that Mexican Kosen students had good grades as a final result of their first semester, individually and as a generation. Almost 90% of the students had satisfactory grades, and most of them had a result over 80%. Their average results as a generation are higher than those of the General Program students. I also made a comparison by subject, choosing those with similar contents between both programs and the Mexican Kosen students had better results. The findings in this paper show that the obtained results meet the expectations for the first semester of the Mexican Kosen, and students are having better results as a generation than General High School Program students, despite having the same starting conditions. The factors for this difference in results represent the elements to observe in the development of the program.

Keywords: Mexican Kosen, new program, comparison, results, motivation, first generation

Introduction

The University of Guanajuato (UG) has a history of 26 years of academic collaboration with Japan. This collaboration has produced agreements with seventeen institutions in Japan so far, including a double degree system for two academic programs at UG. One of the most recent agreements was the creation of a Technological High School Program with an International Profile in the University of Guanajuato, based on the model of Japanese Kosen Colleges, and with the collaboration of the National Institutes of Technology of Nagaoka College, Ibaraki College, Oyama College and Fukushima College.

This new program, best known as Mexican Kosen, was offered for the first time in August, 2015 by the University of Guanajuato. On the first stage of the program, it started in two schools, the Materials Science course at Guanajuato City High School and the Mechatronics course at Salamanca High School. Students at these programs can acquire specialized knowledge on the two offered fields, aiming to be part of the growing manufacturing sector in the state of Guanajuato, mainly Japanese owned industries.

The present paper is an analysis of the results of the first generation at the Guanajuato City High School program, on their first semester. I refer to this school because it is my working place and I had access to the required information. This school offers now two programs, the Technological High School Program (THSP) and the General High School Program (GHSP), which has been operating since 1828. The two programs are very different, but they share two similar aspects, 1) there are four subjects with similar content between both programs on their first level, and 2) they had the same instrument of selection (admission test). Part of the analysis is based on these two similarities, as a point of comparison to better understand the development of the first generation of students at the new program, to evaluate every stage of the process and to determine the direction of the program for the next semesters.
Materials and Methods

All the information used in this paper comes from the Integral System of Administrative Information (SIIA by its initials in Spanish) of the University of Guanajuato. I had access to the final grades of the semester of students from both programs, General and Technological, as well as statistical information by program, generation and subject. All the information from every student at the University of Guanajuato is registered on this online system. I collected the information on final grades for the THSP students, as well as the statistical information of the GHSP students.

As I mentioned on previous lines, there are four subjects at the technological program which can be compared with similar subjects at the general program, according to the contents. Table 1 shows the similarities and differences of the considered subjects between both programs.

Table 1. Information on subjects with similar content from the General High School Program compared with the first semester of the Technological High School Program at the University of Guanajuato.

<table>
<thead>
<tr>
<th>Subject</th>
<th>GHSP</th>
<th>THSP</th>
<th>ICT</th>
<th>GHSP</th>
<th>THSP</th>
<th>ICT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algebra</td>
<td>1</td>
<td>1</td>
<td>Information</td>
<td>1</td>
<td>1</td>
<td>Communication</td>
</tr>
<tr>
<td>Chemistry</td>
<td>I</td>
<td>I</td>
<td>and Communication</td>
<td>I</td>
<td>I</td>
<td>Technologies I</td>
</tr>
<tr>
<td>Physics</td>
<td>I</td>
<td>Kinematics, Dynamic and Work - Energy</td>
<td>I</td>
<td>ICT</td>
<td>OS and Electronic and Digital Documents</td>
<td></td>
</tr>
<tr>
<td>ICT</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

The analysis and comparisons presented in this paper are based on these four subjects. The first part of the analysis shows the individual results obtained by each member of the group of the Technological High School Program. The grading system in this school works in a scale from 0 to 10, being 10 the highest possible grade for a student to obtain. The passing grade at UG is 7.0, so a grade equal or above seven is considered satisfactory.

The second part of the analysis focuses on the comparison between both programs at Guanajuato City High School. The comparison is made on the same four subjects mentioned before, considering the Passing Rate and the Average Grade. The Passing Rate is the percentage of students with a satisfactory grade over the total of students with an obtained grade for every subject. The Average Grade is the mathematical average of all the grades obtained by the students for every one of the four considered subjects. Only the numerical grades were included in the average.

It’s important to mention that the professors who teach at the new program also work on the general program, so I was able to consider that the methodology and evaluation criteria is also similar between both programs.

Results and Discussion

The first part of the analysis refers to the individual results. Table 2 shows a summary of the grades obtained by the first generation of the Technological High School Program with an International Profile on their first semester, considering only the four comparison subjects as mentioned earlier.

Table 2. Results obtained by the students of the Technological High School on the semester August – December 2015.

<table>
<thead>
<tr>
<th>Student</th>
<th>Algebra</th>
<th>Chemistry</th>
<th>Physics</th>
<th>ICT</th>
<th>Average Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>9.5</td>
<td>9.5</td>
<td>9.5</td>
<td>9.625</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>9.5</td>
<td>9</td>
<td>9.5</td>
<td>9.5</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>9</td>
<td>9.5</td>
<td>9.5</td>
<td>9.375</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>8.5</td>
<td>9.5</td>
<td>9</td>
<td>9.25</td>
</tr>
<tr>
<td>5</td>
<td>9</td>
<td>9</td>
<td>8.5</td>
<td>9.5</td>
<td>8.875</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8.75</td>
</tr>
<tr>
<td>7</td>
<td>8.5</td>
<td>9</td>
<td>8</td>
<td>8</td>
<td>8.625</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>9</td>
<td>8.5</td>
<td>8</td>
<td>8.125</td>
</tr>
<tr>
<td>9</td>
<td>7.5</td>
<td>8.5</td>
<td>8.5</td>
<td>8</td>
<td>8.125</td>
</tr>
<tr>
<td>10</td>
<td>7.5</td>
<td>8</td>
<td>7.5</td>
<td>8.5</td>
<td>7.875</td>
</tr>
<tr>
<td>11</td>
<td>7</td>
<td>8</td>
<td>7</td>
<td>8.5</td>
<td>7.75</td>
</tr>
<tr>
<td>12</td>
<td>7.5</td>
<td>7.5</td>
<td>7</td>
<td>7.5</td>
<td>7.375</td>
</tr>
<tr>
<td>13</td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>8</td>
<td>7.125</td>
</tr>
<tr>
<td>14</td>
<td>5.5</td>
<td>7.5</td>
<td>6.5</td>
<td>8.5</td>
<td>7</td>
</tr>
<tr>
<td>15</td>
<td>4.5</td>
<td>7.5</td>
<td>4.5</td>
<td>7.5</td>
<td>6</td>
</tr>
</tbody>
</table>

The results obtained individually by the students are of a good level. 14 of 15 students (93%) obtained a satisfactory average grade, 12 of 15 students (80%) passed all their subjects at their first attempt, and 9 of 15 students (60%) obtained an average grade above 8.0. These results are considered very satisfactory according to our school standards.

On comparing both programs at Guanajuato City High School, I considered the Passing Rate and the Average Grade by subject. Table 3 shows the obtained Passing Rate by students of both programs arranged by subject, and the resulting graphic of these percentages is shown on Figure 1.

Table 3. Passing Rate by subject of students at Guanajuato City High School, compared between General and Technological Program.

<table>
<thead>
<tr>
<th>Subject</th>
<th>PR GHSP</th>
<th>PR THSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algebra</td>
<td>67.4%</td>
<td>86.7%</td>
</tr>
<tr>
<td>Chemistry</td>
<td>75.8%</td>
<td>100%</td>
</tr>
<tr>
<td>Physics</td>
<td>63.2%</td>
<td>80.0%</td>
</tr>
<tr>
<td>ICT</td>
<td>97.4%</td>
<td>100%</td>
</tr>
</tbody>
</table>
The passing rate of the students at the Technological High School Program is higher than the passing rate of the students at the General Program in all four subjects, as it’s shown on the Graphic representation in Figure 1.

The second part of the comparison is based on the average grade calculated by all the obtained grades of students from both programs, by every one of the compared subjects. Table 4 shows the result of the calculated average by subject and by program.

Table 4. Average Grade by subject of students at Guanajuato City High School, compared between General and Technological Program.

<table>
<thead>
<tr>
<th>Subject</th>
<th>AG GHSP</th>
<th>AG THSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algebra</td>
<td>7.1</td>
<td>8.2</td>
</tr>
<tr>
<td>Chemistry</td>
<td>7.5</td>
<td>8.4</td>
</tr>
<tr>
<td>Physics</td>
<td>7.2</td>
<td>7.7</td>
</tr>
<tr>
<td>ICT</td>
<td>8.3</td>
<td>8.7</td>
</tr>
</tbody>
</table>

These results show that the average grades of the Technological High School Program students are also higher than the General High School Program students, as clearly seen on Figure 2. This is observable for all four considered subjects.

Figure 2. Graphic representation of the Average Grade by subject of students at Guanajuato City High School, compared between General and Technological Program.

Conclusions

The Mexican Kosen is a very important project at the University of Guanajuato. There are a lot of people working to make it a successful addition to the University Programs, including the international collaboration with the Japanese institutions. The expectations for the first generation of the Technological High School with an International Profile are very high and the results will determine the direction of the program for future generations. The grades obtained by the Guanajuato City students for the past semester are good, and they bring a good prospective to the development of the generation as well as the program. The individual results are very satisfactory, with very few exceptions and their average results as a generation are higher than those of the General Program students in all four considered subjects, algebra, chemistry, physics and information and communication technologies (ICT). The findings in this paper show that the obtained results meet the expectations for the first semester of the Mexican Kosen, and students are having better results as a generation than General High School Program students, despite having the same starting conditions.

The factors for this difference in results are as important as the results themselves. There wasn’t a specific selection method for the admission of the students. They came from the same public schools as the general program students, took the same test, and study in the same facilities with the same professors. I believe that the main difference in this process is the motivation. The students know that this is a special program, with a high level profile. They know that they’re taking subjects of higher levels compared to the general program, and also that their results will translate in better opportunities in the professional and international aspects of their careers. So they are working very hard, and they are directing their efforts according to their goals, developing at a different speed than the General High School program students. This discussion on motivation and attitude should be analyzed particularly and in a deeper level on further research opportunities.

The results obtained by this analysis are encouraging and motivating for all the people involved in the project, and it will be very interesting to witness the future results of this first generation of the Mexican Kosen.

Acknowledgements

I wish to acknowledge the director of Guanajuato City High School, Juana Silvina Galván Rocha, for all the information of the program and her ideas and opinion on the direction of this paper, being also co-author of it. The University of Guanajuato High School System Office for allowing me to get involved on the program and share with me all the information about it. All the people at The University of Guanajuato who make the Integral System of Administrative Information (SIIA) work, not only for this information, but for all the support in every University process.
References


DEVELOPMENT AND OPERATION OF ENGINEERING DESIGN EDUCATIONAL PROGRAM COOPERATED WITH LOCAL COMMUNITY

T. Sato\textsuperscript{a}, M. Shishido\textsuperscript{a}, T. Houga\textsuperscript{a} and R. Onodera\textsuperscript{a}

\textsuperscript{a} Department of Creative Engineering, National Institute of Technology, Tsuruoka College, Japan

* tsato@tsuruoka-nct.ac.jp

Abstract

In order to train engineering design ability for the students in advanced course in Tsuruoka college, the unique program has been developed and operated. This program includes three policies; 1) cooperation with the local community type education, 2) grouping by mixing different subject-of-study, 3) training camp activities at off-campus area.

Time schedules of the program is as follows; I) preliminary investigation; investigation about target area and suitable engineering technologies assisting the community (8hrs), II) camp activity in local area; field study, lecture, meeting, etc. 32\textasciitilde48hrs (4 \textasciitilde6days), III) group work in campus; continuing manufacturing (26hrs \textasciitilde 2h /weeks \times 13weeks), IV) presentation; proposal about their design or products toward the citizens (8hours), V) others; additional activity time(0\textasciitilde6hrs)

After the preliminary meetings between teaching staffs and official staffs in the local government, main theme was designed. This program have been executed in local area, Sagae city park and Tobishima island in Sakata city in Yamagata prefecture, to tackle the problems peculiar to the areas. Detailed contents were proposed from students by inspection at target area. In Sagae city, for example, the students tried repairing the park bench, and manufacturing the park signboard. In Tobishima island they proposed and manufactured solar cooker and the rocket heater, etc. The debrief session for the citizens about results obtained from this activity was held at “Environmental fair in Tsuruoka” as large environmental event in the city held on Sep. 21, 2014, and Sep. 27, 2015 in the city gymnasium. Students presented in form of poster and exhibiting the manufacture products. By experiencing the program, the students themselves realized the progress especially in motivation to the activity, contribution to local community, and cooperation and communication in group.

The scholastic evaluation for students concerning of this program was judged by the following aspects and using score distribution: 1. evaluation from auditor in presentation, 2. evaluation from the teacher in charge in presentation, 3. resulting report after practice, 4. activity in this practice.

Keywords: Engineering Design, Local Community, Training Camp, Advanced Corse, Group Activity

1. Introduction

The industrial technical society has been highly developed in recent years, and its complication, compounding and upgrading, have been increased rapidly. In the educational curriculum “engineering design” is most essential subject of so-called active learning. In this subject the students learn how to achieve manufacturing the objects or proposing systems fulfilling social needs by integrating various knowledge and technologies\cite{1}. The program tackles the problems which do not necessarily have a correct one answer, and finds out the realistic solutions. The engineering design ability includes various factors such as problem setting, creativity, integration of various knowledge, communication skills, and teamwork ability, and so on. From 2012 in Tsuruoka college, the new subject named "practical design engineering exercise" has been opened for the students in 1st year of advanced course. This paper describes construction and operation of the new program as a training of engineering design. The scope of this subject includes three policies; 1) Cooperation with local community, 2) Grouping by mixing different subject-of-study, 3) Training camp activities at off-campus area\cite{2, 3}.

2. Proposed Program

In order to carry out the design education program effectively, details of those three policies are described as follows:

1) Cooperation with local community; Students recognizes clearly the problems peculiar to the local area, and make effort to draw solutions from various view of points. In the program we tackled the subject in connection with the design of city park in Sagae city and making eco-house in Tobishima island in Sakata city. The activity area and main theme were
determined by repeating the arrangement beforehand between the teachers and corresponding local government staffs.

2) Grouping by mixing different subject-of-study; The group comprised of students was composed by mixing of different subject-of-study, i.e., departments of mechanical engineering, electrical and electronic engineering, control and information systems engineering, and chemical and biological engineering (Fig. 1). The aim of such grouping is that the students tackle the problems from various aspects.

3) Training camp activities at off-campus area; Training camp was carried out for the students to understand the values of collaboration and the responsibility of the individual in groups. As other purpose, the students can concentrate on activity all day. During training camp, lecture meeting by invited visiting lecturer were also held, in order to offer useful various knowledge to the students.

The operation time of this program consists of 90 hours (school hours) and is equivalent to two credits. The time arrangement for this program is shown in Table 1.

The scholastic evaluation for students was judged by the following aspects and score distribution:

1. Evaluation from auditor in presentation ..............40%
2. Evaluation from the teacher in charge in presentation ........ 25%
3. The resulting report after practice ..............25%
4. Activity in this practice ..............10%
   total 100%

3. Practice of Program

3.1 Sagae City Park Project (2012-2013)
In 2012-2013 we had attempted introducing the program toward the Sagae city (Sagae city park project). The purpose of the project is proposing ideas for the park more to be comfortable one for citizens. As a first of the activity, inspection of the city park by students was performed at the Sagae city park. They searched for what are the deficient points in the park facilities. Also, the students began to clean up in the park and to conduct the maintenance-and-repair volunteer (Fig. 2).

Table 1 Time arrangement for the program.

<table>
<thead>
<tr>
<th>Contents</th>
<th>Description</th>
<th>Operation turn</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) preliminary</td>
<td>investigation about target area and suitable engineering</td>
<td>8hrs</td>
</tr>
<tr>
<td>investigation</td>
<td>technologies</td>
<td></td>
</tr>
<tr>
<td>2) camp activity at off-</td>
<td>field study, lecture, meeting, etc.</td>
<td>32 ~ 48hrs</td>
</tr>
<tr>
<td>campus</td>
<td></td>
<td>(4 ~ 6 days)</td>
</tr>
<tr>
<td>3) group work</td>
<td>continuing manufacturing</td>
<td>26hrs</td>
</tr>
<tr>
<td>in campus</td>
<td></td>
<td>(2h/weeks × 13 weeks)</td>
</tr>
<tr>
<td>4) presentation</td>
<td>proposal about their design or products</td>
<td>8 hours</td>
</tr>
<tr>
<td>5) others</td>
<td>additional activity time</td>
<td>0 ~ 6 hrs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>total 90 hrs</td>
</tr>
</tbody>
</table>

Figure 1 Concept of grouping by mixing different subject.

Figure 2 Volunteer activities in the city park.
The purpose of this volunteer activity is to find out clearly the deficient points in the park throughout such activities. There is also the purpose of brewing the atmosphere with which the students of a different affiliation subject of study are each other becoming frank. As results of the inspection, many of the comments about deficient points were proposed, e.g., the map signboard for visitor is not found, the wooden benches have been decayed, etc.

The camp activities were carried out at a training camp site placed side in the city gymnasium. The students held the meeting after returning to the site of a training camp, and designed the plan of activities after today. During the training camp, the visiting lecturers were invited and the lecture meetings were held concerning the engineering design. Each of themes of lectures are listed in Table 2. All of lectures contain very helpful information for constructing the ideas of engineering design, and can lead design solution from various views of points. The contents of activity are listed in Table 3.

Table 2 Contents of activity from respective groups.

<table>
<thead>
<tr>
<th>group</th>
<th>contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>group 1</td>
<td>Repairing the park bench</td>
</tr>
<tr>
<td>group 2</td>
<td>Manufacturing the park signboard</td>
</tr>
<tr>
<td>group 3</td>
<td>City stamp rally which used QR Code</td>
</tr>
<tr>
<td>group 4</td>
<td>Illuminations in the city using a piezoelectric element</td>
</tr>
<tr>
<td>group 5</td>
<td>Cafe establishment of the memorial hall contiguous to a park</td>
</tr>
</tbody>
</table>

For example, details of groups 1 and 2 are as follows:

**group 1** The old wood blocks of park bench were changed for new ones(Fig. 3a, b). Students purchased the new wood blocks from the store and carried out cutting, filing, coating painting, and making screw holes. In particular, the step of making a screw hole was delayed. Because the position of a screw hole should be correctly located, punching the holes toward perpendicular must be very correctly. Punching was performed by the electric twist drill at the park. However, the accuracy in the perpendicular direction was not enough and the screws were not slightly applied to a flame of benches. Then as redo, new woods were purchased and punching were processed by using the driller in the college. By experiencing such basic manufacturing processes, the students would study the important elements in design education, e.g., importance of accuracy of dimensions, and excellency of processing machines.

**group 2** Manufacturing the park signboard was processed by combining thinner timber generated in the park and wood blocks purchased(Fig. 3c).

After the camp activity, the remaining manufacturing were continued after returned buck to the college. The debrief proposal for the citizens about this activity was held in Sagae city hall (Fig. 3d). The city personnel, the citizen, and the media representative audited to the debrief session. The park signboard designed and manufactured was presented to the city and was installed in the city park.

