LESSONS FROM THE TRADITION - JAPAN MARITIME COLLEGE (KOSEN) STUDENTS EXPERIENCE POLYNESIAN TRADITIONAL VOYAGING THROUGH GLOBAL PARTNERSHIP -

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Abstract

Japan maritime colleges (Kosen) and Kauai Community College (KCC) co-execute a three-week cultural exchange program, specially designed for Japan maritime college students, every March on Kauai Island. The main topic of the program is Polynesian traditional voyaging. As the first program was held in 2010, 10th program is going to be held in next March. In this paper, the authors would like to share our experiences in these programs.

Keywords: Polynesian voyaging, voyaging canoe, maritime students, hands on activities, practical communication skills

Introduction

Japan maritime colleges (Kosen) and Kauai Community College (KCC) co-execute a three-week cultural exchange program, specially designed for Japan maritime college students, every March. As the first program was held in 2010, 10th program is going to be held in next March. In this paper, the authors would like to share our experiences in these programs.

History

One of the traditional voyaging canoe, “Hokulea”, sailed from Hawaii to Japan in 2007. As Hokulea is a symbol of Polynesian traditional voyaging, her visiting to Japan was a big news. Many Japanese people related with her voyage. In this circumstance, the authors, namely, Mr. Chun, Mr. Oku, Ms. Ikeda knew each other on the canoe. They discussed how to educate maritime students. One idea was a program related with Polynesian traditional voyaging on Kauai. Although there were many kinds of barriers, the related people solved the problem one by one, and the idea was finally implemented. The first program was carried out on March 2010. Only Toyama College students participated in the first program. As the first program was a great success, the program expanded for all Japan maritime college students. Since then, 8 to 16 students of Japan maritime college join the program every year.

Volunteers in Kauai built their own voyaging canoe, named “Namahoe”. Figure 1 is a picture of Namahoe, taken during the program. It took more than about 15 years for completion. She was launched in 2016. During her building, Japan maritime college students got opportunities to build her as a part of this program. They sanded, varnished, and tied lashing. Hawaiian people believe the power of “mana” or sincere heart. If many people relate with building the canoe with sincere heart, it strengthens the canoe. From this point of view, the maritime students played important roles.

Figure 1  A traditional voyaging canoe, Namahoe.

Program Outline

The program is entitled “Ikena Kahua” in Hawaiian language. It means “Seek your foundation”. Through lessons from traditions, the students are expected to find the foundation of their life.
The main topic of the program is Polynesian traditional voyaging, namely, wayfinding without modern navigation instruments. They know the direction and their position from everything in nature, such as the sun, stars, waves, clouds, birds, and so on. Kyselka (1987) published a book about the Polynesian traditional voyaging and Hokulea. The technique made the Polynesian people possible to voyage on the Pacific Ocean in ancient times. As Japan maritime colleges (Kosen) educate the students who will be a captain or a chief engineer of ocean-going large vessels, it is important for the students to learn how to have good relationships with the ocean. The program focuses not only on the technical aspect of the traditional voyaging but also on the good relationship between the people, who related with the traditional voyaging, and the ocean.

The period of the program is about 20 days. The students learn about Polynesian traditional voyaging in KCC on Kauai Island in Hawaii for first two weeks. They learn the fundamental theory and practical procedure for traditional way finding with KCC students in the KCC classrooms in the morning. Figure 2 shows a picture of the class. They also learn the Hawaiian traditional culture, the history of Japanese immigrant on Kauai.

They also participate in Japanese class of KCC. In this class, KCC students and Japan maritime college students teach their own language each other. Japanese students are motivated to learn English by communicating with KCC students who learn Japanese as a foreign language. In addition to that, as the KCC students who take Japanese class are interested in Japanese culture in general, the students can make KCC friends easily.

The students work on off-campus activities in the afternoon. They build/maintain the voyaging canoe, Namahoe, learn how to swim or float if they fall overboard from the canoe as ocean training, and so on. The accommodation has a kitchen in each room. During the program, they cook dinner by themselves and eat together in the escorting teacher’s room. After the dinner, they reflect the things on the day together, facilitated by the escorting teacher. All elements in daily life is a part of the program.

The motto is “Help each other.” A student who are good at English, he/she should shear his understanding to the other students. A student who are good at cooking, he/she should guide the other students in preparing dinner. A student who swim well, he/she should support the instructor of the ocean training, and so on. As the program includes great variety of elements, we expect all the students make use of his/her advantage and learn as much as possible as a group.

The students participate in a special program of crew training for the traditional voyaging canoe in the third week. The people who relates with the Polynesian voyaging join the training from all over Hawaiian Islands. The number of people depends on the year, but it can be up to 80. They camp together like on a voyaging canoe. The attendees are divided into 3 or 4 groups, so called “watch”. They go along as a group in the program. Three or four students belong to each watch. The students are surrounded by the Hawaiian people who are interested in voyaging canoe. Figure 3 shows a picture taken in the training. They simulate the life on the voyaging canoe and experience/learn more about the Polynesian voyaging and relationship with the ocean.

Results and Discussion

All the students, who completed this program, find something important for his/her life. Some students reconfirm that they have had a good relationship with the ocean. Some students find how to communicate with a person who has different cultural background. Some students start studying English more zealously. As a result, most of the graduates are hired as an officer or an engineer of large vessels or went on to universities or advanced course of Kosen.

Conclusions

The authors report the cultural exchange program, specially designed for Japan maritime college students to share our experience. We hope many attendees are interested in this program through this paper.

References

DOES SEEING MEAN LEARNING WHEN USING TECHNOLOGY-ASSISTED AIDS?
A PILOT STUDY TO UNCOVER LEARNERS’ VISUALIZATION PATTERNS AND COGNITIVE PROCESSES WITH EYE-TRACKING AND INTERVIEW PROTOCOL TO INVESTIGATE MULTIPLE REPRESENTATIONS IN CHEMISTRY

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Abstract

Eye tracking methodology is well-established in market research, UI/UX design and would possibly see greater adoption in AR and VR design. In contrast, eye tracking in education research is relatively nascent. An obvious application is to explore how multimedia instructional design impacts eye movements and learning. STEM subjects, with its emphasis on multi-modal learning, is well-suited for eye tracking studies.

This small pilot study explored if watching an animation movie incorporating multi-media design (MMD) elements such as narration or visual cues, enhanced multi-modal representation competency. The reaction involving silver nitrate and copper was presented on a silent video showing macro-level changes (experimental or E) and another animated video at the molecular level (M). Five learners with Chemistry background from a PhD granting institute from Northeastern USA were eye tracked in the initial view of both videos, on the Tobii Pro T60 with a sampling frequency of 60 Hz. Participants also drew molecular sketches, imagining the behavior of molecules and ions. An interview protocol was used to gather verbal comments in the retrospective gaze plot replay on the M clip. Changes in molecular sketches were made retrospectively. The first-cut descriptive statistics on the M clip indicated that time to first fixation, fixation duration and frequency were enhanced with narration and visual cues. Participants’ verbal comments also corroborated these eye metrics, and revealed the underlying cognitive processes. Water molecule was a salient feature in the animation and was a critical conceptual bridge between both clips. However, no participants described how water molecules caused color change, and only one participant added water molecules in the after-replay sketch. Thus, noticing or acknowledging conceptually critical features might not lead to desired ability in multi-modal articulation.

Although this pilot study precluded deeper statistical analysis, it demonstrated the application of eye tracking to validate instructional design. Invisible cognitive processes could be uncovered with an interview protocol. Data analytics could be used to analyze the massive amount of data from eye tracking work, and shape classroom delivery to better emphasize conceptual linkage between different representations.

Keywords: Eye tracking, multimedia design, chemistry, animation, STEM visualization, multi-modal representation

Introduction

Chemistry is a subject that demands competent integration of chemical knowledge across multiple domains. The triplet nature first introduced by Johnstone (1982) in his seminal article suggested that there are three distinct domains translating into the “macroscopic”, “representational” and the “submicroscopic” realms. The macroscopic level represents directly perceptible chemical phenomena collected through experimental observations. At the other end of the spectrum is the imperceptible domain depicting the subatomic particles. This level provides the all-important explanation of how molecular changes drive macroscopic phenomena. To complicate the learning experience, learners also need to master the representation symbols of the subject, such as chemical equations and formulae. Subject mastery requires the integration across all three levels.

Therefore, technology-assisted instruction could be used in Chemistry instruction to help learners integrate invisible atomic phenomena with the macroscopic world. A critical question of interest to Chemistry educators is what learners attend to when they view learning aids like animations. Are they looking at and processing the important on-screen features intended to facilitate the learning of specific learning content? While eye-tracking method has its early roots in reading research (Just & Carpenter, 1980), the technology has today attracted largely gaming and commercial applications (Chrobot,
Eye tracking used in tandem with interview protocol has gained momentum in education research, to understand how learners devote cognitive and visual resources while viewing computer-mediated materials. In the area of chemical education research, researchers presented a review of application practices in a symposium at the American Chemical Society (Havanki & VandenPlas, 2014).

Eye tracking also allows the empirical validation of multi-media design (MMD) principles. Mayer (2008) proposed 10 principles of effective MMD to optimize the technology learning experience. These design principles recognize the limited working capacity of our cognitive processing systems. Of the 10 principles, signalling and temporal contiguity are tested in this small pilot study using eye-tracking and interview techniques. Signalling is to annotate critical on-screen features to direct viewers’ attention. Timing a spoken narration in close proximity with the target feature is known as temporal contiguity.

**Materials and Methods**

**Study materials:** Three animation materials were used, each depicting a reduction-oxidation (redox) between aqueous silver nitrate and copper. One silent video clip showed the reaction occurring at the macroscopic or experimental level (E clip). The second non-narrated clip presented several mis-representations of events occurring at the molecular level, which was not used for the current study. The third animation of interest was clip M, a fully narrated animation of the same silver-copper redox reaction at the molecular level. The original animation was based on the Vischem visualization clip (http://www.visichem.thelearningfederation.edu.au/topi c13.html). The project team sought permission to modify the original clip for this study. The modified M clip included signalling cues (circles) to annotate critical on-screen features and timed audio narration to describe the interaction between the molecular entities. Screen shots of both the E and M clips are shown in Figure 1.

**Equipment:** Eye movements were recorded on the Tobii T60 with a sampling frequency of 60 Hz. This meant that the software sampled 60 gaze points per second. The Tobii Studio program (version 3.2.3) was used to generate the eye movement metrics such as total fixation duration (TFD) and number of fixations for the AOIs described in the last section. A fixation was defined as a pause in eye movements of 60 milliseconds or longer, a default value recommended by the manufacturer (Tobii Technology AB, 2015). The stimuli were presented on a computer monitor screen of size 42.5 cm with a resolution level of 1280 pixels wide and 1024 tall. At the beginning of each eye movement recording, the equipment was calibrated. All first views (E and M) and subsequent cued retrospective verbal recall (M only) were eye tracked.

**Eye movement data:** The eye metrics measured are time to first fixation (TFF), total fixation duration (TFD) and fixation counts of the AOIs. Table 1 summarized the definitions and computation method of each eye data.

**Table 1. Definitions and computation method of eye metrics.**

<table>
<thead>
<tr>
<th>Eye metric</th>
<th>Time to first fixation (TFF)</th>
<th>Total Fixation Duration (TFD)</th>
<th>No. of fixations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td>Time taken to first fixate on the intended object</td>
<td>Percent time spent fixating on the AOIs within the segment</td>
<td>Number of fixation on AOI (&gt;60ms)</td>
</tr>
<tr>
<td>Computation method</td>
<td>Difference in time to first fixation the moment the AOI screen appeared and the time to first fixation on the AOI itself</td>
<td>Fixation duration of AOI + Frame duration</td>
<td>By software</td>
</tr>
</tbody>
</table>

**Areas of interest (AOIs):** In order to obtain eye movement statistics, the target on-screen features on M must be identified. In this study, six AOIs were identified for the analysis of eye movement metrics on the M clip.
These AOIs not only convey the critical chemical phenomena (the electron exchange interaction between silver and copper, the clustering of water molecules), the scenes in these AOIs also highlighted the saliency of the MMD features, namely signalling and temporal contiguity. Since M is a movie, the position of the AOI differed frame-by-frame. Thus, the AOI was mapped on a per-frame basis, excluding segments of pauses. This was done by tracing the path of the target object, from the moment it appeared on-screen, to the moment it disappeared. Care was exercised to ensure no overlapping of the frame to prevent double-counting of the eye movement data. Table 2 summarized the properties of each AOI.

### Table 2. Summary of the AOIs.

<table>
<thead>
<tr>
<th>AOI</th>
<th>Molecular species</th>
<th>On-screen events</th>
<th>Prior narration</th>
<th>Time (sec)</th>
<th>MMD principle</th>
<th>Mean segment duration (SD), sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16-s Ag (non-circled)</td>
<td>Entry into scene and motion towards copper lattice</td>
<td>At start of clip</td>
<td>16</td>
<td>Signalling X Temporal contiguity X</td>
<td>1.80 (0.20)</td>
</tr>
<tr>
<td>2</td>
<td>31-s Ag (circled)</td>
<td>Motion towards copper lattice</td>
<td>At 19 s</td>
<td>31</td>
<td>Signalling ✓ Temporal contiguity X</td>
<td>4.84 (0.17)</td>
</tr>
<tr>
<td>3</td>
<td>56-s Ag (non-circled)</td>
<td>Previously settled onto lattice</td>
<td>No</td>
<td></td>
<td>Signalling X Temporal contiguity X</td>
<td>2.24 (0.17)</td>
</tr>
<tr>
<td>4</td>
<td>56-s Ag (circled)</td>
<td>Entry into scene</td>
<td>At 36 s</td>
<td></td>
<td>Signalling ✓ Temporal contiguity X</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>56-s H$_2$O-Cu (non-circled)</td>
<td>• Extraction of copper atom by water molecules • Movement of water-copper system</td>
<td>At 36 s</td>
<td>56 - 65</td>
<td>Signalling X Temporal contiguity X</td>
<td>2.56 (0.22)</td>
</tr>
<tr>
<td>6</td>
<td>73-s H$_2$O-Cu system (circled)</td>
<td>• Extraction of copper atom by water molecules • Movement of water-copper system</td>
<td>At 65 s</td>
<td>73</td>
<td>Signalling ✓ Temporal contiguity ✓</td>
<td>3.52 (0.18)</td>
</tr>
</tbody>
</table>

Chemical symbols Silver: Ag, Water: H$_2$O, Copper: Cu. MMD annotation observed: ✓, violated: X

Participants: Five undergraduate students from a large PhD granting institute from Northeastern USA volunteered for this study; the data was collected between February to April 2015. All of them had taken general chemistry courses in the last 12 months. IRB approval was obtained and participants were compensated for their time.

Procedure: A mix of eye tracking and interview was deployed, since eye tracking can only tell where participants were looking, not why they were looking. The interview was guided by a protocol developed by the second author. Some parts of the responses were audio recorded, while other questions required written responses on paper. After calibrating the eye tracker, participants watched clip E first, eye tracked. They were asked to describe what they thought E showed, its purpose and wrote down on paper its important features. One important artefact produced at this stage was the molecular sketch; where participants were prompted to draw events they imagined happening at the molecular world. They were also asked to relate features in their sketch which were in congruence or otherwise, with E. Participants were not shown their gaze plots which traced the movements of their fixations.

Participants then watched clip M and were eye tracked. They were prompted to think of how the events in M were congruent or incongruent with experimental
evidence from clip E. Next, the eye movements were reviewed by the participants. During the gaze plot replay, participants were prompted to describe why they looked at those features with “red dots” (that is, fixation points), audio-recorded. After the gaze plot replay, participants were given their earlier molecular sketches to make changes. Reasons for adding new features or not adding them were audio-recorded. Figure 2 summarized the flow of the study.

(1) Watch clip E

(2) • Describe purpose (recorded)
• List features congruent / incongruent with clip (paper)
• Molecular sketch (paper)
• Compare sketch with E

(3) Watch clip M (molecular)

(4) • List M features congruent/ incongruent with clip E (paper)
• Compare sketch and M attributes (recorded)

(5) Clip M gaze plot replay
• Reasons for looking (recorded)

(6) Molecular sketch changes
• Reasons for and not changing sketch (recorded)

Figure 2. Overview of procedures.

Results and Discussion

Figures 3, 4 and 5 showed a trend in that AOIs in clip M that were annotated, using a circle or with prior narration timed in close temporal proximity, tended to garner shorter time to first fixation (TFF), longer fixation duration and more counts of fixation. This is consistent with literature findings (Boucheix & Lowe, 2010; de Koning et al., 2010). In particular, in a very busy scene such as in AOI 5, multiple events were occurring, such as the “tugging” between the silver and copper, the motion of the ejected copper ion and the clustering of water molecules around it. With quite a number of simultaneous features shown, the non-annotated AOI 5 did not attract participants’ attention at all. The same scene, replayed in AOI 6, with circles as the signalling cue and narration, showed heightened visual attention and shorter time to notice.

The verbal responses of the participants recorded during the cued gaze plots replay also supported the trend that well-annotated cues in an animation film attracted attention. Some examples of such responses are shown in Table 3.

Table 4 compared the features in the molecular sketches of each participant, before and after watching clip M. It can be seen that the most commonly omitted feature, even after review of M, was the water molecule.

Only participant 1 (P1) added water molecules in the post-M sketch. P1 also uttered more frequently about water molecules during the gaze plot replay, as evidenced from the verbatim:

“I was also when the copper was leaving, looking at all the water molecules that seemed to be surrounding it.”

“I was trying to count the number of water molecules I thought was around the silver.”

“And then here again, I was trying to count the number of water molecules around the copper.”
Table 3. Participants’ verbal responses supporting MMD features.

<table>
<thead>
<tr>
<th>MMD feature</th>
<th>Participants’ utterance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporal contiguity (of narration)</td>
<td>“But it did like, repeat itself. So it said “let’s watch that again”, and then, then I looked at the parts, so like there are parts that I missed, that I made up for”. (P2)</td>
</tr>
<tr>
<td>Temporal contiguity and signalling</td>
<td>“Well, in general, it was mostly the first time, ya, I was not looking at it. And then when they, when the animation was like “did you notice that, let me replay it”, and then they highlighted it, then that was when I looked it at.” (P5)</td>
</tr>
</tbody>
</table>

A scene-by-scene qualitative examination of P1’s gaze patterns in AOI 6 also revealed that this participant tended to also fixate on non-annotated features, such as the water molecules and copper atoms.

![Scene 1](image1.png) ![Scene 2](image2.png)  
![Scene 3](image3.png) ![Scene 4](image4.png)  
![Scene 5](image5.png)

Figure 6. Gaze patterns of participant 1 (AOI 6). Dots indicate fixation locations, highlighted by arrows.

Although participants had multiple opportunities to describe the relationship between clips M and E, none of them spoke about the effect of water molecules on the color change. While P1 took notice of water molecules, there was no mention of the concept that the color change was caused by the clustering of the water molecules around the copper ions as they left the lattice. Other participants did not take much notice of water molecules, as seen from the eye movement data.

Table 4. Features of molecular sketches before and after watching clip M.

<table>
<thead>
<tr>
<th>P</th>
<th>Before M</th>
<th>After gaze plot replay</th>
<th>Still missing features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>• Correct Ag charge</td>
<td>• H$_2$O molecules around Cu</td>
<td>H$_2$O molecules around Ag</td>
</tr>
<tr>
<td></td>
<td>• Correct Cu charge</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• NO$_3^-$ ions</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Cu lattice</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Electron transfer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>• Correct Ag charge</td>
<td>• Cu charge to $+2$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Cu lattice</td>
<td>• Mol ratio of 2 Ag to 1 Cu</td>
<td>H$_2$O molecules around silver</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>H$_2$O molecules around copper</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NO$_3^-$ ions</td>
</tr>
<tr>
<td>3</td>
<td>• Correct Cu charge</td>
<td>• Ag charge to $+1$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Mol ratio of 2 Ag to 1 Cu</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>• Correct Ag charge</td>
<td>• Mol ratio of 2 Ag to 1 Cu</td>
<td>H$_2$O molecules around silver</td>
</tr>
<tr>
<td></td>
<td>• Correct Cu charge</td>
<td></td>
<td>H$_2$O molecules around copper</td>
</tr>
<tr>
<td></td>
<td>• Cu lattice</td>
<td></td>
<td>NO$_3^-$ ions</td>
</tr>
<tr>
<td>5</td>
<td>• Correct charge on silver</td>
<td>• Cu lattice</td>
<td>H$_2$O molecules around silver</td>
</tr>
<tr>
<td></td>
<td>• Correct charge on copper</td>
<td></td>
<td>H$_2$O molecules around copper</td>
</tr>
<tr>
<td></td>
<td>• NO$_3^-$ ions</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Mol ratio of 2 Ag to 1 Cu</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Conclusions

Although statistical analysis would not be meaningful due to its sample size, the current study highlighted the usefulness of eye tracking to evaluate MMD elements in technology-based learning and teaching aids. The eye movement data revealed a trend that a well-designed multimedia tool, integrating both cueing and vocal narration timed at appropriate intervals, would make learners pay visual attention. Retrospective cued replay
followed by interview would be a useful method to corroborate the eye metrics.

However, it does not necessarily imply that noticing a critical feature would mean learners could translate its intended conceptual meaning to another representational mode. Despite a very clearly annotated and conceptually correct clip M to show the unfolding of molecular interaction, none of the participants uttered a relationship between the critical role of water molecules to the macroscopic color changed in clip E. A more intentional approach to facilitate this conceptual linkage is necessary in classroom teaching strategies.

One key takeaway from this work is that eye tracking requires clarity on what data to look for, as it generates a massive amount even for this small-scale pilot study. Eye tracking and data analytics embedded in AR/VR technology learning aids could be well-poised to evaluate learning efficacy, as such tools see increasing application in the classroom.

Acknowledgements

The data for this paper was collected as part of a cross-institute collaborative project to investigate multiple representation in Chemistry. The first author would like to thank Prof. Resa Kelley (San Jose State University) and Prof. Roy Tasker (Purdue University) for their permission to use the stimuli materials and to participate in the study. Special thanks also to Prof. John B. Black for his guidance on research practicum methods and to Dr. Peter Gordon (TC) for his kind admittance to the eye tracking facilities.

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Tobii Pro (2013, April 9). *Tobii studio and dynamic stimuli* [Video file]. Retrieved from https://www.youtube.com/watch?v=vLnCevz6QgA&feature=youtu.be&t=39m15s


Sample of participants molecular sketches. Bold ink shows additions after gaze plot replay of clip M.
MIRROR IMAGES ON THE SURFACE OF THE WATER

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Abstract

As a mathematical teaching material for students at the national college of maritime technology, we used mirror images on the surface of the water. The aim is to make attractive unique teaching materials. From the viewpoint of fusion of mathematics and art, we analyzed paintings mathematically. We deal with the distortion of the mirror image in the landscape paintings drawn by Henri Le Sidaner. He is a French painter who worked at the beginning of the 20th century and painted many mirror images in stippling influenced by impressionists and symbolism. In the mirror images of his paintings, we mathematically investigated whether Desargues’s theorem holds and whether there is stretching and shrinking of the mirror image on a concave curved surface. The reason for studying his paintings mathematically is that there is only one painting whose mirror image is collapsed in a few paintings depicting the landscape of the same canal. This time, we introduced the distortion of the mirror image to our students as a mysterious story. We showed pictures to them and observed the process they solved the puzzle, and examined their educational outcomes. Henri Le Sidaner’s drawing style is to express the existence of absence, which is to imply signs without drawing people or creatures on the screen. We explained his style to our students and examined the distortion mathematically. Here, we explained the geometric perspective in the mirror image and the elongation of the mirror image in the depression of the water surface. Our students tried to solve the mystery about the mirror image distortion. The cause of the mirror image distortion was stated by our students as follows: "After a ship passed", "Someone threw a stone", "After throwing away the garbage", "After an animal passed by", "There was a fish", "The mirror image is shifted by the waves", "The surface of the water was shaking", and so on. From the results of the questionnaire, we got impressions that 80 percent of our students had been interested in elementary geometry through solving the art puzzle.

Keywords: teaching material, mathematics, geometry, mirror image, Desargues’s theorem, paintings, art, Henri Le sidaner, maritime technology

Introduction

We develop teaching materials to active motivation for mathematics. We incorporate games and puzzles into lessons to revitalize students’ motivation and autonomy and to improve academic ability. This time, we aim to study the geometry of mirror image, perspective, etc. in paintings under the viewpoint of fusion of mathematics and art and to make use of them as teaching material. Also we aim to research "fun mathematics fused with art".

In the first half of this paper, we describe the mirror image shift in landscape paintings by French painter Henri Le Sidaner. In the mirror image of the paintings, we mathematically consider whether the Desargues’s theorem holds and whether the mirror image is elongated in a dented horizontal plane or curved surface. In the second half, we describe the use of mysterious stories as teaching materials in class. After we showed the picture to the students, they gradually solved puzzles by taking some steps. We investigated the outcome. In particular, we examined changes such as motivation.

Materials

(1) About Henri Le Sidaner ([2],[3],[5],[6])

Henri Le Sidaner (1862-1939) is a French painter born in Mauritius Island in the Indian Ocean. He belonged to a sailor family originated in the Brittany region, in fact both father and grandfather were captains of oceanic shipping vessels. At the age of ten, he moved to Dunkirk, a neighbor of Belgium in the northern part of France. After that, Henri Le Sidaner moved to Paris and entered private school of the academic school painter Alexandre Cabanel, and also entered the National Art School. He painted a stipple drawing under the influence of Impressionists, New Impressionists and Symbolism. He pursued drawing the light. However, he stuck to subtle pale light such as twilight, moonlight and thin light, which was not the bright sunlight shining drawn by Impressionists such as Monet but the momentary light at the turn of day and night. He left many landscape paintings mainly on coverage of the northern part of France such as the Normandy region. In the early 1900’s, he left many landscape paintings at Gerberoy in Oise, which is an important place in the lifetime of Henri Le Sidaner. He set up a residence and atelier in this rural town which is less than 100 km from
Paris, and remodeled the garden, and left a lot of familiar landscape paintings. From this time, he stopped painting people on the screen. In many cases, he painted familiar landscapes under thin light such as garden and alley where rose flowers bloomed, houses along canals and rivers, stairs and windows of houses, tables and chairs, etc. People are not drawn anywhere, but he painted something like a sign as if someone passed by a while ago, a trace as if a person was relaxed, and a window light that suggested family activities there in a quiet space. The characteristic of his work is to express "the existence of absence". His paintings make us feel the thickness of time and the warmth of a person. He is said to be one of the intimists who draw familiar objects. Intimism was established by Vermeer and De Hooch in the 17th century, and Bonnard and Vulliard were intimists of the same era as Henri Le Sidaner. Since Henri Le Sidaner drew many mirror images when drawing houses along canals or rivers, he could be said to be a "mirror image painter". As an aside, since Henri Le Sidaner planted many roses in Gerberoy, Gerberoy came to be known as one of the most beautiful towns in the world.

(2) On the mirror image of the canal in Nemours

Henri Le Sidaner has repeatedly painted the canals in Nemours. Nemours is the city facing the Loire river located in the southern part of Fontainebleau in the region of Ile-de-France, which is a little away from Paris. Among the works of Henri Le Sidaner there are a lot of paintings depicting houses along the Nemours canal in various media such as drawings, oil paintings, pastel drawings, lithographs. "Small table in evening dusk" drawn in a large size of 100 cm × 81 cm is an oil painting on the canvas. It is in the Ohara museum which is the first Western art museum in Japan. "Small table in evening dusk" drawn in 1921 is a stipple drawing of the canal in Nemours. It is a beautiful painting gathered up by cold colors peculiar to Henri Le Sidaner. It is a stipple painting of somewhat slender touch drawn by superimposing blue and orange of its complementary color. It seems to be one of the most popular works since many people gathered in front of this painting in the retrospective exhibition of Henri Le Sidaner in Japan from 2011 to 2012. The first step of the painting method of Henri Le Sidaner is to paint on small panels with oil painting outdoors. Next, he confirmed the difference in color value of croquis and drew a more accurate sketch. After drawing the sketch, he transferred it to canvas by using grid lines at the atelier. The painting drawn on the small panel of 22 cm × 28 cm in the Valenciennes Art Museum was drawn in 1920. With regard to the canal in Nemours, it was drawn in the relatively early stage. It is presumed that other Nemours works by Henri Le Sidaner such as drawing, oil painting, pastel were created based on this painting. As for the work "Small table in evening dusk", firstly it was painted outdoors, then the one with colors put was drawn and a table and chairs were added in the atelier of Gerberoy. Then again, he returned to Nemours for about two days. He checked the details and finally completed it with another atelier in Versailles. Mr. Yann Farinaux-Le Sidaner, who is a great grandchild of Henri Le Sidaner and an art critic, told me the above in 2012. At this time, Mr. Yann Farinaux-Le Sidaner told that Henri Le Sidaner was interested in the mirror images on the water surface. A small pastel painting (30 cm × 20 cm) drawn in almost the same composition as the work in the Ohara museum is in the Lambinet Museum in the vicinity of the Palace of Versailles (Figure 1). But what is placed on the table is different from the work in Ohara museum. In both paintings, the roofs of the houses and the mirror image are heading for a single vanishing point. In his works in 1920, there is "houses along the river under the moonlight" (Figure 2). In the title there is "along the river", but this is a lithograph depicting the canal in Nemours under the moonlight. Lithograph is a stone print making use of repulsion of water and oil, and the picture which is drawn becomes print as it is. There are many lithographs by Henri Le Sidaner. "Stairs", "Pavilion", "Balustrade", etc. were drawn. Those are landscape paintings where people are not drawn, and the things around us such as stairs and windows are focused on. The same canal is also drawn on the cover of the Le Sidaner study book by Camille Mauclair published in 1927 (Figure 3). Figure 4 is the scenery of the Nemours Canal in December 2015. We looked for the place by Google Street View. We went to the scene. Although it is a landscape after about 100 years, we confirmed the present mirror image. We confirmed that the perspective on the houses and the mirror image in "Small table in evening dusk" is the same as the actual one and is correct.

Figure 1."Small table in evening dusk"
(Pastel, Photographed with Permission by the Lambinet Museum)
Figure 2. "Houses along the river under the moonlight" (lithograph, Owned by the author)

Figure 3. Le Sidaener by Camille Mauclair (Owned by the author)

Figure 4. The Nemours canal in December 2015

Figure 5 shows the simplified representation of three points of the roof on land and three corresponding points in the mirror image in "Small table in evening dusk". In Figure 5, we draw straight lines connecting two points (A and B, B and C, C and A) out of three points of the roof on land. Also we draw straight lines connecting two points on the corresponding mirror image (A' and B', B' and C', C' and A'). There are three intersection points (D, E, F). The three points D, E and F are on a straight line and satisfy the Desargues's theorem. In general, there are three vanishing points when looking up or looking down at the building without looking at it from the front. The case of Figure 6 is the general Desargues’s theorem for three vanishing points. And this case is the Desargues’s theorem for AA', BB', CC' whose extended straight lines intersect at a single point G (G, common point). Figure 5 shows the Desargues’s theorem in the case where AA', BB', CC' are parallel and the common point is infinite. In the "Small table in evening dusk", the Desargues’s theorem holds, and the roofs of the houses along the canal and the mirror image reflected on the water surface also is headed for the vanishing point faithfully to the geometric perspective. However, in the lithograph, the mirror image reflected on the water surface is not headed for the vanishing point (Figure 2).

Figure 5. two vanishing points

Figure 6. three vanishing points

Discussion

(1) Deviation of mirror image on the water surface

In the lithograph "Houses along the river under the moonlight", the houses along the canal on land are faithful to the geometric perspective and headed for one vanishing point (Figure 2). However, the image of the houses reflected on the surface of the water is not an accurate mirror image (Figure 2). Meanwhile, the roofs of the houses along the canal and the mirror images of roofs reflected on the surface of the water in the painting called "Small table in evening dusk" and other paintings depicting Nemours canal are headed for the vanishing point (Figure 1, Figure 3). They are paintings about 100 years ago, but they agree with the current mirror image (Figure 4). Why did such a deviation occur in the same scenery? Henri Le Sidaener studied at the National Art School and also acquired painting techniques. In Dunkirk he received a scholarship in painting and was selected also in the salon. Later he was elected president at the Institute of France. In this
discussion, we assume that Henri Le Sidaner who had repeated the studies in one motif did not make trivial mistakes in perspective. In fact, as we mentioned in the previous section, he painted drawings first and transcribed them to canvas by using grid lines, then returned to the field to check the detail. From the above, we can say that Henri Le Sidaner was cautious. In other words, it is unlikely that he was careless enough to make an easy mistake in perspective and overlook it.

(2) Position of absence as existence

We further thought about the deviation of the mirror image in the lithograph from the viewpoint of "absence as existence" which was the style of Henri Le Sidaner which implied a sign of a person without drawing a person. It can be inferred that the scenery of the lithograph "Houses along the river under the moonlight" was the state just after a transport boat passed by or a water bird dived into the water. Probably at that moment about a hundred years ago, a mirror image artist Henri Le Sidaner would have watched closely the situation along this canal. Immediately after the ship passed, the water surface was still dented and the mirror image might be distorted. Alternatively, it may be that a waterfowl dived in the water and a part of the water surface was dented into a concave mirror, and the mirror image was elongated. When we actually went to this place in Nemours in December 2015, we saw a lot of water birds dive and the water surface was dented. From this, it can be inferred that waterfowls have existed here since long ago. On the other hand, the scene after passing through was not drawn in "Small table in evening dusk". There are chairs and a table, and the light of a window in the painting (Figure 1). By adding them in Nemours canal, it seems that Henri Le Sidaner's nature that makes us feel a sign without drawing people, etc. was fully satisfied. Henri Le Sidaner did not dare draw human beings and water birds and other living things on the screen, but we guess that he implied the existence and business by drawing the partial deviation of the mirror image in the lithograph. In this lithograph, we think that Henri Le Sidaner expressed their existence without drawing ships and waterfowls, etc. It can be said that Henri Le Sidaner expressed and arranged the absence in this screen as one of various existence by drawing a partial mirror image deviation in the lithograph.

(3) Mirror image on the water surface

Figure 6. Mirror image on a horizontal plane

Figure 7. Mirror image on a dented horizontal surface

Figure 8. Mirror image on a dented convex surface

Methods and Results

(1) As a teaching material for puzzling

It was utilized as a mathematical teaching material for our students mainly in the department of Maritime Technology. The reason for targeting students mainly in the department of Maritime Technology is that they are in contact with the mirror image on the water surface on a daily basis, such as training at sea. We compared the lithograph "Houses along the river under the moonlight" (Figure 2) with the photo of "Small table in evening dusk" (Figure 1 or other painting of the same composition in the Ohara museum, etc.) and tried to solve the mystery of the mirror image shift. First of all, we explained the era and the background of Henri Le Sidaner and how to solve the puzzle by taking some steps. We proceeded in the order of ① to ④ below for about 100 students and raised the level according to what the students noticed. And we pulled out of the students more interesting opinions which were likely to be closer to the truth and finally approached the elucidation of the mystery of the collapsed mirror image. For good opinions and awareness, and unique ideas, we praised them and gave points (1 point, 2 points, · ·) as games.

① First of all, we asked the first impression of the painting and lithograph. There were impressions such as...
"A stipple drawing is beautiful", "The same landscape, but somewhat different", etc.

② Next, we asked what the students noticed. The first one we took up as a good opinion was "It's a mirror image so it's the same even if it is turned upside down." There was also an opinion that "The window is lit with light." Here, we explained the perspective method by using the picture of "Small table in evening dusk," and told them that the Desargues's theorem holds. In addition, we explained the principle of mirror image.

③ We asked if there was something incompatible with each other in the mirror images of the two pictures. Some students realized that the Desargues's theorem didn't hold in the mirror image of the lithograph.

④ Finally, we have the students think why the mirror image collapsed. Here, we explained "absence as existence" which was the style of Henri Le Sidaner. And we asked why the mirror image collapsed with reference to the style of Henri Le Sidaner. The cause of the mirror image distortion was stated by our students as follows; "After a ship passed", "Someone threw a stone", "After throwing away the garbage", "After an animal passed by", "There was a fish", "The mirror image is shifted by the waves", "The surface of the water was shaking", "Viewed from multiple perspectives", and so on.

(2) Result of the questionnaire

Finally, a questionnaire was conducted by anonymous. 77% of the students felt that this puzzle was interesting, 75% of the students thought that mathematics was related to their future jobs and professionals, 80% of the students felt that they had to do mathematics after solving this puzzle.

Conclusions

Actually, there are many students who usually dislike mathematics and are not interested in mathematics in our college. About 80% of the students felt that they had to do mathematics by solving this mystery. From this, it can be said that there was some effect as their motivation. Furthermore, we will continue to investigate the correlation between the results and motivations especially in the field of geometry.

Acknowledgements

The author would like to thank the students and staff of National Institute of Technology, Yuge College for their patience and goodwill in regards to this project.

References


Abstract

The study aimed to study the effectiveness of the workshop on improving career attitude and aquaponics related STEM knowledge on the participants. A series of STEM workshop - 9-hour in 6 sessions based on mini-aquaponics system was designed and carried out in four runs for four local Chinese-medium Instruction secondary schools over a period of 12 weeks. Total 117 secondary 1 to 3 students were recruited voluntarily from four schools.

A teaching package containing topics DIY mini-aquaponics system, system monitoring and technical setup modification, growth monitoring and sustainable farming was designed and delivered to participants as an experiential learning. Students involved in the activities that required them to carry out experiments after studying the manual, operated hand tools for assembly the system and fitting the tubes and electrical pumps, apply different scientific instruments e.g. balance, colour chart, dissolved oxygen meter to optimize the conditions of the aquaponics.

For studying the effectiveness of the workshop delivery, the pre-workshop and post-workshop questionnaires on students' interests in STEM content and careers and career attitude were conducted. Total 100 responses were received by the end of the workshop.