![Park Bench](image1)

![Wooden Bench](image2)

![Signboard](image3)

![Presentation](image4)

Tobishima is only one of remote manned island in Yamagata Prefecture. The area of an island measures 2.7km². Population is about 200 persons. An elderly ratio is about 67%. Although the industries are fishing and sightseeing, the industries should be more activated for sustaining the living in the island. After the preliminary meeting with the city staff, it was recognized that social of the island have required interesting events which can attract tourists from mainland. From the meeting the teaching staff decided as main theme in Tobishima “the making eco-house” which is the energy self-support type engineering designs using the natural power sources peculiar to the island. In the future, this activity would support the island sustaining the people’s life even if the life-line is broken by a large scale natural disaster. The site of training camp was kindly offered from city staff to use the gymnasium of elementary and junior high schools in island. At the beginning of the camp the students recognized clearly what kind of engineering design is useful for the residents in the island. Features of environment in Tobishima are warm climate and there are many fine days. Solar energy seems to be utilized. Since there are also much driftwoods on the sea side and thinner timbers in woods, a woody fuel is abundant. Therefore, the handmade solar cooker, the rocket heater by burning drift woods, fresh water generation system from sea water, and so on were proposed from the students.

Table 3 Contents of activity from respective groups.

<table>
<thead>
<tr>
<th>group</th>
<th>contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>group 1</td>
<td>solar cooker</td>
</tr>
<tr>
<td>group 2</td>
<td>the rocket heater using drift woods</td>
</tr>
<tr>
<td>group 3</td>
<td>vacuum pump for vacuum preservation of the food</td>
</tr>
<tr>
<td>group 4</td>
<td>system of making fresh water and natural salt by distilling sea water by burning drift woods</td>
</tr>
<tr>
<td>group 5</td>
<td>system of making fresh water generation by evaporating sea water using direct sunlight</td>
</tr>
</tbody>
</table>

Since public transport in the island was poor, the school car was carried for convenience. The students resided in the gymnasium in the school. Meal was prepared by themselves borrowing the kitchen in the school. During the camp period, the lecture meetings were held at the camp site (Fig. 4 a-c).

For example, details of groups 1 and 2 are as follows:

**group 1** At beginning of making solar cooker, students recognized that the commercial one is expensive and large weight. Therefore it was turned out that low cost and lightweight cooker would be useful. The students tried to make the solar cooker by using familiar materials such as aluminum foils and the umbrella (Fig. 5). As a result of experiments, they found out that temperatures at the light concentrate point rose to 65°C while the outside air temperature of 29°C. However, it was not able to reach to more high temperature. In order to attain the further temperature rise, improvements such as extending in area of an umbrella and smoothing of irregularity of the surface of aluminum foils should be needed. In addition, the fixation which can resist a wind is required.
A rocket heater is heating apparatus which burns the combustion gas emitted from burning woods. Combustion gas burns in a hot furnace and generate hot air(Fig. 6). The stack chimney draft was attached so that the combustion gas may not flow backwards. The body of the heater was manufactured by using the discarded metal container. By burning the driftwoods, the temperatures of oil at the bottom in the pan reached around at 250℃, and the exhaust gas temperature was about at 56℃. It was turn out that a high temperature for cooking or heating can be realized by using this system. In order to improve the durability of the body, it should be made a heat resisting property.

The proposal for the citizens about results obtained from this activity was held at “Environmental fair in Tsuruoka 2014 and 2015” as large environmental event in the city held on September 21, 2014, and September 27, 2015, respectively, in the city gymnasium(Fig. 7). Students presented using the poster and exhibiting the manufacture products.

After the practice of the program in Tobishima island, the questionnaires to the students were conducted in order to investigate the improvement of a student's consciousness. The self-evaluation, how are the degree of achievement for students in his own consciousness and capability at before and after the program were conducted. Question items are 1. motivation to the activity, 2. contribution to local community, 3. problem solving capability, 4. responsibility, 5. cooperation and communication in group, and 6. confidence. Each of items were evaluated by marking numbers from 1(weak) to 5(strong), and all scores were averaged(Fig. 8)[3,4].

As shown in the figure, it seems that the students themselves realized the progress in the all items, especially in motivation to the activity, contribution
to local community, and cooperation and communication in group. Although completeness of manufacture products was low and there is also much problem, the students realized the fulfillment and responsibility throughout this practice.

3.2 New activities in Tobishima Island (2016)

In 2016 we are trying new theme in Tobishima island. So far, students have been made to do respective theme setting by themselves under the main theme at the beginning of school term. However, since field survey time was short, we were anxious about the degree of achievement of the results which should response to the business solution. Then, in 2016 teaching staff proposed the respective new suitable theme, and made a student can choose the theme. Also here the grouping was composed by mixing of different subject-of-study. The proposed theme is as follows;

1) Development of beach cleaner
2) Producing naturel salt from sea water and its application
3) 3D printer activities
4) Effective removal of a noxious insect (horse fly)

The theme mentioned above would support the local motion trying registration Tobishima into a geopark zone. The rise of opportunity which the local government and resident people cooperate toward the registration is important. Also, understands the nature and culture of the area are important. So that the main theme was set to support for geopark registration. The theme 1 is the manufacturing activities for collecting seashore beach waste and maintaining the beautiful seashore(Fig. 9).

![rotating plate sand separator capturing fan](image)

**Figure 9** The design figure of a seashore dust cart

The theme 2 is activity for the revival of gastronomic culture which residents have sustained from ancient times. The theme 3 is activity for 3D printer to express topographical information and for Tobishima have familiarity held by many people. The theme 4 is activity for against the horse fly damage to a tourists. The horse fly capture system is being developed. The Results will be reported at elsewhere.

4. Conclusion

This program includes three of unique policies;
1) Cooperation with local community type education,
2) Grouping by mixing different subject-of-study,
3) Training camp activities at off-campus area.
Throughout activities, the students realized the fulfillment and responsibility to tackle the engineering problems in local area, which make the students engineer possessing engineering design ability.

Acknowledgments

The authors would like to thank official staffs and local residents of Sagae city and Tobishima island in Sakata city for their supports and helpful discussions.

References


4. Conclusion

Contribution for local type PBL education program for student in advanced course in NCT, Tsuruoka college have been developed and carried out from 2012.
A QUANTITATIVE EVALUATION OF LEARNING OUTCOMES AFTER SECOND YEAR OF THEME-BASED CURRICULUM IN HEALTH TECHNOLOGY

K. Björn* and M. Soini

* Helsinki Metropolia UAS, Head of Degree Programme, Finland
b Helsinki Metropolia UAS, Principal Lecturer, Finland

Abstract

A major administrative, government steering and funding reform was implemented in the Finnish Applied Science University system in 2014 and 2015. The change of the funding model implied many revisions in the education programme structures. Helsinki Metropolia University of Applied Sciences (HMUAS) implemented major revisions in our programmes beginning of academic year 2014. Among other things a previously separate programme of Health Technology, was integrated into a much larger programme of Information and Communication Technology as one of its specialisation options. The reform is introduced for background of learning outcome analysis. Programme performance indicators according to the new funding model are retrospectively calculated against the pre-reform student data over four years to establish stable programme level performance baseline indicators. In particular, we analyse numerically the results of the first year entry cohorts of 2010-2013 during their studies in the old curriculum compared with the theme based integrated approach over two first years of 2014-2016. A cross-comparison of the programmes is presented based on consistently sampled historical data. A longitudinal follow-up of the student cohorts who selected the Health Technology Major in 2015 is traced back to their original entry cohort of 2014 and initial analysis over the two years of sustained good performance is discussed. The realized and significantly improved indicator values were reported. Critical discussion covers some biased and non-biased error sources and the inherent instability of the introduced trigger-level based funding model. Finally some prudent observations on the reliability of our results are discussed, as well as potential directions how the method should be developed in the future are presented.

Keywords: Curriculum, Health Technology, ICT, Funding model, University reform, Performance, Indicators

Introduction

Major curricula re-structuring and mergers, including all engineering programmes were implemented in HMUAS at the beginning of academic year 2014. The history and rationale of the reform were discussed in our previous paper (Björn & Soini, 2015). Valmu et. al. (2015) also reported positive learning outcomes after the first year of studies in (HMUAS) Electronics and Electrical Engineering programmes after applying similar principles.

Now two full academic years have passed and our 4-year engineering programmes are mid-way through. This gives an early opportunity to evaluate the results, compared to the earlier curricula, as shown in Figure 1.

![Figure 1: Health Technology and ICT until 2013.](image-url)

Until the major administrative reform of all UAS’s in Finland in 2014, the number and title of engineering programmes was high and largely unregulated. Then many separate engineering programmes we forced to be consolidated to only a few large units, with common student entry. The rationale was to simplify the education system from the applicant point of view and to introduce economics of scale.

In HMUAS we introduced Health Technology in 2008 as a separate entry programme, with a nominal entry of (N=30) students each year. The neighbouring ICT programme was a separate entry and significantly larger. Figure 1 shows the entry years 2010-2013 and their entry groups H10-H13 and X10-X13, respectively.
The figure shows the 4 years of normal study time, followed by until now accrued potential overtime of two years.

Merging of the programmes into a single ICT programme created one student entry point and organisation of ICT related common studies into the first year, shown as ICT14 in Figure 2.

Figure 2: ICT programme merging and reform 2014.

The students would then study same programme and select their Major of interest at the end of the first year. Thus, the Health technology Major is shown as H14 for the second year of studies for academic year 2015-16. The retrospective opportunity is now to evaluate their success during the second year of studies, as well as in principle to trace back their performance also during their first year. There are multiple Majors, and it is out of the scope of this paper to make comparative analysis concerning the first year or between the Majors. Thus they are collectively marked by ICT14 and X14, respectively.

Research Questions

The individual and parallel nature of the two programmes, shown in Figure 1, and the aggregated structure followed after their merger, shown in Figure 2 raise a number of research questions on performance measurement. These include: (1) how to establish comparative performance measures for the pre-reform study groups (Hnn and Xnn) as performance baselines to be referred and to be improved; (2) how to apply the measures during the transition period (ICT14) which affects both programmes with new structure and pedagogical principles; and (3) how to apply these measures consistently on the new Majors again.

This paper is focuses on the H14 studies at the curriculum yearly level as shown in Figure 2. An overall but more detailed structure of the new ICT programme is shown on Figure 3, with length of 240 ECTS (European Credit Transfer System) credit points, equivalent of 4 years or 60 ECTS per year. The second year semester 1 and 2 are equivalently highlighted.

![ICT Programme](image)

Figure 3: Engineering Curriculum Framework in ICT.

The focus of the second research question is to evaluate the second year performance (i.e. first year of the Major in Health Technology, group H14). This group is administratively created independently of the entry group of the students. This allows to sample the students retrospectively from their entry groups, like from the ICT14. Therefore the object of discussion is mainly on gross level of ECTS points earned by the selected group and the resulted average per student.

The most interesting and unstable variable is the number of students who achieve the threshold of 55 ECTS. For comparative purposes this target needs to be expressed as percentage, relative to number of all students; in pre-reform we use entry groups and post-reform we use administrative groups.

A more student learning-oriented parallel paper (Soini & Björn, 2016) describes the learning experience feedback from the first semester of the Health Technology Major (PMT I and PMT II in Figure 3).

Materials and Methods

The research data is sampled from the Health Technology student records of 2010-2013 by entry groups, denoted by H10-H13. The ICT programme is an order of magnitude larger and runs on two campuses. The equivalent entry group data for 2010-2013 by entry groups is denoted by X10-X13. In this historical data and in 2014 entry groups both campuses are identified separately. We sampled the Helsinki campus only, as the same staff of engineering education teach in H-groups to eliminate effect of staff and pedagogy at this point.

The performance evaluation of the groups is possible at semester level. The newer curriculum would enable evaluation by half-semesters; however longitudinal comparison by semester suffices well for our purposes.

Furthermore, the new funding model uses the criteria at individual student level of yearly achieving 55 ECTS or more implying full funding or achieving less implying zero funding. This kind of strong threshold model is applied systematically to all UAS’s for them to compete for their relative share of a budgeted amount of funding.
at national level. This share of total UAS funding is as high as 85 percent of the total. For the comparative goal of being able to show longitudinal comparison of results, the new criteria are applied retrospectively to the pre-reform data at yearly basis. Therefore, the first part of the analysis reflects more of administrative view than pedagogical approach. We also recognize the “unfairness” of applying new criteria to older data, but as the new criteria are to exist in the near future, they are used to establish a baseline measures for improvement.

Establishing Programme Performance Criteria

The performance indicators of the sampled data was then aggregated from student and year levels up to entry group and year level, as shown in Table 1. The 4-year programme is shown in first column. Each student has 5 year time to complete it (Overtime 1) and the UAS can allow one more year (Overtime 2), if appropriate. In addition, a student has an individual right to register as being absent for 4 full semesters, i.e. two years. Therefore, the use of entry years to describe the actual pedagogical performance is inaccurate at student level. The main rationale of using entry group data anyway is that it is descriptive of performance at the system level and it records each student in one category only. This is also the reason of sampling many years of H- and X-data and aggregating them before comparison, to eliminate this variable.

Table 1: Program performance by funding criteria 2014

<table>
<thead>
<tr>
<th>Study years</th>
<th>H10 (Entry group)</th>
<th>ECTS</th>
<th>Avg</th>
<th>n(&gt;54)</th>
<th>n/N(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Year</td>
<td>16</td>
<td>906</td>
<td>56,6</td>
<td>11</td>
<td>68,8</td>
</tr>
<tr>
<td>2. Year</td>
<td>16</td>
<td>870</td>
<td>54,4</td>
<td>7</td>
<td>43,8</td>
</tr>
<tr>
<td>3. Year</td>
<td>16</td>
<td>871</td>
<td>54,4</td>
<td>9</td>
<td>56,3</td>
</tr>
<tr>
<td>4. Year</td>
<td>16</td>
<td>616</td>
<td>38,5</td>
<td>3</td>
<td>18,8</td>
</tr>
<tr>
<td>Overtime 1</td>
<td>16</td>
<td>90</td>
<td>5,6</td>
<td>0</td>
<td>0,0</td>
</tr>
<tr>
<td>Overtime 2</td>
<td>16</td>
<td>15</td>
<td>0,9</td>
<td>0</td>
<td>0,0</td>
</tr>
</tbody>
</table>

The analysis was carried out to the entry groups shown on Figure 1. An example of the calculated indicators for the first group H10 is shown in Table 1, where N is the administrative number of students, ECTS is the sum of credit points earned by then during the study year, and Avg refers to the average ECTS/N. Fortunately, the Avg’s are very close to (the forthcoming) target threshold, indirectly indicating also a good group level performance, i.e. low dropouts and very small number of bad performance. Here we recognize some inconsistency of low N compared to yearly entry; however N and their ECTS are mutually consistent from the study records. Sampling principle is consistent across H and X groups.

The indicator n(>54) is the number of students who reached the limit of 55 ECTS during the year. For comparative purposes it is shown as percentage n/N(%) to allow longitudinal and cross comparison of groups. Unfortunately, this indicator appears to be very sensitive and unstable, showing variations (43,8--68,8 %) with practically same Avg (54,4--55,6 %).

Establishing Programme Performance Baselines

As the yearly results of the n(>54) -indicator vary within the same group due to small N, all four years of the same curricula H10-H13 and X10-X13, are totalled in Table 2 with N per entry year around 100 and 300, respectively. For comparison purposes between the H and X at study programme level we estimate that the indicator is stable enough to allow comparison of administrative performance.

Table 2: Established program performance baselines

<table>
<thead>
<tr>
<th>Study years</th>
<th>H10-H13 Totals</th>
<th>X10-X13 Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Avg</td>
<td>N</td>
</tr>
<tr>
<td>1. Year</td>
<td>101</td>
<td>53,6</td>
</tr>
<tr>
<td>2. Year</td>
<td>101</td>
<td>51,7</td>
</tr>
<tr>
<td>3. Year</td>
<td>93</td>
<td>51,1</td>
</tr>
<tr>
<td>4. Year</td>
<td>68</td>
<td>32,8</td>
</tr>
</tbody>
</table>

Perhaps the striking difference is the higher Avg of H-groups around 50 % throughout the main bulk of classroom studies (3 first years), compared to level of somewhat over 40 % in the X-groups. Same kind of level difference can be observed in the n/N(%) -indicator, especially in the first year. Table 1 provides one answer to our research question 1 of establishing performance baselines for evaluating the effects of the reform.

Longitudinal Performance Evaluation

The discussions above have established quantitative performance criteria for programme learning outcomes measurement and they were applied to one cross-comparison of separate programmes. The following research questions are how to evaluate the performance after the groups H and X merged into ICT14 and later split again into H14 and other Majors, denoted as a lump X14. Formulated as above, the issue seems technical. The underlying real challenge is how to maintain the good performance of H-programme? Our paper Björn & Soini (2015) discussed the benefits of strongly integrated curriculum and theme-based active learning. These principles were implemented throughout the new Health Technology curriculum with the initial results in Table 3.

Table 3: Impact of the reform, administrative view

<table>
<thead>
<tr>
<th>Study years</th>
<th>H10-H13 Totals</th>
<th>H14 Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Avg</td>
</tr>
<tr>
<td>1. Year</td>
<td>101</td>
<td>53,6</td>
</tr>
<tr>
<td>2. Year</td>
<td>101</td>
<td>51,7</td>
</tr>
<tr>
<td>3. Year</td>
<td>93</td>
<td>51,1</td>
</tr>
<tr>
<td>4. Year</td>
<td>68</td>
<td>32,8</td>
</tr>
<tr>
<td>Overtime 1</td>
<td>43</td>
<td>6,0</td>
</tr>
<tr>
<td>Overtime 2</td>
<td>16</td>
<td>0,9</td>
</tr>
</tbody>
</table>

The performance indicators calculated for the second year group H14 are in Table 3 with N(Adm) = 40. The second line is evaluated using the administrative number
of the group. This means that the second year Major group was formed based on student selection from both campuses. Students may also be moved between the administrative groups as the new curriculum encourages individual study paths better. This N=40 is the administrative number at the end of the academic year 2015-16. This suggest that for administrative performance, this could be the correct denominator to use, perhaps still use the beginning N of the academic year.

The first year result of H14 is calculated by sampling the student records of the second year group independent of the student’s initial campus. The positive result of the new curriculum for the first year is shown as H14 Avg 50,8 ECTS compared to X10-X13 baseline of 43,1 ECTS and significant increase of n/N from 38,3 % to 72,5 %. In plain words this trend nearly doubles the main funding indicator. The impact is only relative at the funding system level, but this seems positive.

The main question of the paper title relates to some more detailed analysis of the second year row of Table 3. The H14 Avg 50,8 ECTS seems to have remained roughly at the same level compared to aggregate of H10-H13 of 53,6 ECTS. Thus we conclude that the joint ICT14 results are significantly better, compared to X10-X13 level of 43,1 ECTS. Further analysis of the X-groups is out of the scope of our paper.

The second year of H14 shows still a slight improvement from 51,3 ECTS to 55,2 ECTS. Obviously, if the normative offering of studies is 60 ECTS, increasing the average becomes increasingly hard. In active learning one teaching group is pedagogically “full” with 30-35 and physically and pedagogically overloaded at around 40 students. The remaining way and the method of improvement is mainly to keep all in performing and to avoid dropouts. We conclude to some extent that the Avg ECTS -indicator seems to approach its upper limit. Here the discussion exits the administrative view and enters the pedagogy.

Finally, the n/N of H14 also shows a slight improvement (75,0 %) compared to the same student group performance in their first year (72,5 %). We conclude we have implemented the good principles also in the Health Technology Major, as the end of the Major is built on the same principles and this was the first implementation on our learning curve. Also, somewhat radical observation is in comparison of this funding indicator to the previous 50,5 %.

Critical View on Trigger-based Funding Stability

Because the threshold-type indicator is very sensitive both on the actual earned credits, but also on the used denominator N, we consider that some further analysis of this variable is necessary. This leads also to some discussion on pedagogy and some more uncontrolled variables as potential sources or biased or non-biased errors. Attempts to eliminate biased errors on N include heuristic methods, such as elimination of students with zero or very low ECTS, from the calculation of cohort N, and thus indirectly eliminating also their ECTS credits (Valmu et. al, 2015).

Because of our detailed follow-up and feedback collection during the second year of studies we recognize the differences of administrate number of students and the actual numbers N(Actuals). Semester 1 was started with N(Admin)=33 and was added by 7 at the beginning of Semester 2, resulting N(Admin)=40 at the end of the academic year. We used this as a denominator, similar to the entry group size in pre-reform analysis. This number is biased up, so our indicators are prudent. The full set of indicators is again shown in Table 4 top row N(Admin), showing the total earned 2206 ECT credits and 30 students actually reaching the treshold of 55 ECTS. The indicators Avg = ECTS/N and n/N are now prone to possible errors in use of a valid N.

Table 4: Effect of actual attendance, pedagogical view

<table>
<thead>
<tr>
<th>2. Year</th>
<th>H14 (Admin group)</th>
<th>N</th>
<th>ECTS</th>
<th>Avg*</th>
<th>n(&gt;54)</th>
<th>n/N(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N (Admin.)</td>
<td>40</td>
<td>2206</td>
<td>55,2</td>
<td>30</td>
<td>75,0</td>
<td></td>
</tr>
<tr>
<td>N (Actuals)</td>
<td>33</td>
<td>955</td>
<td>28,9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semester 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N (PMT I)</td>
<td>28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N (PMT II)</td>
<td>28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semester 2</td>
<td>36</td>
<td>1251</td>
<td>34,8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N (Average)</td>
<td>34,5</td>
<td>2206</td>
<td>63,9</td>
<td>30</td>
<td>87,0</td>
<td></td>
</tr>
</tbody>
</table>

Because semester 1 started with actual administrative number of students being 33, we also collected the ECTS by semester. This cohort earned 955 ECTS, giving Avg 28,9 ECTS/semester (or indication of 57,8 ECTS/year). Below this line we recognize that the actual number of students in modules PMT I and PMT II varied and as our case study (Björn & Soini 2016) shows, at the end of semester N(PMT I) and N(PMT II) was 28.

Similarly, in Semester 2 we has actual N=36, and earned credits 1251. Using this we get Avg=34,8 ECTS/semester (or indication of 69,6 ECTS/year). Related to offering of studies 60 ECTS the indicators are biased up. This may be due to students taking some additional courses, some may have their elective studies credited based on earlier studies etc. This would require detailed analysis.

Finally, the N(Average) reflects the average of semesters, most likely to be usable in yearly calculation. Avg* is the 2 * weighted average of semester averages, to give a more prudent indicator of 62,9 ECTS/year. Given the fact that 30 students anyway reached the n(>54) treshold, using N=34,5 we show n/N=87 % compared to 75 % when using the administratine N.

Conclusions and Further Research

The rationale and some main lines of a major curriculum change, including a programme merger was described in the extent necessary to expose the research questions of the paper on a practical level.

The new government funding criteria criteria are based on individual student reaching 55 of normative 60 ECTS credits. The criteria are used to analyse retrospectively two merged programmes over four years.
before the merger to establish a baseline performance criteria. The criteria were then applied for cross-
comparison purposes, but excluding other Majors.

The curricula reform and programme merger were analysed based on formation of the Majors by student
selection after their first year. The performance of the Health Technology Major group was analysed over their
performance during their second year. The same criteria were applied on their first year in retrospect. Thus the
analysis shows the longitudinal performance development compared to the old curricula for first two years.

A critical assessment of the trigger-type of criteria are noted, especially their instability due to many
uncontrollable variables, as far as any educational institution is concerned. We conclude that the cross-
reference and longitudinal analyses using the criteria appear technically feasible, although the indicator
comparisons are sensitive to careful sampling and use of correct group size.

A number of more pedagogically related issues were revealed but not discussed. These could improve the
accuracy of the indicators by more dynamically taking into account the actual N at semester, period, or course
level. This is however closer to teaching and group dynamics, i.e. pedagogical performance view. It would
be interesting to apply the indicators this way based on actual course implementations to assess what we could
call a pedagogical performance, or a quantitative view into the learning outcomes.

Our analysis appear to be reasonably valid on system level and in consideration of cross- and longitudinal data.
It is likely that we wish to follow up our groups using the established criteria, or perform more cross-references
against the other Majors. We feel fortunate to report our excellent performance results and improvements based
on the presented criteria. As we all are encouraged to promote increasingly diverse and individual paths of
study, it would, however, be prudent to cross-check our indicators yet again using purely administrative, in fact,
pedagogically actualised teaching groups to decrease the divergence between our administrative performance and
the pedagogical performance with actualized N.

References


INTRODUCTION OF ELECTRONIC HANDIWORK TRAINING TO THE SUBJECT “INTRODUCTION OF ELECTRICAL / ELECTRONIC ENGINEERING” FOR THE OTHER DEPARTMENT STUDENTS

T. Yamada*,a, S. Hamazaki a, M. Andob and A. Yachidateb

a Department of Electrical Engineering, National Institute of Technology, Fukushima College, Iwaki Fukushima, Japan
b Manufacturing Support Center for Education and Research, National Institute of Technology, Fukushima College, Iwaki Fukushima, Japan

* yamada@fukushima-nct.ac.jp

Abstract

In our college, the classes for the introduction to electrical engineering are opened for the 3rd grade students of mechanical engineering course, for the 5th grade students of chemistry and biochemistry course, and for the 5th grade students of civil engineering course. Though these classes are based on lectures mainly, and some simple electronic handiwork trainings are introduced to confirm the principles. In this report, the overview of these classes and the details of handiwork training are introduced.

Keywords: manufacturing education, other department students, electronic handiwork, exchange of different field, active learning

Introduction

In our college, the curriculum was revised in 2005 and in 2010. In mechanical engineering course, some subjects about electrical and electronic engineering were changed in 2005. After the revision, the subject “Introduction to Electrical Engineering” was opened in the 3rd grade, the subject “Introduction to Mechanical and Electrical Engineering” was opened in 4th grade, and the subjects “Electric Circuits” and “Electronic Circuits” were opened in the 5th grade. And, in civil engineering course, the subject “Introduction to electronic engineering” was begun a series of lectures in 2010. On the other hand, in chemistry and biochemistry course, subject about electronic engineering has already opened in the past.

In the initial years after the revision, students of mechanical engineering course have studied about electricity and magnetics in the 2nd grade “Physics” class and “Introduction to Electrical Engineering.” To resolve the overlap of studies, the lecture about electricity and magnetics were cut and some simple electronic handiworks were introduced, instead.

On the other hand, in the 4th grade class of civil engineering course, there are no subjects about physics so many students forget the details about electricity.

Based on these backgrounds for each course, some basic principles about electricity are taught commonly and some topics are different for the purpose of the courses. For example, sensing technics using semiconductor devises for mechatronics are taught in mechanical engineering course, materials of electronic devices are taught mainly in chemistry and biochemistry course, and application of electromagnetic wave and communication technology to surveying such as remote sensing and GPS are taught in civil engineering course.

In chemistry and biochemistry course and civil engineering course, some simple handiwork training is also introduced about common basic things about electronic circuits using breadboard to confirm the principles of the electronic circuits and characteristics of semiconductor devices.

Construction of the subjects

In this section, the items constructing each subject are described.

A) “Introduction to Electrical Engineering” for the 3rd grade students of mechanical engineering course

In this class, students learn about basics of direct current circuit and basics of sensor devices and semiconductor devices such as diode, transistor and operational amplifier, and some basic electronic circuits using them. In the end of this subject, students make the application circuit that operates by sensing of some physical value such as temperature, light, magnetics and force.

The purpose of this class is that the students master how to use semiconductor devices and make simple circuits. In the 4th grade of mechanical engineering course, the ability of realize by electronic circuits to solve some problems for security, ecology, safety, and so on is required in the subject “Engineering Experiments.”
B) “Introduction to Electronic Engineering” for the 5th grade students of chemistry and biochemistry course

In this class, students made some systematic circuits using some kinds of sensors such as optical sensor, thermal sensor, supersonic sensor, and condenser microphone. Through the making systems, students learn how to use the sensors and around electronic circuits and devices.

C) “Introduction to Electronic Engineering” for the 5th grade students of civil engineering course

In this class, students learn about basics of direct current circuit and basics of electronics such as model of atom, energy band, and movement of carrier. Also sensor devices and semiconductor devices such as diode and transistor, and some basic electronic circuits using them are taught, too.

In the end of this class, the students learn basics of electromagnetic wave and the application to surveying. The students in this course were learned surveying in the 3rd grade and 4th grade through training and basics of remote sensing and GNSS surveying. However, the detail of them could not be taught by the temporal restriction. So this subject supplies the deficiency.

Methodology

The class hour of these subjects are 100 minutes for each week. For the purpose, to secure the time for trainings and reduce the time for lectures are required. To solve this problem about the time, a lecture sheet is derived to every student. The summery about basic principle relative the training and the method are described in the sheet. In addition, there is the space to record the results of training and experiments. A sample of the sheets is shown in Figure 1.

For the 3rd grade students of mechanical engineering course, a textbook including the lecture sheets of experiments and note space for the class was made. The overview of textbook is shown in Figure 2.

The members of practice group are 2 or 3 students for each group and one table in the laboratory is assigned for each group. The photos of practice in the laboratory are shown in Figure 3. To reduce preparing time, equipment and circuit elements were distributed beforehand. Figure 4 shows the equipment and elements distributed each group.

Figure 1 A sample of lecture sheet of experiments (for the 5th grade students of civil engineering course)

Figure 2 Overview of the textbook for the 3rd grade students of mechanical engineering course students

(a) The state of the whole laboratory

(b) The state of the practice group

Figure 3 Photos of the practice in laboratory
Discussion of the effect of training

For the 3rd grade students of mechanical engineering course, the learning contents had been not changed since 2010 to 2013. However, the rate of trainings included to the class was different. So the increases of the interest to class of students were whether reflected to the increases of intelligibility are discussed. In our college, the students evaluate the intelligibility of the items that students should understand for each subject by 10 levels. Figure 5 shows the change of the intelligibility for “Introduction to Electrical Engineering” for the 3rd grade students of mechanical engineering course.

The intelligibility was increased conspicuously in 2011 when the trainings were introduced. From this result, we consider that the class including the training influence the increase of intelligibility of students of mechanical engineering course for the introduction education of electrical engineering.

The effect of interest level by the training was evaluated based on the questionnaire to the 5th grade students of civil engineering course in 2015. The questions are as follows.

Q1) The trainings are necessary in the class of “introduction to electronics”?
Q2) The intelligibility about electric and electronic circuits was increased by the trainings?
Q3) The interests to electric and electronic engineering was increased by the trainings?

In these questions, students answered in 4 levels. The results of questionnaire are shown in Figure 6.
In our college, the class evaluation questionnaire is performed in the end of the fiscal year. In this questionnaire, the posture to the student’s learning, the will and teacher’s class way are being asked. The results of comparison of the score for some items in the questionnaire in 2010 and in 2011 for “introduction to electrical engineering” for the 3rd grade students of mechanical engineering course are shown in Figure 7.

We consider about the posture to the class of the students in the value of this questionnaire. The score increased at both of the item “I took the lesson enthusiastically” and “I worked on a practice and homework aggressively.” The reach of the lesson and the level of the question of periodical test are hardly different, so we consider maybe the will to the class of the student and positivism rose by practicing.

![Figure 7](image.png)

Figure 7  The results of comparison of the score for some items in the questionnaire in 2010 and in 2011 for “introduction to electrical engineering” for the 3rd grade students of mechanical engineering course

**Conclusions**

In this paper, the introduction of the electronic hadiwork training to the class of basics of electric or electronic engineering and the effects were introduced. The validity was confirmed by the intelligibility of students, the class evaluation questionnaire, and original questionnaire for the training.

The class time of introduced 3 classes are 100 minuite per week, so the lecture and the training must be have the restrictions timewise. For the restrictions, it is necessary to select the class contents carefully and plan for efficiency using prints and slides, etc. accordingly. It is needed to share with physical class and different class about the theoretical explanation and inddepth movement of a circuit in the case. In other words, communication between the other class persons in charge and utilization of a network offer a key.

**References**


T. Yamada. (2013). Introduction of a class practice case of an electric related special subject in a technical college. Teaching staff member in Fukushima - Tool chest for the person who works for university, junior college, and technical college in Fukushima, pp.52-57.
Application of 3D Technology to Engineering Design Education for Mechanical Design

Yasunori FUJIWARA*a, and Toshitaka HACHINOHE*a

a Department of Mechanical Engineering,
National Institute of Technology, Ichinoseki College, Japan

*E-Mail: fujiwara@ichinoseki.ac.jp

Abstract

The progress of three-dimensional technology (3D technology), such as the 3D-CAD and 3D printer, is remarkable. It has become necessary knowledge in the field of mechanical design, so there are a lot of universities or colleges that introduce 3D technology into curriculum and expansion to subject. In our department that authors belong, we introduce 3D technology into some engineering design subjects as practical machine design educations. In this article, we picked up for the two subjects from among these of course, to report. First one is a subject for the design and development of the robot. We have introduced subjects to develop the walking robot using by the 3D-CAD in third to fourth grade of mechanical engineering. In this subject, students learn the basic use of 3D-CAD, and design a walking robot for each team consists of two students. The design specification of developed robot is to implement the movement mechanism by the link mechanism. Then students develop the robot based on their design, and evaluation of developed robot carried out in the contest of the tournament. In addition to the use of the 3D-CAD, that actually develop the robot, so it is possible to learn about the mechanism design. The another one is to design and develop wind turbine or water turbines by 3D printers. Finally, we summarize the education effect of those subjects introduced.

Introduction

The three-dimensional technology (3D technology) represented by 3D-CAD and 3D printers have made remarkable progress. Nowadays, it is now mandatory skill in the field of machine design. So a lot of technical universities or colleges have introduced curriculum of mechanical design utilizing technology 3D technology. In this paper, we report the two cases an application of the 3D technology to engineering design education in Department of Mechanical Engineering, National Institute of Technology, Ichinoseki College that authors belong.

First one is a subject for the design and development of the robot. We have introduced subjects to develop the walking robot using by the 3D-CAD in third to fourth grade of mechanical engineering. And the another one is to design and develop wind turbine or water turbine by 3D printers. Finally, we summarize the education effect of those subjects introduced.

Subject of robot design and development using by 3D-CAD

As the first case of the introduction of the 3D technology for engineering design education, a subject about the design of robot will be explained. This subject is content to develop a self-made robot over a period of 2 years from the third grade to 4 grade. In the third grade, students design a wind or water turbines by 3D printers. We have introduced an experimental subject in fifth grade of mechanical engineering. After learning the theory of wind or water turbines, students design a wind or water turbines by the 3D-CAD so as to satisfy the specifications. Then modeling in 3D printer and assembling developed wind or water turbines is evaluated by a circulation type water tank or small wind tunnel. By evaluating and consider the work that they have developed on their own, students can learn an important point of the mechanical design. This article reports engineering design education by utilizing 3D technology. With the introduction of 3D technology, we were able to reach up to actually make not only the design. We also considered that there has been an effect of student motivations.

Keywords: 3D Technology, Engineering Design, Robot, Wind Turbine, Water Turbine
Major feature of the design specification is to realize a moving mechanism by a link mechanism. This means that prohibits the movement by the wheel mechanism. Students use the 3D-CAD, to design these mechanisms. Figure 1 shows the actual design example by students. This design example is adopted a Chebyshev link for a movement mechanism. In 3D-CAD software, it has been implemented a mechanism simulation tool. By modelling the mechanism, it is possible to obtain a mechanism motion such as velocity, acceleration. According to the theory of the mechanism, students have been learning in another class. So they will be to design a robot also using this mechanism theory.

After finishing mechanism design, they actually carry out the manufacturing of the robot. Figure 2 shows work of the manufacturing. Robot is made by processing the acrylic plate, an aluminium plate. Students process them in a handy tool such as drilling machine and band saw, and assemble the robot.

Figure 3 shows an appearance of robot developed. This is what has been developed on the basis of the design shown in Figure 2. The production of the robot takes about 12 weeks. Then do the contest of the tournament, evaluate the performance of the robot. At the conclusion of this subject, they make a summary of the one-year effort report by the announcement. Figure 4 and Figure 5 shows contest and presentation.

Figure 3 Developed robot based on design Figure 1

Figure 4 Contest

Figure 5 Presentation about design of developed robot

Subject of wind turbine/water turbine design and development using by 3D printer

From the energy problem in the Great East Japan Earthquake, renewable energy is a lot of attention. While researches about this energy have been actively carried out, but the case incorporating as education curriculum are not many. This is due to that the experimental device is a large scale, or experiment takes a lot of time. On the other hand, it has progressed performance and lowering the price of the 3D printer. In
recent years in particular those of small size that corresponds to the personal use is starting out at a low price.

So, as a renewable energy-related engineering design education, authors had introduced the subject to develop and evaluation small wind turbine / water turbine using by 3D technology.

The following shows an outline of the subject. This subject is implemented as one theme of the student experiment for fifth-grade students, it takes seven weeks from a design to evaluation. Basically, it makes up one of the works in one-person student. Students can select either wind turbine or water turbine, and also what to design a wind turbine or water turbine, it has been left to the student. The design of wind turbine or water turbine is used by the 3D-CAD, which was shaped in a small 3D printer, assemble. 3D-CAD is used to design, and 3D printer is used to building parts. Developed wind turbine and water turbine is evaluated with a small wind tunnel and water tunnel respectively.

As an example a wind turbine that student has actually designed and developed, explaining the flow of the subject. Figure 6 shows 3D model of the spiral Magnus wind turbine designed by student. Spiral Magnus wind turbine has spiral-shaped fins as wings, and lift occurs by rotating this wings (Magnus effect). This is the mechanism by which the wind turbine is rotated.

Figure 6 Design of spiral Magnus wind turbine by 3D-CAD

Figure 7 shows the wind turbine after building by 3D printer and assembly. In this subject, UP Plus2 (Delta-Microfactory) was used to build parts. This is a 3D printer of FDM method by ABS resin, and it is possible to perform building size in 140x140x130 [mm]. Mainly to shape the wing, foundation and so on by this 3D printer, and shaft, bearings is to use the commercially available ones.

Table 1 shows the evaluation result of developed wind turbine. To evaluate the performance of the developed wind turbine, the rotational speed of the wind turbine is measured with respect to the flow rate of the fan. It is supposed that the evaluation method of the developed wind turbine is considered by students themselves. The result shows that developed wind turbine do not rotate in small flow rate. And compared with windmill designed by other student, it shows a low number of revolutions at the same flow rate. For the discussion, a summary report of the results of comparing the structure of the actual large Magnus wind turbine.

Figure 7 Developed spiral Magnus wind turbine

Figure 8 shows the small wind tunnel to evaluate performance of developed wind turbines developed by one of authors. It has a small air channel of the full-length 3.95 [m], and 0.4[kW] fan is mounted. The fan can generate the maximum flow rate 85 [m³/min]. The generated wind is send to the observation section via enlarged portion, the rectifying unit, and the narrowed portion. Cross-section of the observation section has become a 210 [mm] x 210 [mm], and to evaluate the performance and put the developed wind turbine in observation section.

Figure 8 A small wind tunnel for evaluating developed wind turbine.
Figure 9 Evaluation of developed wind turbine by small wind tunnel

Table 1 Performance of developed wind turbine

<table>
<thead>
<tr>
<th>Fan of wind tunnel Flow rate [m/s]</th>
<th>Developed wind turbine Rotational speed [rpm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.3</td>
<td>0</td>
</tr>
<tr>
<td>7.5</td>
<td>139</td>
</tr>
<tr>
<td>8.3</td>
<td>150</td>
</tr>
<tr>
<td>9.8</td>
<td>179</td>
</tr>
<tr>
<td>10.9</td>
<td>196</td>
</tr>
</tbody>
</table>

Effects of engineering design education by 3D technology

As described above, we reported on two engineering design courses through the introduction of 3D technologies. Here, it is to be mentioned for their educational effects.