The survey on interests in STEM content and careers were adopted and translated from the STEM Semantic Survey by Tyler-Wood, Knezek and Christensen (2010). It is a 25-item instrument that measures interest in science, technology, engineering, and mathematics as well as interest in STEM careers generally.

The aquaponics related STEM knowledge was rated by analysing the results of worksheets submitted by the students after each session.

There was no large difference on students’ interest on STEM content by comparing the average score values of before and after the workshop. That meant the 6-session workshop lasted for 3 months did not help improving students’ interest and perception on STEM related topics or knowledge. Generally students are more interested in Science among all area and Technology is the second most interested area among all participants. This observation was same after the workshop. However the general perception on STEM career were decreased by 22.3% which is significant.

However the workshop was not designed to mention and discuss about the possible STEM career pathways explicitly with the students. They were expected to experience the tasks related to different area of STEM and internalised that experience on the sustainable farming tasks into a career aspiration. That was too difficult to junior secondary level students.

Keywords: Aquaponics, STEM workshop, Career attitude, Interest on STEM content, Experiential learning, STEM semantic survey.

Introduction

STEM career attitude development of a students was based on their STEM interest. Development of STEM interest is affected by many factors. These factors includes parents’ support, peer, academic results on STEM related modules, and experience and participation in STEM related activities, like reading on science related books or programme, workshops, day-camp and even competition.

Aquaponics STEM workshop as an out-of-school time science activities aimed to cultivate students’ interest on STEM.

Materials and Methods or pedagogy

Design of STEM learning programme and teaching package. A STEM teaching package related to aquaponics and sustainable farming for junior secondary students (secondary 1 to 3) were designed. It is a 9-hour programme for delivery of 6 lessons. The package consists of PowerPoint slides, teacher guide – the
session rundown and material plan, worksheet and suggested answer.

**Recruitment of participants:** Open recruitments were carried out by sending initiation emails to all local Chinese-medium instruction (CMI) secondary schools during summer of 2016 by email. The email addresses were provided by External Relation Office of VTC. First come first serve principle were adopted in the recruitment. The four schools are Sing Kung Hui Lui Ming Choi Secondary School (36 students), HKCCC Ho Fuk Tong College (24 students), Ling Liang Church MH Lau Secondary School (27 students) and Po On Commercial Association Wong Siu Ching Secondary School (30 students). Total 117 participants were enrolled and they were from secondary 1 to secondary 3. Finally 90 participants completed all 6 lessons of the workshop.

The workshops conducted as scheduled except Ling Liang Church MH Lau Secondary School and HKCCC Ho Fuk Tong College both requested to reschedule one of the lessons due to clashing to their school activity. All the workshops were completed by 17 December 2016.

**Data Collection**

**Preparation of workshop evaluation:** For studying the effectiveness of the workshop delivery, the pre-workshop and post-workshop questionnaire on students’ interests in STEM content and careers (Appendix I) were adopted and translated from the STEM Semantic Survey. The STEM Semantic Survey was based on Knezek and Christensen’s (2008) Teacher’s Attitudes Toward Information Technology Questionnaire (TAT) derived from earlier Semantic Differential research by Zaichkowsky (1985). It is a 25-item instrument that measures interest in science, technology, engineering, and mathematics as well as interest in STEM careers more generally. The five most consistent adjective pairs of the ten used on TAT were incorporated as descriptors for target statements reflecting perceptions of science, technology, engineering and mathematics (each separately). A fifth scale representing STEM career interests was also added by Tyler-Wood, Knezek and Christensen (2010). This instrument had been proved valid and reliable by Tyler-Wood, Knezek and Christensen (2010).

Focus group interview questions to voluntary participants were designed to collect any feedback from participants that may not be covered by the questionnaires. Those questionnaires and interview questions were submitted to research ethics committee and approval were obtained.

The questionnaires survey on students’ interest in STEM content and Career had been conducted before first session of the workshop started and after the last session of the workshop finished. Total 100 responses were received by the end of the workshop.

**Students’ Interest in STEM related learning content:** Study on Students’ Interest in STEM related learning content before and after the workshop were carried out with the STEM Semantic Survey. It was expected to increase students’ interest in STEM after they had participated in the 6-lesson totally 9-hour STEM workshop with mini-aquaponics system.

Since some students were absent in the first and some were absent in the last session of the workshop, direct matching of each students’ response were not meaningful. 99 responses were received in pre-workshop survey and 85 responses were received in post-workshop survey. Overall response with average values on each STEM area were compared as in table below.

The average score values of the semantic survey before and after the workshop were compared as data analysis to see if students’ interest had been improved.

**Participants’ STEM Career attitude after the workshop:** It was expected to be improved after the workshop. Instruments for assessing Interest in STEM Content and Careers (Appendix II) designed by Tyler-Wood, T., Knezek, G. & Christensen, R. (2010) were adopted. The Chinese translation of survey instrument is attached in the appendix. The average scores on three parts - Part 1 – Perception of supportive environment for pursuing a career in science, Part 2 - Interest in pursuing educational opportunities that would lead to a career in science and Part 3 - Perceived importance of a career in science were all at point 3 – undecided over a 5-point scale. Students were not sure about their career perception about science, although they relatively recognised the perceived importance of a career in science by giving a higher average score.

**Results and Discussion**

**STEM Semantic Survey:** The pre-and post-workshop Semantic Survey results were compared in table 1. There was no large difference observed out of the 7-point scale questions, where 1 represents least interested and 7 represents the most positive impression on that area. That meant the 6-lesson workshop lasted for 3 months did not help improving students’ interest and perception on STEM related topics or knowledge. Students are more interested in Science among all area and Technology is the second most interested area among all participants. This observation was kept the same after the workshop. However the general perception on STEM career were decreased by 22.3% which is significant.
Aquaponics correlate to any career in all the workshop explicit discussion on how the farming technology – down of nutrients in composting. Since there were no microbiologist studies the fermentation and breaking electricity need for aquaponics system; or Biologist or designs the solar system and grit system to provide electricity for aquaponics system – Potti® (Superfarm, 2016) ; Lesson 2 - water quality and plant and fish growth; Lesson 3 – Do-it-yourself aquaponics system set up; Lesson 5 – scientific instrument for water quality monitoring; and Lesson 6 – Aquaponics and sustainable farming. Although different farming technologies and techniques with science and engineering background were discuss during the workshop activities – farm design to participants in small group, no job function were mentioned in the discussion, like Energy Engineer designs the solar system and grit system to provide electricity need for aquaponics system; or Biologist or microbiologist studies the fermentation and breaking down of nutrients in composting. Since there were no explicit discussion on how the farming technology – aquaponics correlate to any career in all the workshop sessions, students could most probably directly correlate farmer as the related career of the workshop. This could explain why the average responded scores on all three parts were all in the grade 3 – undecided.

Hong Kong is a highly commercial society that over 90% of food import from other countries (Censes and Statistics Department, The government of the Hong Kong Special Administrative Region, 2018) Hong Kong students and their families are mainly not working in aquaculture and agriculture sectors. They cannot visualise how much STEM knowledge is needed to have good produce and harvest. What Hong Knog student may only know that being a farmer is a tough job that no one would like to do it. That's why the participants could not decide on their STEM career after the workshop. They were not sure about their career perception about STEM and had a decreased perceived importance of a career in science after the workshop.

Our studies showed that Students’ overall interest in pursuing educational opportunities that would lead to a career in science increased significantly by 4.8% (Table 2), but this was not a strong evidence as the average score after the workshop was still below 4. Only insignificantly number of students were affected by the workshop. That meant many participants had still not decided about the career to be STEM related and the workshops cannot improve students’ career perception.

There was nearly no change in average score on the level of agreement on the participants' perception of supportive environment for pursuing a career in science. This parts focused mainly on the supportive environment the participants encountered, for example from family and school. Since the programme only last for three months, it is difficult for observing the change in supporting environment change for individual participant.

### Workshop design and STEM Career Attitude:

STEM Career attitude was expected to be improved after the workshop. However the workshop was not designed to mention and discuss about the possible STEM career pathways explicitly with the students. They were expected to experience the tasks related to different area of STEM and internalised that experience on the sustainable farm tasks into a career aspiration. The skills in managing the aquaponics system was too difficult to junior secondary level students who may have no experience in growing plant or fish.

The workshop topics were all science and technology knowledge based. They were Lesson 1 - Aquaponics system set up – Potti® (Superfarm, 2016) ; Lesson 2 - water quality and plant and fish growth; Lesson 3 – Do-it-yourself aquaponics system set up; Lesson 5 – scientific instrument for water quality monitoring; and Lesson 6 – Aquaponics and sustainable farming. Although different farming technologies and techniques with science and engineering background were discuss during the workshop activities – farm design to participants in small group, no job function were mentioned in the discussion, like Energy Engineer designs the solar system and grit system to provide electricity need for aquaponics system; or Biologist or microbiologist studies the fermentation and breaking down of nutrients in composting. Since there were no explicit discussion on how the farming technology – aquaponics correlate to any career in all the workshop sessions, students could most probably directly correlate farmer as the related career of the workshop. This could explain why the average responded scores on all three parts were all in the grade 3 – undecided.

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<th>SCIENCE (Q1-5)</th>
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Table 1: Average score on different area of STEM Semantic Survey

Hong Kong: Currently Hong Kong New Senior Secondary School encourages a multidisciplinary development of students and analytical and problem solving skills instead of selecting a certain major scopes of study area before tertiary education. Although the student should have a stronger foundation for undergraduate STEM course if he or she could confirm to take STEM related subjects in senior secondary school, it is still common that students has not yet decided on their specialism until getting into university. 4-year undergraduate learning programme allows students to select their major within their faculty after first year study. That means students could decide on their major until 18 or 19 year-old. The participants of our workshop were around 12-15 year-old. It seemed that the workshop discouraged students to define their STEM career. The truth is that it was still far way to go before students’ had make their decision.

A comprehensive study (Dabney et al., 2012) that surveyed on university students about their frequency of joining different kinds of out-of-school time science activities and their development of career interest in STEM revealed that it took a long period of time to develop career interest in STEM. The time frame should be the whole middle school age. The frequency of participation should be at least several times per year for years in variety of activities, like workshop, day-camp, competition, as well as school science club, science non-fiction or science fiction reading or watching.
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Table 2: The change in average score on the level of agreement on the perceived opportunities for developing career interest in science – supportive environment, education and importance.

Many studies had showed that the probability of a student choosing a STEM career without previously established interest in STEM is far lower that that for a student who has had an interest since middle school with formal class activity (Krapp, Hidi, & Remmner, 1992; Lent, Brown, & Hackett, 1994). Our 12-week workshop with STEM related activities that increased participants’ experience in working on STEM related learning skills like observation, data collection and processing, evidence to support decision, and hands-on experiment conducting skills. These experiences are the foundation to establish students’ interest in STEM career. Hosting this kind of short-term, out-of-school time science activities were important to motivate students (Lavonen et al., 2008) on developing such interest, attitude (Prokop, Prokop, & & Tunniclidde, 2007) and career choice within STEM field.

Due to the limitation of resources, our study could only cover four secondary schools for a duration of 3 months. Our study positively demonstrated that short-term activities could not help much in developing students' career in STEM. Without a proper elaboration, the activity could even drive the students away from STEM interest. It is advised that parents and teacher should encourage students to participate more in different varieties of STEM activities for a longer duration of time, like two to three years at least, to see if the students could develop the STEM interest.

From the focus group interview, participants expressed that they loved joining the programme as they did not have good chance to work on experiments in Integrated Science practical class. Although they could not decide on the career in STEM after the programme, the programme did increase their interest on STEM that they could not have though before. It improved their impression on science subject. Participants reflected that some of the experiments were difficult for them. Even the teachers of the participating schools were shocked that their students could manage to handle six test kits and instruments in monitoring the water quality as well as fish body weight by completing the record sheet by the end of the session.

It is a matter of trust on students' performance, but it is also a matter of technical support from school. Each workshop session of our programme was supported by trained workshop helpers in a ratio of 1 helpers to 5 or 6 participants which is impossible for a secondary school to provide for each Integrated Science practical class. The workshop helpers were final year students of aged 18 or 19. They are from Higher Diploma in Environmental Protection and Management of Hong Kong Institute of Vocational Education (Sha Tin). They received training from all the workshop material planning, preparation as well as activity design. This may be also a good chance to recruit some tertiary students with related background to assist secondary school science practicals. This should facilitate an exchange on STEM related learning and career between students of different levels.

Conclusions

Mini-aquaponics STEM workshop was a well-constructed out-of-school time science activity. It was beneficial to developing students' interest in STEM content and career if it is being part of the longer time engaging STEM activities that students joined, for several years and several times per year. Joining once may increase their interest on STEM content shallowly by enhancing the related STEM working skills. Students can gain achievement from working on some tasks. Students need more practice and spiral the skills for creating new experiments in order to fully develop a STEM career. Family support is also important for students to acknowledge their direction. More training opportunities as out-of-school time activities should be provide to students so that they can learn without the pressure from academic performance.

Acknowledgements

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References

### Appendix I – STEM Content and Interest Survey Form

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### Appendix II – STEM Career Interest Survey Form

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MULTI-DISCIPLINARY OVERSEAS INTERNSHIP PROGRAM IN CHINA RADIO INTERNATIONAL

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Abstract

Our Department of Electronics and Computer Science provides the course “Practical Training” for 4th-year students. The course is compulsory and students go to their local companies and learn about work there for two weeks. Although overseas internships are increasing yearly, these run for less than two weeks, and some departments do not certify them as practical training. Moreover, some departments state that their courses are “not held in a company, but in universities or colleges,” so they do not certify these as practical training either. However, I believe that overseas internships are very valuable and have been seeking ideal overseas internships that all departments can certify as practical training. Six years ago I visited Japanese companies in Shanghai and Shenzhen in China. Some companies I visited admitted to doing practical training but, due to certain problems, such training was not conducted. I took the chance to travel to China Radio International (CRI) in Beijing, and I soon found this place to be ideal. After negotiation, the first overseas internship in CRI was held there in 2015, with three members participating. The purpose of CRI is to broadcast to the world about China. Workers at CRI mainly broadcast, make Web pages, and conduct interviews. In our school, however, we mainly study engineering and experiments. There is a lack of group communications in many companies in our society. This overseas internship is held during the summer vacation and, as university students in China also come to CRI, our students can conduct international exchanges with them. In this way students can study the company in China and the company’s ways of communication, while learning from Chinese students. The two weeks of the course are prepared through discussion with CRI staff, and I have based this on what worked and did not work in the past. The second time the course ran, there were four participants, but the third time saw this increase to 14 members in 2017. This was an ideal number for a multi-disciplinary overseas internship program. Some students became tutors to international students. Accordingly, we should see improvements in their communication skills.

Keywords: Multi-disciplinary, Overseas Internship, Communication Skills

Introduction

Our school has been finding new companies for years that accept overseas internship programs. Our school had overseas internship programs for Taiwan, Hong Kong, and Indonesia, but our school had no relationship with China.

Kosen is located in Nagano Prefecture, where there are many manufacturing companies. There used to be many factories in Nagano Prefecture, but they were almost all moved to foreign countries (mainly China). In this way, our school has a strong relationship with China and has been finding new companies there that accept overseas internship programs. I started to search for such companies in China six years ago.

Initially, I asked some companies with factories in China whether they could accept overseas internship programs. Internship programs in our school run for only two weeks and, although most students go to local companies, some join overseas internship programs. Companies often answer that they agree with overseas internship programs in China, but they believe that people in Nagano Prefecture are unwilling to travel abroad. In fact, many companies in Nagano Prefecture have factories in China; therefore, they are willing to adopt young people who do not hesitate to travel. Conversely, they do not generally accept overseas internship programs because they are anxious about how students might commute to work. Factories are located in the suburbs as well as in Japan. They are also anxious about places to live during the two weeks. Workers in China live in a room with many double-deck beds, with no washing machine, and they wash their clothes in buckets.

Teachers at Kosen were gathered in Hong Kong in May 2012, and I participated in this as a representative of our school. I took the opportunity to travel to Shenzhen and visited a factory of a company from Nagano Prefecture. The factory was very clean, but how
to commute there was a problem, even if I were to stay in a hotel.

If overseas internship programs in factories of companies based in Nagano Prefecture are not practical, what do we do? I have heard that many Japanese live in Shanghai where some of them conduct business. What if overseas internship programs were possible in large cities like Shanghai? Surely subway systems will mean that there is no problem in commuting? I traveled to Shanghai myself in August 2012 where I visited some Japanese companies and met with some Japanese who do business in Shanghai, and I asked them about overseas internship programs. They told me that people working in Shanghai need Chinese language skills. Indeed, if students work in factories, perhaps they do not need Chinese language skills but, students working in large cities do. However, internships would be possible for some people who do their own business in Shanghai.

I had a chance to visit China Radio International (CRI) in December 2013. CRI is “a state-owned international radio broadcaster of China; its overseas reporting involves 65 languages.” It has a Japanese Service section, in which about 30 Chinese people are involved. Here I heard about Chinese university students studying Japanese language who come to the Japanese Service section of CRI during summer. Consequently, I believe that overseas internship programs here would be ideal, because CRI is not a technology company, it has a vast range of people, and our students can experience a broad cultural exchange. I asked CRI if they accepted overseas internship programs and they said yes. Although it was too late to begin in 2014, our school began an overseas internship program running for two weeks at CRI in the summer of 2015.

The first overseas internship program at CRI in 2015

Three students (one male, two female) participated in the first overseas internship program at CRI in 2015. I made all the arrangements, bought air tickets, found hotels, and made reservations. Hotels with washing machines were required because of the two-week stay, but it was initially difficult to find such hotels in China. Buying air tickets was also difficult because it is too expensive in summer; however, I found cheaper tickets via Korea. There is no scholarship in this program, so some students participated with their own money from part-time jobs. I made every effort to save students money. By talking with CRI in advance, we had established what would be done in the internship program. Our program would involve the overseas visit and write an article online. We visited the Beijing branch of a company from Nagano Prefecture, another company begun by a graduate of our school, and a Japanese company CRI introduced me to that played an active part in Beijing. CRI’s Japan section has eight Chinese university students whom ours interacted with because they could all speak Japanese. They introduced themselves, discussed what is hot in their home country, what APP is useful, who is popular, and so on. Afterward, they decided on songs to be sung a few days later—our students chose a Japanese song to be sung by Chinese students, and the Chinese students chose a Chinese song to be sung by our students. CRI invited a Japanese man, who was traveling by bicycle in China, to give a speech and Japanese and Chinese students asked him. As one of the Chinese students was a Beijing University graduate student, she invited us to Peking University, which people cannot enter without permission. The Peking University campus is vast, and it took a whole day to explore. She then invited us to a school cafeteria. We saw dormitories on the same campus and, as she explained many things about the life of Chinese students, our students asked her many...

Figure 1 Self introductions

Figure 2 Singing a song together

Figure 3 Cafeteria in Peking University
questions. On another day one of the Chinese students invited us to where they live. In China, residential areas are separated and, as outsiders cannot enter them, this was a unique experience.

A few days later, all students gathered in a CRI recording studio where they sang. The Chinese students sang perfectly, though the Japanese students managed only to sing part of their song because that song was very rapid. Students praised one another and, in this way, the first overseas internship program ended.

**The second overseas internship program at CRI in 2016**

In the second overseas internship program in 2016, four male students participated (three were 3rd grade, one was 4th grade). Our students visited the editorial department of a magazine called “People’s China.” The students who had invited us to Peking University came to CRI for us this year and again invited us to the campus of Peking University. We were all deeply moved, and this shows the strength of our relationship. Also in 2016, a marvelous thing happened. When one of our students was reading a Japanese guidebook of Beijing on the road, two female Chinese university students discovered that it was a Japanese book, and talked to him. We then ate dinner together, and our students became acquainted with them. We traveled to Shijiazhuang—which is a sister city of Nagano—by high-speed rail. A woman who worked at the International affairs division of the Nagano Prefectural office guided us in Shijiazhuang because it was her hometown.

**The third overseas internship program at CRI in 2017**

At the third overseas internship program in 2017, participants increased to 14. Two were female, five members were 2nd grade, three members were 3rd grade, and the others were 4th grade. The reason for this increase might be due to holding a joint overseas internship program meeting, involving Taiwan, Hong Kong, Indonesia, and China. Our students visited the Chinese Academy of Social Sciences, which is “the premier and the most comprehensive academic research organization and national center in China to study in the fields of philosophy and social sciences.” Moreover, our students also visited the house of an honorary professor at Peking University, who was one of the Japanese children left behind in China who wrote an autobiography. They also visited the Beijing Youth Politics College. At the Beijing Youth Politics College, representatives introduced their schools first; then students talked to one another in groups. The college’s students could not speak Japanese, so they spoke...
English. Afterward, some students guided us to the 798 Art Zone in Beijing, and they talked to each other while walking in the zone.

One of the Chinese university students that come to CRI’s Japanese Service section is still in the 4th grade, but their Japanese skill is exceptional. She speaks Japanese very fluently, and she later won first prize in writing an essay in Japanese (competing with Japanese students in China), which was later published in Japan.

Our students visited Tianjin by high-speed rail, while one of the students acquainted with the road traveled separately. We had a wonderful time in Tianjin.

Conclusion

Kosen is a technology school with more male than female students. Students study technology every day, they have to master many kinds of technology skills, tend to learn by themselves, and tend to have fewer opportunities to enhance their communication skills. In this overseas internship program at CRI, students freely talk to Chinese university students because the Chinese students can speak Japanese. They can talk about their cultural backgrounds, and gradually recognize cultural differences. Once friends are made, they can understand one another deeply through communication.

In many cases, technology schools have relationships with other technology schools. This has the advantage that they have similar knowledge bases and technologies. Nevertheless, there might be some disadvantages, as their knowledge is too closely related. Chinese university students who come to the CRI Japanese Service section study Japanese, which is their only common ground. Some of these students learn Japanese in a language department, while others mainly study technology but, also, study Japanese. By deepening their cultural exchange, they can enhance their communication skills.

In 2018 the fourth overseas internship program with CRI will occur, and eight members will participate. This will involve two 1st grade students for the first time. The air ticket from/to Tokyo has doubled from last year, so we have bought flights from/to Nagoya instead. I do not know why but the hotels we have used in the past were all full, and I had to find new hotels with washing machines.

Accordingly, this program has been challenging, but all the participants have enjoyed it immensely. They made friends with Chinese university students, and some came all the way to Nagano, where they were very pleased to meet each other again. I would like to continue this overseas internship program.

References

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http://www.at0086.cn/BYPC/

China Radio International

Chinese Academy of Social Sciences
https://en.wikipedia.org/wiki/Chinese_Academy_of_Social_Sciences

Figure 8 In Tianjin, two students are Chinese

Our students visited Tianjin by high-speed rail, while one of the students acquainted with the road traveled separately. We had a wonderful time in Tianjin.
AN INTERNATIONAL IDEATHON WITH THE THEME OF ITS COLLABORATING WITH INDUSTRY

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Abstract

We report on the implementation of human resource development program "Ideathon" by Kyushu-Okinawa area KOSEN, triggered by the ITS (Intelligent Transport Systems) Asia-Pacific Forum being held in Fukuoka in May 2018. Human resource development by ideathon is highly appreciated by industry field. Industry particularly needs those who can collaborate and solve problems and propose new services and values. In response to such a request, we hold the ideathon at the ITS-AP Forum. We have launched an industry-academia collaboration team and brushed up the contents of ideathon. "Ideathon" is a coined word combining "idea" and "marathon". It is an event by group work which is done for creating new ideas. We decided this ideathon period to be 4 days. That is one day to ice break and pre-learning. On the second day, participants are required to give lots of ideas. On the third day, participants pick out candidates from among many ideas issued and refine them with a multilateral perspective. And the participants made a presentation on the final day.

The main purpose of this event is to train next-generation of human resources with the theme of ITS. Overseas students gather from various fields and create ideas for themes. Participants learn about economic, social and cultural differences as well as technology, and propose suitable solutions through communication, and cultivate global minds and acquire analytic reasoning, complex problem solving, collaboration skills, and teamwork. International mixed teams including invited overseas students present solutions to the problem. Nearly 40 overseas students come from 11 colleges in 5 countries participated the ideathon. Almost the same number of students participated from Kyushu Okinawa district KOSENs. From the viewpoint of youth generation, students provide and share new ideas about ITS specialized services and products that combine elemental technologies and advanced technologies such as IoT fields. Finally, we report on the competency evaluation by students themselves.

Keywords: Intelligent Transport Systems, Ideathon, Active Learning, Collaboration, and Competency

Introduction

The momentum for developing next-generation engineers is increasing more and more. Now it is not uncommon for new technologies or new services to spread all over the world instantaneously. It can be said that it is an era when it is impossible to secure even large corporations that have secured a big position so far. In the era when the advancement and diffusion of technology accelerates, the ability required of engineers can be said to be the ability to create products and services by combining existing elemental technologies and new technologies.

Another ability required of next-generation engineers is the ability to be the active in international stage as well. It is pointed out that high-function, high-quality products developed only for the domestic market cannot overcome products in the global market. After all, since the global market is larger than the domestic market, profits corresponding to development costs can be obtained. Therefore, products, technologies, and services developed by companies should aim at global standards. As a result, companies have come to cross global areas rather than the national framework.

Also, Japan has another serious problem, the problem of population decreases due to the declining birth rate. Population decline is believed to cause two problems. One is the shrinking domestic market, and the other is the labor shortage. Therefore, it is necessary for us to work with international education whether in the domestic or overseas. These are a serious problem for local small and medium-sized Japanese companies. In recent years, more and more expectations are given to the ‘KOSEN’, National Institute of Technology, Japan as an educational institution to solve these problems. In other words, it is a global engineer human resource education. In response to such industry demand, KOSENs in Kyushu-Okinawa district has promoted global human resources development such as overseas internship or international exchange program. ITS-AP Forum 2018 Fukuoka Executive Committee requested us to implement ideathon during the Forum period. In the discussion, we realized that the local companies highly valued KOSEN education. We also consider international exchange as important, so we accepted the request.
Materials and Methods or pedagogy

We explain the overview of ideathon implementation method here. Several requests were received from the Executive Committee in the implementation of the ideathon. The main conditions are listed below.

1) Main focus on human resource development.
2) Inviting a number of overseas guests and making it an international event.
3) The theme of ideathon shall be selected from the field of ITS.

Regarding condition 1, it is consistent with our purpose and there is no big problem. We requested cooperation from Kyushu-Okinawa district KOSENs to achieve condition 2. Not only overseas educational institutions that each KOSEN has exchanges, they invited their international students to participate. In order to achieve condition 3, we held a pre-learning workshop.

In this way, since the outline and concept of the event was decided, we addressed this event as "ITS Ideathon in Kyushu". We describe the implementation period and timetable.

The ITS-AP Forum was held for three days. However, we planned to implement the ideathon over a more extended period of time. We held preliminary study sessions on the day before the forum in order for participating students to get a more effective idea. The variety of students' background also is one of the reasons for planning advance learning. We also expected the effect of ice-breaking.

We show the implementation contents of ITS ideathon held in the four days from May 7th to 10th roughly.

- Day 1, Preliminary study, Welcome party
- Day 2, Ideathon 1
- Day 3, Ideathon 2
- Day 4, Presentation Contest, Award Ceremony

On the first day, we requested cooperation from organizations related to ITS Japan and dispatched lecturers for preliminary learning. This enabled participating students to learn much about practical ITS knowledge. We also held a welcome party at dinner after preliminary study. For most of the participants, this day is the first meeting and it is also important to deepen the mutual friendship. At the time of a welcome party, the principal of Kitakyushu College and the chairman of the sponsor company explained the greetings and purpose and appealed to the participants that this attempt to develop human resources is an industry-academic collaboration. Appreciation of the planetarium at the dome theatre was offered by the generosity of Fukuoka City Science Museum.

The second day and the third day allotted to ideathon throughout the day, but both have their respective objectives. The contents of the second day are mainly focused on widely expanding a lot of ideas. Another object is to organize the team and elect a leader. Of course, this is supposed to change flexibly later. Just a casual argument does not create a good idea. Various methods for effective thinking are proposed as design thinking. It is important for participating students to experience and practice the process of intellectual creation. This time, we asked a professional facilitator to proceed ideathon to learn the latest idea method. The staff for progressing the ideathon consists of one facilitator, one assistant, a few advisors to answer technical questions, and nearly ten mentors to encourage discussion actively. First of all, on the morning of this day, the students created two worksheets called an idea sheet and a plan sheet. Both worksheets had templates and devised so that students can easily express ideas and plans. Students vote on these two worksheets. The top ten of the ideas and plans that won many votes will be adopted as a team task for ideathon. The creator of these selected idea sheets and plan sheets would be the leader. These selection works were done using lunch break time, since adjustment work such as putting together similar ideas is necessary. In the afternoon we organized a team according to the chosen idea. We made some adjustments in organizing the team. Even though it was a similar idea, we used different teams for different approaches. Moreover, because it is the purpose of fostering international sense, we made it possible to consist of students from various countries as much as possible.

From the afternoon, we organized 13 teams according to the selected ideas and plans. We made some adjustments in organizing the team. Even though they have similar ideas, they have different teams when an approach is different. Moreover, because it is the purpose of fostering international sense, we made it possible to consist of students from various countries as much as possible. After the team formation, the students had a discussion until 17:30 PM.

The goal of the morning on the third day is an intermediate presentation. Because there are close to 80 participants, the number of teams will exceed 10 inevitably. At this point, we supposed to narrow down to excellent ideas and interesting ideas. We also held an interim presentation concurrently with the examination. The style of the intermediate presentation is to report about 5 minutes of news. We aimed at the effect that students think about the impact of technology on society by reporting our ideas and plans as news. As a result, any team's presentation was meaningful, so we did not reduce the number of teams.

Students visited the ITS-AP Forum on the morning of the third day. We conducted a preliminary study session. However, we hoped that ideas would be better by utilizing the latest ITS technology exhibited at the venue. Because the idea and the goal of the team became clear, the students actively watched the exhibition to contribute to the team. From the afternoon, each team introduced their own ideas. This introduction was done in the form of what kind of news it can be reported when

The presentation contest was held on the last day. In the presentation, instead of PowerPoint, posters that they created by handwriting were used. Two sheets of 788 × 1091 mm in size were used. Presentation of all 13 teams was held in the morning. A judging committee was held by a panel of judges, including sponsor companies, and
one best prize and four sponsorship awards were decided. An awards ceremony was held in the afternoon and five teams won each.

Results and Discussion

In this section, we consider the results of activities of students in the ideathon. First of all, we refer to the participants' background. It was one of the goals of this ideathon to organize international teams with students from various countries and to have them experience collaboration. In order to achieve this objective, we requested participation in educational institutions from various countries. Figure 1 shows the total number of participants by country. Since it is a local host and all the KOSENs in the Kyushu and Okinawa districts participate, the country with the largest number of participants was Japan. There are also many participants in Hong Kong, Singapore, Mongolia, Thailand. Two students from Mongolia, one student from India, Senegal, and Cambodia are studying in KOSENs.

As you can see, there are many participants from East Asia and Southeast Asia.

Next, we consider the ideas they conceived. The main theme was "to realize a world without traffic accidents". The main element technologies that they focused on were GPS, speed sensor, image recognition, face recognition, deep learning and so on. As factors preventing accidents, they focused on inter-vehicle control, blind spot detection, pedestrian detection, the situation of intersections, age, driver's consciousness, and so on. As an idea with very high identity, there are those that focus on the functions of tires and ideas that applied train technologies to automobiles.

Table 1 shows the number of participants by the educational institution. In addition to the exchange school of Kyushu Okinawa area KOSENs, educational institutions invited by ITS-JAPAN are included. Educational institutions invited by ITS-JAPAN are also included in this table.

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<th>Institution</th>
<th>Participants</th>
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<td>38</td>
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<td>Hong Kong VTC</td>
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<td>Chulalongkorn University</td>
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<td>Republic Polytechnic</td>
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<td>Temasek Polytechnic</td>
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<tr>
<td>Mongolian Kosen</td>
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<tr>
<td>University Putra</td>
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<tr>
<td>Nanyang Technological University</td>
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<tr>
<td>Singapore Institute of Technology</td>
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<td>Hong Kong Polytechnic University</td>
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<td><strong>Total</strong></td>
<td><strong>78</strong></td>
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Table 1. Number of participants by educational institution

![Figure 1. Number of participants by countries](image)

The Best Ideathon Award
- National Institute of Technology, Japan -
Team: ultron
"Utilization of drive recorder data by deep learning"

For the purpose of reducing traffic accidents, they proposed to utilize the data of the drive recorder. Data analysis using deep learning can detect dangerous situations in advance.

The Sponsor Award
- TOYOTA MOTOR KYUSHU, INC. -
Team: sakura
“Real time pedestrian detection”

To prevent traffic accidents, they proposed a system that detects pedestrians in real time using sensors and other technologies.

The Sponsor Award
- ZENRIN CO., LTD. -
Team: KLM
“Facial Conscious Evaluation (FaCE)”

This team concluded that it is important to recognize the consciousness of the driver in order to prevent traffic accidents. Recognizing the loss of consciousness due to a sudden change of physical condition, the degree of drowsiness and fatigue, we proposed a system that supports the driver.

The Sponsor Award
- Pasona Tech, Inc. -
Team: S.C. Tire
“Tire support system according to every situation”

Their idea is to physically deform the tire according to the situation to improve the performance. Its originality was highly appreciated.
We show what was honored from among these candidate ideas. The team name, the idea name, and the outline thereof are shown in figure 2 in order of 1st best prize and 4 sponsors awards. The idea chosen as the best award was to detect dangerous conditions using deep learning. It seems that it was selected as the best award from the usefulness of the idea, the feasibility, the high level of the presentation etc. The students learned various design thinking techniques in the course of two days, and the ideas of any team had a certain persuasive power.

Next, we consider the educational effect of the ideathon. We conducted a competency evaluation using the rubric form in order to measure the educational effect of the ideathon. The competency to measure was made into teamwork, leadership, problem-solving ability and communication. We set four stages of the rubric for each of the four competencies. Figure 2 shows the check sheet for four skills to be evaluated. Figure 3 shows the rubric form. This skill measurement was carried out for all 78 participants in the self-evaluation style. Figure 4 shows the histogram for every four skills.

![Figure 2. Four skills to be evaluated](image)

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<td><strong>Leadership</strong></td>
<td>D</td>
<td>C</td>
<td>B</td>
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<tr>
<td><strong>Solving Problems</strong></td>
<td>D</td>
<td>C</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td>D</td>
<td>C</td>
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Figure 2. Four skills to be evaluated

| **Teamwork** | A. I can evaluate the activities of the team members.  
B. I can mention my opinion or put out ideas actively and can contribute to the team.  
C. I can understand the importance of that work for the team.  
D. I could not do anything. |
| **Leadership** | A. I can act with the leadership.  
B. I can understand the way of better leadership.  
C. I can understand the importance of leadership.  
D. I could not do anything. |
| **Solving Problems** | A. I can understand several solutions and can narrow down.  
B. I can describe with organizing and structuring the essence of the problem.  
C. I can explain my proposal of solution.  
D. I could not do anything. |
| **Communication** | A. I can understand the process of consensus and can improve if necessary.  
B. I can present a keyword that triggers the idea.  
C. I can present description and figure properly.  
D. I could not do anything. |

Figure 3. Four stages of skill Rubric

![Figure 5. Histogram of 4 skills (Japan)](image)

![Figure 6. Histogram of 4 skills (International)](image)
In analyzing this data, we decided to pay attention to what kind of conscious differences exist between domestic students and overseas students. Figure 5 shows the histogram for every four skills for Japanese students, and figure 6 shows the result for overseas students. We can know various features of these two histograms. One of the most prominent features is that none of the Japanese students could think that they act with the leadership. In contrast, none of the abroad students answered that they could not do anything about leadership. (Five Japanese students answered that they could do anything about leadership.)

Figure 7 shows a comparison of histograms using normalized data for more detailed analysis. It can be confirmed that Japanese students have lower self-evaluation than overseas students in all four skills. We regarded these results as representing the current situation very well.

Therefore, we try to apply to a clustering method to this data experimentally. Assuming that Japanese students and overseas students are separated very well, we set the number of clusters was 2. Figure 8 shows the cluster dendrogram. In the first cluster, 20 out of 26 students were Japanese students. On the other hand, in the second cluster, 40 out of 52 people were overseas students. A cluster of students with low self-esteem was formed and it seems that many Japanese students were classified.

Conclusions

We held international ideathon with ITS as a technical challenge for students in East / Southeast Asia area. While there are many ideas to utilize the information communication technology, original ideas such as applying the shape of the tire and train technology were also seen. We organized an international student team with the aim of developing teamwork, leadership, problem solving and communication skills. Using a variety of design sinking techniques, experienced facilitators made students effectively think of many ideas and refined them. All 13 teams made presentations and five teams were awarded. Students, supervisors, sponsors, ITSAP-Forum secretariat, both were well received.

We set up the four skills necessary for the 21st-century type leader, created the rubrics respectively and conducted the competency evaluation. Self-assessment data from students showed that Japanese students' self-evaluation was significantly lower. It can be said that it is in conformity with the sense of Japanese teachers who lead the international exchange program. We strongly suggest that KOSEN teachers need to actively promote international exchange programs, in order to nurture the next-generation engineers who can take active globally. In order to improve this situation, we will continue to work on international ideathon / hackathon continuously.

Acknowledgments

We would like to give heartfelt thanks to Mr. Jun Mitsuyasu who was in charge of the progress of the event and clerical work. We would also like to thank Mr. Noritsune Ooba whose comments and suggestions at the outset of the project gave a significant contribution to this ideathon. They are the leading person who promotes the formation of an organization for this ideathon.

Prof. Shimada who has much experience of international exchange also provide us much useful advice. Assoc. Prof. Komura provided many valuable comments on the rubric design for the competency evaluation. They gave us many suggestions on internationalization and new teaching methods from the viewpoint of teaching staff in a NIT college. We also would like to thank the NIT colleges in Kyushu Okinawa district and overseas educational institutions who recommended many participating students.