On the subject of robot design, the feature is to do all the process in the product development, such as planning, design, production, evaluation, until the presentation. Conventional mechanical design education was only draw to the accompanying drawings. In this way, they do not know whether the machinery and parts designed by work properly. By introducing 3D-CAD design, development efficiency gets increased. Because it enabled the verification of design in 3D-CAD software without prototyping. Thus it was possible to produce a time for developing a robot. In the actual work of robot development, they can reaffirm a lot knowledge about mechanical engineering. We believe that it is the most important point of this subject for students.

The feature of this course is to incorporate the concept of engineering design education in subjects related to renewable energy. Subjects such as fluid dynamics and thermodynamics, which is the basis of renewable energy, it is difficult for students to understand theory or phenomena because it is invisible. By actually designing wind turbine or water turbine, it is believed that can deepen the understanding these theories. Another feature is the introduction of the 3D printer to the course. Manufacturing of fluid machine such as a wind turbine / water wheel are required special processing tools because of its complicated shape. In contrast, 3D printer can perform also easily and quickly build parts with complicated shape. Thus, it is possible to construct a curriculum of mechanical design from design to evaluation.

Common thing in two subjects lies in the fact that we have developing after designing. In the course of the mechanical design, it is an important point than anything that can evaluate their own design. Thus, the subject with 3D-CAD that tend to explain how to use software is varied to the engineering design subject. In addition, since the intended use of the 3D-CAD becomes clear, there was also the effect of student motivation.

Conclusion

In this article, we reported on the engineering design education by utilizing 3D-technology that are carried out in the Ichinoseki College. In the field of mechanical design, 3D technology is becoming essential knowledge, it is important to incorporate this into the educational curriculum. By utilizing 3D technology, it shows that conventional mechanical design education can be changed to engineering design education. Regarding design education that cannot acquire only theory, it is considered that there was a very large effect.

References

On a Certain Method of Active Learning in Mathematics Class

Michiharu SUZUKI*

Natural Science Devision, NIT, Kisarazu College, Kisarazu, Japan

*E-Mail m-suzuki@kisarazu.ac.jp

Abstract

My purpose in this paper is to substantiate that my practice for the last eight years in mathematics class is more effective than traditional chalk talk class by means of questionnaires.

This method is based on the thought of “manabiai” advocated by Professor Nishikawa at Joetsu University of Education and is considered as one of active learning.

Especially I try to introduce you to not only knowledge of mathematics but also what students get through this class.

Keywords: cooperative learning, Course of Study, mathematics education, active learning, questionnaire method

1. Introduction

In this paper I try to substantiate that my practice for the last eight years is more effective than traditional chalk talk class. Moreover I wish some participants will practice “manabiai” method to their subjects and discuss improving this method in the future.

To begin with, I have been teaching mathematics since 1994 and I continue to seek and improve better practice of teaching in KOSEN. I had ever succeeded in my chalk talk practice for about the first 17 years. But in 2008 I happened to see “manabiai” method in a certain website, and then I had concentrated on investigating it and had been studying it hard.

So in the second term of 2008 academic year I started “manabiai” practice in two classes of the first grader and the second grader respectively. Since then I have practiced it.

I report the result of the last two years among my eight years’ practice in this paper.

2. The Typical Scenes in Classes

Quite a few teachers in “KOSEN”, which means the whole name of all the colleges of National Institute of Technology, usually teach their subjects by chalk talk method. That is to say, they teach some contents in detail by writing on blackboard or project on screen by projectors, distributing some papers and so on.

But depending on this way there are a lot of problems arisen in class.

I also had been teaching mathematics basically by chalk talk method and had noticed many problems.

Let me introduce some problems here.

First, some students were often sleeping for a short/long time in class.

Second, many students didn’t learn what they learn next time in advance and also reviewed what they learned.

Third, some students were doing other things during class, such as reading mangas, writing some reports of other subjects, watching a website by smartphones, and so on.

On top of that, they didn’t concern their scores in mid-term or term examinations.

So I wanted to resolve these circumstances for a long time and was looking for some good method of breaking these states.

3. What is “manabiai”?

“Manabiai” is thought to be one method of cooperative learning, but Professor Nishikawa at Joetsu University of Education, who advocated about fifteen to twenty years ago, proclaims that “manabiai” is a thought consisted of three views of education: First, children have their own talents. Second, teachers should prepare students’ learning environment to advance their learning. Moreover teaching ought to entrust students. Third, school is the place where students acknowledge that their fellows are indispensable to them for doing their own tasks in various school activities.

Professor Nishikawa says that all the classes based on these three views are called “manabiai” classes. So, “manabiai” class are not limited to specific subjects and almost all subjects seem to be able to be performed.

But I think that there is an orthodox method as “manabiai” or we, practioners of “manabiai” should keep some rules in class.

First, at the first time of the whole classes in a year teachers have to tell why “manabiai” class is needed for students.

Second, teachers should set up problems each time and estimate students’ performance, that is, they can set targets which teachers indicate or aim to that day.

Third, teachers allow students to solve problems of that day freely and voluntarily as much time as possible. For attaining this purpose they can leave their own seats and talk with their classmates about solutions.
4. The Next Course of Study

The Ministry of Education, Culture, Sports, Science and technology (MEXT) said that the next Course of Study includes Active Learning. MEXT defines Active Learning as the following in YOUGOSHU in 2012 (the original in Japanese):

- Active Learning is not one-way teaching method like lecture, but a general form of teaching method by which learners can attend classes positively. Active Learning aims to raise the whole talents for learners to adjust, solve and tackle various kinds of problems occurring in our societies in the 21st century.

5. My practice for the last eight years in Kisarazu College

I started this “manabiai” to two classes of the first grader and the second grader in the second term in 2008, and have been practicing until now. And I change “manabiai” class little by little every year by taking into account students’ questionnaires’ answers.

But the frame of this practice is almost the same in last three years.

In my college a period of time in one class is 90 minutes.

The procedure of my one class is the following

1) Doing mini test (10 minutes), which is concerning about the contents learning until the previous time,
2) Exchanging mini test side by side and marking it by students (about 5 minutes),
3) Explaining brief outline of the content on that day (from 10 to 15 minutes),
4) Students’ activity (about 60–70 minutes),
5) Comment students’ activities on that day to promote students’ activity next time.

6. Analysis of questionnaires

I mainly attempt to analyze the questionnaires in 2014 and 2015 of the first graders and the second graders. My questionnaires consists of the following ten questions:

1) What do you think about good/bad points in this class?
2) Which one do you like best, “chalk talk class”, “manabiai class”, “both”, “don’t know”?
3) Which one do you like best, explaining a brief outline is beneficial for you? YES, NO, Don’t Know
4) What percentage do you understand questions in your textbook? 100%, 80%, 60%, less than 40%
5) What do you think of this class as a whole?
6) What do you estimate your own performance in this class?
7) What do you change your views by taking this class?
8) Which way of giving homework do you like in the first term or in the second term? In the first term homework is given every time, while in the second term one is given two times.
9) If you take this class by chalk talk method, what do you imagine your understanding mathematics?
10) Could you please explain this “manabiai” class to younger graders or your parents?

At first I’d like to introduce some students’ opinions in Question1.
[Good Points]
1) If I don’t understand what I learn, how to solve problems, and so on, I can ask for my fellows about them on the spot.
2) I can deeply learn what I ought to study on that day, tackling problems with my friends.
3) Working on problems with my fellows is fun.
4) I can concentrate and work on problems hardly.
5) Throughout doing “manabiai”; I can make some friends.

[Bad Points]
1) Nothing about this class.
2) Talking other things unrelated to maths.
3) After finishing solving problems, some students didn’t teach how to solve problems to their classmates.

And so on. Almost all students wrote their own opinions to this question and I’m very happy to be able to get them including criticism to “manabiai”.

Question2’s results are the following

<table>
<thead>
<tr>
<th>Chalk talk</th>
<th>Manabiai</th>
<th>Anything will do</th>
<th>Don’t Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st grader in 2014</td>
<td>0</td>
<td>77.5</td>
<td>22.5</td>
</tr>
<tr>
<td>1st grader in 2015</td>
<td>0</td>
<td>66.7</td>
<td>26.2</td>
</tr>
<tr>
<td>2nd grader in 2014 (2classes)</td>
<td>0 &amp; 11.9</td>
<td>52.5 &amp; 42.8</td>
<td>35 &amp; 33.3</td>
</tr>
<tr>
<td>2nd grader in 2015</td>
<td>9.5</td>
<td>52.4</td>
<td>33.3</td>
</tr>
</tbody>
</table>

This table shows that most students prefer “manabiai” class to chalk talk one.

Question3’s result is the following

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
<th>Don’t Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st 2014</td>
<td>92.5</td>
<td>0</td>
</tr>
<tr>
<td>1st 2015</td>
<td>88.1</td>
<td>2.4</td>
</tr>
<tr>
<td>2nd 2014 (2classes)</td>
<td>92.5 &amp; 97.6</td>
<td>2.5 &amp; 0</td>
</tr>
<tr>
<td>2nd 2015</td>
<td>92.8</td>
<td>0</td>
</tr>
</tbody>
</table>
This table shows that most students want to be given a brief outline by teacher. So from these two results we validate “manabiai” is more acceptable than chalk talk class.

Question4 ‘s result is the following

<table>
<thead>
<tr>
<th>Tab.3 Understanding questions in the textbook (%)</th>
<th>100%</th>
<th>80%</th>
<th>60%</th>
<th>Less than 40%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st 2014</td>
<td>7.5</td>
<td>60</td>
<td>30</td>
<td>2.5</td>
</tr>
<tr>
<td>1st 2015</td>
<td>11.9</td>
<td>47.6</td>
<td>35.7</td>
<td>4.8</td>
</tr>
<tr>
<td>2nd 2014 (2classes)</td>
<td>5</td>
<td>50</td>
<td>37.5</td>
<td>7.5</td>
</tr>
<tr>
<td>2nd 2015</td>
<td>2.3</td>
<td>40.5</td>
<td>47.6</td>
<td>9.6</td>
</tr>
</tbody>
</table>

This table shows that more than 90% of students understand how to solve questions in their textbook.

In Question5 some students’ opinions are the following

[YES]
1) I could ask for my problems which I didn’t understand to my classmates and teach problems which are understandable enough to my other fellows.
2) I could teach problems to many classmates.
3) I wanted all my classmates to pass examinations, so I taught problems to them.

[NO]
1) I thought how to solve problems by myself.
2) I can’t afford to teach my classmates.
3) I finished problems every time but I didn’t teach my classmates.

[Don’t Know]
1) I always learned and discussed problems with the same members, so I didn’t teach to the other members.
2) I was always taught problems by my classmates.

In Question6 some students’ opinions are the following

1) I noticed that to ask for how to solve problems was the fastest way to understand. And I often asked many of my friends for problems which I couldn’t solve.
2) I prepared reading the textbook of maths for attending this class, so I could finish solving problems before this class ended.
3) I asked problems my classmates actively throughout this year. Before I experienced “manabiai” class, I left difficult questions in the textbook. But in “manabiai” class I could understand those questions.

In Question7 some students’ opinions are the following

1) I could ask my classmates for difficult problems without reserve.
2) To teach problems each other is important for us.
3) I understood difficult problems deeply by teaching them to my fellows.
4) It is a chance to be asked for problems, and then I could understand them better.
5) I recognized that asking problems wasn’t a shame.
6) I realized preparing for next time’s lesson was good enough to understand it deeply.
7) I made it a rule to read the textbook carefully before attending the class.
8) I endeavored to understand the content within class every time.
9) I could concentrate on solving problems during class.
10) I felt doing mathematics was fun by attending this class.

In Question8 some students’ opinions are the following

[First term]
1) I preferred to do homework regularly. On top of that I could review the class regularly.
2) I could remember the content by doing homework regularly.

[Second term]
1) I got down to doing homework according to my plan.
2) Turning in homework two times in the second term is easier than doing it every time.

[Other way]
1) I adjusted both.
2) I didn’t have likes and dislikes about how to turn in homework.

In Question9 some students’ opinions are the following

1) Maybe I didn’t try to understand this subject.
2) I thought I understood this subject at the lower level than now.
3) Perhaps I only became a copy machine which took notes every class, so I didn’t understand this subject.
4) I didn’t think I changed my state of this understanding by “manabiai”.
5) Maybe I thought I slept during class, so I wouldn’t understand this subject at all.
6) I thought I did understand this subject by halves.

Moreover in 2015 I analyzed the annual questionnaires of the first graders and I got the following result by categorizing the answers. So I noticed that if I taught students in my class by the traditional chalk talk method, almost half of them couldn’t understand the contents. Therefore at least it is important to do active learning and especially “manabiai” method is more effective than the traditional chalk talk method, I think.
Tab.5 How do you think the chalk talk method, compared to “manabiai”? (%)

<table>
<thead>
<tr>
<th></th>
<th>May</th>
<th>Jun</th>
<th>Sep</th>
<th>Dec</th>
<th>Feb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understandable</td>
<td>17.1</td>
<td>9.1</td>
<td>4.5</td>
<td>9.3</td>
<td>9.5</td>
</tr>
<tr>
<td>Not Understandable</td>
<td>34.1</td>
<td>47.7</td>
<td>40.9</td>
<td>48.8</td>
<td>52.4</td>
</tr>
<tr>
<td>The Same</td>
<td>7.3</td>
<td>9.1</td>
<td>13.6</td>
<td>25.6</td>
<td>7.1</td>
</tr>
<tr>
<td>Don’t Know</td>
<td>21.9</td>
<td>18.2</td>
<td>22.7</td>
<td>4.7</td>
<td>7.1</td>
</tr>
<tr>
<td>Sleeping</td>
<td>0</td>
<td>0</td>
<td>6.8</td>
<td>0</td>
<td>2.3</td>
</tr>
<tr>
<td>Others</td>
<td>19.6</td>
<td>15.9</td>
<td>11.5</td>
<td>11.6</td>
<td>22.6</td>
</tr>
</tbody>
</table>

In Question10 some students’ opinions are the following
1) I think that it is important to ask your classmates your problems. So you should ask your friends the problems actively.
2) I think you can get contents from teaching your fellows the daily problems.
3) I think a courage to say “teach me” is needed.
4) If you wouldn’t teach your classmates after you finished your problems, it owes you one.
5) Doing “manabiai” actively leads your understanding of this subject to you.
6) Asking your classmates difficult problems is not a shame, but a chance to understand them. And also your classmates who tell you them can learn them deeply.
7) In the first several weeks/months you won’t be accustomed to “manabiai”, but you will soon notice good points of “manabiai”. So you can accomplish your score of test with keeping teaching to your friends in mind.
8) The more you discuss problems with your classmates, the more deeply you can understand them.
9) This class is beautiful because there is no sleeping student. Moreover you can understand the content.
10) Studying needs corporation.

6. Results and Discussion

As we see the above results, we can ascertain that “manabiai” class is able to attain the purpose of the next Course of Study.

Looking back to the definition of Active Learning by MEXT, Active Learning is said to be not only a one-way class something like the traditional lecture, but also raising students’ talents including recognitive, social, and ethical capabilities. I think this is the very criterion of Active Learning and to estimate these talents of students is difficult.

I conclude that quite a few opinions of students written on questionnaires will prove this criterion. Concerning social talents, some students were saying that helping my classmates brings to becoming one class. With respect to ethical talent, some students described the value of doing problems with all their classmates.

But of course there are a lot of problems. For instance, I didn’t think I could succeed “manabiai” class for the subjects for the higher graders. The reason I thought is that students’ consciousness for the goal of getting credits by all their classmates was decreasing.

Although there are some points to resolve, I will continue to practice “manabiai” and also research for better practice of “manabiai” class.

7. Conclusions

I think “manabiai” is one of the best practices to attain the purpose of Active Learning defined by MEXT. And this method is available for almost all subjects and indifferent to school’s form, that is, elementary school, junior high school, high school, or KOSEN.

So I hope “manabiai” will be becoming more familiar in the near future.

References


Suzuki, M. (2011). The possibility of developing the class on the philosophy of “manabiai”at all the national colleges of technology, Journal of Education in the Colleges of Technology, 34, 107-112

A REPORT OF SUPPLEMENTARY LESSONS IN MATHEMATICS
USING UPPER-CLASS STUDENTS AT NIT, KURUME COLLEGE

Michihiro Sakai*, Katsutoshi Kawashima and Yasuo Matsuda

* Sciences and Mathematics, Liberal Arts, National Institute of Technology, Kurume College, Kurume City, Japan

Abstract

We carried out three activities: supplementary lessons, open courses and research presentation. Our main purpose is to help our students acquire the skills for learning by themselves and unifying knowledge. Moreover having the upper-class students help us, we expect that they connect these experience to their research and presentation.

The supplementary lessons for the first grade students are divided into two courses, a basic course and an advanced one. In the basic course, the participants are given some problems as easy as ones in textbooks. In the advanced course, given are relatively difficult problems such as entrance examinations. In both courses, the upper-class students played a central role, while we behaved just as facilitators or makers of teaching materials. The results of the questionnaire and the examination given after the supplementary lessons showed that our trial received high evaluation from the participants. In addition, the upper-class students were satisfied with the improvement of their presentation skills and better understanding of what they had already known.

In the open courses held for junior high school students at Kurume College in 2013 and 2014, one of the authors gave an introduction to “knot theory” which is an important field in topology, and had the upper-class students mentioned above to be assistants. The result of the questionnaire showed that the open courses were highly evaluated thanks to the upper-class students’ kind guidance for the participants.

After the open courses, the upper-class students shifted to studying subjects concerning knot theory such as tricolorability, the number of colorings and the Goeritz invariant. Then, without the help of teachers, they obtained some results and gave a successful presentation.

It is possible to regard these three activities as a series of active learning. In this paper, we especially take the supplementary lessons with the upper-class students and describe their effort and result precisely.

Keywords: Mathematics education, Supplementary lesson, Open course, Knot theory, Active learning

§1. Introduction

In recent years, the bipolarization of the grades of the students has been remarkable in NIT of Kurume College. Moreover it is quite serious that some of the students are likely to lose their motivation to learn. Then we need a new way to learn, so-called active learning (see Figure 1).

Along the spirit of active learning, the authors carried trial supplementary lessons for students in a part of the departments together with the upper-class students as teaching assistants in 2014. Since our trial were evaluated positively both by the participants and by the teaching assistants, we decided to proceed activities. So, in the next year, we had three activities: supplementary lessons, open courses and research presentations.

Through the supplementary lessons, the participants (the first grade students) are expected to get positive attitude to learn. In addition, in these lessons, the upper-class students behaved like a teacher to explain some fundamental knowledge on blackboard and to check and write some comments on the answer sheets submitted by the participants. The open courses and research presentations are activities in which the upper-class students join. We here note that in these two activities, they learn knot theory since not only it is an interesting field but also it does not require much background information, and there are various materials to learn visually (e.g., Kawauchi & Yanagimoto, 2012; Sakai, Miyaji & Nakabo, 2013). Experiencing these activities, they are supposed to rebuild learning contents which they have already known and obtain a way to teach something to others.

The result of questionnaire told us that our activities were successful for both the first grade students and the upper-class students. Moreover, we had an unexpected result. That is, the participants felt free to ask questions to the upper-class students. On the other hand, the upper-class students were aware of difficulty to make the participants understand.

In this paper we focus on the supplementary lessons for the first grade students held in 2014 to 2015 with the
upper-class students as teaching assistants and describe their results.

This paper is organized as follows: Section 1 is the introduction. In Section 2, we explain the structure of supplementary lessons. Section 3 is devoted to the description of a result of them. In Section 4, we review the results of the questionnaire. Finally in Section 5, we describe our conclusion of these activities and the future challenges.

§2. The structure of supplementary lessons

As we wrote in the previous section, the bipolarization of the grades of the students has been getting seriously. Then we serve two groups, a basic group and an advanced group, for the supplementary lessons. The participants, the first grade students, can select which groups they attend (we note that not all students in NIT, Kurume College need to participate in the supplementary lessons).

(a) Teaching materials
Teaching materials served to each group with the help of the upper-class students were as follows:

Basic group: Studyaid D.B.® (a computer software made by Suuken Shuppan),

Advanced group: the original materials and a workbook created by NIT, Suzuka College.

(b) Learning contents
The following is the list of the themes of teaching materials. Its contents and order follow the textbooks which the participants use in the ordinal lecture. In 2014, we just taught item 11 to 15.

1. Calculation of polynomials
2. Quadratic functions
3. Quadratic equations
4. Complex numbers
5. Inequalities
6. Sets and propositions
7. Hi-powered equations
8. Hi-powered inequalities
9. Various functions
10. Exponential functions
11. Logarithmic functions
12. Trigonometric functions
13. Linear programming
14. Quadratic curves
15. Permutations and combinations

(c) Construction
We constructed the supplementary lessons as follows.

- Attending students
Basic group: students who have low or insufficient learning level,
Advanced group: students with high motivation for learning.

- Leader
One teacher and two teaching assistants (the upper-class students) a classroom.

- Time and number of lessons
90 minutes and 5 times in 2014, 90 minutes and 15 times in 2015.

- Contents
We give the attending students the materials above.

- Methods
We repeat the following PDCA cycle to make the attending students fix knowledge and improve their learning level.

Plan: Teachers create teaching materials which reflect the requirement of the participants and the comments from the teaching assistants, in accordance with the progress of the ordinal lecture.

Do: On the blackboard teaching assistants write essential information and they answer students’ questions during the lessons.

Check: Teaching assistants correct students’ examination papers and explain the points where they often make mistakes in the next lessons.

Action: We review the previous lesson and the correction of examination papers and discuss the next lesson with the teaching assistants.

§3. Some scenes of supplementary lessons

In this section, we review the scenes of supplementary lessons with some photos.

The teaching assistants write some points to solve the problems on the blackboard at the beginning of the lessons. The participants write the points on their answer sheets before solving problems. At the same time, the teaching assistants walk around the participants to answer their questions (see Figure 2). When the participants asked questions, the teaching assistants sometimes used the blackboard to answer them (see Figure 3). Through these activities, the teaching assistants developed their ability to teach mathematical subjects.
After the lessons, the teaching assistants corrected the mistakes of the sheets which the participants submitted and wrote down some comments. They reported the points that the participants were likely to make a mistake (see Figure 4). We referred to their report to improve the next lessons.

§4. Results of the questionnaire

We continued to carry out the questionnaire for the participants whenever the supplementary lessons ended in 2014. Then the following results were obtained (see Table 1 and 2). The similar results were obtained in 2015.

(1) The items of questions and their results

Question 1. Was their explanation easy to understand?
Question 2. Did you feel free to ask them questions?
Question 3. Were their guidance and comments on the exam paper useful?
Question 4. Were you satisfied with this supplementary lesson?

In addition, one of the authors gave a supplementary lesson for 19 students of the department of Electrical and Electronics Engineering without teaching assistants at the first half of 2014, and he asked the following questionnaire item 5 to compare with our lessons.

Question 5. Were you satisfied with this supplementary lesson?
(2) Free comments of the participants

Additionally, we asked the students to give free comments about the lessons. The students’ free comments are as follows (translated and partially extracted by the authors):

- The upper-class students were very kind and helped my understanding during the lessons.
- The explanations by the upper-class students made me understand mathematics more deeply and I want to take lessons again.
- I found the lessons very beneficial so I want to take them next year too.
- I felt free to ask the upper-class students any question in the lessons. Thank you so much.
- I enjoyed taking lessons and I could understand mathematics deeply.
- The explanation on the blackboard was clear to understand.
- It was good because there was a lot of opportunity to ask questions.
- This lesson gave me a good opportunity to review.
- My understanding was developed by this lesson.
- I got motivated after attending the lesson.
- An advanced lesson made me get more interested in mathematics.

(3) The degree of achievement of lessons

We received extremely high evaluation in question 1 to 4 as is seen in Table 1 and 2. It can be concluded that the preparations for lessons were well and that the instruction of the teaching assistants was educational for each attending student. In particular, as Table 3 shows, supplemental lessons with teaching assistants are far more effective than those without teaching assistants.

The following Table 4 shows the transition of the average of the score in the examinations held for 45 participants.

<table>
<thead>
<tr>
<th>Departments and average</th>
<th>Electrical and Electronics</th>
<th>Control and Information Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average before lessons</td>
<td>38.5</td>
<td>33</td>
</tr>
<tr>
<td>(class average: 55)</td>
<td>(class average: 58)</td>
<td></td>
</tr>
<tr>
<td>Average after lessons</td>
<td>45</td>
<td>60</td>
</tr>
<tr>
<td>(class average: 51)</td>
<td>(class average: 70)</td>
<td></td>
</tr>
</tbody>
</table>

[Table 4: Average of examination for the participants]

(4) Free comments of the teaching assistants

We also had the following comments from the teaching assistants (translated and partially extracted by the authors):

- I could understand mathematics deeply in preparing for the lessons and teaching mathematics to the attending students, in particular in the advanced group.
- I felt fun and difficulty in teaching at this lesson.
- I could review mathematics and obtain teaching method.
- I should have stood in the position of the attending students who are not good at mathematics.

§5. Conclusion and the further problems

The results of the previous section tells us that our supplementary lessons received higher evaluation by not only the first grade students but also the upper-class students than we had expected before these activities. The upper-class students found it both interesting and difficult to teach mathematics clearly. They connected these experiences to higher level active learning such that giving presentation in a meeting. Moreover, we obtained unexpected results. That is, some of the participants became so active to ask questions to teachers and the upper-class students.

As described in the previous section, we obtain that the supplementary lessons by the upper-class students are more effective than ones by teachers (see also Kawashima, Sakai & Matsuda, 2014).

On the other hand, since our materials were not relevant to engineering fields and did not fit the participants with respect to difficulty, we have to research the needs of the participants to make appropriate problems. Besides this, we have to continue these activities to increase the number of the participants and their voices.

Acknowledgements

The authors would like to express their gratitude to the upper-class students in NIT, Kurume College for their great contributions.

References


DEVELOPING COMMUNICATIVE AND PROACTIVE PRE-PROFESSIONALS THROUGH AUTHENTIC REALS (RICH ENVIRONMENTS FOR ACTIVE LEARNING)

C. Pang* and M. Goh

School of Business Management, Nanyang Polytechnic, Singapore

*Chris_Pang@nyp.edu.sg

Abstract

Practitioners face a constant challenge in developing pre-professionals' communicative competence. The challenge is exacerbated by traditional instructional methods that favour inert knowledge acquisition and rote learning. Employers have also remarked that tertiary graduates lack the linguistic productive skills of speaking and writing required of PMETs (Professionals, Managers, Executives and Technicians). Rich environments for active learning (REALs) can address these challenges by promoting intentional learning, situated learning and generative learning activities, all attributes embodied in active learning. The readiness of technology has also transformed a practitioner's ability to create authentic learning activities, by using rich media that can match real-world tasks. Authentic REALs are potentially game-changers as a future prospect for active learning for higher education. The paper therefore, examines the synergistic connection between the learner, task and technology when using REALs to develop pre-professionals' communicative competence. The study uses a case method to illuminate the theory-practice connection of authentic REALs, and strengthen what is already known through existing research. The study looks at the use of REALs in Nanyang Polytechnic's School of Business Management (SBM)'s communication modules, namely Effective Oral Communication and Effective Writing Skills. The study seeks to: 1) Determine the learning design elements integral to embedding REALs in a curriculum through contextual analysis. 2) Develop a conceptual framework for creating REALs to guide future curriculum interventions. Since 2015, about 900 business students have benefited from REALs. Tutors report greater student engagement levels and higher student motivation levels. The research further validated initial findings by conducting a pre-post effectiveness survey and written test measuring students' receptivity, motivation levels and performance change. REALs impact pre-professionals' communicative competence positively through: 1) Authentic tasks which provide realistic learning experiences 2) Use of rich media within a technology-mediated environment 3) Taking into account students' maturity to scaffold learning. The authentic REALs framework can be distilled into a set of curriculum design principles, applicable to other courses.

Keywords: business communication, authentic learning, active learning, motivation

Introduction

Institutes of higher learning, including universities and polytechnics have found that undergraduates' productive linguistic capacities of speaking and writing remain a challenge even today. In Singapore, the challenge goes beyond achieving a functional literacy. It centres upon mastering the required competencies for effective use beyond graduation and in professional settings. Numerous articles and headlines repeatedly state that oral and written communication, known as business communication skills, remain among the most desirable skills employers sought and identified as needing improving (Robles, 2012; Stevens, 2005).

Business communication skills are nearly synonymous with English language proficiency. The closely knitted association is warranted as English remains the lingua franca for business globally. Singapore has always attributed a proficiency in English as having contributed to the island's state economic success and international appeal. In multi-racial and multi-lingual Singapore, it is also the first language for education and governance as it bridges cultures and nationalities (Low and Azirah, 2012). However, the English language as a precursor for business communication skills can be problematic when traditional curricular practices are used to teach business communication. When societies place an importance on meritocratic pursuits, expressed as examination scores, certifications and credentials, learning can be compromised by what Lee (1991) termed as “education for earning, not learning”. This can result in an examination culture that promotes rote learning and repetitive drills and practices in the English curriculum. Moreover, numerous studies show that mastering English necessary to build business communication skills requires an autonomous approach where students must engage in independent learning, tackling more challenging tasks (Hurd et al, 2001).

Therefore, there is a need to re-envision what a curriculum for business communication looks like for a pre-professional undertaking higher education. This can better ensure that educational outcomes align with
work-based competencies that meet employers’ expectations. REALs (rich environments for active learning), as a pedagogical practice, can address these concerns and demands. The potential of REALs are amplified when they are designed with authenticity as the primary principle and mediated by technology. The paper therefore, examines the synergistic connection between the learner, task and technology when using REALs to develop pre-professionals’ communicative competence. The aim is to elucidate a framework to guide instructors and practitioners in using REALs to design active and authentic learning activities.

REALs as a Pedagogical Practice

REALs are constructivist in nature. They arose largely as a reaction to traditional educational models that emphasise inert transfer of knowledge and de-contextualised, simplified examples and exercises. Grabinger and Dunlap (1995) define REALs as comprehensive instructional systems that promote learning in authentic contexts and utilise active, collaborative learning and interdisciplinary, generative learning activities. They further emphasise that comprehensiveness referred to the “…importance of placing learning in broad, realistic contexts rather than in decontextualised and compartmentalised contexts” (p. 11). Grabinger and Dunlap (1995) state that REALs are not a delivery technology or a computer-based virtual environment, simulation or hypermedia. REALs must involve a learning community that goes beyond students and instructors to create a learning environment that encompasses the content taught, the delivery technology deployed, the learning tasks attempted and the context used. In short, REALs are information-rich, activity-rich and media-rich environments that promote exploration and collaboration through contextualised content, tasks and learner support. Grabinger and Dunlap (1995) outlined the key attributes and associated key learning strategies of REALs:

A. Student responsibility and initiative: Reciprocal teaching – Students take turns to perform questioning, summarising, clarifying and predicting activities in a shared context.
B. Generative learning activities: Cognitive apprenticeship – Transfers the apprenticeship techniques of observing masters at work to cognitive tasks and make visible the thinking processes required.
C. Authentic learning contexts: Anchored instruction – Instruction is anchored in a realistic event, problem or theme that requires students to solve interconnected sub-problems together.
D. Authentic assessment strategies: Varied techniques that assess across curricula as an integral part of a learning process rather than a periodic quantifiable measure.
E. Co-operative support: Problem-based learning (PBL) – PBL embodies REALs as it involves students working together to solve realistic problems and in that process, raise relevant concepts and principles that are authentic.

Authentic Learning Supported by Technology

While REALs already include an authentic context in its pedagogical model, it is important to highlight the role that authentic learning plays. Authentic learning is a key feature of REALs as it “…focuses on real-world, complex problems and their solutions, using role-playing exercises, problem-based activities, case studies, and participation in virtual communities of practice” (Lombardi, 2007, p. 2). Authentic learning coupled with the use of technology can be particularly effective when the educational goal is to help learners master a skill. The use of technology heightens authenticity and can optimise learning through a plethora of readily available educational technologies. Herrington and Kervin (2007) outline the principles that can translate authentic learning into practice using technology:

A. Authentic context and activities
B. Expert performance
C. Multiple roles and perspectives
D. Reflection
E. Collaboration
F. Articulation (of a culture of practice)
G. Coaching and scaffolding
H. Integrated authentic assessment
I. Professional learning

These guiding principles can be used to create technology-mediated authentic learning tasks within REALs. When technology is used effectively, the end-result is often rich media. Rich media is another key aspect of REALs. The benefits of using authentic learning supported by technology and rich media are numerous. An area to highlight is its capability to develop motivated and active learners. Authentic tasks in REALs are industry-relevant, compared to decontextualised textbook-based exercises. They provide the opportunity to model the actions and behaviours of multiple experts and to collaborate and strategise when solving complex, realistic problems. The active learning environment fosters the development of skill mastery as well as interest for an industry or profession. Technology makes the cited benefits easier to attain and fits better as a mode of instruction for tertiary students who are born digital natives. The multiplier effect that technology brings to REALs has the potential to intimately connect the learner to task and thus, engage in meaningful, relevant learning that leads to skills mastery.

Methodology

The study investigated students’ receptivity, motivational levels and performance change after REALs were introduced into Nanyang Polytechnic (NYP)s School of Business Management (SBM)s business communication modules, namely Effective Oral Communication and Effective Writing Skills. NYP is an institution of higher learning in Singapore and has
more than 15,000 students across seven schools. NYP is categorised as a TVET (technical and vocational education and training) institution and offers diplomas and specialist diplomas for both pre-employment and continuing education learners. The modules, Effective Oral Communication and Effective Writing Skills, are both taken by Year One business students and each is a 60-hour module with two 2-hourly tutorials a week.

REALs are described in this study as case studies on how learning content was transformed to be authentic and active. The exploratory process and implementation are also documented in this pilot study. A quasi-experiment with pre and post questionnaires and a control group was also deployed for three classes (each class has between 21 and 25 students) taking Effective Writing Skills to evaluate the impact of REALs. The experiment was set up with REALs as an intervention and independent variable. Three other classes, which used the traditional curriculum without REALs, acted as control. Three experimental classes were studied because newly developed REALs are first piloted before being introduced to all classes. Care was taken to ensure that the students in both groups had similar educational profiles and the tutors were experienced instructors with at least two years of teaching experience. Effective Writing Skills was chosen as writing skills provided comparatively more objective analysis than presentation skills. The questionnaires utilised a 5-point Likert rating scale and was administered in class. In addition, a post-test in the form of a written exercise was administered to both groups. The written exercise was on business email writing and was scored using a rubric. The aim of conducting questionnaires and a test was to identify the factors as well as evaluate the impact of REALs in optimising learning. The research purpose remains to identify the factors that will deepen understanding and lead to refining current and designing future REALs.

REALs for Business Communication

REALs was introduced into the curricula of NYP's business communication courses in the School of Business Management (SBM) in mid-April, at the start of the first semester in 2015. Since then, more than 900 students collectively have benefitted from REALs. Tutors report higher engagement levels in the classroom and a more sustained follow-through by students seeking to master business communication skills. The transformed tutorials in these courses have yielded initial promising results.

NYP conducts end-of-semester satisfaction surveys where students rate modules by learning goals, content, delivery, assessments and facilities. Both business communication modules achieved better ratings after REALs were introduced. When students were asked to rate the effectiveness of learning materials, there was an improvement of 8.1% (Effective Writing Skills) and 10.6% (Effective Oral Communication) from 2014 Semester Two (prior to the introduction of REALs) compared to 2015 Semester Two, a year after REALs were progressively introduced. The positive trend is also reflected in the overall delivery rating of both modules where there was an improvement of 6.1% (Effective Writing Skills) and 9.1% (Effective Oral Communication) respectively (NYP, 2016).

While the eventual goal is to transform the entire course, REALs were and are introduced gradually into the curriculum. There are several underpinning reasons for this cautious approach. Firstly, REALs took substantially more time to develop compared to relying on a reference text. Secondly, lecturers and tutors needed time to adjust to the new instructional model and associated authentic learning tasks. Thirdly, it was assessed that a gradual introduction also lowered the risk of rejection, both by instructors and students. Lastly, as education technology was utilised, tutors needed familiarity training and equipment trial runs were also conducted to ensure viability.

For both modules, authentic examples, events and life-like scenarios were already in use prior to REALs. These were the starting points for further exploratory into richer learning environments. The impetus to shift to REALs was clear as there was an expressed need to transform the curriculum and delivery practices to meet growing expectations to produce pre-professionals with strong communicative skills. REALs, as defined earlier, make use of authentic examples, events or cases. However, REALs are more than these. REALs involve anchored instruction in authentic context and must include expert performance. Students go beyond applying learning concepts in narrative cases as they have to make the leap to model decisions and actions based on cognitive apprenticeship techniques. Using Grabinger and Dunlap (1995)'s attributes and learning strategies, both modules were transformed and REALs replaced traditional tutorials for selected topics.

Based on the process used by Russel et al. (2016), the tutorials for both courses were transformed using a three-step process – planning, design and development. SBM follows an outcome-based approach and the main goal is to develop articulate and confident graduates. In aligning learning content and activities to defined outcomes, it was decided that authentic tasks should create complete learning experiences addressing the entire topic and not reinforce a sub-topic or a specific communication strategy. Authentic tasks should also allow for multiple outcomes rather than promote the idea that only a singular model solution exists. Authentic tasks should also connect the significance of the tasks beyond the classroom to emphasise a real-world relevance. Lastly, these tasks should also allow for multiple perspectives from different practitioners where skills are used in context and in actual practice. Learning activities and tasks were also created with inputs, problems and challenges posed by industry practitioners and experts. With these principles guiding the design and development of REALs, it was decided that interactive videos were the optimal delivery technology to achieve the intended outcomes. Table 1 shows the transformed courses.
watching each video clip, tutors led the class in group discussions. Students delved into the situation each expert faced. They were asked to consider the position of the recipient of the communication and that of colleagues and managers. They then tackled the problem the expert posed. The students had to consider the tone, the culture, the situation and the multiple perspectives when applying the writing principles and techniques they had learnt in class. After student groups proposed their solutions, they watched the expert described how he or she resolved the situation. The tutor then asked each group to revise their solutions, which they then presented their improvements. The session ended with a debrief and reinforcement of effective business writing principles and strategies.

### Table 1. Transformed Business Communication Tutorials

<table>
<thead>
<tr>
<th>Traditional</th>
<th>Transformed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials</td>
<td></td>
</tr>
<tr>
<td>Workbook</td>
<td>Workbook</td>
</tr>
<tr>
<td></td>
<td>Interactive Videos</td>
</tr>
<tr>
<td>PowerPoint</td>
<td>Modified Industry &amp; Experts' Content</td>
</tr>
<tr>
<td>Structure</td>
<td></td>
</tr>
<tr>
<td>Mini-lectures</td>
<td>Conversations</td>
</tr>
<tr>
<td></td>
<td>Discussions</td>
</tr>
<tr>
<td>Exercises</td>
<td></td>
</tr>
<tr>
<td>Activities</td>
<td></td>
</tr>
<tr>
<td>Scenarios</td>
<td>Authentic Tasks</td>
</tr>
<tr>
<td>Exercises</td>
<td>Authentic Problems</td>
</tr>
<tr>
<td>Assessment</td>
<td></td>
</tr>
<tr>
<td>Presentation</td>
<td>Presentation</td>
</tr>
<tr>
<td>Written Test</td>
<td>Written Test</td>
</tr>
<tr>
<td></td>
<td>Expert Reviews</td>
</tr>
</tbody>
</table>

**Course:** Effective Writing Skills

**Learners:** Year One business students are taught professional writing covering the full range of formats and types of messages.