We would like to express our gratitude to the four sponsors (TOYOTA MOTOR KYUSHU, INC., ZENRIN CO., LTD., ADVANTEST CORPORATION, and Pasona Tech, Inc.). Finally, we would like to take this opportunity to thank ITS-AP Forum 2018 Fukuoka Executive Committee.

References


Figure 7. Comparison of students' competency evaluation between Japan and overseas

Figure 8. Clustering based on self-evaluation results of all participating students
VIRTUAL OPTOMETRIST - ENGAGING OPTOMETRY STUDENTS THROUGH GAME BASED LEARNING

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Abstract

Virtual Optometrist (VO) is a web-based game designed for Optometry students in the Diploma in Optometry at Ngee Ann Polytechnic (NP). The objective was to enhance students’ learning experience and learning outcomes using a virtual learning space in a game setting where students develop their critical thinking and patient management skills.

The VO consists of two game interfaces where each interface will have different stages to cater to different level of students. Content was tailored based on the learning objectives of the different modules. VO incorporates virtual case studies for self-directed learning for students with different capacities and knowledge. Students were very receptive of the VO with 90.4% of the students surveyed agreed that the VO was useful in helping them to understand the content, and motivating their interest. 97.0% found that the cases presented were relevant, and agreed that the visuals and pictures helped them in their learning.

There was a difference in the perception that the VO experience stretched thinking abilities among different level of students. 100% of Year 1/2 students responded that it stretched their thinking as compared to 57.8% Year 3 students. This could be attributed to their different expectations The Year 3 students were exposed to internship and had completed 1.5 years of actual clinical practices prior. Therefore, they might not find the VO case studies as challenging as the Year 1 and 2 students.

In conclusion, the VO greatly enhances the students’ learning, and is useful in motivating and developing critical thinking. Moving forward, more challenging and complex cases could be incorporated into VO to better meet the learning needs of Year 3 students.

Keywords: Self-directed learning, virtual gameplay, critical thinking, virtual optometrist

Introduction

Digital games for learning have become increasingly popular over the last two decades. Game play has been found to be associated with enhanced problem solving skills (Cooper 2014), and persistence (Shute et al. 2013).

This paper discusses the effectiveness of using a web based game to encourage critical thinking among Ngee Ann Polytechnic (NP) Optometry students.

Background

The Diploma in Optometry (OPT) course is a three-year program offered by NP to train students in becoming future optometrists. Optometrists are primary eye care providers. They are required to have good clinical skills, critical thinking, and patient management skills.

The OPT course was designed to equip students with the content and practical knowledge in the first 1.5 years of their course. The content was taught through various modules across different semesters. In the second year of the course, they are required to integrate skills and knowledge learnt previously to perform full eye examinations, and to provide appropriate management of public patients. Students found these requirements challenging, as they have to remember, integrate and apply what they have learnt from various modules here. As a result, many faced difficulties in integrating the practical skills and the content knowledge to the real world scenarios. To address this issue, case studies were introduced to provide some authenticity during the learning process. However, it was still not authentic due to the absence of a clinical setting. Students often gave feedback on the lack of participation and involvement, especially in the decision making process. This led to the development of the Virtual Optometrist (VO), which provided a platform to enable students to integrate their skills and knowledge in a virtual environment, which is a mimic of the real-world environment.

VO rationale and game design

Researchers (Gee 2004; Shaffer 2006) have indicated that successful computer games are supposed to provide structured and immersive problem-solving experiences to enable the development of knowledge and ‘ways of knowing’. This can then be transferred to the situations outside of the original context of gaming or learning. The VO game was designed with the above pointers.

VO consisted of two interfaces 1) Optical Practice Counter and 2) Optometric Consultation Room, which
cover the two major roles of practicing optometrists. The optical practice counter requires students to recommend and provide appropriate frame and lens selection for the patient. The optometric consultation room allows students to diagnose and manage patients with common eye conditions. Both interfaces consist of realistic cases and optometric test results to simulate actual clinical cases. Students need to assimilate the knowledge obtained from all relevant modules to effectively apply them in the realistic clinical situations.

Figure 1. Stage 2 Consultation Room Interface of VO Game (Selecting of appropriate test)

Figure 2. Stage 3 Consultation Room Interface of VO Game (Diagnosing the condition based on the clinical findings)

Figure 3. Stage 4 Optical Practice Counter Interface of VO Game (Selecting appropriate procedure to perform based on clinical case)

VO was designed with increasing complexity to ensure that the cases presented were appropriate for the student’s cognitive level (Table 1); these differences are deliberately designed to prevent gameplay fatigue and to match their level of study. The gameplay also includes achievement and scoreboard to trigger the intrinsic motivation in students to perform. Scores are based on both speed and accuracy. This urged the students to not only play it fast but also ensure that learning takes place. For instance, if a wrong selection is chosen, the “happy index” of the customer/patient will drop resulting in lower scores. Students will need to perform the task accurately and at the same time efficiently. This simulates a real retail setting where there could be multiple customers coming to a practice and optometrists are required to perform eye examination efficiently and accurately.

<table>
<thead>
<tr>
<th>Game Interface</th>
<th>Stages</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optical Practice Counter</td>
<td>1</td>
<td>Select &amp; Manage Single Vision</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Select &amp; Manage Progressive and Bifocal</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Manage both Single Vision &amp; Progressive based on the customers’ needs and requirement</td>
</tr>
<tr>
<td>Consultation Room</td>
<td>1</td>
<td>Identify and diagnose anterior eye conditions</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Identify and diagnose posterior eye conditions</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Select appropriate test to be perform and diagnose &amp; manage conditions based on clinical findings</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Diagnose, manage and provide advice to patient based on their clinical findings</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Diagnose, manage two complex conditions and provide appropriate advice to patients</td>
</tr>
</tbody>
</table>

Table 1. Summary of VO game stages and requirements

Another important aspect of learning is the importance of providing feedback. Gibbs and Simpson (2004) identified feedback as the single most powerful influence on student achievement. It is most effective when it contains advice originating from the student's own recent work. Immediate feedback with explanation are given throughout the gameplay to allow students to know if their selection is appropriate and provides channel for repeated selection. Both the interfaces consist of different levels with increasing difficulty thus allowing them to develop higher order learning.

The “backend office” of the VO is another highlight of the game. It is fully customisable to allow module leaders to add, edit, and delete cases, dialogue and case results. The versatility in the presented scenarios allows development of learning outcomes aligned with the student’s need. For instance, if there are certain areas that students are generally weaker in; module leaders can include more relevant cases for them to practice. The backend office allows for real clinical photos to be added for simulating real clinical results.

Implementation & Benefits of VO

The VO was incorporated in eight different modules across five different semesters. The objective was to allow students to participate in an immersive environment for development of critical thinking and problem solving skills, as well as a sense of
responsibility. All these soft skills are integral to the role of an optometrist. The VO was used by module leaders differently. They may incorporate it in a flipped classroom pedagogy, or as a form of e-learning. Module leaders are able to generate the results at the backend office to monitor the progress of the students.

As mentioned earlier, there were some learning gaps in the optometry program and VO was implemented to address these issues. VO enhances students' learning in the four following ways:

(1) Enables the application of their clinical knowledge throughout their course of study

Previously, students learn about the different skills and knowledge in the first semester but were unable to practice what they have learnt, as they were not scheduled for clinical duties at the Ngee Ann Polytechnic Optometry Centre (NPOC) until the fourth semester. Many students feedback that they have forgotten the skills when they start their clinical practice and have difficulty in adapting to the clinical environment. VO provides a virtual platform for students to apply their clinical knowledge throughout their course of study. Students are not only constantly exposed to the use of virtual clinical test to enhance their knowledge, they are also able to revisit the previous levels to relearn, recap and revise without constraints in time and space.

(2) Allows for equal learning opportunities

Students are scheduled at different days for clinical practice in NPOC. It is a fully equipped optometric clinic that allows the public to get a detailed eye examination at a nominal fee and at the same time provide a work-based learning environment for our students. Students are able to apply what they have learnt and integrate the knowledge and skills to perform a full eye examination on the general public. The patient profile in the clinic is wide-ranging - from children as young as 3-4 years old, to elderly in their 90s. Some could be having simple prescription issues while others could be suffering from complex ocular or systemic health problems. Due to the diversity in the patient profiles, it is difficult to ensure that all students are given a mixture of all possible scenarios. This leads to students having different learning experiences as some students may get to examine challenging patients, while others can only contend with simple cases. With the VO, students are able to experience all types of critical clinical scenarios that may not necessarily be seen by every student during their clinical training. This ensures that students will have equal learning opportunities and experience.

(3) Allows for immersive learning opportunities

As mentioned earlier, case studies might not be as effective to engage students in their learning even as these were used to provide students with real-world examples. VO not only provides students with practice in handling different types of clinical scenarios, where they are required to integrate their practical and theory knowledge, but also requires them to think critically about the next course of action. Through the gameplay, they are able to understand the consequences and see the value in their learning. This promotes and triggers their problem solving and critical thinking skills.

Students have also shown a preference for learning in an immersive environment where they could make decisions and take charge of their learning and get immediate feedback on their task.

(4) Allows for training of communication skills

While students are able to prepare themselves to respond to different clinical situations by ensuring that they understand and are able to apply content knowledge, many students are weaker in their communication skills. However, the role of an optometrist requires good communication skills, as they need to interact with their patients effectively to gain understanding of their condition and to be able to explain the results of the diagnoses to them. The VO provides students with the opportunity to interact and communicate with the virtual patients as VO is designed with speech interaction between player and patient/customer. If an appropriate response is selected, the “happy index” of the patient/customer will improve, and the reverse happens if an inappropriate response is chosen. It allows students to understand that the role of an optometrist requires not merely good optometric skills, but also good communication skills.

<table>
<thead>
<tr>
<th>Survey Question</th>
<th>% of Strongly Agree/Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Survey Question</strong></td>
<td>Year 1</td>
</tr>
<tr>
<td>VO helped me understand the topic (management of the patient with the disease)</td>
<td>100</td>
</tr>
<tr>
<td>VO stretched my thinking</td>
<td>100</td>
</tr>
<tr>
<td>VO motivated my interest in the module</td>
<td>100</td>
</tr>
<tr>
<td>The activity/activities (e.g. case scenarios and learning activities in each game)</td>
<td>100</td>
</tr>
<tr>
<td>The activity/activities (e.g. case scenarios and learning activities in each game) are appropriate and relevant.</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 2: Breakdown of students’ feedback on VO by OPT students

Feedback from students were generally positive especially among the Year 1 & 2. It is encouraging to know that students find the gameplay useful and the activities appropriate (Table 2). Previously, students had shared that they could see the relevance of some subjects only after they start their clinical practice in Year 2. VO is useful to motivate them in their Year 1 and 2 because they can appreciate how their learning will eventually be useful in their clinical practice. Based on the comments from students (Table 3), it seems that learning objectives were met and students can appreciate the use of this gameplay to enhance their critical thinking & communication skills, particularly among the Year 1 and 2. This might be due to lack of any actual clinical practice. Therefore, the students find the integration of VO interesting, as they are able to relate the theory to practice.
Student Level | Positive Comments
--- | ---
Year 1 | I like how it penalize for bad language, as the way we speak to patient is very important to professionalism.
 | I like the animation, it showcase proper real life scenarios.
 | The whole process not only teach us ocular diseases but also how to react to different situations.
Year 2 | I like how this online activity provides comprehensive description on the various case scenarios.
 | This helps me mentally prepare myself for my upcoming internship where I will physically experience handling real patients.
 | When errors are made, there are additional text boxes with detailed descriptions to clarify my doubts about the case.
Year 3 | The game is fun and interactive but it does not feel like how it will be like in the actual clinical setting.
 | It enables me to think of the differential diagnosis and what causes the conditions from the following signs and symptoms.
 | I like the animation and the improvement could be on the instructions.

Table 3: Students comments on the VO by student’s level

However, there was varied perspectives regarding the motivation and the critical thinking skills development between the Year 1 & 2 (100%) and Year 3 students (57.9%). Year 3 students felt that the cases presented were straightforward and the answers were obvious, and thus is not as helpful in stimulating their critical thinking skills. This difference was as expected because Year 3 students had undergone internship, participated in various eye screenings, and had 1.5 years of clinical practice, which exposed them to clinical cases of various complexity. Hence, the VO game currently might not be adequate to trigger their critical thinking and motivation.

### Learning points

1. **Appropriate level and pacing for learning**

   The design of a digital game for learning requires careful planning to ensure that the learning objectives are met and yet engaging for the students. Gameplay should be paced appropriately to students’ learning.

   “Speed is too fast, I feel I need to clear as many patients as possible rather than really diagnosing what they have” – Year 2

   “Too rushed, the patient get angry too easily, it would be good if patient can calm down while waiting for their turn” – Year 2

   The gameplay tried to mimic a real optometry setting whereby there could be multiple customers coming through a store at once and optometrists are required to perform eye examination efficiently and accurately. However, it seems to be a distractor for students as they see it as a hurdle rather than a challenge. It highlights a key learning on the importance of balancing the challenge to trigger motivation. Challenges should motivate students to do well, but if the challenge is too unachievable, it might demotivate the students. Hence, changes were made to the speed of the game at the backend office to enable a better learning experience.

2. **More complex clinical cases**

   Some Year 2 and Year 3 students have requested for VO to include more challenging cases so that they are able to have a better variety of learning experiences.

   “More variety in the type of cases, some conditions got too repetitive” – Year 2

   “Please provide lesser repetition of the cases for the optometrist clinic” – Year 3

   Based on the above suggestion, the team had made changes to VO e.g. more cases and clinical images were added to provide greater variety of clinical cases. For the Year 3s, other than increasing the variety of the cases, more complex cases were added to provoke their critical thinking and ensure that they benefit equally from VO.

### Conclusion

The VO has been useful in supporting optometry students to enhance their learning experience by providing an avenue to integrate the knowledge from different modules, develop critical thinking, and communication skills. VO also provided the students with equal learning opportunities through the set of clinical scenario. Although students were generally receptive of the VO game, a greater variety of challenging cases should be included to “stretch” students’ ability.

### References


AN EDUCATIONAL TOOL DESIGNED TO DELIVER A VIRTUAL WORLD
IN ORDER TO OBSERVE COSMIC RAYS ON EARTH

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Abstract

It’s important to develop educational tools to observe cosmic rays in order to enhance learners’ interest in particle physics or astrophysics. The learners will be able to confirm interactions of primary cosmic rays and production, transportation, and propagation of the secondary cosmic rays if the observations are performed at different altitudes (sea level, at mountain level, or in balloon born experiments). Cloud chambers or spark chambers are common tools to observe tracks of high-energy charged particles directly. However, it is difficult to take learners and these chambers to the different altitudes and to distinguish among each kind of particles in the tracks generated by charged particles. Besides, effective volumes of the chambers are limited so that it takes lots of time to measure the flux of cosmic rays at each different altitude.

Therefore, our purpose of this study was to develop an educational tool designed to deliver a virtual world in order to observe cosmic rays on Earth. An Oculus Rift was selected as the head mounted display to show the virtual world and Unity was used to produce CG animations. The tools can change the altitude and select the kinds of target cosmic rays. The tool can provide 360 degrees panorama image at various angles of view for the learners so that learners can understand the differences of flux at each altitude immediately and intuitively. The zenith angle $\theta$ of each falling cosmic ray is generated by random number according to a probability density function. The $n$ is determined by the kinds of cosmic rays. The flux and energy of each particle are also generated by random number according to measurement data of the flux and the energy spectrum of each particle at each altitude. Virtual concrete walls were prepared at sea level in the virtual world to make learners feel the differences in energy attenuation of charged particles by concrete. As the results, it was demonstrated that the system can create the virtual world and it was confirmed that cosmic rays were well reproduced at sea level.

Keywords: educational tool, cosmic rays, unity, virtual reality, muon, Oculus Rift

Introduction

Cloud chambers or spark chambers are common tools to observe tracks of high-energy charged particles directly. It is, however, difficult to take learners and these chambers to the different altitudes and to distinguish among each kind of particles in the tracks generated by charged particles. Besides, effective volumes of the chamber are limited so that it takes lots of time to measure the flux of cosmic rays at each different altitude. Therefore, the purpose of this study was to develop an educational tool that can observe cosmic rays on Earth in virtual spaces. Table 1 shows a comparison with the conventional chambers.

Cloud chambers or spark chambers are common tools to observe tracks of high-energy charged particles directly. It is, however, difficult to take learners and these chambers to the different altitudes and to distinguish among each kind of particles in the tracks generated by charged particles. Besides, effective volumes of the chamber are limited so that it takes lots of time to measure the flux of cosmic rays at each different altitude. Therefore, the purpose of this study was to develop an educational tool that can observe cosmic rays on Earth in virtual spaces. Table 1 shows a comparison with the conventional chambers.

Table 1. Comparison with Conventional Chambers

<table>
<thead>
<tr>
<th></th>
<th>Conventional Type</th>
<th>VR Educational Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reality</td>
<td>◎</td>
<td>◯</td>
</tr>
<tr>
<td>Event Rate</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Preparation</td>
<td>△</td>
<td>△</td>
</tr>
<tr>
<td>Any Place</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Energy</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

When primary cosmic rays caused by galactic activities hit on the atoms in the atmosphere, secondary cosmic rays are generated and the each direction of motion is changed. Cosmic rays with extremely high energy over several hundreds of GeV caused particle...
generation repeatedly called an air shower phenomena one after another. The muon occupies about 75 [%] of the cosmic rays falling on the surface of the Earth. The general angular distribution of muon $I$ is approximately described as is follows (1):

$$I = I_0 \cos^2 \theta$$

(1)

where, $\theta$ is the zenith angle and $I_0$ is the flux at zenith angle 0[°]. The zenith angle $\theta$ of each falling cosmic ray is generated by random number according to a probability density function. The flux and energy of each particle are also generated by random number according to measurement data of the flux and the energy spectrum of each particle at each altitude.

**System Overview**

The purpose of this study was to develop an educational tool to support learners to understand basic characters of muons intuitively by using a head mounted display. Figure 1 shows an overview of this system. This system was composed of virtual reality head mounted display “Oculus Rift” (Oculus Rift 2018), a pair of Oculus Touch, and a Windows PC. A DELL ALIENWARE Area-51 15Q42 and the graphic board GeForce GTX 1080 Ti GAMING X 11G were selected to create and draw 3DCG objects in real time. Oculus Touch was used to manage both the movement of the learner and the line of sight in virtual world. The system was implemented by using Unity version 2018.1.0f2 (Unity 2018). The code was written in C# language. Unity is the useful game engine to create a virtual reality space. 3DCG graphics of the muon and landscapes at Sea level, at mountain level or altitude of international airline flight.

Figure 2 is a sample of landscape on learner’s HMD in a virtual mountain lodge. The red lines mean muons created by 3DCG. The learner can change the angle and position in the mountain lodge in real time. The learner can learn with feeling as if they entered the virtual reality space, and move freely within the spaces by operating Oculus Touch.

![Figure 1. Over View of the System](image1)

![Figure 2. A Landscape on Learner’s HMD](image2)

Figure 3 is the data flow diagram of the system. A simulation software EXPACS can calculate atmospheric cosmic-ray spectrum (T. Sato 2016). EXPACS was used to reproduce the muon flux and energy spectrum at different observation sites with different altitudes. The muon flux and energy spectrum was pre-calculated and the cumulative distribution function based on the probability density functions were prepared to generate random number based on science experimental data. Figure 4 is EXPACS calculation result of the flux [muons/cm²/s] from 0[km] to 13 [km] altitude at latitude 34 [°], longitude 133 [°]. Figure 5 means a probability density functions to generate zenith angles $\theta$ of muons proportional to $\cos^2 \theta$ and the cumulative distribution function.

![Figure 3. Data Flow Diagram of the System](image3)

![Figure 4. Calculation Flux by EXPACS at Latitude 34[°] and Longitude 133[°](image4)
Figure 5. PDF for Zenith Angle and the CDF

**Generation of Muon CG graphics**

Figure 6 shows how to create a muon CG graphics. The muon falling through the coordinates \((X_1, Y_1, Z_1)\) in a plane was obtained by two random functions, and the angle \(\theta\) is decided based on the approximate random number obtained by the distribution of \(\cos^2 \theta\). The rotation angle \(\varphi\) of the cone is in the range of 0 [°] to 360 [°]. The generation point \((X_0, Y_0, Z_0)\) was decided by the zenith angle \(\theta\) and the rotation angle \(\varphi\) with the coordinates \((X_1, Y_1, Z_1)\) as a base point. The muon was reproduced by drawing a line from the generation point \((X_0, Y_0, Z_0)\) to the coordinates \((X_1, Y_1, Z_1)\). Three virtual spaces (sea level, at mountain level, or in balloon born experiments) were created by Unity. Each altitude were assumed to be 0 [km], 2.7 [km], 12 [km] and the flux were 0.02 [/cm²/s], 0.033 [/cm²/s], 0.13[/cm²/s], respectively. The drawing region was limited to 4[m²] around the learner under the limitation of draw rate so that the 3DCG of mountain lodge or experimental room less than 4[m²] was used. Figure 7 is the result of a draw rate for muon CG graphics at 0[km]. We can also see a peak around 15[ms] and the tails. These are frame buffer draw events occurred by our graphic board. The average draw rate was 1.3[ms]. Muon flux at 0[km] altitude is about 800[cps] in the area less than 4 [m²] so that it’s confirmed that the system has enough capacity to draw 3DCG objects of muons in the CG world.

Figure 8 is the zenith angle distribution at 0[km] for elapsed time 1, 5, 10, 20 [s]. A \(\cos^2 \theta\) curve was fitted to a given data set of 20 [s]. We can see that the zenith angle distribution was close to \(\cos^2 \theta\) curve proportional to elapsed time. Figure 8 is zenith angle distribution at 0[km] for elapsed time 1, 5, 10, 20 [s]. A \(\cos^2 \theta\) curve was fitted to a given data set of 20 [s]. We can see that the zenith angle distribution was close to \(\cos^2 \theta\) curve proportional to elapsed time.

The overhead view of virtual spaces is shown in Figure 9. An experiment room shown in Figure 9 -(a) and mountain lodge shown in Figure 9 -(b) were selected at sea level and mountain level, respectively. The difference of flux at different altitude is shown in Figure 10. The flux in Figure 10 -(a) is about 1.6 times than the one in Figure 10 -(a). The learner can observe visually that the zenith angle of the muon follows the angle dependence of \(\cos^2 \theta\) and the number of irradiated muons depends on the altitude.
A questionnaire was taken to survey in order to assess learning effects. This survey was taken for 96 students in National Institute of Technology, Kagawa College. As the first step, the students watched a movie about a spark chamber that was taken in High Energy Accelerator Research Organization (Stylograph601 2012). As the second step, the students watched movies in case of 100 [muons/s] and 1000 [muons/s] while listening to the explanation about the correct number of muons. As the last step, four items were tested for the 96 students as follows. As the first item, “How many muons you can see?” was asked after the students had watched two movies about our system in the case of 0 [km] and 2.7 [km]. Figure 11 was the their replies. The points of arrowed lines are the correct answers for both cases. It was confirmed that the learners can understand the number of muons intuitively. The second item was “Do you think muons intensities have zenith angle distribution?”. Figure 12 was the result. The learners more than 87% can understand zenith angle distribution of muons. The third item was “Do you think CG objects of virtual muons in this system was well reproduced real muons observed in the spark chamber?”. Figure 13 was the result and it was confirmed that more than 78% learners agree to be able to reproduce real muons falling. The fourth item was “Do you think that the system can support learners to understand the characteristics of muons?”. Figure 14 was the result. It was revealed that more than 79% learners think the tool has possibility to support to learn muons characteristics.

**Conclusions**

In this study, the educational tool to observe virtual muons in order to enhance learners’ interest in particle physics or astrophysics was developed and demonstrated for 96 students in NIT, Kagawa College. It was confirmed that the system was able to reproduce the angular dependence distribution and flux based on experimental data in virtual space. The questionnaire was taken to assess the learning effects. The results show that the learners can understand both the number of muons intuitively and the zenith angle distribution.

**References**


VIRTUAL REALITY ASSISTED IN ARBORICULTURE TRAINING

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Abstract

Chain saw operation is one of the most common tasks that used by the arborists, tree climbers and tree workers in daily tree care operation. However, it is also the most dangerous operation in arboriculture and tree management for people without proper training. This reveals that proper chain saw safety training is crucial to all arboriculture practitioners before conducting chain saw operation.

A virtual reality (VR) training system has been developed to provide proper occupational safety and health training in using chain saw to students who are studying Higher Diploma in Conservation and Tree Management. Real life immersive experiences are provided in this VR training system, thereby allow replica of hazardous situations on chain saw operation in simulated environment and enable visualized training on procedures in daily tree work operations so that to increase their awareness and understanding of the causes of accidents and how they can be prevented. This training system is based on the safety check of potential dangers in daily tree care operation. The effectiveness of using VR training system in chain saw safety training has been evaluated by dividing two groups of students, one group of students was trained by VR training system, another group was trained by traditional lecture session. Performance of student was compared after conducting pre- and post- training tests. All students have scored much higher after they learned by the VR technology or the traditional teaching. This result indicated that VR training system is feasible to aid both arboriculture practitioners and pre-employment students in learning various dangerous tree care works and operations. More immersive training experiences are recommended to provide for practitioners as well as pre-employment vocational training of arboriculture sector.

Keywords: Virtual Reality, Immersive Training System, Arboriculture, Arborist, Tree Worker Operation, Chain Saw Operation, Occupational Safety and Health, Tree Felling, Pruning

Introduction

Chain saw is a mechanical equipment with a saw chain which rotates around a guide bar. Due to the efficiency, chain saw is the most commonly used mechanical power-driven equipment in arboriculture industry. The tasks of using chain saw including tree felling and removal, pruning, limbing and bucking. However, it is also a dangerous equipment; kickback occurs when the tip of the guide bar touches any object. With reference to the U.S. Consumer Products Safety Commission, there are about 36,000 people treated in the hospitals for chain saw injuries in USA each year.

Providing lectures and on-site practical workshops are the traditional training on the safe use of chain saw, the contents of face-to-face lecture sessions include the introduction of various parts of chain saw, operation procedures, daily maintenance and the safety requirement. In order to facilitate the understanding of trainees, tutors may display photos as well as play video to trainees. During practical workshops, after wearing proper personal protective equipment (PPE), learners usually have a chance to control a chain saw to conduct a simple pruning task. During training, when the learners are careless, do not follow the safety instruction and procedures during operating chain saw or if the tip of the guide bar touches an object, kickback and injuries may occur.

A virtual reality (VR) training system has been designed and developed to provide a real life immersive experiences, so that hazardous situations on chain saw operation in simulated environment can be replicated and enable visualized training on procedures in daily tree work operations so that to increase the awareness and understanding of the learners the causes of accidents and how they can be prevented. Six scenarios have been designed in this VR training system, namely, personal protective equipment for chain saw operation, safe environment when using chain saw, safe use of chain saw, prevention of chain saw kick back, traffic control during tree care operation, and tree felling and removal. Through experiencing these scenarios, learners have an opportunity to have a comprehensive understanding the safe use of chain saw during daily arboriculture tasks which chain saw is needed to use.

This VR assisted training system is developed and integrated into the curriculum of a pre-employment vocational training programme, Higher Diploma in Conservation and Tree Management (CTM) offered by Vocational Training Council, this higher diploma
programme is a full-time 2-year 5-semester programme aims to equip students with the necessary technical and professional knowledge and skills, initially at paraprofessional level, via the blending of theoretical knowledge and practical application, to enable them to pursue a career in conservation, tree management and arboricultural services.

Materials and Methods or Pedagogy

Study participants included 61 students from CTM who took an Occupational Safety and Health in Arboriculture module in February 2017. To evaluate the effectiveness of using this VR training system in chain saw safety training, students were divided into two groups. Of the 61 students, 43 participated in the VR training system, and 18 participated in traditional lecture. Contact hours of both training methods were six.

A pre-test and post-test was arranged for both student groups before and after traditional training method and VR-assisted training respectively. For each of the training methods, mark results (in numerical expression) of pre- and post-tests were compared to evaluate the performance of students. In addition, the results of post-tests were compared between two different training methods using t test.

Results and Discussion

Table 1 shows the range, mean and standard deviation of the pre- and post-tests results of the two groups of students.

Table 1. Pre- and Post-test Results Summary

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Range</td>
<td>Mean ± standard</td>
</tr>
<tr>
<td></td>
<td></td>
<td>deviation</td>
</tr>
<tr>
<td>VR</td>
<td>24 - 68</td>
<td>43.44 ± 10.62</td>
</tr>
<tr>
<td>Traditional</td>
<td>24 - 72</td>
<td>41.56 ± 12.30</td>
</tr>
</tbody>
</table>

Results show that all the participants in both student groups scored much higher after they learned by the VR technology or the traditional teaching method. The result indicated that instead of traditional teaching, VR training system is also a feasible and effective training method to aid learners in learning various dangerous tree care works and operations. In addition, using VR training system as teaching method can provide a safe environment, a repeatable training and avoid the injury when trainers conduct the wrong procedures.

Conclusions

Based on the result of present study, VR assisted in teaching the safe use of chain saw is effective and feasible. There are several benefits of using VR system in arboriculture related training, and therefore, it is recommended to develop more immersive training system to the practitioners as well as pre-employment vocational training learners of arboriculture sector in the future.

Acknowledgements

This is to acknowledge that the development of VR assisted in arboriculture training is funded and supported by Vocational Training Council (VTC), Hong Kong. This VR arboriculture training system is jointly designed and developed by the Applied Science Discipline and Information Technology Discipline of Hong Kong Institute of Vocational Education, and Faculty of Design and Environment, Technological and Higher Education Institute of Hong Kong, VTC.
MAKING THE VIRTUAL SPEECH JUDGE 2.0: [VOICE AUDIO WAVE AND FACIAL EXPRESSION ANALYZING SOFTWARE]

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Abstract

Non-verbal communication is an essential part of understanding the speakers “total message”. Most researchers place non-verbal communication (NVC) cues, as making up about half of the total message. NVC consists of kinesics, paralanguage, proxemics and haptics. Current technology used by voice assistants eg. Google Voice, Apple’s Siri and Amazon’s Alexa have become very good at recognizing words used in verbal communication through their speech recognition (SR) engines. But these SR engines are not effective at analyzing the quality of NVC. Our system, the Virtual Speech Judge (VSJ) 2.0 addresses this gap, and gives students the opportunity to improve their performance on speeches, presentations and interviews.

Through a combination of the Kinect camera and audio-wave analyzing software we can target two components of NVC: richness of facial expression and paralanguage, namely individual sounds, rhythm, intonation and stress. When analyzing facial expression, speakers were filmed using two cameras: a digital video camera, and the Kinect 3D motion sensor. The digital video files of 10 speakers were assessed by 5 Japanese “judges” and 1 English native-speaking judge at 10-second intervals using a 5-point scale. Then these results are compared to the data taken by the Kinect camera. When analyzing paralanguage, we replace the Kinect data with audio-wave analysis software. 43 speakers were given several sentences to read, which were then compared to a native-speaker. Audio files were assessed using a 5-point scale.

The development of this system, along with the collection of more data, gives speakers the opportunity to have their NVC cues evaluated, offering the chance to improve their overall total message, resulting in better speeches, presentations and interviews.

Keywords: Non-verbal communication, gestural analysis, facial expression, audio-wave analysis, total communication

Introduction

When learning a second language, such as English, things like spelling, vocabulary, and grammar can be taught and learned with no direct correlation to the class-size. However, this is not so when training students to perform well for the advanced tasks of giving a speech, making a presentation or taking an interview. These require more one-to-one facilitation in order to improve a student’s communicative competence. Our system, the virtual speech judge (VSJ) focuses on improving non-native speakers (NNS) “total communication” (TC). We define TC as the combination of both verbal (VC) and non-verbal communication (NVC).

Currently, the VSJ pinpoints and gives feedback to NNS with regards to two areas of NVC: quality of facial expression and pronunciation. In a previous study, we showed the correlation between the VSJ and human speech judges when evaluating a speech given by NNS. In that experiment we highlighted the specific facial movement indexes that generally resulted in a high evaluation by a human judge, namely the movement distance & speed of the nasal tip, and movement of the eyebrows. In this paper we will address our current experiments by dividing the methods, results and discussion into two parts.

Methods (Facial Expression)

The VSJ uses the Kinect v2, a motion-sensing camera, created by Microsoft. The Kinect combines features typically found in a two-dimensional web-camera, with an RGB sensor which provides depth data. It has the ability to track 1347 facial feature points, as shown in figure 1:

Figure 1: 3D mask created by the Kinect v2
Nine NNS were asked to talk for approximately two minutes. These videos were evaluated at ten-second intervals on a 1-5 Likert scale (1=poor, 3=satisfactory, 5=highly effective) for the quality or richness of facial expression. Unlike our previous experiments, the subjects were asked to talk freely about any subject. The human evaluators consisted of one EFL teacher [a national-level speech and presentation coach] and five NNS research students. The subjects were randomly selected, and had varying levels of English ability. All videos were evaluated with no sound, with focus on only the facial movement.

While the human judges focused on the overall performance, the Kinect pinpointed on the five areas shown in Figure 2:

1. Avg. between inner eyebrow and nasal tip
2. Avg. between eyebrow middle and eyelids
3. Right and left eyebrow
4. Upper lip and lower lip
5. Corners of mouth

Figure 2: Facial feature points

Our goal was to find a correlation between objective facial movement data with the subjective evaluation of a human judge. Given this data, speakers can get receive precise feedback.

Results and Discussion (Facial Expression)

Compared with previous experiments ($r = 0.86$), the correlation between the human judges’ subjective-evaluation index (SEV) and the Kinect’s produced-evaluation index (PEV) was not high, as shown in Figure 3:

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. total movement</td>
<td>0.35</td>
<td>0.42</td>
<td>0.25</td>
<td>0.47</td>
<td>0.43</td>
</tr>
<tr>
<td>B. domain</td>
<td>0.34</td>
<td>0.42</td>
<td>0.26</td>
<td>0.39</td>
<td>0.51</td>
</tr>
<tr>
<td>C. max. distance</td>
<td>0.11</td>
<td>0.26</td>
<td>0.05</td>
<td>0.53</td>
<td>0.60</td>
</tr>
<tr>
<td>D. peak distance</td>
<td>0.36</td>
<td>0.46</td>
<td>0.28</td>
<td>0.38</td>
<td>0.55</td>
</tr>
</tbody>
</table>

Figure 3: Correlation coefficient ($r$) for evaluation index and subjective evaluation value

However, a look at Figure 4 shows one of the reasons:

<table>
<thead>
<tr>
<th></th>
<th>Teacher</th>
<th>Std A</th>
<th>Std B</th>
<th>Std C</th>
<th>Std D</th>
<th>Std E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Std A</td>
<td>0.35</td>
<td>1.00</td>
<td></td>
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<tr>
<td>Std B</td>
<td>0.49</td>
<td>0.42</td>
<td>1.00</td>
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<td></td>
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</tr>
<tr>
<td>Std C</td>
<td>0.37</td>
<td>0.41</td>
<td>0.67</td>
<td>1.00</td>
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<tr>
<td>Std D</td>
<td>0.17</td>
<td>0.40</td>
<td>0.48</td>
<td>0.54</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Std E</td>
<td>0.20</td>
<td>0.39</td>
<td>0.37</td>
<td>0.40</td>
<td>0.41</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Figure 4: Correlation coefficient ($r$) for evaluation index and subjective evaluation value

There was a wide difference between the scores of the EFL teacher and those of the NNS research students.

Methods (Pronunciation)

Audio analysis for the VSJ was done using “Wavesurfer”, which is sound analysis software developed by the Royal Swedish Technical University. It analyzes audio wav files and indicates temporal changes in fundamental frequency. Forty-three students (International Business Department 1st year Kosen) were given 11 sentences to read into a USB headset. Their sentences were recorded in wav format using the software “Streaming Audio Recorder”. The sentences were created from a list of vocabulary they previously learned in their pronunciation class. While 11 sentences were chosen, only the first sentence was analyzed. The following sentence was used:

For the New Year, the student bought cards for his father, tickets to a rock concert for his mother, and some chocolate for his family.

The human judge evaluated the speakers” pronunciation of the sentence on a modified 1-5 Likert scale. Pronunciation was divided into “individual sounds (8),” “word/sentence stress (6),” and “rhythm/intonation (6).” These classifications were weighted (multiplied by the corresponding number), for example the individual sound was scored from 1-5, then multiplied by the assigned weighting, resulting in a total score of 100.

The resulting wav files were compared to the reference and analyzed using the one-class MT method, calculating the distance in in the y-axis using the formula shown in Figure 4:

$$\beta = \frac{L}{r} \quad \eta_1 = \frac{r \beta^2}{V_N}$$

Figure 4: Formula used for MT method

As the value of $\eta_1$ increases the closer the quality is to the reference.
Results and Discussion (Pronunciation)

Figure 5 shows the correlation between the human judge’s score and that of the wave analysis. As you can see, there is a gap in the scoring correlation.

A more detailed look at the wav files, showed one of the main reasons for this gap was the difference in timing between the native speaker and NNS. Students read words slower and less fluently than the native speaker, as shown in the raw data in Figure 6:

![Figure 5: Scoring correlation](image1)

![Figure 6: Raw data of wave analysis](image2)

Our system was aimed at evaluating pronunciation, (rhythm, stress and intonation), and not fluency. Therefore, the resulting raw data proved to be difficult to assess with the MT Method. To assist in our analysis, the audio wav file was edited to remove the silence or parts where y=0, as you can see in Figure 7:

![Figure 7: Sample of edited audio wav files](image3)

The data shows the approximate time/word where the student needs to improve.

Conclusions

NVC makes up about half the message when communicating. While Google, Amazon and Apple have given us great voice assistants, the job of that software is to recognize speech and not pick up on NVC clues. Therefore, these tools can help, but only with half the message; they can’t assist in learning TC.