**Technology:** Three interactive videos where three experts were interviewed were produced. The experts were asked about the type of business writing they did, and to explain the importance and significance of business communication skills at their workplaces. The experts also spoke about situations they faced that required good business writing and to describe what to avoid and what worked well. They then shared a challenge they faced at work and the solutions used. The experts were chosen after taking the students' experience and maturity into account. The experts were also chosen to reflect role models they can emulate for each career stage:

- A recent graduate who spoke on how good writing helped him perform well during his internship.
- A graduate with several years' work experience who shared about how good writing enhanced her ability to engage customers at work.
- A graduate with more than ten years' industry experience who shared about how good writing is necessary for complex situations that require active management.

**Task:** Students were asked to read about writing principles and strategies prior to class. In class, they were briefed about the learning objectives before participating in REALs featuring the interactive videos. Each interactive video was produced as a series of short clips which had three to five parts, The entire exercise with one interactive video required 60 to 90 mins to complete. Tutors used a stop and pause technique. After

---

**Figure 1. Interactive Video for Business Writing**

**Course:** Effective Oral Communication

**Learners:** Year One business students learn about presentation skills by working on and delivering informative and persuasive presentations.

**Technology:** Four interactive videos were produced from two sources. Two were created using TedxYouth videos. Two others featured experts who were invited as guest speakers and were recorded on video as part of a Business Communication eSeminar. The TedxYouth and eSeminar videos were transformed into interactive videos. The experts chosen were excellent presenters who demonstrated the 3Vs of effective presentations, namely, visual, vocal and verbal qualities flawlessly. The intent was to give the students the opportunity to learn about presenting as well as model effective presentation techniques. The experts were a mixture of young and more experienced presenters. This was deliberate as it allowed for intended contrast which would generate different perspectives in how each used their own strengths to deliver a highly effective presentation.

**Task:** Students watched the interactive videos, which were designed as 45 to 60-min sessions. Tutors used the pause and rewind technique. After watching a part of the video, the tutors asked the class to identify good presentation techniques the experts demonstrated. The video segment was then replayed and paused at appropriate junctions to highlight how the experts structured the presentation and used effective presentation techniques. Students were then asked to predict the reaction of audiences and why the audience reacted as they did to the expert's presentation at critical junctures. The experts also posed a mini-challenge
where students worked in groups to resolve. Each group then nominated a volunteer to present the group’s solution. The class, led by the tutor, provided constructive feedback for each student presenter. The tutor would end each session with a debrief and reinforce the presentation skills taught in prior classes.

![Image](image.jpg)

Figure 2. Interactive Video for Presentation Skills created from Business Communication eSeminar

Results and Discussion

Students’ receptivity, learning preferences, motivation and interest levels were assessed using a student self-reported survey with a Likert Scale of 1 to 5 (with 5 being strongly agree) at the end of the term.

Two questions asked students to state their self-perceived proficiency in writing and communicating. Seven questions focused on identifying students’ learning styles to determine preferences for authentic or traditional learning. Five questions were asked about the students’ motivational and interest levels, measured by follow-through actions.

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 61</td>
<td>Mean</td>
<td>Mean</td>
<td>Mean</td>
</tr>
<tr>
<td>Self-Perceived Proficiency</td>
<td>3.16</td>
<td>3.02</td>
<td>3.01</td>
</tr>
<tr>
<td>Authentic Learning Preference</td>
<td>3.73</td>
<td>3.57</td>
<td>3.63</td>
</tr>
<tr>
<td>Traditional Learning Preference</td>
<td>3.63</td>
<td>3.58</td>
<td>3.52</td>
</tr>
<tr>
<td>Motivation and Interest</td>
<td>3.23</td>
<td>3.30</td>
<td>3.42</td>
</tr>
</tbody>
</table>

Table 2. Student Survey Results

In terms of self-perceived proficiency, there was no significant difference between pre and post results. Cassidy & Eacbus (2000) explained that students’ self-perceived proficiency are formed largely based on prior and current academic test performance. As such, students are more likely to mirror tutor-assessed test scores rather rely on their own judgements. There was also no significant difference between preferences for authentic and traditional learning. The results suggest that students may have entrenched learning preferences that resist new instructional methods. As the survey respondents are first year students, it is possible that they still rely on studying habits developed prior to entering tertiary education. They may also be new to authentic tasks and may require time to develop a preference for such.

There was a significant difference in overall motivational and interest levels, as confirmed by an independent t-test (df=609, -1.964<2.551<1.964). Students were asked if they took more notes, talked about what they learnt with their friends and families and if they took a greater interest in the learning content. This is consistent with studies that report authentic learning enhanced learner motivation (Russell et al., 2016; Duke et al., 2006).

Students were also given a timed test to write a business email. They were given 15 mins to produce a bad news message addressing an authentic situation. Students’ written emails were coded for the ability to open using an appropriate tone, to generate relevant points and to close appropriately, with the maximum score being 10 points.

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 68</td>
<td>Mean</td>
<td>Mean</td>
</tr>
<tr>
<td>Ability to write an appropriate opening</td>
<td>1.59</td>
<td>1.46</td>
</tr>
<tr>
<td>Ability to generate relevant points</td>
<td>3.57</td>
<td>4.74</td>
</tr>
<tr>
<td>Ability to write a forward-looking close</td>
<td>1.29</td>
<td>1.51</td>
</tr>
<tr>
<td>Total</td>
<td>6.85</td>
<td>7.71</td>
</tr>
</tbody>
</table>

Table 3. Writing Test Results

There was a significant difference in the ability to generate relevant points, as confirmed by an independent t-test (df=130, -1.978<2.790<1.978). The ability to open and close appropriately had no significant difference. These findings can be attributed to students having observed multiple experts share a myriad of approaches in resolving real-world problems. Students also benefitted from having actively discussed and collaborated when they had to propose and refine their solutions. Tutors observed a higher level of active participation. Parsons and Ward (2011) explained that the nature of assignments determined students’ level of participation. They added students preferred higher-order authentic tasks to easier academic tasks.

Guidelines for Developing REALs

An outcome of this exploratory research is to encapsulate and operationalise our experience developing and implementing REALs into a framework. In linking practice to learning science, the identified characteristics of REALs were encoded into instructional design guidelines. Table 4 shows our resultant REALs framework used, which was based on three key theoretical principles – authentic learning, active learning and technology-mediated learning. The guidelines were developed mainly to assist tutors to distinguish REALs from more fundamental authentic learning tasks.
Levels | Authentic Learning | Active Learning | Technology-mediated learning
---|---|---|---
Level 1 | Examples, Events, Problems | Questioning, Discussing | Projection of Media
Level 2 | Role-plays Cases | Investigating, Collaborating | Elearning Social media Immersive videos
Level 3 | Complex Situations | Modelling | Interactive videos
REALs | Linked Scenarios | Synthesising | Immersive environments
| Expert Performance | Reflecting | Microworlds

Table 4. Operationalised REALs Framework used for NYP SBM’s Business Communication Modules

It is important to note that level 3 defined what REALs are. REALs are characterised by complex situations that contextualise learning involving expert performance providing multiple perspectives. They require rich, interactive media within immersive environments to allow for cognitive apprenticeship techniques.

Conclusions

In summary, this study confirms that REALs are beneficial for mastering business communication skills as they positively impact student motivation and communication ability. The key lesson in using REALs as an intervention is that they require the synergistic use of authentic and active learning activities, enhanced by technology, to create a rich environment for optimal learning and skills mastery. The operationalised REALs framework, which emphasises expert performance, used in this study can guide instructional design for other course modules seeking to create comprehensive active learning environments.

Acknowledgements

The authors would like to sincerely thank the senior management of NYP and SBM for their immense support and sound advice during the course of their research project.

References


Nanyang Polytechnic. (2016) School of Business Management Student Feedback Survey Results. NYP.


Challenging in PBL Education on the Field of Materials Science

Yoshiyuki Uruma*

Department of Materials Science, National Institute of Technology, Yonago College, Hikona-cho, 4448 Yonago City, Japan

*E-Mail uruma@yonago-k.ac.jp

Abstract

Kosen is a college that educates engineer and researcher to gain deep knowledge to overcoming challenges. However, in today's educational environment, teachers and tutors face variety problems such of globalization and progress of technology that are induced by instantaneous and rapid changes of social environments. Under these conditions, teachers need to have a flexibility in their coaching in order to develop interest and motivation among students. Our college employs a new curriculum style, known as Projective based learning (PBL) system. This style is to be spontaneously learning for students. Therefore they are able to have ability for solving unknown problems. Wisdom and skills in order to solve the problems are necessary. Herein, I described experimental lesson with NMR measurement of unknown sample using PBL methods. From student’s comments, this method clarified a useful for problem-solving ability.

Keywords: PBL education, Active Learning, NMR analysis

Introduction

Up to now, Kosen education has been conducting in order to bring up technical engineers. Therefore, Alumnae and alumni play an active role as efficient worker in the industrial society. However, shift with change in academic development, educational method need to be changed. Most of the teaching centres, schools, colleges, universities and tuition have their teaching methods based on lectures where instructors would lead the whole learning environment and convey information to students via power point screen or notes written on boards. This teaching strategy would give effects when students are interested and passionate on the learning process or instructors able to give consecutive motivation on their means of teaching. However, with today's student, lecturing does not hold their attention long. Students today have grown up dealing with interactive tools like Internet, computers and smartphones and these gadgets and media allow students to enjoy the real-world problem solving and also give opportunity to express their own views and hear their own voices. Educational life should work the same. A very good example of this is the projective base learning (PBL) engaged in the robotics projects. Students get into group to seek solution to real challenging problems. This process creates a learning community where all participants take responsibility for learning and achieving understanding of concepts by themselves, also deepens the communication skills. With this supportive evidence, implementing PBL in teaching of chemistry has come to action, yet not a major influence in education. In our college, students are allowed to engage in practical tasks which give a complete different learning exposure to chemistry. In fact, they learn better and understand deeper through operating experimental procedures. This paper provides an overview of the findings in our department education system and discusses the consequences of implicating PBL based syllabus on educational development.

Outline of this experimental lesson

Our department of chemistry afford students with complete experience in understanding chemistry by variety of experiments based on biology, physical chemistry and analytic chemistry according to their education grade. Particularly, students of the fourth grade has more intense experimental tasks of 3hours a week. They are offered with opportunities to enhance their knowledge in chemistry through class includes 10 practical themes; NMR spectroscopy (1H NMR, 13C NMR) measurement, X-ray spectroscopy, density and viscosity against water-alcohol system, measurement of heat of solution for sodium thiosulfate, measurement of boiling point for methanol-benzene system, electromotive force of Daniel-Volta battery, hydrolysis rate of methyl acetate, logic circuit, absorption spectrum and emission spectrum, computer simulations.
The students are grouped and time is provided for students to do some research on their experiment, in they are assigned to design the own experiential procedures that aim to explain and describe the hypothesis of each task. This enable personalized learning. Participants set their own learning pace and concepts by merging the gap between theory and practice which play a crucial role retaining ideas gained from classroom learning. This journey also imparts high focus on collaboration and valuable discussion among members which increase students’ engagement in chemistry. Of course, teachers confirm the pre preparation by checking their notes and instructing them the safety alerts before they are allowed to carry out the experiment.

Teacher taught a meaning chemical shift and split of signals (singlet, doublet and triplet). In the case of ethanol, the chemical composition formula weight is C2H6O1. Firstly Degree of unsaturated (D. U.) was calculated from chemical composition formula weight. D. U. shows a number of unsaturated bond and existence of cyclic structure in the molecule. As a result, a candidate molecular structure were easily obtained (Figure 4). In this case this value show 0; unsaturated bond not involved in the molecule. From this knowledge, students can write two kinds of candidate structures (Figure 4).

One out of these compounds determined by 1H NMR and 13C NMR analysis.

Results and Discussion
Participants set their own learning pace and hypothesis of each task. This enables personalized procedures that aim to explain and describe the chemistry. Of course, teachers confirm the preliminary members which increases focus on collaboration and valuable discussions among students from classroom learning. This journey also imparts high practice which plays a crucial role in retaining ideas gained.

The students are grouped and time is provided for them to do some research on their experiment, in preparation by checking their notes and instructing them to design their own experiential. The data have to be analyzed until next lesson.

The objective of this lesson is to have ability for solving problem by discussing their friends. How do students think about this lesson? I have been interested in student’s thought. For some students, this experimental lesson may be pretty hard to write a report. However, a written report is good one. The NMR assignments of unknown samples were also written very well. I carried out the survey about how to proceed the experimental curriculum for the student. The survey includes following listed questions.

1) What grade are you in college?
2) How do you feel about this experimental curriculum?
3) If you feel good, please fill in your comment.
4) If you feel nothing or no good, please fill in your comment.
5) Please teach me about skills you are learning into the experiment.

These answers are below. The answer for question 2 shows much good feelings. Therefore answers for the question 3 are collecting a lot answers. Mainly answers are to be discussed with the student about not understanding problems and to be understood importance of teamwork. Answer for the question 4 is not answered. This is meaning that all students feel satisfactory. From the student’s comments, they have been discussed with their friends about analysis of NMR data. According to discussion, students have an ability to solve problems for unknown matter and communication skills.

Conclusions

In this lesson, students carried out by discussion with group members for a structure analysis of organic compound. As a result, students are able to have ability for solving problem. This ability facilitates solution of difficult problem and to create newly technology.

Acknowledgements

I gratefully acknowledge Prof. Takenaka for his valuable suggestion and discussions.

References


Approval Certificate

You are required to submit the approval certificate for the purpose of maintaining and publicizing the record of the symposium. The copyright of all contents on your paper is reserved by the author(s) and/or the institution, even if you submit the approval certificate. The sentences on copyright holder(s) and the handling of papers are indicated on every page.
A STUDY OF INDUSTRIAL COMPANIES’ PERSPECTIVE OF BUSINESS ADMINISTRATION GRADUATES

Anuwat Charoensuk

Faculty of Business Administration, Thai-Nichi Institute of Technology, Bangkok, Thailand

anuwat@tni.ac.th

Abstract

This research study was conducted to investigate the industrial companies’ perspective of graduates who had a bachelor’s degree in business administration. The main purpose of this study was to develop teaching and learning for students in a business administration program in order to become an employable graduate in industrial companies. The researcher used simple random sampling. The samples of this study were 250 industrial companies located in industrial estates in Bangkok and Eastern areas of Thailand including energy saving and renewable energy industry, textile and apparel, automotive, plastic, mining ceramics and metal base, construction, agriculture and agricultural products, electronics and appliances, metal production machinery and transportation, and services and public utilities. The research instrument was a 5-point rating Likert scale questionnaire. The data were analyzed for their descriptive analysis Percentage, Mean, Standard Deviation using statistics Program and single level Structural Equation Modeling (SEM) analysis. The result revealed that first of all, industrial companies expected graduates to have ethics and morality. They also needed to have knowledge, cognitive skills, and interpersonal skills and responsibility. Besides, numerical analysis, communication and information technology skills were also required.

Keywords: industrial company, companies’ perspective, business administration graduates, industrial sectors, Thailand

Introduction

Technology Promotion Association (Thai-Japan) (TPA) was founded by the cooperation of Thai and Japanese organizations with the goal of supporting and transferring knowledge and new technologies to Thai personnel. The institute has been developed continuously and created reputation in various aspects such as hosting a conference for technology and management, teaching of foreign languages, being a consultant for many industrial enterprises as well as being a centre that gathers experts from different fields. In order to provide right-quality personnel for Thai industries, Thai-Nichi Institute of Technology (TNI) was founded. TNI aims to produce graduates following the Monozukuri principle so that graduated would be good in both theories and practice. Students need to pass their internship in order to graduate and have more opportunities to get a job after graduation. They would be able to communicate in Japanese and English.

Faculty of Business Administration has played an important role to build quality personnel for industrial companies. The faculty consists of six majors including industrial management, Japanese business administration, business and industrial management, international business management, accountancy, and Japanese human resources management. The goal of the faculty is to build a proficient graduate who is skilful in theories and practice. Japan is one of important investors in many kinds of industries in Thailand. Therefore, all students in the faculty need to learn Japanese every semester. When graduate, they would not only be able to communicate in English, but they would be able to communicate in Japanese as well.

Regarding to the goal of building a right-quality graduate for business and industrial sectors, it is essential to know what quality business and industrial sectors need for their personnel. A research study for this aspect is needed to be done in order for the statute to adapt and develop a curriculum and lessons that are suitable for the needs. Therefore, this study was conducted with the objective to examine industrial companies’ perspective of graduates from the Faculty of Business Administration.

Materials and Methods

Participants: Simple random sampling was used to select the samples. The participants were 250 administrators from 250 industrial companies located in Bangkok and Eastern areas of Thailand.

Research Instrument: The research instrument was a 5-point rating Likert scale questionnaire containing three sections: 1) participants’ company information; 2) companies’ perspective of business administration graduates; and 3) an open-ended question for comments and suggestions. The questionnaire was adapted and validated by three experts and piloted with 30 industrial companies for its reliability before used with the main study. Cronbach’s alpha coefficient was used to analyze the
data. Then the revised version contained 71 items including 24 items of knowledge (Kno), 8 items of cognitive skills (Cog), 21 items of numerical analysis, communication and information technology skills (Num), 12 items of ethics and morality (Eth), and 6 items of interpersonal skills and responsibility (Int).

Data Analysis: The data were analyzed using descriptive analysis and single level Structural Equation Modeling (SEM) in order to create a model.

Proposed Model

![Diagram](Figure 1: Proposed Model)

Results and Discussion

When the participants completed and returned the questionnaire, the data were analysed. The results are reported in this section.

Table 1 demonstrates participants’ company information. Most participants were from companies with 301-500 employees (25.6%), the second large group was from companies with 101-300 employees (23.6%) and the third large group was from companies with 100 employees (18.8%).

The departments that participated most were export (12.4%), production control (10.8%), and financial (7.2%), respectively. The smallest group was from the sales department (1.6%).

The three types of industries that participated most were textile and apparel industry (19.2%), energy saving and renewable energy (12.4%), mining ceramics and metal base (10.8%) and metal production machinery and transportation (10.8%).

The participants from companies with 11-20 years of operation (34.4%) were the largest group participated in this study. The second large was companies with 5-10 years of operation (30.4%) and the third large was companies with more than 20 years of operation (20%).

Most companies had authorized capital of 5-10 million baht (30.8%), 51-100 million baht (29.6%), and 101 million baht (22%).

The results from Table 1 illustrate a variety of participants in the present study which would help the institute to gain more confident from the results.

The next table, Table 2, is showing the result of industrial companies’ perspective of graduates’ qualifications.