Currently, the VSJ is helping improve the TC for the selected research participants, but this requires a person with an IT background to explain the data. There needs to be an improvement in the user interface (UI) so students from all academic backgrounds can visualize where they need to improve.

Acknowledgements

This work was supported by Grant-in-Aid for Scientific Research (C) (17K02964).

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VIRTUAL REALITY SIMULATION AS HUMAN BODY LEARNING TOOL


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Abstract

Human anatomy and physiology used to be a very difficult module to teach on students especially those without biological science learning at their secondary school curriculum. Furthermore, students are getting less official access or more restriction to pictures, illustration or photo lately. If combining the most latest advanced visualization technology, virtual reality as learning tools with reconstruction of our clinical Magnetic resonance imaging (MRI) and computed tomography (CT) scan images; it would be a very attractive and valuable learning tools to student who does not have much biological background but now like working with a virtual cadaver with orientation. For those who did have deeper knowledge, such tools would facilitate them for better understanding in a three dimensional image and how body physiology works seamlessly in our body instead of using real cadaver which is not practical in our health care studies teaching environment.

In the past this process could be very complicated because the DICOM data shown on a computer monitor would not be an accurate 3D representation for the lack of orientation. Thanks to the advanced technology, students are now able to quickly visualize the patient inner anatomical structures in virtual reality and have it available for different people on different platforms. This also allows lecturers to explain the clinical conditions with the students much effectively and efficiently.

We have conducted a preliminary trial for six Institute of Vocation Education Lecturers, we all were impressed and satisfied with the preliminary trial result. We would like to apply such on teaching our real students in coming future and further explore its effectiveness in related modules and compare their academic performances. We are expecting that the use of latest vitural reality and simulation technology on teaching and allowance of personal self hand on control and hope it would increase their interest in learning related subjects and with good performance outcomes.

Keywords: Virtual Reality, Human Body, Anatomy, Physiology, Pathophysiology

Introduction

BodyMap Pro is the human anatomy learning tool combing with the most advanced visualization technology, virtual reality. Through reconstructing human bodies based on Magnetic resonance imaging (MRI) and computed tomography (CT) scan, BodyMap Pro provides the comprehensive medically accurate anatomical systems in the following twelve categories: integumentary system, skeleton system, muscular system, nervous system, circulatory system, digestive system, endocrine system, reproductive system, urinary system, respiratory system, lymphatic system and connective tissue.

Virtual reality (VR) is an interactive computer-generated experience taking place within a simulated environment, that incorporates mainly auditory and visual, but also other types of sensory feedback like haptic. This immersive environment can be similar to the real world or it can be fantastical, creating an experience that is not possible in ordinary physical reality. Augmented reality systems may also be considered a form of VR that layers virtual information over a live camera feed into a headset or through a smartphone or tablet device giving the user the ability to view three-dimensional images.

1. Education and training.

Basic Anatomy and Physiology along with health care Nursing or Clinical procedures are often difficult for our VTC students to master, yet obviously nobody wants to be a foolish or contemptible nerd.

The study of human anatomy has also emerged as a popular application of augmented and virtual reality technologies. New tools promise to enable students to “peel” away skin and muscle and observe the placement and functioning of bones and internal organs. We’re intrigued by the augmented reality.

2. Pathophysiology Understanding

It shouldn’t be a surprise that complex surgeries are planned in excruciating detail with virtual reality technology with wearing special goggles.

“Kids playing video games have had this technology for 10 years. It’s amazing we only now get it in the operating room.” He further suggests that patients and their families find it easier to understand his surgical plans when they can virtually experience them.
3. Telementoring
Imagine you’re a lecturer in the midst of a complex procedure that’s pushing the student limits of their training and experience. It would be a scary thought if on real patient especially if anything unexpected happens during the procedure. Now, using augmented reality technology developed; mentor can virtually join the procedure while it’s underway; using special google to superimpose a real-time projection of the mentor’s screen and sight from across the hall or around the world even.

4. Student experience
Studies outcomes with full understanding are paramount. Augmented and virtual reality technologies almost certainly have a role to play here. It’s great to explore the benefits of virtual reality amongst students and appears that “escaping” to imaginary worlds for recreation could significantly reduce student’s boredom and studies depression.

5. Augmented reality enhanced health care
Healthcare, by its nature, is extremely information intensive. The challenge, however, is helping students or participants get the right information at the right time and place so they can deliver effective care and full understanding on delivered knowledge.

6. Preparation of their Future
The goggles are triggered by a QR code and can pull in electronic health record information ranging from nurses’ notes to lab results. “I believe wearable computing will replace tablet-based computing for many clinicians who need their hands free and instant access to information.

The European Space Agency (ESA) is thinking even bigger. They’re testing an augmented reality system to help astronauts who may be called on in emergencies to diagnosis medical conditions and perform basic surgeries. “Although medical expertise will be available among the crew to some extent, astronauts cannot be trained and expected to maintain skills on all the medical procedures that might be needed,” says Arnaud Runge, a biomedical engineer overseeing the project for ESA.

The Computer Assisted Medical Diagnosis and Surgery System (CAMDASS) will use ultrasound technology to overlay information and images into a head-mounted display. It’s designed to function even when out of communication with earth-based flight controllers, an advantage for deep space voyages. Does is sounded too far away from our reality here?

BodyMap Pro was proven to be working well with lecturers’ trial class with 100% satisfaction and perfect experience on its practical setting. It enhanced our clinical experiences and proper knowledge without actual hand on real contact. The hide feature allowed participants to further explore deeper anatomical structure and further along with physiological elaboration and reasoning by lecturer like having a dissection simulation class.

BodyMap Pro is the most comprehensive human anatomy tool, where students are able to learn from our virtual cadaver to understand the human body. This allows for a better understanding of the human anatomy that may have been confusing in the past. In clinical field, our proprietary cloud rendering service is to supply medical centers an effortless turnkey solution to generate each patient’s medically accurate avatar based on their DICOM for diagnosis and surgery simulation.

In the past this process could be very complicated because the DICOM data shown on a computer monitor would not be an accurate 3D representation for the lack of orientation. Thanks to the advanced technology, students are now able to quickly visualize the patient inner anatomical structures in virtual reality and have it available for different people on different platforms. This also allows lecturers to explain the clinical conditions with the students much effectively and efficiently.

Results and Discussion
We have conducted a preliminary trial for six Institute of Vocation Education Lecturers, we all were impressed and satisfied with the preliminary trial result.

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We would like to apply such on teaching our real students in coming future and further explore its effectiveness in related modules and compare their academic performances. We are expecting that the use of latest virtual reality and simulation technology on teaching and allowance of personal self hand on control and hope it would increase their interest in learning related subjects and with good performance outcomes.

References

LEARNING STUTTERING WITH NO BORDER: SHARING EXPERIENCE TOGETHER

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Abstract

With advances in technology, collaborative learning is an e-learning approach trend where students are able to socially interact with other students and instructors. Currently, instructors are able to distribute teaching materials, collect students’ assignments, and communicate with students via e-learning platforms. However, this trend does not always fully utilize the functions of e-learning platforms. To explore some broader capabilities, we created an e-learning experience using a free open learning platform (MOOC) for students from two institutes (National University of Malaysia and Rockhurst University) who enrolled in their respective stuttering courses. Students were asked to share their experiences in their assignments to act in public as a person who stutters (pseudostuttering) to better understand their patients’ perspectives. An online discussion was created using MOOC for students to write their experiences as a 'stutterer' and to comment on their peers’ experiences. Feedback from students indicated that they felt this activity was useful to understand the emotional impact and pressure felt by the patient as a person who stutters, which would impact their perceptions and clinical management for these patients. This e-learning experience from two different cultures raises the likelihood of knowledge absorption, knowledge sharing, increased engagement, social learning interactivity, and cross-cultural understanding of communication impairments.

Keywords: stuttering, health care, public awareness, communication disorders, speech-language-therapist

Introduction

Massive open online courses (MOOCs) is rapidly growing worldwide. It is “massive” because one course enables the serving of thousands of students. It is “open” because it is free. It is “online” because the course is delivered through the Internet. It is a “course” because each sequence is structured with specific learning objectives and curriculum (UK Department for Business Innovation and Skills, 2013). Often, these online courses are delivered in various formats, including watching and listening to online lectures, completing tasks, reading articles, and having group discussions. This online forum provides students opportunities to engage with their peers and teachers around the world. The MOOC is becoming increasingly popular because it is free to access 24/7 from all countries on the same level of education, especially to learners from developing countries (Anderson, 2013).

For many years, behaviorism, cognitivism, and constructivism have been the three main learning theories that are most utilized in instructional environment (Kop & Hill, 2008). Behaviorism states that learning is through observable behavior and this is more important than understanding internal activities (Gredler, 2001). Cognitivism views learning as a process of inputs, which are managed in short-term memory and coded for long-term recall. Constructivism states that the learner creates knowledge as they attempt to understand their experiences (Driscoll, 2000, p.376). These theories, however, were developed before learning was impacted through technology and fail to describe how learning happens outside of people (i.e., learning that is manipulated by technology). In today’s environment, we can easily obtain new knowledge by drawing information through the internet. Hence, Siemens (2004) proposed the “connectivism” theory, whereby knowledge is distributed across an information network and can be stored in a variety of digital formats. Siemens (2004) states, “A community is the clustering of similar areas of interest that allows for interaction, sharing, dialoguing, and thinking together.” Connectivism provides a framework for understanding learning processes in a digital era that captures the MOOCs unicity - the sense of community and the opportunity for participants to engage online in order to learn from each other.
With e-teaching becoming more and more popular, advances in educational technology have enabled educators to incorporate technologies in the teaching-learning process (Peng, 2017). While MOOCs are increasingly popular, it is not known whether this method of self-learning at the student’s own pace is better than conventional lectures. At present, students have reported both positive and negative experiences using MOOCs (Zutshi, O’Hare, & Rodafinos, 2013). From the academics’ and teachers’ perspectives, most agree the MOOCs could never replace a knowledgeable and engaging teacher in front of a class (Cassidy, Breakwell, & Bailey, 2013). However, MOOCs could provide students with a different type of learning experience from their peers. Currently, instructors distribute teaching materials, collect students’ assignments, and communicate with students via Forum on the e-learning platforms. However, it does not fully utilize the functions of e-learning platforms. On top of conventional lectures, we added an online discussion on a MOOC platform to provide opportunities for students in two countries to discuss and share their experiences on a task. This paper summarizes the task that the instructors designed and reports students’ views on participating in MOOC for a course.

Materials and Methods or pedagogy

An e-learning experience using a free open learning platform (MOOC) was developed by the research team for students from two institutes (National University of Malaysia and Rockhurst University) who enrolled in the institutions’ respective stuttering courses. Students were taught about the clinical characteristics of speech production in individuals who stutter in class before participating in the pseudostuttering tasks. Students were asked to share their experiences as a person who stutters (pseudostuttering) to better understand their patients’ perspectives and emotional reactions. Students were asked to produce at least three episodes of pseudostuttering in different speaking environments with strangers over the course of a week. Students were to speak using the speech patterns of stuttering, including primary characteristics of stuttering, such as repetition of sounds and words, prologations of sounds, and inaudible blocks, interjections, and revisions, as well as secondary characteristics, such as eye blinks and head nods. This task created the opportunity for students to feel their client’s emotional reactions to stuttering, thus developing empathy. Students were able to observe the various reactions of the general public to people who stutter, from kind and supportive to derisive and dismissive. This pseudostuttering task was also implemented to help desensitize students so that they will not act negatively when they begin working with their clients. An online discussion platform was created using MOOC for students to write about their experiences, observations, and reflections as a ‘stutterer’ in terms of modifications of their speech and their emotions during these interactions. Students were encouraged to read about their peers’ experiences and make comments on these. Finally, students filled out a survey that expressed their opinions on this task and the MOOC experience.

Results and Discussion

A total of 49 students (16 Malaysia, Mean age 23.6 years old [SD=1.4]; 34 American, Mean age 24.3 years old [SD=1.3]) participated in this study. The students in Malaysia were enrolled in the undergraduate stuttering course during participation. The US students were enrolled in the graduate stuttering course. (In Malaysia, the undergraduate degree is the terminal degree for becoming a clinician, whereas in the US, the graduate degree is the terminal degree for the profession. This explains why students take their stuttering course at different levels. Two parts of results are reported in this paper. The first section focuses on the emotional impact and knowledge that students have learned from this task and their reflection about this activity. The second part report the survey results, whereby descriptive data on the survey are summarized in Table 1, and two major themes were found from students’ responses and summarized here.

Theme 1: Understanding the emotional reactions and social challenges faced by people who stutter.

This experience taught us not only to see the challenges people who stutter (PWS) face but also challenge our own perspectives towards PWS.

Stuttering can be really exhausting! PWS should be praised for their attempts to communicate with other people because not only they have to gather courage to speak up in public but they also need to bear with all the exhaustion that comes after it.

Based on my observation, most of them made attempt to hear and understand on what I want to say. They give their full attention especially the waiter and cashier in order to get a correct order and to avoid any mistakes. Some of them also did ask for clarification when ordering the food (e.g: cashier at KFC asked, ”what drinks?”) in expecting me to repeat my order.

In conclusion, this assignment experienced me the difficulties for PWS to carry out a conversation and to fulfill their social demands. Normal people seem enjoy to have a conversation, but for PWS it can be very stressful for them. Here come to SLP’s roles in providing intervention by teaching some techniques and have an empathy towards them on how does stuttering affects their daily life.

This activity helps me to understand that stuttering is not only about the fluency problem. It affects individual as a whole. Their social network will become very limited. It takes a lot of courage for them to start a conversation. It influences their life so badly, even when I tried to speak few sentences with stutter I already felt tired. As a speech-language pathologist, this
activity helps me to see how emotionally influencing stuttering is and we should always concern about emotion aspect of each client.

This pseudostuttering assignment is actually very worthy as I did manage to feel how a stutter feels so tired when every time he/she to maintain conversation and also manage to felt how people looked at me weirdly.

Theme 2: Interaction with peer through online-learning

I can relate to how you felt on your first trial! When I prepared for my first trial, I practiced and show how still had the same anxious feelings. I agree with you that this activity was eye opening and gave me a better understanding of how people who stutter feel in social situations.

I had the exact same thoughts as you did while going through this experience. When I stuttered at my waitressing job, I was extremely embarrassed and felt like I couldn't do my job to the best of my ability. I'm sorry to hear that someone chuckled at you and that someone eventually started to ignore you. That just reinforces how hard it must be for those who stutter on a regular basis.

I like how you mention we need to work on our reactions to people who stutter. They are already struggling to fluently communicate and may become embarrassed so it would be nice if the person they are communicating with is understanding and patient with them to make them feel more comfortable.

I can understand your anxiety and nerves. I was also nervous when I was at the pharmacy. People were staring at me and the lady behind me was very rude. I also agree that this experience is very eye-opening to understand what the clients we will work with are going through.

I can relate to your experiences. I anticipated that it would feel awkward to stutter in public, but this experience enlightened me to how strong the feelings of anxiety and anxiousness can become when others are overtly commenting on your speech. The blank stares and confused expressions also negatively reinforced my feelings of anxiousness. This assignment helped me to become a better listener for PWS and to be more aware as a future clinician.

Online teaching through MOOC is one of the emerging technologies in the field of education (Viswanathan, 2012). It enables participants to connect outside the traditional learning environment, thereby offering autonomy, openness and emergent knowledge. The growing trend of encouraging connected learning among students reflects the need for teachers to participate in an online course.

Using the MOOC, we provided a platform for students from two countries for learning and sharing their experience using a simple pseudostuttering task. One of the important aspects of the MOOC was the opportunity it provided for students to engage with other students. The course coordinators posted the task where students can express and comments freely among themselves and with the coordinators. In this case, the course coordinator/teacher acts at the connected educator, as suggested by Dabbs (2012). None of the students reported that they felt reluctant to fully engage in this discussion activity due to English concerns. Indeed, some of the students stated that they enjoyed this aspect of the course and the opportunity to communicate with students from different countries.

One of our goals was to increase general understanding of clinical symptoms and emotional reactions in individuals who stutter among speech-language pathology students. From the task that we have designed and the reflections from students, we found that students were able to grasp the emotional and clinical symptoms of a persons who stutter. Implementing MOOC in addition to traditional in-class lecture encourages the students to share their views with others and this trains students to take up responsibility for the learning (Mary, 2012). Students from both countries were able to share their experiences and comment on each other’s experiences online without face-to-face discussions. This fits the theory of Connectivism for having the ability to seek out information and including the social context in the learning process (Kop & Hill, 2008). This activity shows that acquisition of knowledge happens not just by listening to lectures, but through interactions with other participants. The MOOC provides an online community that students could participate in consistently and collaborate with others. Future work could further explore the needs of student when using MOOC, especially students from developing countries to better

Table 1. Students’ response about the task (percentage, US/Malaysia).

<table>
<thead>
<tr>
<th>Activity</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pseudostuttering &amp; speech environment with emotional influence</td>
<td>80% (US) 75% (Malaysia)</td>
</tr>
<tr>
<td>Pseudostuttering &amp; speech environment with emotional influence for other clients</td>
<td>80% (US) 75% (Malaysia)</td>
</tr>
<tr>
<td>Pseudostuttering &amp; speech environment with emotional influence for own clients</td>
<td>80% (US) 75% (Malaysia)</td>
</tr>
<tr>
<td>Pseudostuttering &amp; speech environment with emotional influence for group clients</td>
<td>80% (US) 75% (Malaysia)</td>
</tr>
<tr>
<td>Pseudostuttering &amp; speech environment with emotional influence for family clients</td>
<td>80% (US) 75% (Malaysia)</td>
</tr>
</tbody>
</table>

Table 2. Students’ response about the task (percentage, US/Malaysia).

<table>
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<tr>
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</thead>
<tbody>
<tr>
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<td>80% (US) 75% (Malaysia)</td>
</tr>
<tr>
<td>Pseudostuttering &amp; speech environment with emotional influence for family clients</td>
<td>80% (US) 75% (Malaysia)</td>
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Table 3. Students’ response about the task (percentage, US/Malaysia).

<table>
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<tr>
<th>Activity</th>
<th>Percentage</th>
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<tbody>
<tr>
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</table>
understand the culture differences and impact of such learning experience (Liu et al., 2016).

Conclusions

This e-learning experience from two different cultures raises the likelihood of knowledge acquisition, knowledge sharing, increased engagement, and social learning interactivity. Students from a developing country can now learn the same knowledge and interact with other students from an advanced country with no cost.

Acknowledgements

This project was supported in part by the Sumitomo Foundation #168490 (1st author).

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PRACTICING EFFECTIVE CLASSROOM MANAGEMENT USING YAMMER IN OFFICE 365®

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Abstract

Office 365®, which is the brand name for a software-as-a-service-type cloud service provided by Microsoft®, offers service subscriptions for productivity software and related services. Since 2015, service subscriptions under the “Microsoft Education Alliance Agreement” have allowed all users in KOSEN to use Microsoft Office apps on various operating systems, and have also provided email, storage, and social networking services (SNSs).

I decided to utilize the SNS “Yammer” with the aim of managing my classroom effectively. Access to a Yammer network is determined by a user's Internet domain; therefore, it is easy to construct a private communication environment. In addition, it can be used not only through a web browser on a PC but also on mobile terminal-dedicated applications on smartphones and tablets. I regard Yammer as a very easy and convenient service for students who are familiar with mobile communication devices.

This report covers the practice of effective classroom management using Yammer. The practice had the following features. First, using the document posting function, I issued an announcement about assignments for daily duty, cleaning duty, and so on. Then, the students posted comments, instead of keeping a class diary. Second, using the file attachment function, I distributed electronic documents such as application forms and class schedules. Further, the students posted pictures of school events. Finally, using the private message function, I distributed electronic documents such as application forms and class schedules. The students posted pictures of school events. Finally, using the private message function, I could make contact with students, for example, to call them to my office for an interview. In addition, using Microsoft Forms, I made a questionnaire survey regarding the laboratory students wished to enter, their desired career after graduation, and so on. Once signed in to the class’s Yammer, the student would immediately see the feed, which notified them of any activity and of important posts by those in the class.

I believe that it will be relatively easy for various types of schools to adopt Yammer for managing classrooms effectively. In this paper, I detail my activities and present matters for the consideration of schools wishing to use this cloud service in the future.

Keywords: classroom management, information and communications technology (ICT), social networking service (SNS), Office365, Yammer, questionnaire survey

1. Introduction

Our college aims to cultivate global, sensitivity-rich, creative, and practical engineers working in the global society. In 2017, to respond to recent changes in society and the industrial arena, we reorganized four former departments into one department consisting of four major divisions with seven courses. We put our ardent for developing human resources to lead the future of mid-northeast Japan into the name of our new department, “Department of Engineering for Future Innovation.” In this new program, 2nd-grade students will select one of four major divisions, “Mechanical and Intelligent Systems Engineering,” “Electrical and Electronic Engineering,” “Computer Engineering and Informatics,” or “Chemical Engineering and Biotechnology” that is a good fit for themselves after receiving first-year common education.

Prior to the reorganization, in 2007, we had revised a curriculum and established a technical subject, namely Information and Computer Literacy (ICL) [2], in which all first-year students take lectures using the same syllabus in mixed classes composed of students from all technical backgrounds. By innovating the ICL course, we tried to enrich the quality of computer and information education and expected that various educational benefits would develop. Through the ICL class, all first-year students learn ICT skills. As stated above, we are engaged in our ICT education, including making good use of smartphones.

In 2015, service subscriptions under the “Microsoft Education Alliance Agreement” allowed all users in KOSEN to use Microsoft Office apps on various operating systems and also provided email, storage, social networking services (SNSs), and so on. Specifically, Office 365 A1 Plus Licensing has been...
provided since 2015, and then Office 365 A3 Enterprise Mobility + Security E3 was provided since 2017. This means that many apps in Office 365 and services are available for all of the faculty and students in our college free of charge.

In this context, I took the opportunity to be in charge of a 5th-grade class in 2017 and decided to utilize Office 365, specifically the SNS "Yammer" and "Microsoft Forms" in Office 365®, with the aim of managing my classroom effectively.

In this paper, I describe contents of our activities and their background in Section 2. Then, we also describe the effects and features in Section 3. Finally, in Section 4, I conclude my paper with a focus on the possibility of various types of schools adopting Yammer for managing classrooms in the future.

2. Materials and Methods or Pedagogy

In this section, I provide a report of the background of adoption and examples of utilization of the SNS "Yammer," with the aim of managing my classroom effectively.

2.1 Yammer

Yammer is provided as a service in Office 365 and is characterized by a timeline, file sharing, and private messages, similar to Facebook or Twitter, while it also allows for social interaction in a limited environment such as a school class. In addition, it can be used not only through a web browser on a PC but also on mobile terminal-dedicated applications on smartphones and tablets.

I regard Yammer as suitable for keeping up with changes in groups that require interaction by my students who are familiar with mobile communication devices. This report covers the practice of effective classroom management using Yammer. The practice had the following features.

A) Document posting function (Timeline)

I issued announcements on the timeline as follows.

- [Update/Announcement]
  - Announcements from a class teacher (including announcements from the Office of Academic Affairs)
  - Assignments for daily duty
  - Assignments for cleaning duty
  - Group photos posts of on-campus events,
  - and so on

Note that a student whose turn it was on day duty had to post comments, instead of keeping a class diary, and a student whose turn it was on cleaning duty had to post that the task was completed (see Figs. 1&2). Further, the students posted pictures of school events (see Fig. 3).
I conducted a simple questionnaire about changing the seating arrangement several times a year (see Fig. 4).

I posted praise to students who won prizes in various contests (see Fig. 5).

I distributed electronic documents, along with various announcements, such as on-campus documents, application forms, class schedules, and photos (see Figs. 6 & 7).

I could make contact with students, for example, to call them to my office for an interview.

Thus, once signed in to the class’s Yammer, students would immediately see the feed, which notified them of any activity and of important posts by those in the class.

Microsoft Forms allows for the creation of customized documents that can be assigned to a student and results that can be collected and analyzed. Once I create the form, I can share the form or assign it only to my class’s students.

I made various questionnaire surveys for my students as follows.

- Laboratories students wish to enter (see Fig. 8)
- Desired careers after graduation
- Their desired schedule for teacher and parents meeting
- Attendance checking at on-campus events
3. Results and Discussion

In this section, we review the effects and features concerning the adoption of Yammer in Office 365 as a classroom management tool. My activities are described in the previous section, while the class that I am in charge of was organized by 5th-grade students, final-year students in the department of electrical and computer engineering. A final-year student class has the following feature. The number of courses they take in their classrooms decreases; on the other hand, the amount of graduation research they conduct in their laboratories increases. Therefore, it tends to be difficult to contact my students directly in their classroom. For this reason, I decided to make use of Yammer with the aim of managing my classroom effectively.

First of all, providing a “Portal Site” using Yammer can reduce my operation cost as a homeroom teacher; namely, Yammer is an effective service for various announcements and communications. I believe this is both a feature and a merit.

Another reason why I adopted Yammer is because I am often out of my office on meetings or business trips, and it is hard to ensure sufficient time to contact my students.

Each effect and point of attention is described below in detail.

### 3.1 Yammer

A) Document posting function (Timeline)

I can contact my students from both on-campus and off-campus at any time efficiently and effectively. On the other hand, my students can receive my notification as needed.

B) File attachment function (File Sharing)

There is no need to print for me, so I can save printing paper, time, and trouble printing documents. From the students’ point of view, they can take a look at documents uploaded to Yammer any time without losing them. If they need to print something out, they can do it by themselves.

C) Private message function (Private Messages)

For my part, I do not have to go to their classroom or their laboratory to directly contact or call them. In addition, I can keep the record of that. Then my students can notice my message immediately.

### 3.2 Microsoft Forms

Taking and tallying a questionnaire survey electronically is very convenient, compared to those in the print medium. Besides, I can share the form only to my class’s students with the user authentication function for Office 365. Once my students complete the form, I can come back into forms and see the responses immediately.

There are several topics of discussion, as follows.

It is generally effective as a method of announcement and contacting my students. I believe this is because Yammer is also provided as an application on smartphones, and it is easy for students to notice a notification on their smartphone’s screen. It is noted that all the students in my class are in a Yammer group and have their smartphones, but it could not be confirmed that all the students made use of the Yammer application on their smartphones. This means that a few students might not check the timeline.

However, I am not sure whether interactive communication through Yammer can be achieved sufficiently or not. Though I instructed students whose turn it was on duty or cleaning duty to post comments, instead of keeping a class diary, or to post that the task was completed, students did not post much more than those posts (see Fig. 9). To activate a class, it is desirable to have more interactive communication, not only as teacher-to-student but also as student-to-student. In fact, it seemed that private groups on LINE were utilized only among classmates.
Next, the point to be discussed is the case in which we want to share information with faculty, as well as my class students. For example, an announcement of a presentation of graduation research should be common knowledge among my class students and teachers in our department. In such cases, I had to use two other ICT tools, Moodle and Gmail. Fortunately, in our college, Moodle has been put into service a decade ago with the aim of supporting classes [3]; all students and teachers use the system in their daily school lives. Moreover, Gmail is adopted as an emergency contact method for our students [4]. By creating a unique mailing list for each class in each grade, we can contact not only individual students but also an entire class by email. In daily school life, it is mainly used for announcements from a class teacher, teachers in charge of class subjects, and so on. Thus, I utilized ICT tools as complements to Yammer.

Finally, I review students’ opinions on adopting Yammer as a classroom management tool. There are many affirmative responses, such as convenience for making contacts, easy to take information, appreciation of class teachers trying hard to keep everyone informed and on task, and so on. Here, I must mention the opinion of the minority. In contrast, a few students said that Yammer is a bother to check, so Gmail is better, and that they wanted to keep a class diary in a paper medium

4. Conclusions

As shown by the above, Yammer in Office 365 can be comparatively easily adopted and utilized for various kinds of schools other than KOSEN, and also adopted for any educational activities other than class management. However, I am of the view that the several issues mentioned in the previous section should be taken into consideration when adopting these services. I continually improve the method of managing these services, including other SNS-like services such as Microsoft Teams by utilizing PDCA cycles. For instance, I now utilize Yammer for managing my laboratory (see Fig.10).
References


IN-CLASS E-TESTING OF STATISTICS IN A LARGE COHORT OF DIVERSE ABILITY

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Abstract

We report on our experience of running in-class e-Tests for a new Level 1 Business Decision Making module taken by 800 Business School students at the University of the West of England (UWE Bristol). The module comprises a one semester course covering statistical methodology in far greater depth than had been taught previously and modernised to include analyses using the statistical software SPSS rather than by hand calculations. The syllabus constituted a challenging amount of material to cover, especially since the student cohort was a large, diverse group of non-mathematicians.

The controlled conditions element of the module’s assessment comprises the average mark of the best two from three in-class e-Tests. In each e-Test a student receives their own unique data set to work on and performs a complete statistical analysis of it, using SPSS. We describe how we securely assessed the large number of students over fifteen 50 minute PC classes.

The main learning tools were key skills e-Assessments that provided the student with a random data set to import into SPSS to then appropriately analyse and report on. Repeated use of these would ensure that a student would thoroughly learn a key skill and cover various analysis outcome scenarios, for instance significant or not significant test outcomes. Each key skill e-Assessment has multiple embedded links to comprehensive Help pages that provide SPSS ‘how-to’ information or output interpretation. This form of support is more targeted and immediate than a student having to refer back to the notes. It also encourages the student to self-learn rather than automatically seek staff help. This allowed the staff to concentrate on giving statistical understanding and interpretation advice as opposed to say wasting time on the mechanics of producing SPSS output.

The e-Assessment system used was Dewis which is a fully algorithmic open-source e-Assessment system which was designed and developed at UWE. It is a completely stand-alone web based system used for both summative and formative assessments. Dewis’ ability to communicate with the R programming language greatly facilitates the task of generating bespoke student data and providing answers that match SPSS screen output.

Keywords: e-Test, e-Assessment, Statistics, Dewis, R, SPSS

Introduction

We report on our experience of running in-class e-Tests for a new Level 1 Business Decision Making module taken by 800 Business School students at the University of the West of England (UWE Bristol) and partner institutions (Villa College, Maldives, British College Kathmandu, Nepal and Northshore College, Sri Lanka). The module comprises a one semester course covering statistical methodology in far greater depth than had been taught previously and modernised to include analyses using the statistical software SPSS rather than by hand calculations.

The module covers the following statistics topics, which were taught in the order listed:

- Exploratory data analysis including normality testing;
- One sample t-test & nonparametric equivalents;
- Probability & Decision trees;
- Two sample t-test & nonparametric equivalents;
- Critical Path Analysis & Gantt charts;
- Correlation and simple linear regression;
- Chi-squared tests;
- Time series.

The controlled conditions element of the module’s assessment comprises the average mark of the best two from three in-class e-Tests. In each e-Test a student receives their own unique data set to work on and performs a complete statistical analysis of it, using SPSS. The e-Assessment system used was Dewis which is a fully algorithmic open-source e-Assessment system which was designed and developed at UWE. It is a completely stand-alone web based system used for both summative and formative assessments (Gwynllyw and Henderson, 2009; Dewis Development Team, 2012). Dewis’ ability to communicate with the R programming language greatly facilitates the task of generating bespoke student data and providing answers that match SPSS screen output (Gwynllyw, Weir, and
Teaching strategy

The syllabus presented above constituted a challenging amount of material to cover, especially since the student cohort was a large, diverse group of non-mathematicians. In addition, students were expected to learn how to use SPSS and to gain sufficient competency/understanding of the techniques so that they would be able to perform data analysis when collecting their own primary data in their level 2 research project the following year. Some of the challenges to overcome in designing the way the statistics material was to be taught and assessed were identified as follows:

1. How to teach the students so that they were able to self-learn SPSS;
2. How to securely assess the large number of students over fifteen 50 minute PC classes.

Description of the problem or issue

The Statistics staff deliver to the students a one hour lecture and a one hour computer practical each week. Business School staff supply relevant context to each of the statistical topics taught through a one hour tutorial per week. The Business School staff were also responsible for the uncontrolled element of the assessment.

The Statistics staff provided notes that covered statistics and use of SPSS and this material was delivered in the lecture. The initial computer practical session concerned the basics of SPSS (e.g. data entry, variable labels, file opening and saving) and the creation of summary statistics, graphics and tables. For this purpose, several bespoke self-learn videos were created so that the students could pause at will and thus work at their own pace. This was deemed necessary due to the wide range of computer abilities amongst the cohort.

From the second computer session onwards, the main learning tools were Dewis key skills e-Assessments. Each use of these provided the student with a random data set to import into SPSS, appropriately analyse and report on. Repeated use of these would ensure that a student would thoroughly learn a key skill and cover various analysis outcome scenarios, for instance significant or not significant test outcomes. Each key skill e-Assessment has multiple embedded links to comprehensive Help pages that provide SPSS ‘how-to’ information or output interpretation. This form of support is more targeted and immediate than a student having to refer back to the notes. It also encourages the student to self-learn rather than automatically seek staff help. This allowed the staff to concentrate on giving statistical understanding and interpretation advice as opposed to saying wasting time on the mechanics of producing SPSS output.

On submission, students are supplied with the correct answer as well as colour-coded feedback on each of their answers. Green indicates that they are correct and red indicates that the answer was incorrect. Access to full and bespoke feedback is important because it has been found that students learn from e-Assessment feedback, using it to perfect their technical knowledge (Greenhow and Gill, 2008).

To supplement the key skills e-Assessments, students are also given pre-prepared word templates which are designed to represent a complete statistical analysis on a specific supplied data set. The templates have the SPSS output removed, numerical values blanked out and inserted multiple choice interpretation decisions to make. Setting it up in this way for students to complete enables them to concentrate on the mechanics of the creation of SPSS output and interpretation of results.

Dewis key skill e-Assessment example

The data scenario for this particular key skill e-Assessment concerns using a 95% confidence interval (CI) for the mean to infer whether the mean IQ of people on a particular medication appears to differ to the general population IQ value of 100. Fig. 1 shows a screenshot of the question that is presented to the student.

The data is supplied to the student via a CSV file as a downloadable link. The successful transfer of the data into SPSS is checked by the student comparing the stated standard error of the mean to that which they obtain in SPSS. Having confirmed agreement, the student is told to input all numerical answers to the same number of decimal places that SPSS reports to.

After the appropriate analysis in SPSS, the student is then required to input the numerical values for the sample size, sample mean and the 95% confidence interval limits before choosing from a dropdown menu the correct inference concerning the problem posed. In Fig. 1 for illustration purposes, the student’s attempt has a mixture of correct, incorrect and blank answers.

Fig. 2 demonstrates the initial report which summarises the students attempt and provides an e-Assessment percentage score. Fig. 3 displays ‘The Solution’ and ‘The Report’ sections from the feedback of the student’s attempt at this e-Assessment. The ‘Solution’ section supplies the correct answers that the student needed to complete. A pictorial representation of the confidence interval is included along with accompanying text in blue that is extra feedback information that aims to aid the students understanding of the correct inference to the question posed. The ‘Report’ section indicates, with colour coded marking, what the student has answered correctly (green) or incorrectly (red). It can be seen that the student has one wrong answer and a not answered (NotAns) input.
The Question.
The average IQ in the general population is 100.
The boxplot below is of the IQs of a random sample of people who are taking a certain medication.
Does the 95% confidence interval for the mean indicate that the medication is affecting IQ?

Data and transfer check
Download the [file] and transfer it into SPSS. Help
Check that your data transfer has been successful by obtaining the Std. Error of the mean for your data which should appear in SPSS output as 3.903. Help
If you do not have this exact value, then you may have not transferred your data from the Excel file to SPSS correctly. Do not continue with the test until your value agrees as otherwise you may not have correct answers.
Unless otherwise directed you should report all numeric values to the accuracy displayed in the SPSS output that is supplied when your data has been transferred correctly.

Question Help
Complete the following:
The sample of [15] people had a mean IQ of [89.47] (95% CI: [81.09] to [ ]).
Based upon the 95% confidence interval, it appears that the mean IQ is [ ] whilst on the medication.

Marking scheme
- Numerical entries: correct = 1 mark / incorrect = 0 marks
- Dropdown choice: correct = 1 mark / incorrect = 0 marks
- Not answered = 0 marks

Figure 1. Screenshot of key skill e-Assessment example. The student has entered correct answers bar not supplying the 95% CI upper limit and has an incorrect inference concerning the mean IQ.
Figure 2. Screenshot of key skill e-Assessment example initial report.

Figure 3. Screenshot of key skill e-Assessment example solution and report sections of the feedback.
The in-class e-Tests

The first in-class e-Test concerns the data dependent choice of the application of either the one-sample t-test or Wilcoxon signed rank test to evaluate a supplier’s claimed average sodium content of mineral bottle water. Each run of the test would result in data of random sample size and with a supplier’s claimed average that was also random. Furthermore, the data was randomly generated so that with equal chance students would experience both tests and significant or nonsignificant results. The basic statistical analysis tasks tested were the ability to transfer data from CSV format to SPSS, perform an exploratory data analysis for summary statistics, graphics and assumption testing; identification of appropriate statistical test (parametric or nonparametric equivalent), interpretation and reporting of test output. In total there are 22 numerical/dropdown entries that are each assigned 1 mark if correctly answered. There are a further 3 marks available for the correct choice of test to report; this weighting acknowledges the complexity of a decision based upon taught guidelines that consider sample size, skewness and normality.

The second in-class e-Test concerns the data dependent choice of the independent samples t-test, Welch’s t-test or Mann-Whitney U test to evaluate the average amount of time visitors spent on two website designs. Each run of the test would result in data of random sample sizes with equal chance that students would experience any of the three tests with significant or nonsignificant results. The statistical tasks required built upon those of the first test and included as extras the interpretation of overlapping confidence intervals and the evaluation of equality of variances. The extra complexity of the guidelines for choosing between three tests was weighted to be worth 4 marks, there were 21 numerical/dropdown entries that are each assigned 1 mark if correctly answered.

The third in-class e-Test concerns the prediction of the sales value of a particular product from the market potential. Each run of the test generates data from a random number of sales territories with varying strengths of positive correlation between the two variables. Students are required to perform and report both a correlation analysis and a regression analysis. It is required that they report on the strength of the correlation, assess the fit of the regression model, report on outliers, interpret the gradient coefficient and produce predictions together with associated 95% confidence intervals. Unlike the analysis in the other two e-Tests, this analysis does not require the student to make any data dependent decisions on techniques to apply. In total there are 25 numerical/dropdown entries that are each assigned 1 mark if correctly answered.

In-class e-Testing procedure

The in-class tests that were run at UWE Bristol were scheduled to run in the same session/room as students' timetabled PC session. This was the only practical way of running the e-tests given the large number of students involved and the fact that the biggest PC lab on campus holds at most 50 students. Each session was scheduled for 50 minutes and the time limit for the in-class e-Test was 30 minutes. Each student was allocated to a group on the University’s Virtual Learning Environment (VLE) which corresponded to their PC session. Using adaptive release, access to a practice test for each group was enabled immediately after the corresponding PC class a week before the in-class test. The practice test was exactly the same as the in-class e-Test and remained available to that group until midnight the day before their in-class test was scheduled. During its availability period, students were allowed unlimited attempts at the practice test getting different data (and hence analysis outcomes) each time they attempted it together with full feedback. The Dewis system enforced a strict time limit of 30 minutes to get students used to working under exam conditions.

Using adaptive release the link for the in-class test was only available for a particular PC group during their scheduled computer lab. At the start of the in-class test students were instructed to log into the VLE to access this link and to open the SPSS software. The in-class test link was protected by an examination key and this was different for each PC group. Once all the students were ready to start this examination key was issued and students were directed to enter it and “Start the online exam”. This ensured that only students within the room were able to access the in-class test. During the in-class e-Test students were only allowed to access Dewis and the SPSS statistical package. Dewis displayed a persistent grey bottom horizontal bar containing details of the student’s identity. This display was intended to facilitate the invigilation process and has been successfully used previously for e-exams run using the Dewis system (Henderson, Gwynllwy and Hooper, 2016). On submission of the assessment, the colour of the horizontal bar changed to pink. Students were allowed to submit their answers ahead of the 30 minute limit and, in such cases, they were instructed to ask an invigilator to view the pink bar before leaving the room. This bar provided the invigilators with an easy visual check of the student engaging with the Dewis system and also of the status of their assessment attempt. The first two in-class tests were invigated by academic staff involved with the module; however the final in-class test was supervised by staff from the university’s exam invigilator team.

Each student’s attempt was marked instantly on submission. However disclosure of the mark to the students was delayed until the end of the week. This allowed us time to review and analyse the complete spread of marks once all the students had taken the in-class test. Once we had completed the review process, students were able to log back into the in-class test link and view their submission to get full bespoke feedback for their attempt as well as their mark.

The number of students taking the module at partner institutions was considerably smaller than for those taking it at UWE Bristol. This meant that they were able to give access to the whole cohort in one sitting.
Results

Results have been excellent (e-Test 1: one-sample t-test \( N = 643, M = 75.2, SD = 20.0 \); e-Test 2: two-sample t-test \( N = 640, M = 75.8, SD = 24.0 \); e-Test 3: correlation and regression \( N = 380, M = 67.5, SD = 24.7 \)). The decline in the number of students attempting the third e-test is due to the final mark being the best from two; many students with high marks from the first two tests elected not to take the final test. Based upon the best two from the three e-Tests, 83% of students passed this element of the module. This is an excellent pass rate, especially as 9% of students did not sit any of the e-Tests.

Of those students that sat each e-Test, the majority had previously tried the practice tests (e-Test 1: 59%; e-Test 2: 64%; e-Test 3: 54%). Many students made multiple attempts at the practice attempts (e-Test 1: \( Mdn=5, IQR = 2 – 9 \); e-Test 2: \( Mdn = 6, IQR = 3 – 11 \); e-Test 3: \( Mdn = 4, IQR = 2 – 7 \)). Those that did practice experienced a significant uplift in average marks compared to those that did not practice (e-Test 1: \( 20.8 \) (95% CI 18.1 – 23.5); e-Test 2: \( 24.3 \) (95% CI 20.9 – 27.7); e-Test 3: \( 20.7 \) (95% CI 16.2 – 25.3)).

There was a high number of students who have viewed their feedback (e-Test 1: 72%; e-Test 2: 70%; e-Test 3: 56%). This is much higher than the 10% that is typical for paper-based work. Research (Race, 2014) shows that feedback has to be quick to be effective, while students still remember clearly the work they were engaged in and online exams are one way of achieving this.

Discussion

Feedback from students to the module has been mixed, in part due to the fact that some students did not feel that there was enough linking between the Statistics and Business elements of the module. Given that 2017/18 was the first year that the module ran in this form this is not totally surprising and greater liaising is planned for future years. However in general the students liked the in-class tests, recognising that “it is fair for all students” because it is not possible to “cheat” as is the case for uncontrolled coursework.

Using e-Assessment for coursework has become standard practice in many institutions (Singwin, 2013) and it seems likely that online examinations will become standard practice in the near future (Kuikka et al, 2014). However progress has been slower than predicted by Collins, Ripley and Roads (2003). Gray, Sheppard and Ferrell (2016) found that there is considerable interest in online exams yet few reliable sources of good practice. Roads (2016) reports that most organisations expect to increase their use of e-Assessment over the next five years and identified that lack of space for invigilated testing as one potential barrier. In this paper we provide a model for how robust online testing of statistics can be achieved.

The Statistics element of this module is designed to provide a solid foundation for Business School students in using SPSS to perform standard statistical tests. They will experience further material in their second year and will then be required to use the techniques that they have learnt to analyse real data in a substantial research project. It is hoped that the testing regime and the fact that students will have access to the comprehensive materials produced throughout their studies will facilitate their transition to becoming independent researchers.

References


INSPIRING YOUNG PEOPLE TO LEARN ABOUT THE LATEST HEALTHCARE TECHNOLOGIES AND PRACTICE THROUGH HEALTHTECH CENTRE

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Abstract

As the manpower demand of healthcare practitioners arising from ageing population and healthcare concerns is reiterated almost every year in the Chief Executive of Hong Kong Special Administrative Region Government’s policy addresses, education and professional trainings in these two areas are crucial and essential in Hong Kong.

Apart from traditional classroom-based lectures and workshops learning and teaching activities, equip learners with practical skills in healthcare areas through workplace attachment is necessary. Therefore, training opportunity in an emulating industrial working environment that can enhance customer service and interpersonal skills of students; facilitate interaction with the healthcare industry and community is important. In view of this, the HealthTech Centre (“The Centre”) was established with the mission of promoting awareness of community health and offering Vocational and Professional Education and Training (VPET) in this field.

The HealthTech Centre, located in the Hong Kong Institute of Vocational Education (Kwai Chung), a member institution of the Vocational Training Council (“VTC”), was officially opened on 16 March 2017. The Centre aims at providing advanced and professional facilities for training manpower needed in the healthcare services sectors.

The HealthTech Centre is equipped with advanced and professional technology-centric facilities, providing real-world training for students pursuing health studies, applied nutritional studies, vision health care, community health care for senior citizens and medical centre operations. The centre is collaborating with local community organisations and elderly centres. Elderly residents are invited to join the health activities provided by the Centre like cognitive training and exercising games with the aid of Virtual Reality technologies. The Centre also provides general health services, foot health, geriatric services, vision health and nutrition counselling services. The elderly participants can gain more health knowledge and interact with young people. At the same time, students can put into practice what they have learnt through conducting basic health screening services for the elderly in areas like vision health, nutrition and cognitive abilities.

Keywords: Active learning, practice-based learning, workplace learning, healthcare skill learning

Introduction

The HealthTech Centre (“the Centre”) was established in Hong Kong Institute of Vocational Education (Kwai Chung) on 16 March 2017, with an aim to provide advanced and professional facilities for training healthcare professionals. Elderly was recruited, through the elderly centre networks, to participate in different kinds of health activities in the Centre. Under the guidance of the teachers, students from different higher diploma programmes in Applied Science Discipline were providing health services to the elderly.

As illustrated in the floor plan in Figure 1, the Centre was divided into two different zones, namely Delighted Zone and Service Zone. The Delighted Zone is a multi-purpose area that is equipped with a 100” multimedia wall and innovative health technology applications. Some innovative applications were designed by colleagues and students of Applied Science Discipline to facilitate the provisioning of health services. For example, a motion-sensing cognitive training application named “Wet Market” was installed in the Delighted Zone. Making use of multimedia wall and Kinect technology, participants were required to pick a variety of food ingredients in a simulated wet market environment. Students and elderly could experience the latest cognitive training and exercising technology. It also created a training opportunity for students to interact with the elderly.
The Service Zone is further divided into General Health, Foot Health, Elderly Care, Vision Health and Nutrition Service areas. Sophisticated equipment are installed in respective areas to enable the students to apply what they have learnt to handle the real cases. For example, by using equipment like non-contact tonometer and digital retina camera, Higher Diploma in Vision Health Care students can provide simple vision screening service including visual acuity, Amlser Grid, rough refractive error, eye pressure assessment and retina health screening to the elderly participants. On the other hand, other higher diploma students can use bladder Scanner, In-body analyser and podoscope to provide a wide range of health services in the Centre.

The Learning Process

Dammers (2007) mentioned that the use of real patients complemented a problem-based learning approach by creating a strong motivational context and fostering a sense of responsibility. Real patients brought complexity and encouraged “elaborated” learning when new information is incorporated into what learner already knows and restructured into more complex networks. The learning experiences in the Centre could bring an empathic dimension, which is unlikely to be replicated in a lecture setting.

Dornan (2006) found that today’s students learned practically relevant theory in seminar rooms using well theorised methods. They could integrate their knowledge and skills in workplaces through a process for which there are no better descriptors than ‘clinical teaching’ or ‘primary care placement’. The simulated workplace like HealthTech centre could be where competence has eventually to be applied.

Since the service pilot run in September 2016, over 300 students participated in 170 sessions of health services. A total of 4,000 training hours were provided, benefiting 2,500 elderly participants and clients. In each service session, 10 to 15 clients were recruited to join the health service. Teachers tried to arrange the same number of students to provide a one-to-one service for the visitors.
The details of training process can be illustrated through an example of a typical service session: at 9:30 on one Monday morning, a group of Higher Diploma in Medical Centre Operations students were scheduled to provide health services to 12 elderly residents recruited by an elderly centre. Students were required to carry out the registration process, conduct particular health screening activities and take care of the elderly. The training session lasted for about 1.5 hours. Teachers would provide support and guidance in the whole process.

Before sending invitation to elderly centres, several briefing sessions were conducted to help students to get familiar with the equipment and the procedure of the service session. With a small group of students, each student would have more chances to practise different kinds of health screening equipment such as In-body analyser and Bone densitometer. Under the guidance of teachers and technicians, students could have a deeper understanding of using the equipment, ranging from equipment calibration to the techniques of handling different situations. Those activities are usually difficult to arrange for a larger class size. Knowing that they need to handle real cases in subsequent sessions, students would have a higher motivation to learn how to use the equipment and the skills needed to provide a good service to the clients. After each service session, debriefing would be conducted to review the performance of each student. Teachers would explain some improvement actions to the students if necessary.

Evaluation method

An evaluation questionnaire was designed to investigate whether the health services in the HealthTech Centre could facilitate the learning of skills and knowledge of their respective programmes. A total of 50 year 2 students (17 male and 33 female) studying different health programmes in Hong Kong Institute of Vocational Education (Kwai Chung) took part in the survey. They have participated in an average of 14.3 hours of learning activities in the Centre. Students’ comments on the learning activities were collected in the evaluation questionnaire. Participants’ selection was based on willingness to take part in the study.

A 5-point Likert scale was adopted in the questionnaire. Students were asked to evaluate the setting and experiences of the HealthTech Centre. Observations of the group process and feedback from the students were kept by the teachers. On the other hand, discussions with the participating teachers were held to collect the feedback from the teachers’ perspectives.

Results and Discussion

All 50 students completed the questionnaire covering the evaluation on the environment, the facilities and the design of learning activities. Students were asked to describe their learning experiences in the survey. All responded the question “Training activities in the HealthTech Centre enhance his/her communication skills with patients/clients”. All of them expressed positive value in the question “Health technology application and equipment can improve his/her motivation in learning.”

Table 1. Extracts of results of the questionnaire survey

<table>
<thead>
<tr>
<th>Questions</th>
<th>Mean</th>
<th>N</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities in the Centre enriched my nursing skills and experiences</td>
<td>3.78</td>
<td>50</td>
<td>0.78</td>
</tr>
<tr>
<td>Activities in the Centre improves my communication skills with patients</td>
<td>4.02</td>
<td>50</td>
<td>0.71</td>
</tr>
<tr>
<td>Through the activities in the Centre, I can gain confidence in working in</td>
<td>3.88</td>
<td>50</td>
<td>0.68</td>
</tr>
<tr>
<td>the healthcare industry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activities in the Centre helps me to have a better understanding of what is</td>
<td>3.8</td>
<td>50</td>
<td>0.72</td>
</tr>
<tr>
<td>learnt in lectures</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Findings show that the Centre can provide a different environment for the students to learn the skills proactively.

Teachers reflected that students could learn to deal with different situations through real cases. For example, they could learn to communicate with the elderly who could only speak certain dialects. In another occasion, they could learn how to handle an elderly who were reluctant to try out some activities. The Centre could provide a semi-structured environment and tailor-made training opportunity for the students, which might not be easily replicated in a normal classroom setting.

In addition to the knowledge and skills of medical practice, students need to acquire confidence and a sense of professional identity and sustain their motivation. Attaining those various learning outcomes reinforces the learning process, and failing to acquire them weakens it. The educational climate and behaviour of individual practitioners – nurses as well as doctors – has great power to enable or disable workplace participation that brings students closer to their ultimate goal of helping patients. (Dornan et al, 2007) During the discussions, teachers acknowledged that HealthTech Centre could provide such an environment to facilitate the learning of nursing skills for the students.

The survey showed that the practice in the Centre could help prepare the students psychologically and equip them with the necessary soft skills to cope with the challenges in the workplace. Under teachers’ guidance, students could gain more confidence to apply their skills on providing services to the people in need.
Conclusions

Opportunities to engage in work, the kinds of tasks in which individuals are permitted to participate, and the guidance provided, become key bases to understand and evaluate how and what individuals learn through their work. (Billett, 2002) The Centre was believed to provide the environment and opportunities to inspire the young people to sharpen both their soft and hard skills, contributing to the development of talents to work in the healthcare industry.

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EFFECT OF PREPARATION WORK FOR MANUFACTURING PROJECT ON INTERNATIONAL EXCHANGE ACTIVITIES

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Abstract

Development of global human resources is important mission for National Institute of Technology, because a lot of engineers are working not only domestically but overseas. Although our college holds international exchange activities, there are the room to develop new exchange activities for younger students. This paper describes a new activity for our Year-2 students. When the target students are not used to exchange activities, organizer should be careful to prepare topics for the students. Therefore, common topics are provided by some cooperative works that included in the exchange activity. Especially, technical English communication is not easy for younger students, because they study technical English words not so much yet. Since the presentation about the mechanism of every project is given by students instead of teachers, the students have to prepare the English slides and also make the prototype before the presentation. The preparation gives students opportunity to study technical English words and to practice English presentation. The manufacturing project includes four themes such as “Electric music box”, “Electric guitar”, “LED electric bulletin board”, and “Small claw crane”. The questionnaire result about international exchange activities shows 51% students feel “Very fun” or “Slightly fun” before the activity. On the other hand, 90% students chose the above feeling after the activity. The preparation work term is assigned 2 weeks before starting the exchange program. Students make prototype of the things for each project and create presentation slides. The preparation work contributed to improve the satisfaction of the students that participated in the international exchange activity. Furthermore, 70% students were interested in electric manufacturing before the manufacturing project, but more than 90% students were interested in them after the project. This result shows that interest in engineering improves by not only passive lessons but also active teaching for other people.

Keywords: International exchange activity, Manufacturing project, Preparation work, Presentation, Cooperative work, Electric kit

Introduction

Development of global human resources is important mission for National Institute of Technology, because a lot of engineers are working not only domestically but overseas. Kamahara, Eugene, and Daimon (2016) reports the effect of short-term study abroad program for their undergraduate students. Yamazaki, Matsumura, Hasegawa, Inoue, and Murakami (2016) developed CEFR-based (Common European Framework of Reference) Can-do list to evaluate the capacity of engineering student English communication skills. Although our college holds international exchange activities, there are the room to develop new exchange activities for younger students. This paper describes a new activity for our Year-2 students. When the target students are not used to exchange activities, organizer should be careful to prepare topics for the students. Therefore, common topics are provided by some cooperative works that included in the exchange activity. Especially, technical English communication is not easy for younger students, because they study technical English words not so much yet. Since the presentation about the mechanism of every project is given by students instead of teachers, the students have to prepare the English slides and also make the prototype before the presentation. The preparation gives students opportunity to study technical English words and to practice English presentation. The manufacturing project includes four themes such as “Electric music box”, “Electric guitar”, “LED electric bulletin board”, and “Small claw crane”.

Schedule and Preparation Works

The exchange program includes three days from ice breaking and four projects to farewell party. The table of this schedule is shown in Table 1. The preparation work term is assigned 2 weeks before starting the exchange program. Students make prototypes of the things for each project and create presentation slides. They can understand the structure deeply through the making prototype process, so that they can tell technical know-how to other country students with their assurance. Students can study technical English words through creating presentation slides and also they experience speaking English through the practice of the presentation. Important point is that they are ready to accept other...
country students with just a little confidence instead of anxiety that they don’t know what happens.

Table 1 Exchange Program Schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Contents</th>
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</thead>
</table>
| Preparation works (2 weeks) | Making prototype  
                               | Creating presentation slides |
| 1st day       | Ice breaking, Team building  
                               | Project 1: Electric music box  
                               | Project 2: Electric guitar |
| 2nd day       | Project 3: LED electric bulletin board  
                               | Project 4: Small craw crane |
| 3rd day       | Presentation, Farewell party                 |

**Project 1: Electric Music Box**

The electric music box is shown in Figure 1. It consists of a piezoelectric speaker, a melody IC, and a battery box. The melody IC looks like a transistor but it includes a song and it can drive piezoelectric speaker. Students study some technical skills such as, soldering electric parts on a universal board, a simple electric circuit, and driving a piezoelectric speaker, through this project.

![Figure 1 Electric music box](image)

**Project 2: Electric Guitar**

Electric guitar is shown in Figure 2. It consists of a speaker, strings, a piezoelectric element, an amplifier circuit with operational amplifier IC, and a battery box. Students study some technical skills such as, soldering electric parts, amplifier circuit with operational amplifier IC, using piezoelectric elements as vibration sensors, hardware design for good sounds.

![Figure 2 Electric guitar](image)

**Project 3: LED Electric Bulletin Board**

LED electric bulletin board is shown in Figure 3. It consists of an 8 * 8 LED matrix panel, a micro-computer (ATMega 168-P), and 4 push switches. Students study some technical skills such as, soldering IC, and controlling LED panel by push switches.

![Figure 3 LED Electric bulletin board](image)

**Project 4: Small Craw Crane**

Small craw crane is shown in Figure 4. It consists of two DC motors, a servo-motor, motor driver IC, Arduino UNO board, 5 push switches, and a battery box. Students study some technical skills such as, Arduino UNO programming, mechanical hardware design, making electric circuit on a breadboard, DC motor driving IC, and controlling servo motor.

![Figure 4 Small Craw Crane](image)
Results and Discussion

For the preparation work, making prototype and creating slides were well done, but the creating slides finished at the day before starting the exchange program. Therefore, the students were able to practice the presentation only one day. Actually, almost all Japanese students talked with notes. However, some students talked without any notes. This results shows that they need more than two weeks for preparation works.

After the exchange program, students answered for a questionnaire about this exchange program and each technical project. Figure 5 shows the questionnaire result about international exchange activities and Figure 6 shows about the same question after the exchange program. This shows 51% students feel “Very fun” or “Slightly fun” before the activity. On the other hand, 90% students chose the above feeling after the activity, and the breakdown of the percentage was 44% of “Very fun” and 46% of “Slightly fun”. Since the 72% of students that worked on the preparation were included in the number of percentage which answered “Very fun”, the preparation work contributed to improve the satisfaction of the students that participated in the international exchange activity.

Furthermore,

Figure 7 to 10 show the questionnaire results about each technical project. 70% students were interested in electric manufacturing before the manufacturing project, but more than 90% students were interested in them after the project. This result shows that interest in engineering improves by not only passive lessons but also active teaching for other people.
Figure 8 Questionair result about “Electric Guitar” after the exchange program

![Pie chart for Electric Guitar](image1)

Figure 9 Questionair result about “LED Electric Bulletin Board” after the exchange program

![Pie chart for LED Electric Bulletin Board](image2)

Figure 10 Questionair result about “Small Craw Crane” after the exchange program

![Pie chart for Small Craw Crane](image3)

Conclusions

This paper showed the effect of preparation works for international exchange program. The preparation works gave students confidence about telling technical know-how and speaking English, so that they really enjoyed exchange program. On the other hand, preparation works require more than two weeks for students. This is not so easy to hold the term for students and also staffs.

Acknowledgements

We would like to thank Z. Tsang and Sacred Heart Canossian College students for planning this exchange program and coming to our school.

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INTRODUCTION OF SOME APPROACHES FOR EDUCATIONS OF ROBOT DESIGN AND MANUFACTURING

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Abstract

Recently, educations for development of robots attract attentions. The robot educations can make students to have interest in manufacturing through development of robots. Our Course has a practical training which is called “Practice of Creating Robot I” from 2018 for the 4th grade students. In this practical training, students are developing mobile robot which is able to carry some objects using limited materials and components which are an aluminum plate, two aluminum bar of different diameter, three stepping motors for actuating arm which is enable to carry objects. A mobile robot is given to each group and students can design arm for carrying objects on the mobile robot. Some gears and shaft bushes are able to be selected and used freely. At first, students are divided into 20 groups. Each group consists of 3 or 4 students and consider method of carrying objects, structure of their robot and so on. Then, they decide details of mechanism using 3DCAD and redesign structure of their robot. After that, they design some components and assembly diagram of their robot by hand. After 6 month into this practical training, each group presents an interim report and 20 ideas are narrowed down to around 10 ideas. Students of 10 group who are not selected their idea join into selected group, and start to manufacture based on some components and assembly design of their robot. This practical training underlies “Practice of Design and Manufacturing” which is traditional practical training of our course. “Practice of Design and Manufacturing” were practical training and students developed a crane type robot. In “Practice of Creating Robot I”, a crane type robot is extended into a mobile type carrying robot. This paper shows our longtime approaches which are enable to realize educations of development of robots and propose some method of design and manufacturing.

Keywords: robot design and manufacturing, robot education, PBL, active learning

Introduction

Recently, the development of robots and social advancement attract attention with the rapid development of science and technology, and opportunities for robots to be active in society have increased. Since the 1980's, industrial robots have been used in the automobile industry, and have been doing work such as welding, painting and assembly. At present, automatic driving robots applying robot technology and home cleaning robots also attract attention in the development of home appliances and automobiles. Subjects concerning the training of robot engineers in engineering education are indispensable, and in recent years, it is one of theme that various educational institutions are working on. National institute of technology, kitakyushu college was established in 1965 and consists of Department of Machine Engineering, Department of Electrical and Electronic, Department of Materials Chemistry, Control and information system engineering until 2014, therefore it was reorganized into the Department of Production Design Engineering in 2015. In the Creative Department of Engineering, the 1st and 2nd year students study fundamental subjects for engineering. From the 3rd year, the students will choose one specific engineering course from five specialized ones as their expertise: Machine Systems Engineering Course, Robotics and Mechatronics Course, Electrical and Electronic Engineering Course, Information and Systems Engineering Course and Materials Chemistry Course. This education system provides the students with opportunities to learn basis of knowledge and technology in wide engineering fields as well as to acquire advanced expertise about the engineering field in which they are interested. Robots need to recognize environments and own conditions, manage some information and decide behavior for carrying out complex works which are worked by human. Moreover, robot technologies are used in appliances and automatic operating systems of cars and one of the most important technologies for resolving some social issues. In robotics and mechatronics course, an education curriculum was constructed, which is enable to acquire interface, robot design, embedded system, intelligent technology, system control and system integration. In this paper, we introduce the educational approach for training robot engineers in this course.
Contents of the previous curriculum

The previous curriculum had some contents for students were able to learned mainly about mechanical engineering, computer science and control engineering, and engineers who are able to create interfaces which combine computer and machines were developed. In this section, typical classes of the previous curriculum were introduced.

Practice of fundamental robotics: The Practice of robot fundamental robotics had a purpose that students were able to learn some fundamental knowledge required robots control throughout lectures and practices. In the lectures, students learned histories of control engineering, some method of robots control and outline of control using sensors and a computer. In the practice, students carried out manufacturing an autonomous robot and programing by using a practice kit called “Robodesigner” and produced by JAPAN ROBOTECH, and learned fundamental methods realized motions using sensors and computer as shown in Figure 1. Visual programing tool called “TiColla” was employed as the programing tool and robot programing was carried out combining function blocks of TiColla as shown in Figure 2. In this practice, basic practice such as programming and experiments related to input processing from the touch sensor and infrared sensor are carried out, and the control program of an autonomous mobile robot such as a line trace robot and an obstacle avoiding robot is created and the robot operation is confirmed.

Sensor technology engineering: The purpose of sensor technology engineering is to understand fundamental points of hardware control using sensors and to learn interface technology which combines machines and computers. In the lecture, students learned operating principle of several sensors such as thermocouple, strain gauge, infrared sensor and so on. A thermocouple is a thermometer that makes a circuit by bringing the tips of two types of metal wires into contact with each other and measures a temperature difference through a Thermal electromotive force generated at the junction. Some methods and principles of creating interface circuit as shown in Figure 3. In the experiments, circuits using micro-computer, sensors and Discrete electrical parts were created. PIC micro-computer was employed as the micro-computer and students learned fundamental embedded technology such as IO control, AD conversion, serial communication between PC and PIC, interrupt control, PWM control and so on. Additionally, PBL are was carried out; students discussed and surveyed about some problems of sensor technology, and presented the result.

Practice of design and manufacturing: In Practice of design and manufacturing, students learned how to solve the problem by applying mechanical engineering, control engineering etc. with the theme of designing and manufacturing cranes. the class was divided into 10 groups and designed and manufactured a crane for each group. The crane operates on the field as shown in Figure 4,5. A function to move the weight of about 300 g as shown in Figure 6 from a start point to finish point is required for the crane and students can use two aluminum bares of different diameter and an aluminum plate as materials and gears and shaft bushes can choose what they need for each group. Three stepping motors can be used as actuators, and cranes were designed and manufactured by combining motors, gears, bushes, and aluminum materials. Students designed in the second semester of the fourth grade and manufactured in the first semester of the fifth grade. Students manufactured robots using some processing machines such as Lathes, Drill machines, a Shearing Machine and so on as shown in Figure 7. Then, they assembled their robots and created a circuit for the crane control as shown in Figure 8,9. Finally, presentations were carried out and qualities of the robots were evaluated.
Problem of the previous curriculum: In the previous curriculum, several classes were conducted and students got some beneficial effects. However, some problems were appeared. In practice of fundamental Robotics, a visual programming tool was employed as a programming tool and students could understand the robot behavior easily. On the other hand, how robot behaviors are expressed using C programming language. There was a problem that consistency was not given between practice of fundamental robotics, sensor technology engineering and practice of design and manufacturing because programming languages were different in those class.

In sensor technology engineering, it was very effective for students to make circuits using a breadboard, however some problems appeared because of bad electrical contact and others. As one of the problems, it was difficult to find the point of bad electrical contact, therefore it took students long time to correct. In additionally, programming of the PIC microcomputer was advanced, so it was difficult for students to understand the essence of the program.

A class of practice of design and manufacturing was conducted for long period and several ideas were produced. Accordingly, it was difficult for students to come up with a new idea. So, we needed to change the theme and enable students to create several new ideas.
Contents of the current curriculum

**Feature of the current curriculum:** In the new curriculum, as purposes of unifying the programming language and simplifying the circuit making, we chose “Arduino” as using a micro-computer. Fundamental points are the same as C language, though a programming language of Arduino has some characteristic points, and students are able to use “if statement”, “for loop” and so on for the programming of Arduino. Programming of Arduino is easier than programing of PIC micro-computer, and it is enough to learn some fundamental programing and principles of micro-computer such as IO control, AD conversion, serial communication, PWM control, interrupt control and so on. Additionally, Arduino is a micro-computer module constructed fundamental circuits, therefore students just construct circuits of motor control, led control and so on. Student can focus on their learning. In lower grades, we adopted visual programing for Arduino's programing and also made it possible to check the program structure of actual Arduino. We further developed class of design and manufacturing, and set up the contents of the practice that motivates students' creativity. In this section, typical classes of the current curriculum were introduced.

**Fundamentals of Engineering II:** Fundamentals of Engineering II carries out the basic contents of 5 courses in an omnibus style. The other four courses provided lectures and exercises on the basis of each specialized field such as Mechanical engineering, Electrical and electronics engineering, Information engineering, Chemical engineering, Bioengineering and so on. In our intelligent robot system course, we carried out two lectures on the foundations of robot engineering, control engineering, mechanical engineering, and carried out two robot production practices. In the robot production practices, students created an obstacle avoidance robot (Figure 10(a)) and a line trace robot (Figure 10(b)) using the robot kit "ROBO DESIGNER +" sold by JAPANROBOTECH. A microcomputer module of this robot is compatible with Arduino. “ArduBlock” was employed as a programming tool. ArduBlock is an Arduino extension program that allows you to develop Arduino IDE programming with a combination of working blocks. Also, since you can actually output the Arduino IDE program as shown in Figure 11(a)(b), students can see what structure of program actually will be. In engineering foundation II, we aimed students to be interested in robots by programing and production of robots.

![Figure 10](a) A robot kit “ROBO DESIGNER +” (a) an obstacle avoidance robot (b) a line trace robot

![Figure 11](a) programming using ArduBlock. (a) A visual programing of ArduBlock. (b) A program source outputted by ArduBlock.

**Embedded system practice II:** In embedded system practice II, students learn the basics of embedded technology. Because class of embedded system practice II is a subject that followed the contents of sensor engineering technology, students develop robots for each group in the class. Students learn about how to build an embedded system by practicing in 20 groups. They learn IO control and switch as practice of IO control and serial communication for communication between PC and Arduino. Additionally, students learn about difference between analog signal and digital signal, experiment about AD conversion, and learn how to read the AD converted value to PC by serial communication. Then, they learn about interrupt control which is one of the important concepts for constructing embedded system, experiment about timer interrupt, and learn the importance of interrupt control. Finally, in order to realize motor control which is one of the important technologies for moving the robot, learn the concept of PWM control and create a mobile robot that can be controlled by serial communication with the PC as shown in Figure 12. This robot has a circuit created with Arduino, breadboard and some discrete electrical parts on the mobile cart, so it can operate by commands from PC and read information from touch sensors to avoid obstacles. As a summary of the practice, students create
control programs and circuits for this robot and learn the basics of system integration.

Robot creating practice I: Because class of robot creating practice I is a subject that followed the contents of practice of design and manufacturing, students develop robots for each group in the class. At the end, we will conduct a competition and evaluate the presentation and the quality of the robot. In the first semester, students divided into 20 groups and designed the robot. In the second semester, ten ideas are selected from 20 ideas, reorganize the group and start to manufacture the robots. When choosing ten ideas, it is decided by the student's vote. This aim is to raise the awareness of the students and to activate the discussion. A robot manufactured in practice of design and manufacturing class is a crane type robot that does not have a mechanism for moving a field, whereas class of robot creating practice I will develop a baggage carrying robot that can freely move a field. At the last time of the classes, we will hold a competition and evaluate the presentation and the quality of the robot. In order to evaluate the quality of the robots, battle-style game will be held by the robots. Competition are carried out in the fields shown in the Figure 13 each team is divided into a blue team and a red team, carry baggage in the red and blue areas. The baggage has structures as shown in the Figure 14, and points are different depending on the size and shape of the hook. The baggage is placed in the center of the field in Figure 13. Robots do not put baggage directly in the red / blue field, but they must be transported in a box once mounted on the robot. Based on the above, the robot to be developed is required to have a function to lift the package and put it in the box, a function to move the baggage to team’s field, and a function to put the baggage out of the box and put it in team’s field. Students are provided with a mobile robot as shown in Figure 15 so that the students have to consider the structure of the arm part for picking up baggage, the method of installing a box containing baggage and put out it from the box. Other materials, stepping motors, gears, bushings are provided as with Practice of design and manufacturing. In the first semester term, 20 teams have completed the design, and as an example there is an idea as shown in Figure 16. This idea is to scoop baggage by rotating boards, put them in a box, boxes are up and drops the baggage to their own field.
Conclusions

Some approach of our school's intelligent robot system course for robot engineer training were introduced. We adopted Arduino to unify the programming languages in fundamentals of engineering II of the second grade, embedded system practice II of the third grade, robot creating practice I of the fourth grade and to simplify the circuit production. In engineering foundation II, we aimed students to be interested in robots by programing and production of robots and robot production was carried out. In embedded system practice II, students learned the basics of building an embedded system using Arduino and experiments about IO control, interrupt control, PWM control, serial communication, AD conversion and so on were carried out. In robot creating practice, contents of practice of design and manufacturing were followed, and designed and manufactured a baggage carrying robot. In the first semester, 20 teams have completed the design and they will manufacture the robots from the second semester. At the last time of the classes, we will hold a competition and evaluate the presentation and the quality of the robots. As a future schedule, we will incorporate lesson on robot intelligence in fifth grade and deepen knowledge of robot development.

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Figure16 Example of robot design
IMPLEMENTATION AND EVALUATION OF THE FLIPPED CLASSROOM APPROACH IN ENGINEERING EDUCATION

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Abstract

Engineering education at the University of the West of England has traditionally followed a conventional approach of large group lectures. This approach has well-known drawbacks in terms of learning. Research has suggested that the flipped classroom approach can help address the issues associated with the traditional delivery method, encourage active-learning and enhance the student experience. This approach was implemented for a module taught to Mechanical Engineering and Automotive Engineering students. Details of the implementation strategy are provided, including how the pre-study educational resources and virtual learning environment supported the flipped classroom approach and how the re-purposed contact-time became a facilitated active-learning environment involving more discourse, group-working, problem-solving and mastery of the topics.

Evaluation of the implementation was collected via the formal end-of-semester module feedback activity. The results demonstrate a strong preference for this delivery method. In 11 of the 13 categories assessed with the Likert scale, over 80% of the students either ‘Agreed’ or ‘Strongly agreed’ with the statements. The student comments were particularly positive, with students highlighting the various benefits of the delivery approach. In addition, the step-change that has occurred in levels of attainment suggest that the approach is working in terms of students’ understanding. This implementation of the flipped classroom approach in engineering education was very successful.

Keywords: engineering education, flipped classroom, inverted classroom, evaluation, implementation

Introduction

Engineering education at the University of the West of England has traditionally followed a conventional lecture-based approach, often accompanied by small group unstructured tutorials. The traditional lecture format has drawbacks in terms of learning: it is predominated by one-way delivery of the content to largely passive audience, with the tutor unable to accommodate for the diversity of the student body and the differences in the way students learn. The students are then required to use unfacilitated out-of-class time to master the content.

In order to address these issues, the flipped (or inverse) classroom approach enables active learning to be embedded within the module. The flipped classroom “means that events that have traditionally taken place inside the classroom now take place outside the classroom and vice versa” (Lage et al. 2000, p.32). It is thus an approach whereby students use out-of-class educational resources to obtain the content before the teaching session, and the time in class can then become student-centred, dedicated to active learning activities such as problem solving, experiential activities and group work. By applying the new knowledge, rather than merely taking note of it, students are enabled to develop personal ownership of their learning, where they care more about the material they seek to master, and hence have a vested interest in developing a deeper understanding of the material (Gerstein, 2012). In addition, the approach encourages collaborative and peer-assisted learning within the teaching sessions (Foot and Howe, 1998). Lastly, this less didactic approach encourages students to be actively involved in knowledge acquisition (Abeysekera and Dawson, 2015).

Supported by this evidence, the flipped classroom approach was implemented for a third-year undergraduate mechanical engineering module, ‘Vibrational Dynamics’. This paper reports on the method of implementation used, including details of the pre-study material, the use of the virtual learning environment to support this approach, and the structured facilitated sessions. Furthermore, the impact of the approach is illustrated through evaluation conducted as part of the standard formal module feedback activities.

Implementation

Vibrational Dynamics as a 15-credit module (7.5 ECTS) taught over one semester to a cohort of third year students studying Mechanical Engineering and Automotive Engineering. The cohort size for the 2017-2018 academic year was 102 students. It is a highly analytical module, focusing on the theory of vibrating systems, including multi-degree-of-freedom, damped, forced, unforced and non-linear systems, and builds upon the foundations of dynamics taught in the first and second years. In an effort to minimise the impact on timetabling,
the contact time was retained as one two-hour long session per week with the whole cohort, and one one-hour long session per student per week with smaller groups.

The implementation followed the scheme illustrated in Figure 1. Each week, students would conduct independent study on the course content that would be used in the whole cohort teaching session and the small group tutorial sessions; they would then spend time in the facilitated sessions, and follow this up with independent study and the pre-study material for the following week.

![Figure 1: Schematic diagram illustrating the implementation approach.](image)

- **Pre-study using course notes and videos**
- **During**
  - **Sessions:** Active learning practice applying key concepts with feedback
  - **Tutorials:** Sessions to go through problems
- **After**
  - Independent study and pre-study for next session

The pre-course educational resources took a number of forms. A full set of course notes were made available to students. These notes contained all assessed content spread over eight chapters. Each content chapter contained a clear set of learning objectives, and interspersed with the content were dedicated spaces for in-class questions. Also aligned with the content are a number of worked examples, and at the end of each chapter are a set of exercises relevant to that content.