Table 1: Participants’ Company Information

<table>
<thead>
<tr>
<th>Participants’ Company Information</th>
<th>Numbers of Participants</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of employees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>47</td>
<td>18.8</td>
</tr>
<tr>
<td>101-300</td>
<td>59</td>
<td>23.6</td>
</tr>
<tr>
<td>301-500</td>
<td>64</td>
<td>25.6</td>
</tr>
<tr>
<td>501-1000</td>
<td>43</td>
<td>17.2</td>
</tr>
<tr>
<td>1001 and more</td>
<td>37</td>
<td>14.8</td>
</tr>
<tr>
<td>From</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research and Development</td>
<td>16</td>
<td>6.4</td>
</tr>
<tr>
<td>Management and Secretary</td>
<td>12</td>
<td>4.8</td>
</tr>
<tr>
<td>Production</td>
<td>15</td>
<td>6.0</td>
</tr>
<tr>
<td>Export</td>
<td>31</td>
<td>12.4</td>
</tr>
<tr>
<td>Credit and Law</td>
<td>13</td>
<td>5.2</td>
</tr>
<tr>
<td>Production Control</td>
<td>26</td>
<td>10.4</td>
</tr>
<tr>
<td>Technical</td>
<td>21</td>
<td>8.4</td>
</tr>
<tr>
<td>Financial</td>
<td>18</td>
<td>7.2</td>
</tr>
<tr>
<td>Accounting</td>
<td>17</td>
<td>6.8</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>12</td>
<td>4.8</td>
</tr>
<tr>
<td>Purchasing</td>
<td>7</td>
<td>2.8</td>
</tr>
<tr>
<td>Customer Service</td>
<td>8</td>
<td>3.2</td>
</tr>
<tr>
<td>Products</td>
<td>5</td>
<td>2.0</td>
</tr>
<tr>
<td>Sale</td>
<td>4</td>
<td>1.6</td>
</tr>
<tr>
<td>Human Resource</td>
<td>12</td>
<td>4.8</td>
</tr>
<tr>
<td>Insurance</td>
<td>5</td>
<td>2.0</td>
</tr>
<tr>
<td>Quality Control</td>
<td>13</td>
<td>5.2</td>
</tr>
<tr>
<td>Types of industries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy saving and renewable energy</td>
<td>31</td>
<td>12.4</td>
</tr>
<tr>
<td>Textile and apparel</td>
<td>48</td>
<td>19.2</td>
</tr>
<tr>
<td>Automotive</td>
<td>18</td>
<td>7.2</td>
</tr>
<tr>
<td>Plastic</td>
<td>18</td>
<td>7.2</td>
</tr>
<tr>
<td>Mining ceramics and metal base</td>
<td>27</td>
<td>10.8</td>
</tr>
<tr>
<td>Construction</td>
<td>25</td>
<td>10.0</td>
</tr>
<tr>
<td>Agriculture and agricultural products</td>
<td>12</td>
<td>4.8</td>
</tr>
<tr>
<td>Electronics and appliances</td>
<td>26</td>
<td>10.4</td>
</tr>
<tr>
<td>Metal production machinery and transportation</td>
<td>27</td>
<td>10.8</td>
</tr>
<tr>
<td>Services and public utilities</td>
<td>18</td>
<td>7.2</td>
</tr>
<tr>
<td>Years of Operation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 5</td>
<td>38</td>
<td>15.2</td>
</tr>
<tr>
<td>5-10</td>
<td>76</td>
<td>30.4</td>
</tr>
<tr>
<td>11-20</td>
<td>86</td>
<td>34.4</td>
</tr>
<tr>
<td>More than 20</td>
<td>50</td>
<td>20.0</td>
</tr>
<tr>
<td>Authorized Capital</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 5 million</td>
<td>44</td>
<td>17.6</td>
</tr>
<tr>
<td>5-50 million</td>
<td>77</td>
<td>30.8</td>
</tr>
<tr>
<td>51-100 million</td>
<td>74</td>
<td>29.6</td>
</tr>
<tr>
<td>101 million</td>
<td>55</td>
<td>22.0</td>
</tr>
</tbody>
</table>

Table 2: Industrial Companies’ Perspective of Graduates’ Qualifications

<table>
<thead>
<tr>
<th>Qualifications</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethics and morality (Eth)</td>
<td>250</td>
<td>4.092</td>
<td>.28961</td>
</tr>
<tr>
<td>Knowledge (Kno)</td>
<td>250</td>
<td>4.236</td>
<td>.45291</td>
</tr>
<tr>
<td>Cognitive skills (Cog)</td>
<td>250</td>
<td>4.064</td>
<td>.43435</td>
</tr>
<tr>
<td>Interpersonal skills and responsibility (Int)</td>
<td>250</td>
<td>4.648</td>
<td>.47855</td>
</tr>
<tr>
<td>Numerical analysis, communication and information technology Skills (Num)</td>
<td>250</td>
<td>4.696</td>
<td>.46954</td>
</tr>
</tbody>
</table>

From Table 2, morality and ethics is the most important qualification that graduates should have, with the mean of 4.092. The second qualification is numerical analysis, communication and information technology skills with the mean of 4.236. The third important one is cognitive skills with the mean of 4.064.

Using SEM to analyse the data, the result revealed the effect of the five qualifications including knowledge, cognitive skills, numerical analysis, ethics,
and interpersonal skills. They were observed variables while industrial companies’ perspective was latent variable. Knowledge, cognitive skills, and numerical analysis were defined as fundamental skills (Fun) while ethics and interpersonal skills were defined as social skills (Soc).

Table 3: Statistic Analysis of Structure Equation Modelling for Industrial Companies’ Perspective of Business Administration Graduates

<table>
<thead>
<tr>
<th>Observed variables</th>
<th>Structure Equation Modelling (SEM)</th>
<th>( \beta )</th>
<th>SE</th>
<th>Z</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fun. skills</td>
<td></td>
<td>0.450</td>
<td>0.101</td>
<td>4.468</td>
<td>0.000**</td>
</tr>
<tr>
<td>1. Kno</td>
<td></td>
<td>0.004</td>
<td>0.023</td>
<td>0.190</td>
<td>0.849</td>
</tr>
<tr>
<td>2. Cog</td>
<td></td>
<td>0.012</td>
<td>0.007</td>
<td>1.708</td>
<td>0.088</td>
</tr>
<tr>
<td>3. Num</td>
<td></td>
<td>-0.041</td>
<td>0.011</td>
<td>-3.809</td>
<td>0.000**</td>
</tr>
<tr>
<td>Social skills</td>
<td></td>
<td>0.251</td>
<td>0.078</td>
<td>3.240</td>
<td>0.001**</td>
</tr>
<tr>
<td>4. Eth</td>
<td></td>
<td>0.017</td>
<td>0.039</td>
<td>0.436</td>
<td>0.663</td>
</tr>
<tr>
<td>5. Int</td>
<td></td>
<td>-0.017</td>
<td>0.057</td>
<td>-0.295</td>
<td>0.768</td>
</tr>
</tbody>
</table>

\(Z\)/1.96 is \(p<.05\), \(Z\)/2.58 is \(p<.01\)

The factor loading of industrial companies’ perspective of business administration graduates shows the statistical significance at the level of .01 of both fundamental and social skills. However, the factor loading value of fundamental skills (Fun = 0.450) is higher than the value of social skills (Soc = 0.251).

From Table 3, of five variables, numerical analysis is the only one variable showing the statistical significance at the .01 level. This result could be interpreted that industrial companies expect graduates to have all of those qualifications; however, numerical analysis is the less important one.

For the validity (\(R^2\)), the table shows the value of covariance of both observed variables and latent variable. Table 3 also shows that the \(R^2\) values are between 0.00 to 0.0849.

Moreover, the result from SEM analysis using Mplus program confirmed the construct validity of the hypothesis model. The Chi-square statistic \(x^2\) of the hypothesized SEM model was \(x^2 = 19.210\), df = 14 which was a non-significant \(x^2/df = 1.161\) which was less than 2 (p=0.2949) as required for SEM (p > 0.001 and < 2). The model had the good fit with the empirical data regarding the fit indices, CFI = 0.987 and TLI = 0.985 (closing to 1). RMSEA = 0.025 and SRMR = 0.036 (closing to 0). Figure 2 demonstrates the model from SEM analysis.

Figure 2: Model of Industrial Companies’ Perspective of Business Administration Graduates

From the model created by using SEM analysis, it demonstrates that the five qualifications affect the perspective of industrial companies in Thailand. Fundamental skills and social skills are also related to each other and affect the industrial companies’ perspective. The result confirms the proposed model.

Finally, the result from this study revealed that all industrial companies expected business administration graduates to have all five qualifications even though each qualification might not have the same level of requirement. The most required qualification was ethics and morality. The result was the same as previous study conducted by Jaensirisak and Sangsawang (2015), Thanuwarapat (2012), and Sillaparat (2008), which confirmed ethics and morality were the most desirable qualification of graduates. Thanuwarapat (2012) reason was that when a company hired graduates, their work would relate to many different sections of that company depending on their responsible duties. The duties might relate to insiders and outsiders, important documents, or financial matter. Thus, if employees did not have ethics and morality, it would have serious effects on a company itself and other cooperated companies.

The second important qualification was numerical analysis, communication and information technology skills. It could not be denied that information technology, nowadays, has an enormous effect on the industrial sector. Doing business, fast and accurate numerical analysis was necessary in order to win over other competitors. The fast and effective communication was also playing an important role as shown in a study of Thanuwarapat (2012).

The previous studies (e.g. Buakruen, Srisarun, & Girdtempoom, 2015; Yakhampon, 2014) not only confirmed these two qualifications, but the other three qualifications including knowledge, cognitive skills, and interpersonal skills also were confirmed as important qualifications that any companies expected from the graduates.
Conclusions

In conclusion, from their perspective, industrial companies in Thailand expected graduates to have all five qualifications, and the most important one was ethics and morality. In this study, the result was the overview from different types of industrial companies. Therefore, for the future studies, they could be conducted on some specific types of industries. Then the result could be compared with the result in general and gain more insight of industrial companies’ perspective of newly graduates.

References


Thanuwarapat, K. (2012). Preferable qualifications of the English for communication graduates, Faculty of Social Sciences and Liberal Arts, North-Chiang Mai University (Unpublished research report).

Yakhampom, W. (2014). The graduate attributes in Bachelor of Business Administration Degree Management as requirements by the entrepreneur in Loei province. [Journal of Marketing and Management], 1(2), 130-141.
AN EXPERIENCE OF MANUFACTURING GOODS THROUGH
PRODUCING WOODEN LATHES

Ariunbold Ganbold*, Ariunaa Tsogzolbaatar*

Teacher of Mechanic/ Institute of Engineering and Technology, Mongolia

* Email: ariunbold.bless@gmail.com

Abstract

This school was established as a model class of Japanese-style Kosen in October 2014 and Mongolian Kosen was opened in September 2015. In the beginning, 1st grade students learned fundamental exercise of engineering science, and advanced to 2nd grade classes, three course of study by choice and achievement such as machinery engineering, electronic engineering, and electronics and constructional engineering. Fundamental exercise of engineering science has already been reported before.

The authors in charge of machinery engineering class and teach 2nd grade students. Mongolia, however, can be said as an isolated island in the continent and they have little manufacturing machinery. Fortunately enough, wooden material is abundant. We have produced wooden lathes with the help of Japanese instructors and hand crafts/tools and wood cutting machines. In due course of time, we have a plan to introduce manufacturing machinery. So far we would like to deepen understanding of processing whole-wood by lathe machine.

We would like to report 2nd grade students' process and circumstances of creating wooden-lathes.

Keywords: wooden lathes, lathe, wood

1. Introduction

In Japan, manufacturing practice using lathes are usually performed in fundamental exercise of engineering science course. However, in Mongolia, we do not have anything but a desktop drilling machine. We have determined, during 2nd grade, to make lathes which would be used for 1st grade students. Under circumstances where almost no manufacturing machinery exists and is difficult to obtain metal material, we found out that wood material is easy to obtain at inexpensively. After having obtained wood craft machinery such as electrically-powered tools, saws, planes, chisels, etc., we have invited a specialist for wood craft from Japan who taught wood craft practice. We came to a conclusion that making wooden lathes is not a difficult practical application task for 2nd grade students who have already experienced wood craft during 1st grade. After completion of wooden lathes, we plan to put them into actual lathes cutting exercise for 1st grade students. It is our aim for 2nd grade students, through making wooden lathe to deepen understanding of origin and history, structure, and usage of lathe. We would like to put emphasis on the importance of constructing wooden lathes by students' own hands. We were planning to manufacture early stage hand-powered lathes in its history.

2. Manufacturing Procedure

2.1 Miniature model

In manufacturing wooden lathes, it is our policy for the students to think by themselves, as well as give ideas by referring to schematic diagram of textbooks and shapes of modern wooden lathes: we reflects students' ideas at present time.

Figure-1 depicts assembled drawing.

Figure 1 assembled drawing of wooden lathe

Actual lathe will be made from plywood of 2m(length) x1m(width), 17mm dimension in thickness. We have decided to make 1/5 scale of miniature lathe. By making a miniature model, we will obtain an image of real lathe, number of parts needed, shape of parts, and procedure of assembly as well as to check correctness of drawing and dimension of parts. The writers instructed students to work coordinating each
other and each group is requested to report points or procedure to improve.
We used polystyrene board of 3mm in thickness, while actual lathes plywood of 17mm in thickness will be used. We drew parts shapes on 300mm x 600mm polystyrene board referring to parts drawing lists. After drawing parts shapes, we have cut the polystyrene boards. We then arranged them in order to check and confirm number of parts and dimension. (Figure2)

![Figure2 number of parts and dimension](image)

After having checked correctness, we put polystyrene parts into ply-boards and glued them together. Figure 3 is a photo of completed miniature lathe.

![Figure3 a photo of completed miniature lathe](image)

2.2 Wood cutting

In Mongolia, it is rather difficult for us to obtain already cut wood, on the contrary, it is easy to obtain 1m x 2m, 17mm in thickness plywood inexpensively price which are solid in shapes and without conspicuous knots. We measured the plywood with scale, carpenter’s square and pencil. (Figure 4) It is recommended to figure out the order to cut the plywood without wasting beforehand. The authors asked students to compare position of outlined parts-shape, and order to cut and efficiency with each other.

![Figure4 measuring the plywood with scale, carpenter’s square and pencil.](image)

2.3 Cutting into shapes

We start cutting into shapes from the plywood by using electric circular saw. Before using electric circular saw, we conducted safety guidance, which are: plugging into power outlet should be done after having checked the safety around circular saw, plywood to be cut should be fixed by a suitable method, electrical power code should be long enough for whole cutting procedure, electrical circular saw should be held tightly so that the plywood does not move by reaction when turning on the power switch. We roughly cut the plywood into several portion for easy handling. Then, we cut the portioned plywood by using sliding circular saw or saw. (Figure5)

![Figure5 cutting into shapes](image)

We cut the plywood into shapes about 5mm to 10mm bigger than the original shape. Figure 6 shows the cut shapes.
2.5 Dimension modifying and grooving

As mentioned before, all the parts are cut at 5mm to 10mm bigger than the original dimension with some displacement occurring during the piling procedure. Dimension adjustments were made by sliding circular saw. Left and right symmetrical (bilaterally symmetrical) parts, except too much thick parts, were cut in piles at the same time.

Grooving procedure was conducted by chisel. It is the first time for most of the students to use chisel, however, they soon get accustomed to using it. (Figure 9)

2.4 Gluing parts

Figure 7 shows how to glue parts. We applied wood glue (polyvinyl acetate emulsion adhesive) evenly onto the surface and pile up the parts and then fixed by using C-clamp. Some of these c-clamps were made by 2nd grade students during the welding class. This wooden lathes class is held once a week. Students will know the result of the gluing one week later. Figure 8 shows the glued parts.

2.6 Assembling

Assembling procedures are made in accordance with (1) leg section, (2) spindle section (3) bed section. In the first place, students temporarily assembled the wooden lathe by adjusting horizontal and vertical level using level and then fix them by wood screws. Students faced with the difficulty in adjusting horizontal level of the bed section because floor of the workshop is not precisely horizontal level. We have checked perpendicularity between bed section and spindle section, bed section and legs. Figure 10 shows the finished lathe.
2.7 Manufacturing spindle section

Spindle section cannot be made by wooden parts. With the cooperation of College of Industrial Technology Japan, spindle sections were manufactured in Japan. Figure 11 shows stage car with V-belt are installed to motor.

Figure 11 stage car with V-belt are installed to motor

Figure 12 is an assembly drawing of belt driven wooden lathes

<table>
<thead>
<tr>
<th>Schedule</th>
<th>No of lesson</th>
<th>Hours</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>2</td>
<td>4</td>
<td>Origin of lathes, history, construction, usage</td>
</tr>
<tr>
<td>Drawing</td>
<td>6</td>
<td>12</td>
<td>Dimension, Parts assembly drawing, assembly</td>
</tr>
<tr>
<td>Making miniature lathes</td>
<td>3</td>
<td>6</td>
<td>Making miniature lathes</td>
</tr>
<tr>
<td>Discussion</td>
<td>2</td>
<td>4</td>
<td>Completion of miniature lathes and collating with drawings</td>
</tr>
<tr>
<td>Part drawing</td>
<td>3</td>
<td>6</td>
<td>Drawing parts’ shape on big boards</td>
</tr>
<tr>
<td>Cutting into parts</td>
<td>3</td>
<td>6</td>
<td>Cutting into parts from big boards</td>
</tr>
<tr>
<td>Gluing parts</td>
<td>3</td>
<td>6</td>
<td>Gluing parts together</td>
</tr>
<tr>
<td>Grooving and assembly</td>
<td>4</td>
<td>8</td>
<td>Grooving and assembling parts</td>
</tr>
<tr>
<td>Conclusion and observation</td>
<td>1</td>
<td>2</td>
<td>Making reports concerning conclusion and observation</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>54</td>
<td></td>
</tr>
</tbody>
</table>

3. Results and consideration

3.1 Progress of work

Table 1 shows all the process from drawings to completion of wooden lathes. Each group consists of five to six students co-operating with each other to manufacture wooden lathes during two-hour-lesson each week. Due to insufficient number of tools and machinery, students faced difficulty in conducting simultaneous processing. We proceeded manufacture of wooden lathes taking the above facts into consideration.

3.2 Observation and impression

Here are summary of students’ observation and impression

1) It was easy for me to cut wood boards, finish surface and assemble parts, however, difficult to draw up part’s shapes on the wood board. It is quite a bit difficult for me to measure. I am grateful to complete wooden lathes.

2) During the wood processing, I found out that wood boards tend
We were able to assemble our wooden lathe rigidly than other teams. We made some mistakes, however, we finally stood together and worked hard.

19) We succeeded in manufacturing wooden lathe. Teamwork is important. It is important to realize that I am a member of the team.

20) It is good for me to make a new one and study.

21) I was able to handle wood material. I think I am able to design hereafter.

22) By doing teamwork, I noticed that procedure was able to expedite.

23) It was my first manufacturing goods. It was fun.

24) Teamwork was good. We were able to create new goods. Good experience.

25) It is grateful for me to manufacture lathe for the first time. I noticed that I manufactured a machinery for my own study field. It is wonderful experience for me to study and manufacture machinery by wood.

4. Conclusions

Students gave ideas on wooden lathe and manufactured wooden lathes by themselves. It is the first time for us to make wooden lathes. I feel it is obvious that our project to manufacture wooden lathes are successful taking students’ conclusion and impression.

We come to conclude that:

(1) We were able to complete manufacturing wooden lathe from scratch.

(2) We performed the job by team work and we found that group work is essential.

(3) We were able to expedite manufacturing wooden lathes because we first made miniature models before making actual size lathes. Miniature models helped us understand lathes construction details and analyze manufacturing process into several steps.

5. Challenges for the future

While we are not able to manufacture spindle section by students. Figure 13 and 14 show hand-powered lathes designed by students. Manufacturing wooden lathes is a subject for 2nd grade students. For the 3rd graders, we plan to measure tension onto woodworking bits, how much feet and hand power are needed by operators. For this reason, we manufactured motor-powered wooden lathes before manufacturing hand-powered wooden lathes. It is our challenges for the future to manufacture foot-operated lathes as shown Figure-1.
6. Gratitude

We would like to express our gratitude for honorly Professor Yuji Nakanishi who gave us suggestion in completing this paper.