Accompanying these notes were video recordings of the lectures from when this module was delivered in a traditional format. The video recordings were re-processed into smaller segments (up to 5–10 minutes, generally), aligned with the content, and the slides were inserted over the top of the raw video of the lecture, cutting back to the raw video when appropriate. The slides used for the lecture were integrated with the notes, so students could easily follow the notes as they watched the videos. There is evidence that video lectures are at least as effective as in-person lectures (Zhang et al, 2006; Bishop and Verleger, 2013; Davies, Dean and Ball, 2013) and that technology is an important defining aspect of the flipped classroom, particularly when used for the content delivery aspect of the teaching (Strayer, 2012; Bishop and Verleger, 2013). The videos themselves were optional to watch, as all the content was contained within the notes. They were supportive material, and help address issues associated with a diverse student body, particularly international students and students requiring reasonable adjustments.

The virtual learning environment, Blackboard, was set up to support this delivery approach. The content was broken up by weeks, and each week, a new folder revealed itself to students (using the timed release feature of Blackboard). Within each folder were the educational resources for the pre-study content. This included: the videos for the content; the slides used in the videos; the full-worked solutions to the end of chapter exercises; and a survey which could be used by students to provide feedback on their learning and any particular topics that they would like to cover during the upcoming whole cohort teaching session. Lastly, in an effort to encourage engagement with the content, for the 2017–2018 academic year, an e-assessment test was used on the pre-study content, which was designed to be relatively straightforward to answer correctly had the student engaged with the material. The test was available during the week prior to the associated teaching session, and students had one attempt at answering the question. Marks were given for the correct answer, as well as for engagement with the test. (These ten tests contributed to 20% of the module mark).

### The Teaching Sessions

The contact time comprises one two-hour session with the whole cohort, followed by one one-hour session in smaller groups. The two-hour session starts with a quiz using the Turning Point student response system, where multiple choice questions are presented to the class and they participate, anonymously, in answering the questions. This allows both the students and the academic to locate the level of understanding, and potentially highlight any gaps in the knowledge that can be explored during the session. The learning objectives for the topic (as presented in the course notes) are then discussed in more detail, again to help students place their learning and understanding. The session is then facilitated; the academic works through the notes, with the students engaging with the in-class questions, working with each other on the problems, and working through the examples together. The session finishes with a recap of the learning objectives for the topic.

Following the whole cohort session, the group is broken into smaller groups (nominally around 30 students) and the one-hour session takes places in one of the Technology Enhanced Active Learning (TEAL) spaces. These rooms are designed to support active group working, with tables that require students to sit in groups, and each table has a computer terminal on which to use software to support their learning. For this module, the students were all given a question, and the students in these ad-hoc groups work collaboratively on the problem, with the tutor on hand to give advice and provide support as necessary throughout the session. Because this is effectively the third scenario in which the student is experiencing the content, the complexity of the question is at a deep level (i.e. similar to the sort of question they might see in an exam). By visiting the different groups, the tutor gains an insight into the students’ level of understanding and mastery of the content. The end of the session is wrapped up by a presentation of the model solution. For groups that completed the question in good time, they are free to make use of Matlab to aid solution visualisation and validation.

### Evaluation Methodology

In this paper, the evaluation of this implementation of the flipped classroom approach is based on the formal module evaluation activity that is conducted at the conclusion of the module. This evaluation has two
sections: the first section contains 13 statements with a 5-point Likert scale, with the respondents choosing whether to ‘Strongly Agree’, ‘Agree’, ‘Neither Agree nor Disagree’, ‘Disagree’ or ‘Strongly Disagree’ with the statements. The 13 statements are:

1. Module teaching staff are good at explaining things
2. Teaching staff make the module interesting and/or engaging
3. The module has challenged me to produce my best work
4. I knew in advance the criteria my work would be marked against
5. The module assessments and marking are fair
6. I’ve received timely feedback on my work submitted for the module
7. Feedback on the module has helped me improve my academic performance
8. The Library has enabled me to access the resources on my reading list
9. I’ve received sufficient advice and support on the module
10. I can contact module staff when I need to
11. I understand how the module fits within, and supports, my wider studies
12. The module is well organised and has run smoothly
13. I am satisfied with the module

The second section of the evaluation form affords the students to provide qualitative comments. The questions for this section are:

- Do you have any other feedback (for example what were the most positive aspects and what would you have changed?)
- Please comment on the flipped delivery approach used in this module.

The module feedback form was made available during the penultimate week of the teaching block in which this module was taught and remained open until after the assessment took place. Of the 102 students registered on the module during the 2017–2018 academic year, 53 responded to the module feedback form, representing a response rate of 52%.

Lastly, whilst no statistical analysis has been conducted, levels of attainment—pass rate and average mark—for the past four years (representing one year of the traditional lecture-based paradigm, and three years of the flipped approach) are presented.

Results and Discussion

For the first section of the feedback form, a positive response is either ‘Agree’ or ‘Strongly Agree’, with anything else regarded as negative. (This aligns with the way the National Student Survey rates responses). For this study, there is a very strong positive outcome. 11 of the 13 categories achieve a positive rating of over 80%. The data for all statements is shown in Figure 2.

The two categories that failed to meet the 80% threshold where statements 7 (Feedback on the module has helped me improve my academic performance) and 8 (The Library has enabled me to access the resources on my reading list). For statement 7, 71.7% of respondents gave a positive rating. As there is no assignment during the module (apart from the online e-assessments) students would not normally receive feedback tailored to improve performance. For statement 8, 30.2% of respondent gave a positive rating, but the majority of respondents (60.4%) gave a rating of ‘Neither Agree nor Disagree’. As all the content is contained within the course notes, a copy of which the students receive at the start of the module, the students’ need to access the resources identified on the reading list is not a necessary component of the course.

It is worth highlighting that four of the categories (statements 1, 11, 12 and 13) achieved a positive rating of 100%. With regards to the flipped implementation, statements 11 and 12 are relevant: “I understand how the module fits within, and supports, my wider studies” and “The module is well organised and has run smoothly”. It can also be argued that statement 13 (I am satisfied with the module) should carry greater weighting, and achieving a 100% positive response rate for this question is particularly pleasing. Students are clearly satisfied with the module.

For the second section of the feedback form, a full presentation of all the qualitative comments made is not appropriate for this paper. It is possible, however to identify some common themes, with selected quotes to justify these themes.

The first theme is the clear preference to the flipped classroom approach to teaching. It is noteworthy that there was not one negative comment concerning the delivery approach. Quotes supporting this theme include:

- “It’s much better and engaging than old method”
- “This delivery approach is by far the best style of teaching so far in my degree.”
- “The flipped delivery approach was a great idea.”

Figure 2: Overall responses for the Likert-scale questions of the module evaluation. (Note: S1 signifies Statement 1, and so on.)
“100% preferred the flipped classroom approach compared to conventional style.”

“[I] firmly believe that other engineering modules could benefit from similar approaches.”

“The reverse [i.e. flipped] teaching method needs to be ran on more modules.”

“I would like to see this style of delivery in more modules.”

“Very well delivered and other modules should include it. It made a difficult module much easier, very happy”

“I wish that more lecturers would adopt this approach!”

“more modules should be done this way.”

The third identified theme is how the approach made revision for the assessments more straightforward as they had already ‘put in the hard work’ during the module. Quotes include:

“It also made my revision much more effective as I was able to dive straight into past papers and example questions leaving me very confident going into the exam.”

“The tutorials were both helpful for revision and general learning.”

“It gives you more of an incentive to do all of the work for that week there and then rather than leave it till the end of the semester, just before exams.”

Lastly, the fourth theme highlights the extreme levels of satisfaction with the module as a whole. The following quotes show high levels of appreciation:

“By far the most well taught module I’ve taken.”

“The best module I’ve experienced in my time at UWE.”

“It has been the best taught module I have had since I have been at UWE.”

“Keep doing your thing! Top lecturer.”

“Keep up the excellent work.”

There were a limited number of comments containing constructive criticism. There seems to be a desire to have more worked examples covered in the teaching sessions, and some desire a switch to have a one-hour whole cohort session and two-hours in smaller groups. These comments have been considered in the design of future runs of the module.

The levels of attainment for the past four runs of the module are shown in Table 1. In the 2014–2015 academic year, the module was taught with the traditional approach. The pass rate and average mark for this particular cohort were particularly poor and as such, a mark uplift was applied (with external examiner approval) to bring up the pass rate and average mark. It was these results that motivated the shift in approach. It is clear that in the 2015–2016, 2016–2017 and 2017–2018 academic years, the levels of attainment have shown a significant uplift. Whilst tests of statistical significance have not been conducted, the results suggest that the change of delivery approach to the flipped classroom method has brought about this step change in levels of attainment.

Table 1: Levels of attainment for the most recent four runs of this module

<table>
<thead>
<tr>
<th>Academic year</th>
<th>Pass Rate</th>
<th>Average Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014–2015</td>
<td>57.38%</td>
<td>45.98%</td>
</tr>
<tr>
<td>2015–2016</td>
<td>85.57%</td>
<td>57.88%</td>
</tr>
<tr>
<td>2016–2017</td>
<td>91.80%</td>
<td>69.70%</td>
</tr>
<tr>
<td>2017–2018</td>
<td>92.16%</td>
<td>69.60%</td>
</tr>
</tbody>
</table>

Conclusions

In an effort to address the deficiencies of a traditional lecture-based delivery approach and to increase levels of active-learning, the flipped classroom approach was implemented for a third-year engineering module entitled ‘Vibrational Dynamics’. Details of the implementation approach are provided, highlighting the pre-study educational resources provided, the use of the virtual learning environment to support the approach, the use of e-assessment to support engagement and the structure of the teaching sessions. To evaluate this implementation, the formal module evaluation activity that takes places at end of the module was used. This formal module evaluation is divided into two sections: the first section provides quantitative data using a Likert-scale against 13 different statements. The second section provides qualitative data, with students able to comment using free text on certain questions provided as part of the evaluation. Attainment levels were also used to compare this approach to the previous approach using the traditional lecture-based delivery.

The results of the evaluation are very positive. In the first section of evaluation, 80% of students either ‘Strongly agree’ or ‘Agree’ with 11 of the 13 statements, with four statements achieving 100% positive results. The two categories that did not achieve 80% positive results were not relevant to this module and the approach used to deliver the content. The second section of the evaluation highlighted four themes: a strong preference for the flipped approach, the desire to have other modules use the same or similar approach, the benefits of this approach when it comes to exam revision, and the clear levels of satisfaction with the module. Whilst statistical significance has not been determined, the step-change in levels of attainment following the implementation of the flipped classroom approach suggest that the it can provide benefits in terms of results. In summary, when implemented as described, the flipped classroom approach has been successful for engineering education.

References


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Abstract
Nowadays, it is important for educational institutes to develop students' generic skills and competencies across the curriculum. National Institute of Technology (NIT) has designed “Model Core Curriculum (MCC)” that provides a framework for learning contents and outcomes levels in specialized fields as a minimum standard for National Colleges of Technology (NIT Colleges: Kosen). It is important to provide students not only with academic knowledge and skills, but also generic skills, such as critical thinking, communication, collaboration and problem-solving skills. Therefore, in MCC, the development of generic skills and competencies are also defined as key components to be developed.

In December 2017, NIT held a “Hackathon” at Hakodate as a nationwide educational event to provide real experience for the students to examine the achievement of the educational goals. Rubrics were employed to assess three major generic skills (i.e. Teamwork, Problem-solving and Communication) and engineering design skills. Peer evaluation as well as pre and post self-evaluation were also carried. The survey results are analysed in comparison to one obtained from an ideathon also held by NIT. It is shown that the Hackathon is a good opportunity to develop students’ skills. It is also found that students’ prior knowledge and experience relevant to required technical and/or non-technical skills are important to understand their performance and the survey results.

Keywords: Competency, Rubric, Ideathon, Hackathon, Stakeholder, Regional Problem-Solving, Group work, Facilitation, GIS (Geological Information System) and World café

Introduction
According to a blueprint for education reform in Japan, globally competitive talent of students has been a top priority on the agendas. To improve the preparation of KOSEN students to meet these high demands in rapidly changing world, we have to improve the curriculum as well as our educational approaches. Generic skills, a set of essential abilities, are what our students need for their future (e.g., Ananiadou, K. & Claro, M., 2009); these skills should be recognized as one of the most important outcomes of teaching and learning through the curriculum. Thus, the curriculum should contain the knowledge, skills as well as competencies that are required for the student's future success.

For these purpose, National Institute of Technology (NIT) has designed “Model Core Curriculum (MCC)” that provides a framework for learning contents and outcomes levels in specialized fields as a minimum standard for National Colleges of Technology (NIT Colleges). Since April 2018, all national Kosen College’s syllabus based on MCC are listed and shared on the Kosen Syllabus website (https://syllabus.kosen-k.go.jp/Pages/PublicSchools). It should be noted that each NIT College plans and implements its own distinctive education in addition to MCC, since MCC covers only the core part of curriculum contents (60-70%). Besides the specific engineering skills for each expertise field, the development of Generic Skills and competencies are also defined as key learning components in MCC. In order to achieve these educational goals, Educational Research Office of NIT has been working on several projects to develop educational programs to foster students' competencies.

In this project, “Hackathon” following ideathon in the previous year is held as an educational platform to examine our educational approach. The details of implementation of Hackathon as well as the evaluation and survey result analysis are reported in this paper.

Kosen (National College of Technology) Education
The outstanding characteristic of Kosen education is its 5 years of consistent engineering education starting from age of 15 years. With the additional 2-year advanced course education, up to 7 years of consistent engineering education can be conducted through various methods. Another big difference between NIT Colleges and other higher education institutes is its nationwide educational network. At present, there are 51 colleges of technology (55 campuses) under National Institute of Technology in Japan, and approximately 50,000 students from age of 15 to 22 years are enrolled. Figure 1 shows the location of 51 NIT Colleges. As KOSEN colleges were established to respond to a need for well-trained manpower in the rapidly growing industrial sector during
the rapid economic growth in 1960’s, each College locates basically at industrial city/zone.

Over fifty years have passed since the first Kosen colleges were established and the social demands for KOSEN education have changed. For the improvement of education, NIT has designed “Model Core Curriculum (MCC).” In the MCC, the attainment targets of each subject area are determined basing on Bloom’s Taxonomy. Table 1 shows the relationship between the attainment target levels and the corresponding education program (fields). The MCC provides a framework for learning contents and outcomes levels in specialized fields as a minimum standard for NIT Colleges education.

| Table 1. Attainment targets for each category and corresponding program in MCC. |
|---|---|---|---|---|---|---|
| Skills required for engineers | 1 | 2 | 3 | 4 | 5 | 6 |
| Attainment Target | Performance Level | Critical Level | Knowledge Level | Understanding Level | Application Level | Analysis, Evaluation, and Creativity Level |
| 1. Mathematical Skills | K | K | K | A | S | S |
| 2. Natural Science | K | K | K | A | S | S |
| 3. Humanities and Social Science | K | K | K | A | S | S |
| 4. Engineering Basics | K | K | K | A | S | S |
| 5. Specialized skills for engineers should master in their area of expertise | K | K | K | K | A | S |
| VI. Specialized Engineering by Field | K | K | K | K | A | S |
| V. Engineering Experiments and Research Methodology | K | K | K | K | A | S |
| IV. Substitution of Specialized Skills | K | K | K | K | A | S |
| VII. Application Skills | K | K | K | A | S | S |
| VIII. Attitudes and Orientations (Personal, Social, and Professional) | K | K | K | A | S | S |
| IX. Responsibility and Ethics of Engineers | K | K | K | A | S | S |
| X. Compliance Learning Experience and Content Objectives | K | K | K | A | S | S |

(K: Kosen regular (College) course, A: Advanced course, and S: Higher-level qualification such as professional engineer). Note: These English translation of MCC is not the final version to be released.

Thus, the MCC is a fundamental part of NIT College education to ensure its levels and quality assurance. In order to implement the education based on MCC, it is necessary to adopt and develop new educational approaches. Although typical lecture plays an important role, the generic skills should be also fostered effectively through a variety of educational approaches (e.g. Active Learning). Figure 2 shows the scheme for the implementation of MCC. As the preparatory phase, Faculty Development (FD)/Training, Sharing Teaching Materials, Development of Portfolio System, and Fostering Generic Skills have been executed. This project is a part of “Competency Evaluation” in the implementation phase in which Development of educational environment and Student Projects are also being proceeded.

KOSEN Hackathon

For Competency Evaluation, “Ideathon” and “Hackathon” have been employed as practical educational platforms in this projects to provide real experience and tangible results for the students and to evaluate their development of competencies. The Hackathon, is an intensive and workshop-like activity in which students discuss in small groups and collaboratively develop ideas and prototypes for problem-solving. In this project, three major Generic Skills (Cross-sectoral Skills), Teamwork skills, Problem-Solving Skills, and Communication Skills, as well as Engineering Design Skills are mainly focused (Figure 3). Teamwork skills are subdivided into Teamwork (interpersonal) and Independence/ability to perform actions (intrapersonal). Problem-solving Skills are also divided into Logical thinking/Problem Solving skills and Ethics/Social responsibility and action. A rubric for the Hackathon which is similar to one for the Ideathon was designed to evaluate these five competencies and engineering design skill.

Fig. 1. The location of 51 NIT Colleges.

Fig. 2. Preparatory and Implementation phases of MCC

Fig. 3. A comparison of necessary skills for Ideathon and Hackathon.
KOSEN Hackathon

The main theme of Hackathon, schedule, and programme are following:

**Hackathon@ Hakodate (10th -12th Nov. 2017)**
Main theme: Regional revitalization through Monozukuri (Innovation)
Student Participants : 39 (18 Colleges)
Supporting Companies: 6

Programme:
Day 1: Ice-breaking, Ideathon and team formation
Day 2: Idea Presentation and Hackathon
Day 3: Outcome presentations, Judging, and Winner announcement

This Hackathon ran for three days. On the first day, World Cafe was chosen to conduct group discussion as the ideathon part at the beginning of hackathon, and regional problems were addressed from the viewpoint of Kosen students. World Cafe is a structured conversational process in which groups of people discuss a topic at several tables, simultaneously. Basing on the discussion results through the World Cafe, issues of concern to be addressed are shared among the students and they choose their own problems/challenges to tackle. The students then break into small groups for further discussion, delve into the problem and prototype: developing the solution using Information Communication Technology (ICT). As the goal of this hackathon is to create usable software, it includes programming, applications, APIs, and/or interface hardware parts. For their prototyping, supporting companies’ staffs and Kosen faculties provide technical advice and mentoring for the students.

At the final presentation, each team pitch and demonstrate their solution and receive appropriate feedback from the judges. The students evaluate their performance using the rubric (e.g., Jonsson, A. & Svingby, G. 2007) and the self & peer evaluation sheet are carried out after the Hackathon. The participant’s info are shown in Figure 4.

In order to promote prior knowledge and experiential learning of a topic, a pre-assignment of investigating local facts and information as well as pre-reading materials were given to the students. A geographic information system (GIS) is also suggested to be used. GIS (Maurya, S. P. et al. 2015) is a system designed to capture, manipulate, analyze, and present spatial or geographic data. GIS enable the students to visualize, analyze, and interpret data to understand relationships, patterns, and trends. The student brought their reports and shared their findings with others for discussion.

![Fig. 5. Scenes of the Hackathon: ideathon (upper), team presentation, hackathon, and final presentation & demonstration (bottom).](image-url)
**Results and Discussion**

In this project, two different surveys were conducted to measure students’ skill development and behaviours: a simple 5-level rating for 6 competencies and a rubric evaluation. Figure 6 shows the result (average) of self, peer and faculty 5-level rating during the event. It is confirmed that students tend to underestimate her/his outcomes, meanwhile peer members and faculties rate them higher. This tendency is also observed in the former Ideathon events. It seems that those highly motivated students set their attainment goals higher than we expected, resulting in lower self-evaluation rates. This assumption is also supported by the results that Engineering Design Skills and Logical thinking Skills/Problem Solving Skills show smaller improvements through the Hackathon than those for other skills, except ethics and social responsibility. From these results, it is suggested that the students did not satisfy with their performance in the development of solutions/prototype and found difficulties to link ethics and social responsibility to their solution/idea. This observed students tendency should be also taken into account in the implementation of Hackathon/Ideathon to guide the students properly.

![Image](image_url)

**Fig. 6. Self, Peer and Faculty 5-level rating results**

Table 2 shows the rubric for Teamwork Skills (1B) as an example. It should be noted that the students can check their performance at each attainment target using 3-star rating. This rating system allows us to examine the details of their performance. In order to examine students’ performance in Hackathon, the result is compared with those obtained from the ideathon which was held in 2016 with the main theme of Problem solving for local community and region. The results of students’ rubric evaluation of 5 competencies are shown in Figure 7.

**Table 2. The rubric for Teamwork Skills (1B)**

<table>
<thead>
<tr>
<th></th>
<th>Basic</th>
<th>Proficient</th>
<th>Advanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>1B. Independence/ Willing to perform actions</td>
<td>Be willing to participate in discussion and also be capable of doing it.</td>
<td>Observing team activity, be able to express an opinion according to circumstances to support and/or encourage discussion</td>
<td>In addition to the active participation as an individual member, be able to contribute to team discussion basing on the understanding of each member’s role and function.</td>
</tr>
<tr>
<td>1B. Logical thinking/ Problem-solving skills</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>1B. Communication</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2A. Teamwork</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>10. Independence/ Willing to perform actions</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>11. Independence/ Willing to perform actions</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>12. Communication</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>13. Communication</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>14. Communication</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

The details of Ideathon are following:

**Ideathon @ Hakodate College (2days)**

**Topic:** Regional revitalization and Promoting tourism in Hakodate

**Student Participants:** 51 (15 Colleges)

![Image](image_url)

**Fig. 7. Results of rubric evaluation for 5 skills.**

It is shown that the students’ performance decreases with the attainment level as general tendency for both ideathon and hackathon. However, it should be noticed that the result of communication skills for hackathon is found to be higher than that for the ideathon. It seems that the prototyping activity promotes more communication and collaborative work among students in the hackathon. Figure 8 shows the standard deviations of students’ rating for the ideathon and hackathon. It is found that the standard deviation of students’ rating for the hackathon tends to be higher than those obtained in the ideathon, except ethics and social responsibility. Especially for Teamwork skills of 1A-4 to 1A-6 which relate to the implementation of idea, it exhibits higher standard deviation than others. Table 3 shows the average values and standard deviation for each competency category obtained from the results in Figure 8. Different from the result shown in Figure 9, the standard deviation for the hackathon are found to be lower than those of the ideathon. From these results, it is assumed that there are two types of student participants: well experienced students with programing/technical skills and students without enough skills.

![Image](image_url)

**Fig. 8. Standard deviations of students’ rating for the ideathon and hackathon.**
The former students are capable of managing group work and implementing their ideas through the hackathon. However, due to the lack of skills on programming and others, the latter students are supposed to behave passively. This assumption is supported by the result of rubric evaluation for the Engineering Design Skills shown in Figure 9. For six levels from the beginning to exemplary one, the obtained average values are found to be less fluctuated than other skills and be around two with a small standard deviation of 0.08 among the levels. However, standard deviations relatively larger than 0.7 for the average values of about 2 are obtained for each level. This result indicates that there are two types of students mentioned above: polarization of students’ attainments due to their pre-developed skills. It seems that, in the hackathon, prototyping and implementation of ideas are key ingredients for the problem solving; it is important to consider the students’ pre-developed skills to form the group and implement the hackathon effectively.

Table 3. Average values and standard deviation for each competency category obtained from the results in Fig. 8.

<table>
<thead>
<tr>
<th>Competency Category</th>
<th>1-A</th>
<th>1-B</th>
<th>2-A</th>
<th>2-B</th>
<th>3-A</th>
<th>3-B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Skills for Teamwork</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>2.26</td>
<td>0.31</td>
<td>2.32</td>
<td>0.34</td>
<td>2.21</td>
<td>0.36</td>
</tr>
<tr>
<td>SD</td>
<td>0.34</td>
<td>0.15</td>
<td>2.24</td>
<td>0.14</td>
<td>0.37</td>
<td>0.11</td>
</tr>
<tr>
<td>2. Skills for Problem Solving</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>2.07</td>
<td>0.32</td>
<td>2.21</td>
<td>0.15</td>
<td>2.34</td>
<td>0.14</td>
</tr>
<tr>
<td>SD</td>
<td>0.28</td>
<td>0.02</td>
<td>2.47</td>
<td>0.11</td>
<td>2.47</td>
<td>0.08</td>
</tr>
<tr>
<td>3. Communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 9. Rubric evaluation results for the Engineering Design Skills: Average values and Standard deviation.

This result should be considered for implementation and management of Hackathon/Ideathon held as educational opportunities for developing students’ skills. From the comments, it is shown that the hackathon is very effective way to gain and to build students’ confidence towards tackling next problems collaboratively. In addition to these results, from the student comments and observation, it is also shown that the hackathon among NIT Colleges provide the students opportunities to form their network as future collaborators and share the views of Kosen education reflecting their regional characteristics.

Conclusions

In this project, “Hackathon” was chosen as an educational platform to provide the students real experience of collaborative problem solving to foster their generic skills and engineering design skills as a part of implementation phase of MCC defined by NIT. It is shown that the students recognise their generic skills and engineering skills are improved through the Hackathon. However, the self-evaluation for ethics and social responsibility exhibits decrease after the hackathon. It seems that the students recognise the difficulty for problem-solving taking into account ethics and social responsibility, because those are not usually covered by lectures. This result suggests that faculties need to give them proper feedback to the students through the Hackathon activity. It is also noted that Engineering Design Skills and Logical thinking Skills/Problem Solving Skills show smaller improvements through the Hackathon. It seems that the students did not satisfy with her/his performance in the development of solutions/prototype. From the average and standard deviation analysis of the rubric evaluation results, it is shown that there are two types of student participants: well experienced students with required technical and/or non-technical skills (e.g. programing/technical skills) and students without enough skills. The polarization of students’ attainments due to their pre-developed skills should be considered for improvement.

It seems that the Hackathon is very effective way to foster students’ generic skills. However, it is very important to consider the students’ pre-developed skills to implement the hackathon effectively.

It is shown that the Hackathon is a good opportunity to develop students’ skills. Basing on the obtained results from this study, further international collaborations among partner institutes (e.g. International Hackathon) is also suggested to be promoted for the development of students’ global and intercultural competencies.

Acknowledgements

The authors acknowledge all colleges and students as who participated in this project. We would also like to show our gratitude to supporting companies for their technical support and mentoring.

References


ANALYSIS ON THE EFFECTIVENESS OF RAISING STUDENTS' ENERGY SAVING AWARENESS THROUGH ACTIVITY-BASED LEARNING

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Abstract

The Hong Kong Government has introduced the combination of educational, social, economic and regulatory means in the policies in order to drive energy saving. Substantively practicing energy saving can reduce cost, improve air quality and protect our environment. In this paper, a 1-year government-funded community project is introduced to gain the awareness and improve the behaviour of Hong Kong secondary school students on energy saving issues. The programme aims to nurture secondary school students' energy saving sense through a series of interactive activities, including training courses, games, experiment and seminars with proper use of energy. About 500 students from 12 schools in Hong Kong participated in this programme and data is collected by questionnaires and analysed by pre-test and post-test. The students who participated in the project activities were measured on their environmental conservation knowledge and behaviours before and after participation. The results indicate that the participants not only showed gains in their energy-saving knowledge but also reported an improvement in their behaviours of energy-saving.

Keywords: Activities-based learning, Energy-saving, Pre-test Post-test Analysis, Environmental conservation, Secondary school education

Introduction

This Government-funded community project is a pilot plan to promote domestic energy saving extensively and raise the public concerns and awareness on the proper use of energy through students' peer effects. Secondary-school students in Hong Kong are invited to participate in the pilot programme to broaden their knowledge of energy and the ways to quantify energy saving. Selected students after completing training would become ambassadors and help in promoting energy saving message to the public. Meanwhile, the ambassadors would be responsible to bring the concept of energy saving back to secondary schools and suggest feasible solutions in domestic energy saving to their peers.

Programme Structure

The 1-year programme is divided into 4 stages: Stage 1 is the pre-test questionnaire. Participants from secondary schools are requested to complete a questionnaire with an aim to investigate students’ awareness on energy saving and STEM education, which also included students’ expectations on the stage 2 activities. Students’ level of education, gender, age, district of accommodation will be recorded for evaluation. Stage 2 consists of a 3-hour activity-based learning with a class size of 30. The 3-hour learning section includes energy generation and conservation, the importance of energy saving and a carbon emission audit. A survey with the same questions as the pre-test questionnaire will be conducted right after the training to verify the effectiveness of stage 2 activities. In stage 3, a 15-hour training to 40 selected students from 11 secondary schools are provided to nurture them as energy saving ambassadors. The final stage covers the promotion and energy-saving message spreading in schools and projects evaluation.

Learning outcomes

Energy saving is the effort made to reduce the consumption of energy by using less of an energy service which is a part of the concept of environmental conservation for sustainable development. In this project, students should be able to address what is energy, how energy affects our daily life, what if our life be without energy, why energy saving is important, etc. In order to achieve a high degree of awareness in energy saving, we had designed an interactive training course with applied activity-based learning strategy, to teach students the skills of energy saving, the importance of environmental conservation, the relationship between people and energy, and what will happen if they applied energy saving in their daily life.

Methodology
A pre-test consists of 15-20 questions for assessing students’ knowledge on energy and energy saving was conducted. The questionnaire was distributed to 500 secondary 3 to 5 students who aged from fifteen to seventeen at the beginning of academic year. All respondents from 12 secondary schools are expected to participate in Stage 2 training section and complete the post-test on site after the training was finished.

Table 1 showed the first 10 questions students to be completed in the questionnaire. Students were required to answer all of the questions by selecting the appropriate degree of consent to each statement listed on the questionnaire. A 4-point scale was designed to illustrate the degree of consent and no ‘neutral standpoint’ would be given which allows the results obtained to be more significant. Options available are i) totally agree; ii) agree; iii) disagree; and iv) totally disagree respectively.

| Q.1 | I agree the Earth is now in sick, I have to do something for environmental conservation. |
| Q.2 | I switch off any electrical appliances when not in use. |
| Q.3 | I am aware of the household electricity consumption. |
| Q.4 | I understand the concept of energy saving. |
| Q.5 | I am familiarized with the energy consumption unit kWh (Kilo-Watt Hour). |
| Q.6 | I know the energy consumption of each household electrical appliance. |
| Q.7 | I know how much I should pay for the electricity bill of each month. |
| Q.8 | I am familiar with the EMSD’s energy label. |
| Q.9 | I know what carbon footprint is and I can reduce carbon emission as much as I can. |
| Q.10 | I had been aware of the reading on electrical energy meter in the past 2 months. |

Table 1: First 10 statements in the questionnaire

In Stage 2, each secondary school was given an identical 3-hour training section. The topics conducted in the courses were the extension of the energy-saving knowledge they had learned or they had ignored in their daily life. The training content covers the topic of i) energy generation, ii) energy saving, and iii) carbon audit in a class size of 25-30. Splitting classes were applied when the class size is larger than 30 for effective learning in accordance with Koc, N. & Celik, B. (2015) finding. The teaching package was designed based on students’ foundation knowledge learnt in school and the convenience students may apply in their daily life. After the training section participants were invited to complete the identical survey as post-test that they have completed in Stage 1, together with an event evaluation form before they leave the venue. The data would be compared with the result of Stage 1 and feedbacks from participants had also been collected with a purpose of Stage 3 planning.

The significance of the course is then verified by ANOVA with a null hypothesis of the 3-hour training course will not lead to a better understanding in energy saving. Two groups of 61 candidates’ data are selected by random, one group with 3-hour training and the other group as control will be selected from population of the 500 secondary school students to evaluate the significance of the training.

Project on-going

A total of 40 shortlisted students will be selected as energy saving ambassadors and received further training in Stage 3. The ambassador selection criteria are based on students’ eagerness and participation in stage 2 training section together with school teachers’ or Institute trainers’ recommendations.

In Stage 3, energy saving ambassadors will receive further training in the following areas: i) electrical quantities measurement with tools, equipment and apparatus; ii) various forms of energy conversions; iii) cautions on using new electrical appliances; iv) operating principles on renewable energy sources; and v) presentation skills.

In final stage, energy saving ambassadors will spread the energy saving awareness to the public, through their peers as secondary audience. To start with, student ambassadors after participating in the training will have a sharing on what they have worked in the training and how they implement the energy saving concept in school to teachers and schoolmates with a total number of over 4000 audiences in 11 secondary schools.

Results and Findings

Figure 2 illustrates the pre-test result after the survey conducted in Stage 1. The result showed that most students know they should conserve the environment by reducing energy consumption but more than half of students are not familiar the way to quantify household energy consumption as well as the electrical energy consumption unit.
Figure 3 illustrates the post-test survey result after the training conducted in Stage 2. The result has recorded the percentage of students who ‘totally agree’ with the statements in the questionnaire has been raised. It should also be addressed that in question Q1, Q2, Q3, Q4 and Q8, ‘totally disagree’ percentage has increased slightly. Possible reason for the polarization is the training did help students to enrich knowledge and identified they did not acquire a complete understanding. The change in percentage of each statement in the questionnaire is tabulated in Table 4.

<table>
<thead>
<tr>
<th>Change in % (Post-test – Pre-test)</th>
<th>Totally Agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Totally disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1.</td>
<td>7%</td>
<td>-18%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>Q2.</td>
<td>4%</td>
<td>-13%</td>
<td>5%</td>
<td>3%</td>
</tr>
<tr>
<td>Q3.</td>
<td>7%</td>
<td>-8%</td>
<td>-2%</td>
<td>2%</td>
</tr>
<tr>
<td>Q4.</td>
<td>13%</td>
<td>-15%</td>
<td>-1%</td>
<td>2%</td>
</tr>
<tr>
<td>Q5.</td>
<td>16%</td>
<td>18%</td>
<td>-25%</td>
<td>-10%</td>
</tr>
<tr>
<td>Q6.</td>
<td>9%</td>
<td>7%</td>
<td>-18%</td>
<td>0%</td>
</tr>
<tr>
<td>Q7.</td>
<td>7%</td>
<td>-3%</td>
<td>-4%</td>
<td>-1%</td>
</tr>
<tr>
<td>Q8.</td>
<td>11%</td>
<td>-6%</td>
<td>-9%</td>
<td>3%</td>
</tr>
<tr>
<td>Q9.</td>
<td>9%</td>
<td>1%</td>
<td>-9%</td>
<td>0%</td>
</tr>
<tr>
<td>Q10.</td>
<td>9%</td>
<td>8%</td>
<td>-13%</td>
<td>-5%</td>
</tr>
</tbody>
</table>

Apart from the 4-point scale questions, 2 open-ended questions are extracted from the questionnaire and illustrate the findings. The survey had found out students recognized how to reduce energy usage from daily life, such as turn off all unused household appliances, half of the students would start with turning off unused lighting and air conditioning first. For instance, (1) turn off the light/air-conditioner while no one using, (2) reduce to use light/air-conditioner, (3) use fan to replace air-conditioner. Only a small number of students know to adjust the temperature to 25°C or turn off the appliances with standby state.

It is also found that after the training in Stage 2, more students reflected they obtained environmental friendly and energy saving information through different sources of media than pre-test as shown in Table 5. The training may either raised students’ interests or nurtured them to identify information relating to environmental friendly or energy-saving. It is also noticeable that most students receive the information of energy saving were from school (73%) and from TV programs (55%).

Table 5: Students feedback from pre-test and post-test

<table>
<thead>
<tr>
<th>Source of Media that students obtain environmental friendly and energy saving information:</th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>TV</td>
<td>55%</td>
<td>62%</td>
</tr>
<tr>
<td>School</td>
<td>73%</td>
<td>82%</td>
</tr>
<tr>
<td>Book/magazine</td>
<td>24%</td>
<td>34%</td>
</tr>
<tr>
<td>Online media</td>
<td>48%</td>
<td>54%</td>
</tr>
</tbody>
</table>

Table 6 illustrates the result of the single factor ANOVA. From the result obtained a low p-value (0.021) has been acquired which the null hypothesis can be rejected. The negative value in Sum and Average refer to better acceptance/a higher degree of consent to the statements in the questionnaire after the post-test. From the comparison among sample respondents who had taken the training course and the control sample, a significant difference of -16.6 (with course) and -0.2 (no course) has been recorded. The 3-hour training course is found effective in terms of the acceptance of environmental conservation and energy saving. During the course, students could experience how much effort they had to pay to generate electricity and had seen the actual profit of energy saving on the electricity bill through activities. Such learning experience allows students to quantify energy and explore ways to reduce losses during energy conversion.
Discussion on Activity-Based Learning

The Activity-Based Learning (ABL) helps students to develop their knowledge and ideas through interactive actions and experience. The interaction is the main key for the successful learning. Suydam, M. N., & Higgins, J. L. (1977) and Çelik, H. C. (2018) expressed their views on interactive resources and environment are critical tools for helping learners to get more interest in learning. R. Ravi and Xavier P (2007) also stated activity-based learning is a method that teaches students to think against the problems, motivate them to explore possibilities for them in the learning period.

The project team implements a number of activities-based elements such as laboratory work, quiz contest, professional talks, sharing, etc. to the teaching. The involvement is the most important element of ABL. Students are given chance to raise questions actively which motivate a bi-directional communication. Meanwhile, short lectures were included for traditional teaching. Such mixed arrangement allows students to adapt the learning environment smoothly.

Conclusion

From the comparison of pre-test and pro-test result shown, the activity-based-learning adopted in the training sections demonstrated the effectiveness in the promotion of energy saving. The questionnaires result reflected a significant improvement of participants’ energy saving knowledge and energy saving awareness. It is very impressive that participants considered they had gained a certain degree of energy saving knowledge. Significant improvements in terms of depth are also recorded from survey result such as the energy consumption of different electric appliances, electric bill, proper use of energy, etc. and students’ skills on energy saving were also improved.

According to the students’ feedback in an evaluation after Stage 3 training, it is concluded that ABL achieved an improvement in learning energy saving concept and students found the training content is useful. The programme provided opportunities to students whom may experience and learn through activities other than vision and hearing. It is believed that activity-based learning stimulated students’ motivation and interest.

From the visits at Stage 4, it is observed that students are able to make good use the activities’ content to explore their own leaning pace and relate them to daily life in spreading the energy saving message in stage presentation.

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References


GROWING CHARACTERISTICS OF GENERIC SKILLS OF STUDENTS OF NATIONAL INSTITUTE OF TECHNOLOGY, SENDAI COLLEGE AND A PROPOSAL OF AN EVALUATION METHOD OF GENERIC SKILLS

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Abstract

It is very difficult to quantitatively evaluate the Generic Skills (GSs), because GSs cannot be evaluated only through school examinations. In order to quantify GSs, evaluation methods using rubrics are the most common. These methods, however, still have the following problems: 1) the results of the evaluation cannot avoid including the teachers’ and/or the students’ subjective views and 2) there may be some differences of the recognition in the evaluation between the teachers and the students.

Since the academic year of 2014, we have conducted “Progress Report on Generic Skills (PROG) test1),” as a method for confirming the educational effects and evaluating our college students’ GSs accurately and objectively. From the results of PROG tests in the last 4 years, the growth of our students’ GSs has been found to have the following tendencies:

1. In the Literacy part, all graders have shown the steady growth in their abilities every year.
2. For the Competency part, upper graders (the fourth-, fifth-grade and advanced-course students) have shown the steady growth in their abilities, while lower graders (the first-, second- and third-grade students) have not.

Meanwhile, National Institute of Technology (NIT) has proposed the Model Core Curriculum (MCC)2) of the learning contents. In the MCC, the corresponding skills to GSs are defined as Cross-sectoral skills (CSs) required for engineers, by 16 components. NIT has been trying to obtain quality assurance of its education by utilizing these components. However, its evaluation method has not been established yet, because some elements cannot be evaluated only through classes in the school. Therefore, as one of CSs evaluation methods, we propose to evaluate CSs by converting the PROG results to the CSs scores. Since it has been found that CSs can be sufficiently evaluated by using the PROG results, we introduce the converting method.

Keywords: Engineering Education, Quantitative Evaluation of Generic Skills, Utilization of PROG test, Active Learning, Problem/Project Based Learning

Introduction

The development of the students’ GSs has long been required in educational institutions, in addition to the acquisition of expert techniques and knowledge in particular fields. To meet the requirement, educational institutions of any generations have been enthusiastically working on developing the GSs. However, it is very difficult to quantitatively evaluate the GSs in accurate and objective manners, because GSs are abilities acquired through their experiences and some components of GSs cannot be evaluated only through school examinations. In order to quantify GSs, evaluation methods using rubrics are the most common. These methods, however, still have the following problems: 1) the results of the evaluation cannot avoid including the teachers’ and/or the students’ subjective views and 2) there may be some differences of the recognition in the evaluation between the teachers and the students.

Since our proposal was adopted as the Acceleration Program for University Education Rebuilding (AP)3) in 2014, our college has strongly promoted the introduction of AL techniques and PBL to regular lessons and experimental practices and we have been working on developing students’ GSs. To evaluate our college students’ GSs accurately and objectively, we have conducted PROG tests since the first year of AP. From the results of PROG tests in the last 4 years, we have observed the growing tendencies of our students’ GSs. In this paper, therefore, we report the growing tendencies of our students through the reform of the teaching methods.

Meanwhile, National Institute of Technology (NIT) has proposed the Model Core Curriculum (MCC) of the learning contents. In the MCC, the corresponding skills to GSs are defined as Cross-sectoral skills (CSs) required for engineers, by 16 components. NIT has been trying to obtain quality assurance of its education by utilizing these components. However, its evaluation method has not been established yet, because some elements cannot be evaluated only through classes in the school. Therefore, as one of CSs evaluation methods, we propose to evaluate CSs by converting the PROG results to the CSs scores. Since it has been found that CSs can be sufficiently evaluated by using the PROG results, we introduce the converting method. We show that the
PROG test can be used to quantitatively evaluate the elements of GSs which are defined independently by each educational institution.

**An Evaluation method of Generic Skills (PROG test)**

We adopted the PROG test to evaluate our students’ GSs. The PROG test was originally developed by KAWAI-JUKU\(^4\) and the test consists of two parts: the Literacy part which evaluates the ability to apply knowledge to solve new or inexperienced problems and the Competency part which evaluates decision making or action principle characteristics that are developed through the experience of adapting to surroundings. Evaluation components of PROG test were defined by reference to key-competencies determined by DeSeCo project\(^5\) of OECD. The evaluation contents of the Literacy part were classified into six categories, and those of the Competency part were classified into three categories that consist of 9 contents and 33 components.

The questions of the Literacy part are similar to those of Synthetic Personality Inventory (SPI)\(^6\), while, in the Competency part, a number of questions are given in a questionnaire format, to examine the characteristics of behaviours. The scores of components in the Competency part were evaluated, by comparing the answers of the examinees with statistically processed exemplary answers from many Japanese businesspersons who were classified into the high level. The scores of PROG test are quantified with values from 1 to 7 (or 5, depending on the components), indicating that larger numbers are better results.

**Results (Growing characteristics of Sendai College)**

Sendai College consists of 7 departments of regular five-year training courses (Associates’ Degree Course) and 2 majors of advanced two-year training courses (Bachelors’ Degree Course). Since 2014 (the first year of AP), we have conducted the PROG test for our students. Table 1 indicates the grades of students who took the PROG test in each year.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Year</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular 1</td>
<td></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Regular 2</td>
<td></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Regular 3</td>
<td></td>
<td>○</td>
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○: Students of every department and major took the PROG test
△: Only students of some departments and a major took the PROG test
×: Students did not take the PROG test

*In the analysis in this paper, the data of △ are not included because the numbers of samples are very different.

Figure 1 shows the annual changes of the overall scores of the Literacy part for four years from 2014 to 2017. And, the average score of our upper graders is higher than those of the first-grade students at University.

![Fig. 1. Annual changes of the overall scores of the Literacy part for four years from 2014 to 2017.](image1)

Figure 2 shows the annual changes of the overall scores of the Competency part for four years from 2014 to 2017. Furthermore, the average score (3.07) of the first-grade students at University in 2017 who study at departments of engineering is equivalent to those of our lower graders.

![Fig. 2. Annual changes of the overall scores of the Competency part for four years from 2014 to 2017.](image2)
Both the results of the Literacy and the Competency part tell us that the education of GSs at our college is sufficiently effective.

Next, we will explain the results of the analysis by using subdivided components rather than the overall scores of both the Literacy and the Competency part. Figure 3 shows the result of the analysis of subdivided components of the Literacy part of the fourth-grade students in 2017, who never failed to take the test for all four years from 2014 to 2017. In figure 3, coloured line charts indicate the scores of each year for all six components of the Literacy part and yellow bar charts indicate growth from the first grade for the components. It is obvious from the bar charts that our students’ abilities have grown up for all components as they promote from the first grade to the fourth grade. However, some differences in the growth rate of individual components appear to exist. Our students tend to show steady improvement in the skills of (A) Collecting information and (B) Analysing information, while not in the skill of (E) Linguistic processing.

For the Competency part, the result of the analysis of subdivided components of the fourth-grade students in 2017 is shown in Figure 4. Figure 4 tells us that the skills of (A-2) Cooperating with others, (B-2) Self confidence and (C-1) Identifying problems show steady improvement, while the skill of (C-2) Planning solutions does not. The reason for little improvement of the skill of (C-2) Planning solutions might be that there had been only a small number of classes to grow the skill until the fourth grade, but we need to examine this result closely, including effects of the reform of the lesson curriculum.

Utilization of PROG test for evaluation of Cross-sectoral skills in the Model Core Curriculum

The MCC of the learning contents has been proposed by NIT to obtain quality assurance of its education. In the MCC contents, CSs unrelated to specialized fields are included as corresponding to GSs. The CSs are made up of 16 components listed in the right side of Figure 5. NIT has been trying to evaluate the CSs by using rubrics. However, due to the present situation that activities outside classes (e.g., activities at the student council, clubs and dormitories that not all students belong to) are objects of the evaluation and that in some components the rubrics have not been determined, its evaluation method is not said to have been established yet. Furthermore, in addition to a great deal of burden of a small number of teachers required to evaluate many students’ CSs, there might be some differences between the teachers’ evaluation and the students’ self-evaluation. Therefore, it is very important to evaluate the students’ CSs accurately, excluding the evaluators’ (both teachers’ and students’) subjective views. Hence, as one of accurate and objective evaluation methods of the CSs that can reduce the burden of the teachers, we propose an evaluation method of the CSs which converts the PROG results to the CSs scores.

In Figure 5, the outline of PROG components and 16 components of the CSs are shown. As an example of converting the PROG results to the CSs scores, we will explain about two cases of (A) Communication Skills and (E) Logical Thinking Skills of the CSs. Since evaluation components of PROG related to (A) Communication Skills of the CSs are considered to be (E) Linguistic processing in the Literacy part and (A-1) Friendliness and
interest in others in the Competency part, the average score of these 3 components was determined as the score of the Communication Skills of the CSs. Similarly, the score of (E) Logical Thinking Skills was determined by the average score of (B) Analysing information, (D) Forming strategies and (F) Non-linguistic processing in the Literacy part. The scores of all components of the CSs are determined by converting the average score of the related PROG components in the same way as the scores of the Communication Skills and Logical Thinking Skills.

Figure 6 shows the result of fourth-grade students in 2017 evaluated by the components of the CSs. Obviously, from the figure, the growing characteristics of the students can be observed even if the components of the CSs are chosen for evaluation components. The components of (C) Skills to Gather, Utilize and Address of Information, (D) Discovering Challenges and (E) Logical Thinking Skills show great improvements, while the components of (F) Independence and (G) Self-Management Skill show only slight improvements. It does not mean that the analysis of growing characteristics is not possible for two components that do not show steady improvement, because these components also show little improvement in the PROG results. Hence, we can say that the CSs can be sufficiently evaluated by using the PROG results.

Figure 6 shows the results of the simplest conversion form which uses the average scores, as described above. When we actually evaluate the CSs by using the PROG results, however, it is necessary to carefully consider the
selection of the relevant components of the PROG test to the individual components of the CSs and the determination of factors involved in converting the PROG results to the CSs scores.

Conclusions

As a method for confirming the educational effects and evaluating our college students’ GSs accurately and objectively, we have conducted PROG test since the academic year of 2014. From the results of PROG tests in the last 4 years, the growth of our students’ GSs has been found to have the following tendencies:

1. In the Literacy part, all graders have shown the steady growth in their abilities every year.
2. For the Competency part, upper graders (the fourth-, fifth-grade and advanced-course students) have shown the steady growth in their abilities, while lower graders (the first-, second- and third-grade students) have not.
3. The PROG scores of our college students are not inferior to those of the students at University who study at departments of engineering.

As a method to accurately and objectively evaluate the CSs of MCC at NIT, we propose an evaluation method of CSs by converting the PROG results to the CSs scores. It is found that CSs can be sufficiently evaluated by converting PROG results that are related to the CSs components. This result indicates that the PROG can be used for quantitative evaluation of the GSs elements that are defined independently by each educational institution.

Acknowledgements

This survey was supported by the Acceleration Program for University Education Rebuilding, Ministry of Education in Japan. We are deeply grateful to the principal, teachers and support stuffs of our college for their contribution to this project. In addition, we appreciate Mr. Kondo at RIASEC Inc. for helpful cooperation in the analysis of data.

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PROGRAMME SPECIFIC COMMUNITY ENGAGEMENT TO ENHANCE VOCATIONAL EDUCATION – WAY OF SUCCESS

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Abstract

Vocational education and training are designed to equip students with the professional skills and knowledge of the trade, as well as relevant soft skills to prepare them for a future career. Hong Kong is facing an ageing population, manpower supply for skilled personnel in healthcare and rehabilitation industries are in severe shortage. However, some youngsters are hesitated to engage in these industries even after they have received relevant training. It possibly is because of the stereotypical image of rehabilitation and elderly service industries that youngsters perceive. They often perceive such a career would be of relatively low salary, and they are uncertain about the career advancement prospects. Indeed, some youngsters also perceive a negative image upon elderly and presume them as annoying and clumsy. Hence, the workforce of the rehabilitation and geriatric fields is always in shortage. On the other hand, these youngsters are believed to be a key member in the rehabilitation and healthcare-related industries. They should take up the responsibilities soon.

To facilitate the supply of manpower and improve the quality in these related fields, it is crucial to promote the attitudes and perceptions of the youngsters. Regular programme specific community engagement (Regular-PSCE) could be a solution. PSCE not only promotes youngsters’ understanding of target populations but also strengthens their relationships with the served populations. Therefore, it boosts their level of commitment, participation and understanding towards various populations. Of note, such close interactions with different populations during the community engagements should be accompanied by timely feedbacks, coaching and supervision from experienced workers. This assures the youngsters to gain practical experiences and become competent in these fields. In this sense, it strengthens the learning experience of the youngsters as well as to promote professional development through good quality of contact experiences. Most importantly, once they involve in the workforce after graduation, such valuable experiences can reinforce them with considerable quality services for various target populations.

Keywords: Programme Specific; Community Engagement; Regular; Volunteer; Success; Vocational Training

Introduction

The ageing population becomes a challenge to Hong Kong that the manpower supply for skilled personnel in healthcare and rehabilitation industries are in severe shortage. However, some youngsters are hesitated to engage in these industries even they have received relevant training. It could be related to the stereotypical image relating to the rehabilitation and elderly service industries that youngsters perceived. They perceive the job nature of such career as not appealing as they would be engaged in dirty tasks and heavy labour when taking care of the elders. They are also uncertain about the career prospects with the relatively low salary offered by the current market. Indeed, some youngsters also perceive a negative image upon elderly and presume them as annoying and clumsy. (Mok, Wu, Poon & Chan, 2015) Therefore, it is critical to arouse the youngsters’ interests to continue to engage in the rehabilitation and healthcare-related industries after they have received relevant training to ensure a steady supply of workforce in these fields and to improve the service quality in order to cope with the social demand of the ageing population.

Ageing Population in Hong Kong

The ageing population has evoked considerable attention across the globe and in Hong Kong. Due to the medical advancement, the average life expectancy of men and women in Hong Kong is found to be 81.3 and 87.3 years respectively in 2017, while it is estimated to be 87 for men and 93.1 for women in 2066 (Census and Statistics Department, 2017). It is also projected that the number of elderly aged 65 and above would increase from 17% in 2018 to 33.7% million in 2066 (Census and Statistics Department, 2017). Such demographic change towards an ageing population would impose an
enormous demand on rehabilitation and elderly services in Hong Kong.

**Insufficient Manpower Supply in the Rehabilitation and Geriatric Industries**

Despite the huge service demand, it is noted that there are 10% – 34% vacancies for professional workers in the elderly care and rehabilitation service sectors. The shortage of manpower situation is most prominent for occupational therapists and physiotherapists in elderly care. (The Hong Kong Council of Social Services, 2014) It has been reported that one of the reasons for the shortage of frontline workers in the elderly care service industry is because youngsters are less willing to enter the field due to the relatively low salary, poor career prospects and other stereotypes of the field (Kwok, Wong & Yang, 2014). In particular, such stereotypes may influence the perceptions, attitudes, and behaviours of youngsters towards older people. (Mok *et al.*, 2015) Although earlier studies have suggested possible ways to reduce prejudice in younger generation by examining the reciprocal relationships between perceptions, attitudes and contacts with the elderly (Knox, Gekoski, & Johnson, 1986; Okoye & Obikeze, 2005), these methods might have different effects when put into local context among Chinese population in Hong Kong.

**Phenomena of Secondary School Education in Hong Kong**

Nowadays, youngsters and teachers in Hong Kong are facing a lot of stress to cope with the standard curriculum in secondary school. The core curriculum (i.e. Chinese, English, Mathematics, and General Education) and the standard electives often focus on generic skills and theoretical knowledge rather than critical analysis and practical skills in tackling day-to-day issues. Despite the generic nature of the standard curriculum, the academic results the students attained in the Hong Kong Diploma of Secondary Education (HKDSE) remain as the major admission criteria for most of the degree and sub-degree programmes to consider by the tertiary education institutes in Hong Kong. It is therefore common for youngsters in Hong Kong, especially for those senior secondary school students, to attend extra tutorial classes, either being offered by the school and/or private tutors, during non-school hours in order to better prepare for the HKDSE examination. Although youngsters might have opportunities to participate in some extra-curricular activities and/or other learning experience (OLE) activities during their secondary school study to enhance their understanding of elderly (e.g. visit to elderly home), these short-term extra-curricular activities have little linkage to their secondary school curriculum, and oftentimes these activities do not account for their academic result. Therefore, youngsters and perhaps their parents might prefer to put more focus on other academic and merit-related activities.

**Vocational Education and Training Programme**

Vocational education and training (VET) is designed to equip students with the professional knowledge and skills of a specific trade, as well as relevant soft skills to prepare them for a future career. VET programme differs from the traditional or convention classroom training is that VET has trade specific context as the learning focus. VET equips the students with the specific knowledge and skillsets that are required by the employers and the society. It means that the training context and the assessments of the VET programme have to be industry-specific. In other words, VET programme emphasises what the students can do, not just what they know (Moodie, 2002). The success of the VET programmes relies on the strong interlinkage of different stakeholders and the close collaboration with each other (*Figure 1*). For instance, if students are engaged in rehabilitation and geriatric related VET programmes, the students should be equipped with specific knowledge and skills that enable them to fulfil the job requirements in the rehabilitation and geriatric industry upon graduation. To make this successful, not only the VET curriculum needs to embed different theoretical classes (e.g. theory of rehabilitation, common geriatric pathologies) to equip students with the trade-specific knowledge at school. The students also need to undergo solid practical training (e.g. rehabilitation exercise techniques, caring techniques for elderly) and to gain industrial exposure in the rehabilitation and geriatric settings (e.g. hospital or elderly home) to ensure that they process the required skills to work in these settings. Hence, such VET programme bridges the gap for youngsters to transit from school training to become a work-ready employee of the related industries upon graduation as they have been trained with the industry context. In turn, employers from the industries could recruit skilled workers that are well-trained to fit for purpose.
Programme Specific Community Engagement for VET

Despite the design of the VET programme curriculum is trade specific and task-oriented, it is important that the education programme also cultivate youngsters’ passion for learning such that they value the learning opportunities and actively engage in activities throughout their study. Owing to the stereotypical images that youngsters project on elders, it is particularly important for those VET programmes relating to elderly service industry to find ways to nurture the students to have positive attitudes and perceptions towards the elders. Programme specific community engagement (PSCE) could be a solution. PSCE means arranging students to engage in specific volunteer services in the community that are related to their VET programme curriculum. Volunteering defines as a person who freely offers to take part in an activity or to provide unpaid help or assistance to others. If rehabilitation and geriatric related VET programme could incorporate relevant volunteer activities for students to engage in the community, this would enhance the student’s hands-on exposure and understanding on the various needs of the elders in reality. In fact, a recent study by Mok et al. found that PSCE was effective to nurture youngsters’ positive attitude towards the VET programme and related industry. (Mok et al., 2015) Mok et al. compared the final year students who studied in a 2-Year Higher Diploma in Rehabilitation Services programme at a local tertiary institute, who had engaged in PSCE with frequent associations with elderly (PSCE group) in regular basis to those who did not (non-PSCE group), found that students from PSCE group had significantly better perceptions towards the elderly than those from non-PSCE group. PSCE group had a more favourable attitude towards the elderly and paid more attention to the physical and psychosocial needs of the elderly. More importantly, the PSCE group also had a greater appreciation for their pursued education and the rehabilitation field, and they were more assertive in entering the rehabilitation field after graduation. (Mok et al., 2015)

The essential elements that contribute to the success of PSCE in enriching the VET programme stem from letting the students volunteer to seize different opportunities to gain relevant contact experiences from the industry, such that students could apply what they have learnt in a real work setting under the supervision of VET programme teachers. Apart from applying their vocational skills, students also have the opportunities to interact with clients and co-workers to train up their soft skills as well as interpersonal skills. Such experiences to interact with real clients would be more relevant than having the students to be trained in a confined or simulated environment with standard scenarios. It is particularly important for those VET programmes that are targeting the health services industry. For example, students who studied in Higher Diploma in Rehabilitation Services are to engage in the PSCE programme which targets to pay home visits to the elderly. Upon arrival to the elderly client’s home, it is noted that the client is living alone in a non-lift landing flat on the third floor, and he is also dependent on meals-on-wheel support service for his everyday meals. Moreover, the client also complains that he is suffering from multiple medical conditions of stroke with left hemiplegia, and right knee pain. In this case, students not only need to analyse the client’s physical and mental conditions critically, but also need to assess the elder’s home environment in order to propose appropriate measures to fit for the client’s needs. Students also have to adjust their plan according to the client’s instant feedback. Notably, in comparing the value of PSCE over those ordinary volunteer activities to visit the elderly’s home that are arranged by non-VET programme related organisations, another crucial element that contributes to the success of PSCE is the quality of supervision provided by the VET programme teachers. In the example above, the VET programme teachers could provide quality supervision on the spot. They could relate the client’s multiple medical conditions to what has been taught in the VET programme (e.g. to coach the students in assessing if the client’s right knee pain could be related to the overuse in stairs climbing to his non-lift landing flat; or could it be related to the compensating movement resulting from his left hemiplegia). VET programme teacher could provide the programme specific and timely feedback to coach their students on how to apply their knowledge and skills practically at the client’s home. Such hands-on practical experience under quality supervision would consolidate students’ knowledge and practical skills far more effective than other forms of training at school or in a simulated environment. Apart from these advantages, a study by Mok et al. also found that students who participated in the PSCE reflected that their confidence increased through the process. They also had a better understanding of the elderly populations as well as strengthened their relationships with their grandparents. (Mok et al., 2015)

Conclusion

VET serves to equip trainees with trade-specific knowledge and skills to prepare them to enter the relevant industry. It helps to alleviate the manpower shortage of different industries. Implementation of PSCE in VET programme could bring many positive changes to youngsters’ attitude and perceptions towards their chosen education and future career. This is particularly important for VET programmes that targeting the elderly, rehabilitation and health services sectors in order to cope with the ever-increasing manpower demand owing to the ageing society.
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EDUCATIONAL EFFECTS OF THE VANGUARD ENGINEERING PROGRAM: 
DEVELOPING THE NEXT GENERATION OF GLOBAL LEADERS

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Abstract

The Ministry of Education, Culture, Sports, Science, and Technology in Japan (MEXT) has 
highlighted the need for drawing up “regional revitalization strategies.” In addition, MEXT has 
been demanding that every educational institution should collaborate with local companies and promote 
the cultivation of advanced human resources to solve today’s complex and various challenges. The terms 
“regional revitalization” and “globalization” are in other words, keywords in the development of human 
resources. Under these circumstances, MEXT has started a grant-in-aid for the “KOSEN 4.0 Initiative” 
project. Two project proposals from our college were accepted; one was the “Vanguard Engineer Fostering 
Program” to support and lead the development of regional industries internationally, and the other was the “NaDeC (Nagaoka Delta Cone) Entrepreneurs Fostering Program,” a regional revitalization project based on “Nagaoka Rejuvenation.” Along with the two new educational programs and system design educational program, we also began work on a new human resources development program with the goal of nurturing next-generation leaders. The system design educational program has already embedded its roots deep in our college. The new program focuses on fostering the ability of students to solve problems, develop an entrepreneurial mindset, and to have a global mindset that is able to develop better communication, relationships, and understanding among colleagues and global partners. In this research, we introduce the “Next-Generation Engineers Fostering Course Programs” and “Vanguard Engineer Fostering Program.” In addition, we discuss the educational effects of the aforementioned engineering program.

Keywords: Globalization, Global Leader, Innovation, KOSEN 4.0

Introduction

The terms “regional revitalization” and “globalization” are keywords in the development of human resources in Japan. The Japanese Ministry of Education, Culture, Sports, Science, and Technology (MEXT) has emphasized the requirement of “regional revitalization strategies.” In addition, MEXT has been demanding that every educational institution, in collaboration with local companies, must promote the cultivation of advanced human resources to solve today’s various complex challenges (MEXT, 2015). Under these circumstances, MEXT has started a grant-in-aid for the “KOSEN 4.0 Initiative” project (MEXT, 2017).

KOSEN4.0 is one of the competitive grants offered by the Japanese government, and targets all KOSENs in Japan. The fund is aimed at projects that promote the three directions of “human resource development leading the new industry,” “contribution to the region,” and “acceleration and promotion of internationalization.” Therefore, based on these policies, we must renovate our educational system.

Our college proposed two innovative projects that were both accepted, namely, “Vanguard Engineer Fostering Program” to support and lead international development of regional industries, and the “NaDeC (Nagaoka Delta Cone) Entrepreneurs Fostering Program,” a regional revitalization project based on “Nagaoka Rejuvenation.” In this regard, we began working on a new human resources development program with the aim to nurture next-generation leaders.

In the present research, we introduce “Next-Generation Engineers Fostering Course Programs” and “Vanguard Engineer Fostering Program.” Additionally, we discuss the educational effects of the educational program.

Outline of Next-Generation Engineers Fostering Course Programs

The Next-Generation Engineers Fostering Course Programs were created for fostering innovative human resources who can respond to the internationalization and impact of the social economy in Japan. The programs are based on the professional education of various departments, and consist of “System design educational
program” (Toyama, 2015), “Vanguard Engineer Fostering Program” and “NaDeC Entrepreneurs Fostering Program” (Fig. 1). The new program is focused on fostering the students’ abilities to solve problems, develop an entrepreneurial mindset, and have a global mindset that is capable of developing better communications, relationships, and understanding among colleagues and global partners.

The three course programs consist of a “basic course” that will be available for 4th- and 5th-year regular students, and an “expert course” that will be available for 1st- and 2nd-year advanced course students. However, first-year students can also opt for some of these courses.

Each course program is composed of subjects that are common to all departments. Thus, all students can take the courses, regardless of the department.

In addition, course students can learn various educational methods from faculty members beyond their departments.

Vanguard Engineer Fostering Program

In recent years, the globalization of the market and the subsequent multi-nationalization of companies has progressed rapidly; hence, it is necessary to encourage human resources that can play an active role internationally. In this course, opportunities to develop communication skills, a challenging spirit, and intercultural understanding considered necessary for global human resources are provided by Global Project-Based Learning (Global PBL), with Nagaoka or various foreign countries as the location for learning.

Having a wide range of experiences and connections, both domestic and international, as well as deepening the understanding of the local culture of Nagaoka, regional cultures, or cultures of other countries will be great assets in the future. In this college, one can expand their social circle to include people from all over the world, and aspire to become engineers who can play an active role on a global scale.

Some new subjects in this course were included; one of them is a “Global PBLI,” in which mixed teams are created with local companies, Nagaoka Delta Cone (NaDeC) (Fig. 2), as well as foreign partner universities and international students, to work towards resolving various issues. “Global PBLII” is almost the same as PBLI, except the learning takes place overseas. Furthermore, “global debate” subjects for acquiring the debate skills necessary for discussion have also been arranged. The course encourages students to become engineers with leadership skills who have the ability to think appropriately for the international community and can also proactively expand the superiority of local culture and industries overseas.
Global PBLII

This subject differs from Global PBLI in that it is conducted overseas. We introduce the program with Guanajuato and Salamanca KOSEN in Mexico (Akazawa, 2017).

In March 2017, we conducted Global PBLII in Mexico, along with students of the KOSEN course in the University of Guanajuato and Salamanca in Mexico. We worked on solving local problems (e.g., the problem of graffiti, effective use of rainwater) in English. After these activities, we created a questionnaire for both the students and faculties. As a result, it became apparent that the project was highly appreciated by them, and all attendees and participants of the program were highly motivated. It has been obvious that this program was extremely effective in encouraging a global mindset and problem-solving skills of students (Fig. 5, 6).

Global debate

“Global debate” collaborates with NaDeC students to nurture their ability to debate in English.

First, the students learn the basics of debate using e-learning. Then, they discuss familiar subjects with each other, after which they attempt to debate against social problems. Finally, the students debate in English with NaDeC students, including students of the Nagaoka University of Technology.

All faculty members can watch the English debate stage. It is revealed that the educational effect is quite high for students (Fig. 7).

Development of overseas partnerships

As part of spreading international exchange activities, new overseas academic agreements have been formed. We visited the Metropolia University of Applied Sciences and the Turku University of Applied Sciences (Turku AMK) in Finland in March, 2018. Our KOSEN concluded a Memorandum of Understanding (MOU) with Turku AMK, and the student exchange program has started since May this year (Fig. 8). Furthermore, we are promoting the preparation of a double degree program with Turku AMK.

As other activities of the projects, we improved the learning commons, produced a brochure summarizing international activities, and prepared for participation in the CDIO (Conceiving-Designing-Implementing-Operating) initiative, which involved the development of an innovative educational framework for producing next-generation engineers.
Furthermore, to increase the global skills of faculty members, providing them with overseas work experience as well as encouraging them to participate in international conferences are being attempted. Through these activities, we are fostering “vanguard engineers,” and promoting the internationalization of our College.

Conclusions
We developed novel educational programs for fostering vanguard engineers who are capable of debating with foreign students in the English language, as well as improved the learning commons. In addition, we concluded a new MOU with a foreign university, having been attempting to increase the global skills of faculty members. Through these activities, we facilitated a novel human resource educational system called the “Vanguard Engineer Fostering Program.”

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NURTURING ENGINEERS FOR IOT: NEXT-GENERATION EDUCATION PROGRAM OF KOSEN BY A VIRTUAL WORKSHOP

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Abstract

IoT has been getting a lot of attention in the global industry. Recent education programs also adopt information technologies such as IoT and ICT to improve the teaching method. However, education of KOSEN is desired to teach how to realize IoT and ICT, not only to utilize information technology. In this education program, we give lectures about social needs of IoT and the management method of a project first. Based on the lecture, students investigate real information applications and then propose their new seeds of information applications independently. They discuss their proposal information applications and choose some seeds taking account of supervisors’ suggestions. Furthermore, some projects are launched to realize the seeds. Students make their project plans and clarify the role division in the project. To move their project forward, they can use a virtual workshop in National Institute of Technology, Gunma College. Finally, students discuss their final products within the projects, and then we evaluate deliverables and processes of their projects. The virtual workshop includes visualization of existing equipment, which is placed in laboratories and facilities of our college, by network management. We connect the hardware and software resources to our college network and rebuild the resources to the virtual workshop which is shared across our college. Moreover, we employ new network-compatible IoT products other than existing equipment. This paper describes our plan to nurture IoT engineers in Gunma College.

Keywords: IoT, Education program, Project based learning, Virtual workshop, 3D-printer, Small board computer, Interactive projector.

Introduction

For several years now, IoT, Internet of Things, has attracted attention in the industry fields of the world. The phrase “Internet of Things” was made by Kevin Ashton in his presentation of RFID at Procter & Gamble in 1999 (Ashton, 2009). “IoT” is currently used to mean that various kinds of networked industrial products, e.g. smartphones, home electronics, electrical vehicles and smart homes, aggregate, exchange, and share their data each other to automate diverse human activities. The IoT technology was realized by the price reduction and miniaturisation of sensor devices and the spread of the internet.

Information technologies such as IoT and ICT have been introduced into some education methods too. The Japanese government proposed that companies should proactively utilize IoT, artificial intelligence (AI), big data and robots in order to increase productivity against a shrinking population (2016). In response, Ministry of Education, Culture, Sports, Science and Technology also has promoted an education reform to cultivate human resources capable of supporting the 4th industrial revolution (2016). Therefore, many primary and secondary schools adopted programming education as a mandatory subject and introduced tablet-type computers (hereinafter called just “tablet”) and electronic blackboard systems. Teachers in the schools have been attempting to “visualization” of education to be helpful in finding student’s learning problems by logs accumulated in the tablets, and “active learning” by using the tablets and electronic blackboard systems.

Present Situation of IoT Education in KOSEN

Basically, the goal of KOSEN education is to nurture excellent engineers in the industrial field. Therefore, education of KOSEN is desired to teach how to realize IoT and ICT, not only to utilize information technology.
Most of the present colleges in KOSEN are comprised of conservative departments: mechanical engineering, electrical engineering, information engineering, chemical engineering and civil engineering. Practically, KOSEN has few departments that focus on the IoT technology, which includes the interdisciplinary field between mechanical engineering, electrical engineering and information engineering. However, education of the IoT technology is very important for all departments of the future KOSEN since IoT has a potential ability to fuse all technologies around us via the internet.

Gunma College has five regular courses, offered by above five departments, and two advanced engineering courses, which consist of a production system engineering course and an environmental system engineering course. The production system engineering course has conducted a PBL (Problem Based Learning) class since 2015 (see Figure 1). Students in the PBL class solve various problems given by real local companies, which need knowledge of the IoT technology.

**Efforts to Reform KOSEN Educations: KOSEN4.0**

National Institute of Technology, Japan, which organizes 51 Colleges of Technology (KOSEN), invited the proposals “KOSEN4.0” to reform education of each College in three aspects: 1) human resources development to lead the new industry, 2) regional contribution and 3) internationalization of education. Gunma prefecture, in which Gunma College is located, has promoted the next generation industries in six fields such as an autonomous car, a robot, healthcare, etc. since it is famous for the manufacturing industry like Subaru Corporation. To realize the next generation industries, human resources that can use the IoT technology and work with engineers in different fields are indispensable. Therefore, Gunma College applied for the KOSEN4.0 as “Nurturing Engineers for IoT: Next-Generation Education Program of KOSEN by the Virtual Workshop”, which selected 1) human resources development to lead the new industry and 2) regional contribution in the above three aspects. Specific methods of the education program were designed based on the PBL class for the advanced course of production system engineering.

This education program plans to produce global IoT engineers who lead the 4th industrial revolution while endeavoring to strengthen partnerships between universities, local industries and Gunma Industrial Center (see Figure 2).

**Next-Generation IoT Education Program of KOSEN**

This IoT education program will offer a class “Laboratory of Interdisciplinary Creative Engineering”. In this class, we give lectures about social needs of IoT and the management method of a project first. Based on the lecture, students investigate real information applications and then propose their new seeds of information applications independently. They discuss their proposal information applications and choose some seeds taking account of supervisors’ suggestions. Furthermore, some projects are launched to realize the seeds. Members of each project are composed of students who majored in different fields. Students make their project plans and clarify the division of roles in the project. To move their project forward, they can use a virtual workshop in National Institute of Technology, Gunma College. Finally, students discuss their final products within the projects, and then we evaluate deliverables and processes of their projects.

**Virtual Workshop**

The virtual workshop includes visualization of existing equipment that is placed in laboratories and facilities of our college by network management besides machine tools related to IoT. Although Gunma College has IoT-related hardware and software such as AI, deep learning and robot, college faculty, staff and students do not know how to utilize the resources well. Therefore, we connect the hardware and software resources to our college network and rebuild the resources to the virtual workshop which is shared across our college. However, the resources are not necessarily network-compatible. In this case, we add the resource so that users can confirm whether it can be utilized or not via the network. Moreover, we employ new network-compatible IoT products, a 3D-printer, a small CNC, a stereolithography apparatus, a circuit board plotter, small board computers and Interactive projectors, other than existing equipment (see Figure 3).
Schedule and Final Goals

Progress schedule of this education program is shown in Table 1. For five-year regular course, the virtual workshop was built and a class syllabus of “Laboratory of Interdisciplinary Creative Engineering” was formulated in 2017. The class will be offered to students in the mechanical engineering department, the electrical engineering department and the information engineering department in 2018. Furthermore, the same class will be offered to students of all departments including chemical engineering and civil engineering in 2019. On the other hand, we formulated a class syllabus of PBL for the advanced course of environmental system engineering in corporation with local companies in 2017 because the advanced course of production system engineering has already conducted a PBL class. The PBL class will be offered to students of all advanced course in 2018. The education program of the regular course and advanced course will be assessed by external institutions in 2019. Finally, we are going to share the education program with a lot of KOSEN colleges by packaging the education method. Final goals of the education program are employment growth in the next generation industries of Gunma prefecture and an increase of technological consultations with local companies.

Conclusions

In this paper, we reported the new education program to nurture IoT engineers in Gunma College. To date, the virtual workshop was built and specific educational methods of the program were decided. Practically, this education will be conducted this year (2018). IoT engineers will be increasingly necessary from now on since all the things around us will be connected to the network by the price reduction and miniaturisation of sensor devices and the spread of the internet. Gunma College will continue to nurture IoT engineers, who lead the 4th industrial revolution, in the education program to respond to the technological innovation of IoT.