References

1) Zagdragchaa Ulambayar and others: Attempting to train engineers in Mongolia, ISATE 2015 Presented Papers
2) Yuji Nakanishi and others: Machinery manufacturing 1, Jikkyo Publishing, P 14, 2013.1 Japan
DESIGN AND PRODUCTION OF LORENTZ FORCE ROCKETS IN A COURSE FOR THE FIRST YEAR STUDENTS

T. Suzuki*\(^a\)

\(^a\) Department of Creative Engineering, National Institute of Technology, Kushiro College, Japan

*tsuzuki@kushiro-ct.ac.jp

Abstract

Since 2009 to 2015 we offered a one year course "Monozukuri-Kiso" to the first year students in National Institute of Technology, Kushiro College. This is, as the name means, an elementary course for design and production. The course is also prepared to help the students in choosing their major field. At the beginning of the second year, the students will choose their major from 5 fields of engineering, those are information one, mechanical, electrical, electronic and architecture. The course consists of 10 subjects covering various aspects of the 5 fields to give the students a little valuable opportunity where they may observe typical features of each of 5 fields. "Design and production of Lorentz force rockets" is one of the subjects from the field of electrical engineering. The rocket is launched by the Lorentz force between the current around the coil which is driven by the external electric power unit and the induced current on the conductor plate attached on the bottom of the rocket. The students are required to achieve three tasks to launch the rocket. First, they are required to make the coil of coated cables. The second task is to make the launch pad of craft papers. In the last task, they should fine tune the settings of the rocket and the coil on the launch pad. From these tasks, the students could learn the following. First, they acquire an elementary knowledge about the fundamental laws of the electromagnetism, such as the Lorentz force and the Faraday's law of induction. The second, the students enjoy the fun of designing and producing. The third is to learn the power of high precision tuning. The last, the students see that it is so difficult to use efficiently the electric energy to make mechanical work such that launching rockets. All of them would be valuable experiences to engineers working in every field.

Keywords: design and production, Lorentz force rocket, first year student, choosing major field, electromagnetism, high precision tuning, electric energy

1. Introduction

In National Institute of Technology, Kushiro College, the first year students take a one year course "Monozukuri-Kiso". The first purpose of this course is, as its name means, to make the students gain a little experience on design and production. The second purpose is to help the students in choosing their major field. At the beginning of the second year, the students should choose their major field from 5 fields of engineering, those are information one, mechanical, electrical, electronic and architecture.

In "Monozukuri-Kiso", each student takes 10 subjects which cover various aspects of the 5 fields. Each subject would be useful for the students in observing typical features of the field concerned.

"Design and production of Lorentz force rockets" is a subject which is offered from the field of electrical engineering. The rocket is launched by the Lorentz force between the current around the coil, driven by the external electric power unit, and the induced current on the conductor plate attached on the bottom of the rocket.

To launch the rocket, the students should achieve three tasks. The first task is to make the coil of coated cables. From this task, the students acquire some knowledge, at least qualitative, about electromagnetism. This would excite their intellectual curiosities. The second task is to make the launch pad of craft papers. In this task, the students enjoy the fun of designing and producing. A few students propose very unique designs, some of which are well thought-out and have excellent structures. The third task is that in order to launch the rocket higher and longer the students should fine tune the settings of the rocket and the coil on the launch pad. From this experience, they could learn how powerful it is to tune the settings at high degree of accuracy. Here we would like to give one comment. That is, from this subject the students see it is so difficult to use efficiently the electric energy to make mechanical work such that launching rockets.

The organization of this article is as follows. In Sec. 2, we briefly explain the principle of the Lorentz force rocket. In Sec. 3, we give the outline of the subject in some detail. In Sec. 4 we enumerate the results. Sec. 5 and Sec. 6 are devoted to the discussion and the conclusions respectively.
2. Principle of Lorentz Force Rocket

(1) Composition of the System

In Fig. 1, we show the composition of the system. The system is composed of two parts. One is the rocket-launcher part, and the other is the electric power unit part.

![Figure 1 Composition of the system](image1.png)

The rocket-launcher part consists of 3 components. They are the rocket itself, the coil and the launch pad. See Fig. 2.

![Figure 2 The rocket-launcher part](image2.png)

As shown in Fig. 3, the coil is attached at the bottom of the rocket.

![Figure 3 The coil is attached at the bottom](image3.png)

The electric power unit part is mainly made of 8 capacitors connected in parallel. The capacitance of each capacitor is 10,000 $\mu F$, then the total capacitance is 80,000 $\mu F$ (See Fig. 4).

![Figure 4 The electric power unit](image4.png)

(2) Principle of Lorentz force rocket

The Lorentz force rocket is, as its name means, launched by the Lorentz force, which arises between the conductor plate attached at the bottom of the rocket and the coil.

As shown in Fig. 5, when the current is derived to flow around the coil by external electric power unit, the loop current is induced on the conductor plate. It is the consequence of the Faraday’s law of induction. The induced current on the conductor plate flows in the opposite direction against the current around the coil, then the repulsive force arises between those currents. By this repulsive force, known as the Lorentz force, the rocket is launched. (There are many text books of electromagnetism. For example, Feynman, Leighton and Sands (1964).)

![Figure 5 Principle of Lorentz force rocket](image5.png)

3. Outline of Subject

(1) Schedule

The subject is planned to consist of three periods, each of which takes 4 hours.

The first period is mainly devoted to design and making of the coil. The students are strongly promoted to do trial launch as many times as possible.

In the second period, the students make the launch pad of craft papers. Designing the launch pad is their homework between the first and the second periods.

At the third period, the distance competition is held. Each student has two chances to launch the rocket. The better of two performances is the record of each student.
(2) Making of coil
In the first period, the students make the coil of coated cables. The length of cable is about 2 meter. The design of the coil almost free, except for one requirement that the coil should have margin of about 20 centimeter on the both ends. This margin is necessary to connect the coil to the electric power unit.

(3) Making of launch pad
The second period is devoted to making the launch pad of craft papers. Because this task takes much of time, designing of the launch pad becomes the homework. The most important point in designing is that the launch pad should have enough strength to withstand the impact of the launching.

4. Results

(1) Making of coil
The styles of coils are roughly separated into two classes. One is a class of one layer style, and the other is a class of two layers.

Though many readers think that two layer coils give higher performance than one layer coils, the difference between performances of each two types is actually small. One of the important key factors affecting the performance is the carefulness of work. The students would find that coils wounded carefully, keeping flat and tight, give high performance.

(2) Making of launch pad
One crucial point which influences the performance is the toughness of the base part of launch pads. The students propose various ideas which strengthen the base part of launch pad. Fig. 6 shows one of the most excellent structures among those we found. The structure of tightly stacked multi-layer enables paper crafted bases to have very high rigidity.

![Figure 6 The structure of tightly stacked multi-layer](image)

The task of making launch pad has the largest degrees of freedom in designing in the tasks of the subject. Many impressive and well thought-out works are produced. For example, the work shown in Fig. 7 is designed to enable the launching angle to change in multi-step.

![Figure 7 multi-step launching angles](image)

5. Discussion

(1) Making of coil
One of very fruitful harvests obtained from this task is to acquire a little knowledge about electromagnetism. Because the principle of Lorentz force rocket is the same of almost all electric machines, the knowledge would be very useful for the students.

In addition, what is required for improving the performance of the rocket, the carefulness of work, is also the same as those in cases of other electric machines. Therefore, the experience of this task might be valuable lesson.

(2) Making of launch pad
There are various methods to achieve high strength of the base part of the launch pad. The possibilities might be limitless. A few students propose excellent ideas beyond our poor imagination. It is also true in other aspects in designing the launch pad. Many students produce unique, impressive and well thought-out works. This task plays an important role in bringing up the creativity of the students.

(3) Others
In the third period, we show the formula for the electric energy charged in the capacitors, and calculate the electric energy. We also show the kinetic energy utilized to launch the rocket. By comparing both energies, we emphasize how difficult it is to use efficiently the electric energy to make mechanical work, such as launching rockets.

6. Conclusions

Since 2009 to 2015, in National Institute of Technology, Kushiro College, the first year students take a one yaer course "Monozuki-Kiso". In this course, each student takes 10 subjects which cover various aspects of the 5 fields. Each subject would be useful for the students in observing typical features of the field concerned.

From the field of electrical engineering, "Design and production of Lorentz force rockets" is offered to the students. Through this subject, the students learn a little knowledge about electromagnetism, enjoy the fun of designing and producing, and obtain a valuable lesson about the carefulness of the work. Also they see how difficult it is to use efficiently the electric energy to make mechanical work.

Acknowledgements

We thank K.Chida for his great effort in starting the subject. We also thank T. Honda and S. Inamori for their collaboration in management of the subject.

References

EDUCATIONAL SYSTEM
FOR TEACHING MICROWAVE ENGINEERING

Kamel Haddadi

Institute of Technologies (IUT A) / Dept. of Electrical Engineering (GEII) - University of Lille
Institute of Electronics, Microelectronics and Nanotechnology (IEMN – CNRS)
Avenue Poincaré CS 60069 – 59652 Villeneuve d’Ascq Cedex – France

*kamel.haddadi@univ-lille1.fr

Abstract

This paper describes an educational system developed at the department of Electrical Engineering of the Institute of Technology (IUT A). Basic microwave theory and related concepts are difficult to understand whereas they can be easily illustrated in a laboratory environment. To render the topic comprehensive and attractive for students, an educational system based on a dedicated learning laboratory has been developed at the IUT A. The lab provides computer-aided design (CAD) tools, equipment’s for circuits’ fabrication and tests/measurements. The lab provides all the facilities to complete a full project including analysis, design, modeling, fabrication, measurement and related applications.

Keywords: Microwave teaching, hardware project, teaching laboratory, active learning.

Introduction

One of the main applications of electromagnetics is the design and realization of electronic circuits and systems in the microwave frequency range [1]. Microwave technology has gone through periods of revolutionary changes including coaxial and waveguide structures, hybrid microwave integrated and monolithic circuits [2]. These technological evolutions have changed the tools required by engineers for designing and fabricating microwave circuits. Therefore, the teaching of microwave engineering is fundamental for the students in the specialities of radio and communication [3]-[4]. Many courses in electromagnetic and microwave engineering are considered to be the most difficult in the electrical engineering curriculum as it involves theory of distributed parameter circuits and microwave networks that are full of abstract and complex concepts. Consequently, inappropriate teaching content leads students unable do deeply grasp knowledge, skills and competences in the field. This problem has been found in many universities especially due to the lack of modern educational system for microwave engineering courses.

In this paper, we present an educational system developed at the department of Electrical Engineering of the Institute of Technology. Section II describes the course including organization and contents. The course is illustrated through a project related to the development of microwave radar for vital sign detection. Section III presents main results and the advantages gained by the students.

Materials and Methods

The all project requires the two-semester sequence for a total volume around 60 hours. Students work in team of 12 students to develop a microwave system that is attractive and that can find viable applications in the modern society [5]. A project example concerns the design, fabrication and experimental validation of microwave radar for detection of vital signs and activity of a human subject at the industrial, scientific and medical (ISM) radio frequency of 2.45 GHz. The organization of the course is discussed below with reference to the content.

A. Specifications of the radar

The project is defined in close relationship with the medical field and involves a doctor as an external partner and consultant. Therefore, the first step of the project is to define the specifications of the system through a meeting between the students, the instructor and the doctor. The main conclusions are given here after.
- The measurement of the respiratory rate is always interesting to detect respiratory diseases especially in a non-contact manner as it saves time for the doctor.
- It is better to perform a back measurement for children.
- The detection of stress is mainly linked to the cardiac frequency. The breathing accelerates after a period of time.
- The sensor can be useful to monitor infants and avoid sudden death.
- The system can find applications to awaken people after rapid eye movement (REM) sleep where breathing is faster.
- The system is interesting in geriatric services where it is difficult to manipulate patients.
- It is interesting to develop a communication link between the radar and a laptop or smartphone in order to perform permanent storage or visualize the data in real time.

**B. Experiments with medical sensing techniques**

Conventional techniques for measuring vital signs are studied using the “e-Health Sensor Platform Complete Kit” from LIBELIUM® [6]. It includes a pulse and oxygen in blood sensor (SPO₂), an airflow sensor (breathing), a body temperature sensor, an electrocardiogram sensor (ECG), a glucometer sensor, a galvanic skin response sensor (GSR - sweating), a blood pressure sensor, a patient position sensor (accelerometer) and an electromyography Sensor (EMG) sensor. The sensors are controlled by an Arduino® platform to monitor in real time the state of a patient or to get sensitive data in order to be subsequently analyzed for medical diagnosis.

Fig. 1 - e-Health Sensor Platform Complete Kit [6].

This study has mainly two objectives. The first one is to train the students with conventional measuring methods found in medicine. The second objective is to automate the ECG and airflow sensors as reference measurements to be compared with radar measurements.

**C. Lecture on radar techniques**

During this lecture, the students get familiar with radar techniques and microwave circuits. Passive circuits consist of transmission lines, impedance matching circuits, power dividers, couplers and circulators. Active microwave circuits discussed in the course include amplifiers, oscillators, mixers and power detectors. Main topologies of radars and related subcircuits are included. A focus on microwave radar for vital sign detection is proposed. A brief state-of-the-art can help the students to situate the project in the general context of microwave engineering. In particular, the first work related to the sensing of physiological movements using microwave radar dates back to the early 1970s [7]. Since then, and abundant literature on the subject has been reported [8]-[10].

In a second part of the lecture, a radar architecture is proposed and described. The solution to build the radar is straightforward and eliminates complicated subcircuits. The simplified block diagram of the radar is illustrated in Fig. 2.

![Block diagram of the radar system for vital signs detection.](image-url)

The radar system consists of six subcircuits, i.e., voltage-controlled oscillator (VCO), power divider, antenna, power detector, DC amplifier and a data processing unit for acquisition and analyse. The VCO is used to generate at continuous wave (CW) signal at 2.45 GHz. The system operates in monostatic mode: a single antenna is used to transmit and receive the microwave signals. The implementation proposed avoids the use of bulky and expensive duplexer, such as transmit/receive switch or circulator commonly found in monostatic radar configurations. The power divider separates the emitting wave from the received one. Thereby, the power divider delivers the transmitted signal to the antenna and injects the signal scattered by the target to the power detector. The resulting signal is therefore directly down-converted to DC voltage. A DC high speed instrumentation amplification with gain adjustment stage to match the input requirements of the ADC is used. The DC voltage that is directly proportional to the target motion (breathing and cardiac) is then digitized.

Fig. 2 - Block diagram of the radar system for vital signs detection.

The students are divided into small groups of 2 or 3 students that have to design and fabricate the different circuits of the radar.

**D. Theory and computer-aided tools**

For each part of the project, a write-up was prepared explaining the objective, the theoretical and practical skills needed and providing a set of instructions. The main idea beyond this project is to provide an educational system close to the industry rather than the traditional academic system that separates the mathematical background and experiments. All the
Microwave subcircuits are designed with Genesys® that is an accurate and easy-to-use RF and microwave simulation software created for the circuit board and subsystem designer.

In the following, to present a clear picture of the study, we focus on the design of the microwave power detector only. The detection circuit is based on an Agilent Technology HSMS-2850 zero-bias Schottky diode [11]. The circuit of detection comprises a resistive matching network that offers low sensitivity to both temperature and positioning variations of the diode (Fig. 3). At the output of the diode, the microwave signal is filtered by means of a surface mount capacitor.

![Fig. 3 - Power detector architecture based on a Schottky diode.](image)

The first step is to implement the electrical model of the diode in the CAD environment. All the information are provided on the datasheet of the diode [11] (Fig. 4).

![Fig. 4 – Schottky diode HSMS-2850 from Avago Technologies® [11]. (a) SOT-323 package lead code identification. (b) Equivalent electrical circuit of the Schottky diode with \( C_p = 0.08 \) pF, \( L_p = 2 \) nH, \( C_j = 0.18 \) pF, \( R_s = 25 \) \( \Omega \) and \( R_v = 9 \) K\( \Omega \).](image)

The power detection circuit implemented in the CAD software is given for illustration in Fig. 5. The circuit is designed on hybrid microwave integrated technology using FR4 Epoxy substrate (\( \varepsilon = 4.8 \)) with transmission microstrip line propagation structures in copper (conductivity \( \sigma = 5.8 \times 10^7 \) S/m) with metallization thickness of \( 35 \mu m \).

![Fig. 5 – Design of the power detector based on the Schottky diode HSMS-2850. (a) Schematic of the power detector. (b) Zoom of the Smith chart showing the reflection coefficient of the power detector. (c) Layout of the power detector.](image)
layout is built [Fig. 5(c)]. The detector is then ready for fabrication.

E. Realization of the radar

All the circuits are realized separately to be tested individually before the integration of the overall system. For laboratory tests, coaxial to microstrip transitions are used for connecting the devices to measuring instruments. Each subcircuit is fabricated by means of rapid printed circuit board (PCB) prototyping. This allows the students to test ideas and easily make changes. The circuit board plotter includes powerful system software for converting layout data into actual printed circuit boards: it takes the data from the design software, edits it for production, breaks it down into individual process steps and guides the user, step-by-step, through the manufacturing process. The lab is equipped with a LPKF® Protomat S62 circuit board plotter (Fig. 6) [12]. Each student received a training course on the equipment. The course consists to learn how to configure and calibrate the plotter, to use the software interface to fabricate the circuit.

Fig. 6 – Circuit board plotter LPKF ProtoMat® S62 [12].

After fabrication of the PCB, the next step consists to solder the surface mount devices and the connector on the PCB. An illustration of the PCB and devices to be soldered is given in Fig. 7.

Fig. 7 – Elements of the power detector before soldering.

Dedicated equipment, accessories and products needed for dispensing alloy, placement of surface mount devices and soldering tools have been installed in the laboratory. Fig. 8 gives an illustration of the main resources from ‘Circuit Imprimé Français’ – CIF® installed in the laboratory [13].

Fig. 8 – CIF® equipment’s for devices assembly. (a) Dispenser DOTTY CMS 450.V2 for dosing solder pastes. (b) Pick and place station PRECITEC® manual system for the placement of surface mount devices. (c) Batch reflow oven for prototypes FT05.B forced convection system.

Each subcircuit has been fabricated and tested separately before assembly.

Results and Discussion

The learning laboratory is equipped with all microwave facilities to perform full electrical characterization from DC up to 26 GHz. Students start using the equipment for measurements associated with the project. In particular, the electrical characterization of the power detector concerns the measurement of the reflection coefficient using a vector network analyser.
As expected, the return loss is very close to the simulated value. The second experiment consists to measure the detected voltage as a function of the input microwave power (Fig. 9). To that end, the vector network analyzer is configured as a variable microwave source as illustrated in the inset of Fig. 9.

---

**Fig. 9** – Detected voltage as a function of the input microwave power – $f = 2.45$ GHz.

Each circuit has been characterized. Depending on the measurement performance, optimizations of the initial design are required to meet the specifications. Thus, the CAD software, the circuit board plotter and equipment’s for devices assembly are used extensively by the students to gain practical experience. Fig. 10 shows a picture of the final assembly of the radar including DC amplification stage and software resources.

---

**Fig. 10** – Monostatic radar for vital signs detection – $f = 2.45$ GHz.

The code developed concerns specifically the analysis of the data to extract the breathing and cardiac frequencies. In particular, Fast-Fourier Transform (FFT) algorithm has been successfully implemented in the microcontroller. Furthermore, a communication link between the radar and an Android smartphone has been developed using a simple Zigbee® module plugged on the Arduino® board. Two students have developed the smartphone application as illustrated in Fig. 11.

---

**Fig. 11** – Communication link. (a) X-bee module with integrated antenna. (b) Smartphone application for breathing rate measurement.

The main results are (1) basic theory is introduced progressively by the instructor and can be applied directly to simulation/experiment, (2) students make the link easier with skills and trades expected in industry, (3) the project encourages autonomy, students learn how to work in group. The evaluation is based on technical reports, oral presentations and experimental demonstrations with a jury composed of colleagues and external partners.

**Conclusions**

The motivation, organization and contents of an educational system for teaching microwave engineering have been described. The course proposed is built around a dedicated learning laboratory that merges all the facilities to study, design, fabricate and measure microwave systems. The experience gained from this educational system significantly enhances the student’s pedagogic and professional experiences. Students observe practical issues not covered in conventional classroom and gain confidence in their abilities to understand and use microwave concepts for modern applications.

**Acknowledgements**

The author thanks Arnaud Caillier and Valérie Buquet from the International Relationships for their constant support.

The author thanks the Region Hauts-de-France for their financial support related to the development of the microwave learning laboratory.

**References**