References


Table 1 Progress schedule

<table>
<thead>
<tr>
<th></th>
<th>Regular courses</th>
<th>Advanced courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>Construction of the virtual workshop</td>
<td>Construction of the virtual workshop</td>
</tr>
<tr>
<td></td>
<td>- Formation of the class syllabus</td>
<td>- Formation of the PBL class syllabus</td>
</tr>
<tr>
<td></td>
<td>- Construction of the virtual workshop</td>
<td>- Formation of the environmental system engineering course</td>
</tr>
<tr>
<td>2018</td>
<td>- Offer the class in the mechanical, electrical and information engineering departments.</td>
<td>- Offer the class in all advanced course.</td>
</tr>
<tr>
<td></td>
<td>- Assessment of the program by external institutions</td>
<td>- Improvement of the PBL class.</td>
</tr>
<tr>
<td></td>
<td>- Construction of the virtual workshop</td>
<td>- Assessment of the program by external institutions</td>
</tr>
<tr>
<td>2019</td>
<td>- Offer the class in all departments.</td>
<td>- Assessment of the program by external institutions</td>
</tr>
<tr>
<td></td>
<td>- Assessment of the program by external institutions</td>
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<tr>
<td>2020</td>
<td>- To share the education program with a lot of KOSEN colleges by packaging the education method.</td>
<td></td>
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</table>

Fig. 3 Configuration of the Virtual workshop.
STUDENTS’ PARTICIPATION IN DEGREE PROGRAM-LEVEL QUALITY ASSURANCE ACTIVITIES

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Abstract

Active Involvement of students in the program-level quality assurance (QA) and improvement processes is a significant part of the continuous development cycle in higher education. When evaluating the degree program’s effectiveness and efficiency in reaching its intended goals, it is important that also the students participate in the continuous development work in different ways. Universities typically use several methods to include students in their QA processes. Also Turku University of Applied Sciences (TUAS) has many tools enabling the students’ voices to be heard. In this paper, student involvement in the TUAS quality assurance and improvement activities is described in general. In addition, the recent experiences on student feedback and efforts in order to facilitate the positive feedback culture are reported.

Keywords: continuous development, feedback, higher education, improvement, students, quality assurance

Introduction

Active involvement of students in the program-level quality assurance (QA) and improvement processes is a significant part of the continuous development cycle in higher education. In Europe, the so-called Bologna Process has put increasing weight on the engagement of students in the QA in higher education (Alaniska et al., 2006). When evaluating the program's effectiveness and efficiency in reaching its intended goals, it is important that also the students participate in the continuous development work in different ways.

Universities typically use several methods to include students in their QA processes. Students provide feedback on the courses they have taken, contribute to the development of teaching and learning in their subject area, or participate in different decision making processes (Alaniska et al., 2006). Also TUAS utilizes multiple tools enabling the students’ voices to be heard. There are student representatives in the university board and in most of QA-related working groups, as well as in the industrial advisory boards. The student representatives nominated by the Student Union also mediate development initiatives and possible identified problems to the degree program management. In addition, a university-level student feedback survey is organized annually, the program leaders and tutor teachers have regular development discussions with their groups, and it is possible to give feedback on every course separately. The received feedback is processed systematically, and the students are informed on the implemented corrective actions based on their initiatives.

However, many faculty members describe the student feedback culture at TUAS as critically-oriented. That is, a significant part of the feedback is considered to focus on sharing negative experiences and complaints often without constructive initiatives on how the reported issues could be improved. Naturally, it is important that all the identified topics requiring corrective actions are filed, but the strength of positive feedback should not be forgotten either. In this paper, student involvement in the TUAS quality assurance and improvement activities is described in general. In addition, recent experiences on student engagement and feedback in the Information and Communication Technology (ICT) Unit of TUAS and efforts in order to facilitate the positive feedback culture and attempts to benefit from the reinforcing effect of it are reported and discussed in particular.

Students’ roles in quality assurance

Alaniska and Eriksson (2006) have discussed students’ roles in the academic community. In order to achieve optimal results in there should be a collaborative culture of learning present in the higher education institutions (HEIs). The closer the students are involved in a department’s activities the more open dialogue and better result for improvement. The students’ involvement in QA activities can be divided in four categories (Alaniska & Eriksson, 2006):

1) Student as an information provider: Giving feedback in different forms is the most common way of engaging students in QA. A typical procedure is to ask feedback for every completed course or collect data every semester, for example. There is a multitude of ways to collect student feedback and both quantitative and qualitative methods are used.

2) Student as an actor: Students have potential to have a more active role than just the role of a source of data. The students can participate in designing the feedback questionnaires in cooperation with the academic staff and join the analysis of the collected data.
as well. Students can also organize workshops concerning different improvement topics where the issues can be discussed together with the staff members in a comfortable environment.

3) Student as an expert: One of the focal points of QA in education should be the quality of learning – not teaching. The students are experts in their learning; they are able to reflect how (and if) they have reached the intended learning outcomes and how teaching has guided them in this process. Utilizing the students’ expertise can be implemented by inviting them to join different working groups, meetings and seminars. Considering students as experts demands positive attitude both from the staff and from the students.

4) Student as a partner: The partnership between students and staff refers to an authentic and constructive dialogue enabling reflective feedback. The common responsibility and ownership about the activities and their further development is recognized, and there is an easy-going atmosphere and culture in the department. Continuous cooperation and co-organization takes place leading to open and authentic QA and improvement.

Successful student involvement can contribute to several parts and processes of the institution. Typical effects include curricular improvements, course content updates and further development of learning and teaching methods leading to improved student experience and, most importantly, enhanced achievement of the learning objectives. In other words, the students give diagnostic feedback to the faculty for improving their teaching. Furthermore, the activities provide a measure of teaching effectiveness for personnel decisions, the students themselves gain information for the selection of courses and instructors, and the outcomes may support research on learning and teaching. The student involvement can also play an important role in a national or international QA exercise such as a formal audit or accreditation process. Yet, also criticism and controversies exist in the discussion on student engagement in QA. Do the student’s evaluations on different teaching instruments and course contents including complex and multidimensional aspects really measure effective teaching and learning? (Marsh, 2007; Aškerc & Braček Lalić, 2016)

Wyns et al. (2015) present a case study report from Belgium: The student involvement at KU Leuven has long traditions. Every faculty has its own student organization and student representatives are appointed annually through elections. In addition to improving QA, student participation has been shown to positively influence the students’ skills in communication, critical analysis and leadership. Students also become aware of their own institution by participating in different QA and decision-making processes.

Student involvement at TUAS

In accordance to the European traditions and higher education quality paradigms, TUAS aims at engaging the students in several different ways. The goal is to create and further facilitate a collaborative culture of partnership in learning between the students, faculty and other staff members.

Formally, the students are represented by the Student Union of TUAS. The union is an independent association-format organization that selects its own key persons and committee members via annual elections. The Student Union has also employed personnel who takes care of the administrative issues as well as participates in driving the students’ interests both within the different bodies of TUAS as well as in other local and national networks. The most important actors on a
departmental/program-level are the so-called Executive Board Student Representatives who are nominated annually for each department. These representatives have a key role in mediating different topics between the institution and their students. The representatives participate in different working groups and, for example, they are members of the Industrial Advisory Committees. The official representatives may have a team of other active students supporting their work. For instance, in the ICT Unit of TUAS each student group (of about 30 students) has 2-3 student coordinators who are supposed to lead the student involvement activities within their group.

Traditional course feedback can be given for every course implementation. The teachers are responsible for the course feedback process concerning their own courses. It is possible to utilize a standard feedback form of the student information system, or the teachers can choose other means to collect their feedback.

An important university-wide tool for feedback collection is the annual Student Barometer. The Barometer is a large-scale web-based survey that is implemented in the beginning of each calendar year. The survey questionnaire contains a large number of questions (usually round 50) but some of the questions are presented only to limited student groups, such as the first-year students. Most of the questions are general quantitative scale-formulated questions but there are also some open-ended free-text parts that are expected to provide more detailed and elaborated viewpoints. The survey is kept rather stable in order to maintain comparability between the different years. Yet, there can be specific annual themes focusing on different development areas.

In the ICT Unit of TUAS, the Student Barometer process is supported by a development discussion with each student group. These discussions are held between the group responsible students, the group’s tutor teacher and the respective program leader. Sometimes also the union’s student representative and the study counsellor take part. The group’s student coordinators are expected to discuss possible feedback, questions and improvement initiatives with their group members before the discussion and then bring these topics to the common table. Many questions get answered already during the development discussion but sometimes the issues require further investigations and corrective actions. A summary memo is written after every meeting and the memos are published and shared openly. The series of discussions are timed so that all the memos are available at the same time when the annual Student Barometer results are received.

The Student Barometer results are analyzed together with the development discussion summaries both by the program teams (staff) and the students. Usually, the union’s student representative leads the analysis process and aims at defining the most important development initiatives based on the annual feedback. This is a demanding task since there is lots of data and it is not uncommon that there are both positive and negative comments on the same topics. The feedback summaries categorized by degree programs and student cohorts are presented in an open event called the Feedback Day. This “day” is a 2-3 hour event organized by the faculty together with the students. The event is usually opened by presenting the TUAS QA practices and the different opportunities available for the students to participate in the development activities. Thereafter, the feedback summaries are discussed by the students, and they have the possibility to add new viewpoints to the topics and comment the analysis prepared by the student representative and his/her team. Sometimes the dialogue gets lively. Also the staff members may comment the students’ argumentation yet the intention of the event is not to start any defensive debates from the faculty’s side. Finally, an open memo summarizing the feedback analysis and the results of the discussion and presenting the most important development initiatives and proposed corrective actions is prepared and published.

The results are analyzed and discussed in the degree program teams. The cycle is completed by organizing another event usually in the middle of the new autumn semester. This event is called the Feedback on Feedback meeting and it is organized by the department. The aim of the meeting is to bring back the previous-year’s feedback to the table and provide the department’s response to it. The decided corrective actions based on the feedback are presented. Also the topics that will not
lead to any actions are presented and explained. Some of the minor corrective actions are typically implemented immediately whereas others are included into the operational plan of the department or escalated forward to different university-level bodies. This concludes the development cycle and it is time to start a new round in the continuous development process. The tutor teachers start to coach their groups together with the student representative towards a new development discussion round and the Student Barometer in the beginning of the next calendar year. This “TUAS Development Day” process is illustrated in Figure 1. (Turku University of Applied Sciences, 2018)

Reflections on QA activities and student feedback

Based on my 15-year experience on educational administration, it is easy to agree that students’ engagement in the QA activities is vital for making positive development happen and for fostering a fruitful culture of learning in general. However, also criticism and concerns connected to the student participation and the return on investment on it exist. The critical voices may reflect a still developing maturity of the institutions’ or departments’ processes and atmosphere but, if nothing else, it is important to consider these viewpoints as well in the continuous development work.

Little and Williams (2010) agree that the students are expected to play an active role in the educational process: Optimally, this means that the students and staff work in partnership to improve learning. The student representation system is not dominated by negative comments on specific issues but, instead, there is a shared and forward-looking sense of shared responsibility. However, they argue that the recent developments including the expansion and differentiation of higher education, increased accountability for public spending, and tuition fees have formed the students’ role towards a consumer profile. Possible over-emphasis of the student as a consumer/customer may lead to increasing one-directional transactions between the higher education provider and the learner. If the students start behaving as passive recipients of educational services, it will limit their possibilities to inform and enhance their learning experience. The student engagement may also start to act in opposition to the present quality measures (Pickup, 2017).

There are no recent studies on this perspective available at TUAS but there are regularly doubts within the faculty especially concerning the usefulness of the student engagement in relation to the time and efforts invested in the activities. A common discussion topic in the teachers’ coffee room is that the response rate is rather low in most of the feedback channels. This makes it easy to question the relevance of the results and gives room for defensive explanations concerning the received feedback. It is sometimes claimed that the feedback is dominated by students with negative experiences and, as the general response rate is low, most of the students are considered to be actually fairly satisfied.

TUAS Student Barometer 2018 overview

The Student Barometer 2017 was replied by only 138 students of the degree programs hosted by the TUAS’s ICT Unit resulting in a response rate of roughly 14% only. Similar figures had been typical also during the earlier few years. I was decided to put extra effort in getting the students more interested in answering the 2018 survey. The student representative promoted the survey via her channels, and the tutor teachers kept the students informed about the approaching opportunity to participate. When the survey was activated, many tutors also took their groups to a computer classroom and informed them directly on how to reply to the Barometer (voluntarily, of course).

These efforts clearly affected the students’ activity. The Student Barometer 2018 got 307 answers submitted by the ICT students. That is, the number of replies was more than doubled from the year before. The response rate of 31% was not sky-high either but much more representative than the traditional figures. Yet, most of the respondents were first-year and second-year students which should be kept in mind when interpreting the results. 212 responses (69%) originated from these younger students whereas 51 third-year (17%) and only 39 fourth-year (or older) (13%) students replied.

When the students were asked how satisfied they were on their studies at TUAS in general, the average was 3.7 (scale: 5 = Very satisfied, 1 = Very unsatisfied) that can be considered as a good result and slightly above TUAS average. Less than 30 respondents (<10%) answered that they were unsatisfied or very unsatisfied. So, the overall feedback was fairly positive.

Positive feedback was also given in the open-ended question asking on which issues TUAS has been successful. This optional question was replied by 227 respondents. Most of the positive comments dealt with the facilities and learning environment which received more than 50 replies. Many students (>20) also mentioned the curricula and course contents, teachers and staff members’ expertise, versatile learning methods, and project-based courses. However, only a small number of these free text replies contained more detailed explanations behind the statement that could have helped to understand the reasons for positive experiences. Most of the answers contained just a few words like: Good facilities or Quality of teaching. The claims that the student feedback focused only on negative issues seemed in any case a myth according to the Barometer results.

Yet the Barometer results also contained critical replies. 237 students replied to the question on which issues TUAS could improve. Several respondents (>30) wished for more contact teaching hours. More than 20 mentions received also the TUAS information systems, classroom schedules and, somewhat surprisingly, also the facilities. There were clearly more answers containing detailed elaborations motivating the proposed development areas but still most the replies were short and so generally expressed that it was very difficult to define any improvement actions based on them: Teaching of some courses, The quality of teaching, or Some teachers do not give enough feedback. Also the
provides illustrative examples etc. facilities group spirit, generally formulated, “motivations seemed to be, also in this case, rather their selections according to the instructions yet the three in a staff meeting mid-June. The students had made department’s development day mid-April and the other nominations of three staff members were published in the several courses during the first two academic years. The six nominees were teachers that were involved in active also this time than their older fellows. Five out of five seemed to have spent time and effort on the selection process, maybe these hesitations reflected defenses connected to thoughts of not being among the nominees?

A positive feedback initiative

One of the TUAS Staff Survey 2017 results indicated that the teachers wished for more positive feedback on their efforts. Many staff members had experienced that success in research activities, such as new funding decisions and publications, received more (and more often) positive acknowledgement than teaching work that, on the other hand, was rather often discussed reflecting the critical voices of student feedback. The experience of receiving feedback is, naturally, a complex topic that cannot be solved by a single action. Yet, a pilot of a positive feedback campaign was decided to be implemented in the ICT Unit during spring 2018 based on these survey results together with the teachers’ remarks concerning the negative-oriented focus of the discussed student feedback.

The Student Union’s student representatives took the challenge to select one staff member that had made an especially positive contribution each month between December ‘17 and May ‘18. That is, in total six staff members were supposed to be nominated during the half-year-long pilot period. The department promised to award these staff members with a small token of appreciation. The students’ responsibility was to organize the nomination process in some democratic way, and to announce the nominees two times during the pilot period – the first three in the beginning of April and the next three in the beginning of June 2018. The nominees were supposed to be ICT Unit’s own staff members, one person could be selected only once during the pilot, and the students should publish a short but clear motivation explaining the selection of each person. In addition to the improvement of positive teacher feedback visibility, the other important internal QA-related goal was to facilitate the focus and discussion to recognition of positive contributions within the student community.

The pilot was implemented as planned. The nominations of three staff members were published in the department’s development day mid-April and the other three in a staff meeting mid-June. The students had made their selections according to the instructions yet the motivations seemed to be, also in this case, rather generally formulated, “...facilitates group spirit, provides illustrative examples etc.”

The nominated staff members were clearly happy about the received acknowledgement. Also the students seemed to have spent time and effort on the selection process even though it remained unclear how wide audience they had been able to include into the process. It is possible that the younger students had been more active also this time than their older fellows. Five out of the six nominees were teachers that were involved in several courses during the first two academic years.

However, there were also some staff members who seemed not to feel comfortable with the process. Perhaps they were afraid of that the nominees could not have been the “right” ones? Or maybe these hesitations reflected defenses connected to thoughts of not being among the nominees?

Discussion and conclusions

In this paper, the different roles of and forms of student engagement in QA processes in higher education were reported. The student involvement practices of Turku University of Applied Sciences were presented and discussed. In addition, recent experiences on student feedback collection and analysis including critical viewpoints were reflected.

Involving students in multiple ways and roles in QA and decision making processes is a significant part of creating and further developing a culture of learning partnership between all the members of the academic community. Student engagement shall not be seen as a continuous development tool only. It is also an important tool for the students to get familiar with their environment, to gain responsibility and respect of the community, and to learn important working life skills.

Also TUAS uses several different ways to involve its students into QA activities and other processes. These practices are well aligned with Finnish and European traditions and trends. Yet there is room for improvement. There is more potential to benefit from these activities and the resulting data than is currently feasible. Even though the group development discussions and interactive feedback events provide value-adding content to the versatile but rather one-directional and general Student Barometer data, a significant part of the current feedback does not provide clear enough information for deeper analysis and development. Additional attention should be paid to guide the students to provide feedback that also explains the backgrounds of the experiences and, more often, elaborates possible improvement initiatives. This could lead to even better return on investment in this work.

References


Abstract

The paper summarized the change in student’s expectation on teacher’s qualities, when comparing teens (age 17 to 20 y.o.) and adult learners (age 30-55 y.o.). The surveys and data collected are based on students studied in Singapore Polytechnic. The paper is intended to act as a fundamental guidance for teacher who is preparing lessons for classes of different age group.

Refer to the “references” and personal teaching experience, 10 common teacher’s qualities were identified as follow:

1. Punctuality.
2. Fairness.
3. Humorous.
4. Threats.
5. Anger.
6. Friendliness & Familiarity.
7. Alert & Observation.

Threat and Anger are considered as part of the teacher’s common qualities. Both qualities are considered as very effective tools when classroom control is required in shortest possible time.

The qualities are further grouped into 4 categories. Each category describe the qualities that resulted a student having,

Cat. 1: “ineffective” learning experience.
Cat. 2: “effective” learning experience.
Cat. 3: “good” learning experience.
Cat. 4: “joyful” learning experience.

Upon the survey, it is found that the students’ expectation on the teacher qualities by “category” are the same between age groups. However, the priority order of respective quality are changed when compared between them.

The process of filtering resumes and interviewing candidates had guaranteed all teachers are competence in their field of expertise. However, the effectiveness on knowledge transferred is largely depends on teaching approach. Teaching approach is classroom specific. When a teacher teaches a similar lesson to different age group of students, his approach had to be changed accordingly in order to make the lesson effective. It is similar as tuning a radio to the favourite channel, it can only be done when the frequency is in-sync with the station.

Keywords: Teacher Quality, Punctuality, Fairness, Humorous, Threats, Anger, Friendliness & Familiarity, Alert & Observation, Confidence, Well Organized, Positive Language, Student’s expectation, age group, in-sync.

Introduction

The objective of the paper is to provide fundamental guidance on teaching approach based on student age groups.

In order to encourage truthful feedback, all students took part in the surveys were instructed to return the completed survey form (Form 1) without stating name or identification for reference. The intention is to avoid student input only positive or favourable comments to gain favour from the teacher.

Accuracy of the survey shall improves as more students are involved in the survey. However due to time and resources limitation, approximately 70 Singapore Polytechnic students from each age group, were selected for the survey.

Materials and Methods

Based on the identified qualities, survey forms (Form 1) were created and distributed to groups of teens and adult learners. The forms are intended to obtain feedback about their priority order and categorising of the identified teacher’s qualities. The completed forms were analysed based on teens and adult groups.

Refer to the question 1 in the form, the most desired teacher’s quality shall be given 10 marks, second is 9 marks, until the least is 1 mark. Then, the marks of same quality were summed to form a percentage for easier analysis. Refer to Chart 1 and 2 for percentage obtained by each quality.

Refer to question 2 in the form, the qualities that were placed under category I were given 1 mark, category II were 2 marks and so on. Then all the marks of same quality were averaged. Finally, quality with average marks of,

- 1 to 1.5 is grouped as Cat. I,
- 1.5 to 2.5 is grouped as Cat. II,
- 2.5 to 3.5 is grouped as Cat. III,
- 3.5 to 4 is grouped as Cat. IV.
Refer to Chart 1 and 2, categories of qualities are indicated based on colour as follows,

- Brown is Cat. I,
- Red is Cat. II,
- Green is Cat. III,
- Yellow is Cat. IV.

The computation on priority & category is an assumption based on direct summation, percentage & average. It may not reflect the actual student’s perception by figures or percentage. It acts only as reference for easier analysis.

**Results and Discussion**

Refer to the pie chart, it is found that both teenagers and adults shared similar opinion on categorising the qualities,

- Cat.I - Anger and threat
- Cat.II - competency, confidence and well organised.
- Cat.III - Friendliness, positive language, fairness, punctuality and good observation.
- Cat.IV - Humorous.

Upon construction of the charts, small group discussion had been organised among the students to find out their reasons of such selections.

Anger and threat (Cat.I) are found to the least effective qualities in engaging the students in classroom, even though there are known by teachers for ability to draw student attention in shortest possible time. During small group discussion, the students did feedback that, when a teacher showing his anger and using threatening words to draw class attention, they will normally follow the instructions by temporary shut down their thoughts at the moment. However in the long run, it will cause their mind to develop a natural resistance towards the lesson or simply just shut down their thinking during the class. Teaching is effective when the knowledge transferred is occupying a space in student's mind. However, when the mind resist the lesson or shut down, it will causes the teaching process to become ineffective at all.

Both groups of students shared the similar opinions that the minimum qualities required by a teacher are,

- competence in his expertise,
- confidence in lecturing,
- Well organised in teaching notes,
- Readiness in practical work demonstration,
- provide organised, simple and straightforward answers when queries are raised,
- Prepared before coming to class.

The description of students about the minimum are matching the core competence and duties of a teacher. All student always expect teacher to exercise his due diligent during class, else they shall considered the teacher as lazy or incompetence. It is the basic cycle of sowing & reaping - only diligent teacher may produce diligent students.

Qualities in category III (punctuality, positive language, fairness, alert, observation, friendliness and familiarity) are refered to a well-behaved person. A well-behaved teacher is always a respectable figure. He makes the student feel comforther when he is around. Naturally, the teacher will become a role-model to the student. Hence, a teacher may be categorised as “good” after he became a role model to the students. Role model is always respected and mirrored by the students.

Humorous is the quality that makes a teacher and his teaching interesting. Both teenager and adults did feedback that humorous may not be the strength of every person, however a humorous teacher do make the teaching more interesting and lift the spirit of learners. The students also mentioned that humorous should come naturally and the act should be relevant to the lesson as well.

Upon the categorised the qualities, further discussion were made on the priority of each quality. Priority orders of qualities in Category I, II and IV were reviewed and found similar reasons as categories.

The main differences in priority orders are within Category III – qualities resulted in good learning experience. It is found that the results are leading to human behavioural changes correspond to aging.

In the Category III for teenagers, their priority on teacher's quality in descending order are friendliness, positive language, fairness, punctuality and finally good observation. Based on the priority orders and feedback from students, it is concluded that teacher for teenagers shall use more friendly and encouraging words when communicating with students. The teacher shall not practice favouritism among the students. Punctuality for class and observant on student behaviour changes are important, so that the student feel comfortable and trustworthy toward the teacher. Teens students want the teacher to become his role model. Their ideal role model is a leader who is friendly, open minded, polite, fair, observant and always punctual for class. Teenager's leader is their achievement target, the leader that they want to replicate his success or capability.

In the Category III for adults, their priority on teacher's quality in descending order are punctuality, friendliness, positive language, good observant and fairness. Based on the priority orders and feedbacks, it is concluded that adult students expect teacher to be always on-time and on-track with lesson plan. They would like the lesson delivery with short, clear and precise words. Adult learner do not like to feel “waste-of-time-in-class”. Adult students would like to be treated with equal social status as teacher (friends), but separated by classroom hierarchy (teacher-student relationship). The teaching approach to be open-for-discussion type including experience sharing from students. Polite in words, observant in students change of mode (adult students normally feel exhausted easier than teens due various reasons) are the qualities they expected from a good teacher. Role model for adults is a natural leader, who respect his works and respect others. A natural leader is the person able to gain respect from others due to his personality and actions, not by rank.

**Conclusions**

In order to deliver a lesson in a well organised and confidence manners, required lots of efforts. Students are
very sensitive to the amount of effort from the teacher. In student perspective, teacher's effort is reflecting his appreciation towards the class. When a teacher is well prepared for his class with correct differentials, then the students will appreciate the class in return.

Teacher needs to package his presentation and appearance to become a role model. Role model attracts students' attention, so that they pay more attention in class. When the teacher is in-sync with the students, then they may take-in and digest the lecturer’s words joyfully, which make the whole knowledge transfer process become more effective. Role model for teens is a leader that is friendly, open-minded, polite, fair, observant and always punctual for class. Role model for adults is a natural leader, who respect his works and respect others.

Humorous is similar to spice. Spice will enhance the favour of food. During a small group discussion, a student feedback that good teaching is a teacher able to guide the flow of student's imagination. He explained that during classroom, her pictorial imagination is working, in order to follow the lecture. If a teacher able to relate his lecture or presentation to the flow of student's imagination, and further excite it with jokes or funny gestures. It will resulted a joyful learning environment and excite the student interest to learn more about the knowledge. It is human nature to prefer joyful moment and want more of it.

I personally consider anger and threat is the best tools to gain control of classroom in shortest possible time. However, use it sparingly or during emergency case only, else the student will consider the teacher has personality of impatient type or insufficient passion for teaching.

References:

For articles:
- Twelve Characteristics of an effective teacher by Robert J. Walker.
- The Teacher Skills Checklist by KAPPA Delta PI, www.kdp.org

For URLs:
- Georgetown University. Top Qualities of an Effective Teacher. Retrieve from https://cndls.georgetown.edu/atprogram/twl/effective-teacher/
# Survey Request

Class, I would like to request your feedback on teacher’s qualities. Please take your time and answer 2 questions below:

<table>
<thead>
<tr>
<th>S/N</th>
<th>Description</th>
</tr>
</thead>
</table>
| 1.  | Punctuality  
Lecturer is punctual for class.                                         |
| 2.  | Fairness  
Lecturer is fair to all student.                                         |
| 3.  | Humorous  
Lecturer is humorous during his lecture.                                 |
| 4.  | Threats  
Threaten student to face disciplinary action during, hoping that student will perform academically or not make mistake? |
| 5.  | Anger  
Lecturer to have good emotion management.                                |
| 6.  | Friendliness & Familiarity  
Lecturer is friendly to student and welcome questions from them.          |
| 7.  | Alert & Observation  
Lecturer is observant enough for the changes of student mode and student problem in class. |
| 8.  | Confidence & Competence  
Lecturer is competence and confidence for the module.                     |
| 9.  | Well Organized  
Lecturer is well organized for his preparation for the class. (Course Note, Lesson Plan, Presentation Slides etc.) |
| 10. | Positive Language  
Lecturer always input positive words and thought to student.               |

**Q1** Based on the Lecturer’s qualities above & yours opinion, please sort it in descending order, which is the most until the least important to you. (First quality named is most important, and the last is least important to you)

1.  
2.  
3.  
4.  
5.  
6.  
7.  
8.  
9.  
10.

**Q2** Based on your opinion, group the 10 teacher’s qualities into 4 categories. What are the qualities, which resulted in,

I. **“Ineffective”** learning experience?

II. **“Effective”** learning experience?

III. **“Good”** learning experience?

IV. **“Joyful”** learning experience?
KOSEN SECURITY EDUCATIONAL COMMUNITY (K-SEC) AND RELATED ACTIVITIES IN TOMAKOMAI COLLEGE

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Abstract

Information security skills are basic for engineering students. These skills are acquired not only practice classes by teachers but also collaborations with regional agencies and citizens. The National Institute of Technology, Tomakomai College has participated in the KOSEN Security Educational Community (K-SEC)[1] since 2016. In this paper, we report the recent activities related to the program. In 2016, we mainly practiced three activities. First, we provided children with a QR-code puzzle derived from Capture The Flag (CTF) at a public regional lecture. Second, some students participated in the Security Mini-camp in Hokkaido to learn and practice the newest information security techniques and their related ethics. Last, Hokkaido Prefectural Police had a lecture about information security and usage of communication tools such as SNS (Social Networking Service) for the fourth year students. In 2017, we continued to take part in the public regional lecture and Security Mini-camp in Hokkaido. In addition to this, we started two new approaches. First, we signed an agreement of human development on the cyber security field with Hokkaido Prefectural Police. This agreement has been in effect since April 2018. As the subject to the agreement, both Hokkaido Prefectural Police and Tomakomai College collaborates to nurture engineering students who have basic information security skills. Last, the K-SEC program has been developing and improving teaching materials about information security. We also have been developing an experiment material using an IoT car derived from the K-SEC project. The scope of the experiment material will be the third year students. This means that the material should include not only information security but also basic computer network and configuring skills. Not only a teacher but also a laboratory student in an advanced course has been involved in the development. The laboratory student can acquire the information security skills through the development. We will firstly provide the material with the students after October 2018 and improve the material through the questionnaire result of the experiments.

Keywords: Information Security, Human Development, K-SEC, Regional Collaboratives, Experiment Materials Development

Introduction

As IoT devices have been used in various fields, for example, agriculture, forestry, fishery, and so on, the number of IoT devices has been increasing and will reach 30 billion in 2020[2]. It is shown in Fig. 1. Therefore, engineering students should acquire some basic information security skills. However, Ministry of Economy, Trade and Industry reported that the number of information security engineers in Japan will be shortage of about 193,000 in 2020[3], so the development of information security engineer has been desired.

Fig. 1 The demand of number of IoT devices [2]

To accommodate the demand for security engineers, National Institute of Technology (NIT) launched a project to nurture security engineers in April 2016 and will end until March 2019. To produce the desired security engineers, the K-SEC project classifies students into three categories; First, general students will practice and acquire basic information security skills; Second, students who belong to ICT related department will practice and acquire secure configuration and system development in addition to the basic information security skills; Last, students who want to pursuit security skills can acquire higher level practices not only our lectures but also external security events and lectures.

NIT Tomakomai College has been taking part in the project since the beginning of the project and has been working on many activities related to the project for two years. In this paper, we summarize our activities and future work.
The K-SEC Project

The K-SEC project [1] launched in 2016 to nurture students who have a discipline of information security. Recently, ICT has an important part in communications among individuals and organizations using the internet. However, malicious hackers run attacks on the internet to get money or critical information. To protect ourselves from the attack, the demand of nurturing information security persons has been increasing. The K-SEC project has a part in nurturing students who have a discipline of information security. A logo of K-SEC is shown in Fig. 2.

![K-SEC Logo](image)

Fig. 2. The Logo of K-SEC.

This project aims at the following three points. First, this project identifies skill sets of information security and develops teaching materials. Second, this project constructs a framework to produce students who have the information security discipline. To achieve this, this project prepares for the newest learning environments related to information security, including computer hardware, computer software and know-how. Last, this project consolidates hubs of security practice at some colleges. By utilizing the hubs, the colleges should conduct information security education for elementary schools, junior high schools, municipalities or companies.

Public Regional Lecture (Kagaku-no-Tobira)

NIT Tomakomai College holds the public regional lecture “Kagaku-no-Tobira” every year. The purpose of the lecture is that elementary school or junior high school students learn the fun of science and engineering from the lecture. All departments and technical staffs exhibit at least one theme for the lecture.

Department of Computer Science and Engineering exhibits a QR-code puzzle, which is derived from Capture the Flag (CTF). The procedure of QR-code puzzle is as follows: First, we generate a QR-code and split it into four square parts; Second, we present four parts to a student; Last, the student constructs the original QR-code until the constructed QR-code is readable. A scene of the QR-code puzzle is shown in Fig. 3.

![QR-Code Puzzle Scene](image)

Fig. 3. A scene of QR-Code Puzzle.

It was difficult for the attendants by the result of questionnaire, but some attendants felt fun.

External Security Events from College

It is also important for students to take part in security practice events. One of the representative events is Security Mini Camp. Security Mini Camp has been organized by Information-technology Promotion Agency (IPA). The purposes of the camp is to find nurturing talented young students, and therefore, the aim of the camp concurs that of K-SEC. Security Mini Camp consists of a national convention and local conventions. In this event, participants attend some advanced security lectures and practices. Lecturers teach the current security situations and backgrounds. As a result, they can acquire the newest security technologies and ethics. This event in Sapporo recruits at most about 25 students under 22 years old.

Five students in 2016 and eight students in 2017 from NIT Tomakomai College participated in the event. As the maximum number of attendees was 25, NIT Tomakomai College has enough students who are interested in information security.
Fig. 4 The students who attended Security Mini Camp in Sapporo in 2016 (top) and 2017 (bottom)

Collaboration with Hokkaido Prefectural Police

NIT Tomakomai College has taken part in Hokkaido Area Information Security Liaison (HAISL) since 2016. Hokkaido Prefectural Police (HP) hosts an officer of HAISL. HP made a special lecture for students in the department of Computer Science and Engineering about the crimes using SNS, targeting mail attack, Man-In-The-Browser attack and how to conduct an investigation of cyber security crimes. The lecture is shown in Fig. 5.

After this participation, NIT Tomakomai College and Hokkaido Prefectural Police reached an agreement to cultivate students who have cyber security skills in March 2018. The ceremony of agreement about the collaboration was shown in Fig. 6.

HP talked SNS and its risk for 200 students in the first year orientation on April 2018. This orientation aims to understand how students’ life at the college goes on. Many students often start to use smartphones at the entrance of the college at latest, but some trouble occurred through communications on SNS at college. Therefore, it is important to learn how to use SNSs. This lecture was shown in Fig. 7.

Collaboration with National Police Agency

The K-SEC Project and National Police Agency (NPA) have been working together closely. NPA visits NIT colleges and performs a special lecture about the current information security. In 2017 the special lectures were held at NIT Oyama College and Tomakomai College.

In Tomakomai College, eighteen students participated in the special lecture. The special lecture consisted of the following two sections:

1. A lecture and a demonstration about the current cyber security situation.
2. A practice using a virtual scenario to arrest a criminal person.

The practice was composed of a log analysis on a proxy server and a disk image analysis. Some of our
students often used the virtual private server (VPS), so it is easy for them to retrieve important information from the log. However most students didn’t experience the disk image analysis. After the special lecture, the students seemed to feel new and fun about the disk image analysis.

Experiment Material Development of IoT Security

We have been designing and constructing experiments about IoT security. We plan to use the IoT security car derived from the K-SEC project. The picture of the IoT car is shown in Fig. 9.

Fig. 9 A overview of IoT car

The IoT car consists of a Raspberry PI 3, a camera connected to the Raspberry PI and a motor driver Maple Syrup, so configuration of the IoT car conforms to a standalone Raspberry PI.

Now we prepared the following materials:

- Text References
  - Slides used at the experiment
  - A set up manual for IoT car
- Vulnerable application programs
  - A web user interface for user operation of IoT car.
  - A protected management console that is required to pass an authentication.

An example of vulnerable applications includes a web user interface. A snapshot of the web user interface is shown in Fig. 10. A snapshot of the management console is shown in Fig. 11.

This web user interface consists of a panel of operating IoT car, a preview of capturing from a camera connected to Raspberry PI 3 and a login form to access management console. Once you press a button either “forward”, “backward”, “left” and “right”, a request is sent to a Web Application Programming Interface (API) of the IoT car. This API constructs a command instruction from a query string and invokes a shell program to run. This involves a command injection
vulnerability. To attack the vulnerability, a user sends a special string to the API with a certain command. Once a user sends the string, the web interface will dump information to the web application unintentionally.

The login form of the web user interface has a Structured Query Language (SQL) injection vulnerability, so an attacker may get login information or may intrude the management console after sending a special query string. Moreover, the connection between a client and a server isn’t encrypted, an attacker may get a capturing picture from the camera easily.

We developed the materials described above and will use the materials on a six week experiment for the third year students in the department of computer science and engineering. The protocol of the experiment is as follows: First, in the first and second week the students set up an IoT car as a Linux machine. After the setup students access their IoT car through SSH, so the students configure the SSH server appropriately and securely. To be secure, the students should set up the SSH server using public key infrastructure (PKI) as an authentication process and change the port using SSH from its default port 22. The students report different authentication processes and why users should change the default port;

Second, in the third and fourth week, a teacher gives a lecture including existing general vulnerabilities such as command injection attack and SQL injection attack, one of solutions for a command injection attack is that a system must not launch a shell program if the user sends the string, the web interface will dump information to the web application unintentionally. A command injection attack is that a system must not launch a shell program if possible. Another solution is that developers should rather use libraries than launch another program.

After the experiment, we will make a questionnaire about the experiment and improve the experiment. Items of the questionnaire is now developing.

enPiT2 Security involvement
NIT Tomakomai College takes part in enPiT2 Security, which is the curriculum for university students to learn and practice information security. enPiT2 security resembles the K-SEC project. Our advanced course students were admitted to join to a special lecture from the professors at Hokkaido University and they will go to the university on August 2018. In this lecture, students will practice the log analysis using Unix CUI environment.

e-Net Caravan
NIT Tomakomai College trains teachers who can teach information security and the Internet literacy for elementary and junior high schools. The e-net caravan is operated by Foundation for Multimedia Communications (FMMC). When a school requests a e-net caravan lecture to FMMC, FMMC recruits and asks a lecturer from registered teachers. Once a lecturer is admitted to talk, the lecturer performs a lecture on the scheduled time. This framework is useful for NIT Colleges because teachers combine the lecture with publicity at the requested school. We had the lecture at Tomakomai Misono elementary school on June 2018.

A questionnaire about cyber security in Tomakomai Regional Companies
As a research project, NIT Tomakomai College has started a questionnaire project to bring enlightenment to the regional companies. There are many regional companies in Tomakomai area, but they are often small. Large companies can afford to pay for information security, but the regional companies may not afford to pay. The regional companies may perceive the necessity of information security, but they may not know what to deal with risks of information security.

To clarify the consciousness of information security around the regional companies, we will make a questionnaire. After the questionnaire, the information will be useful to make an effective plan for information security. The fifth year student has been working on the questionnaire project as a graduation study.

Conclusions
We described the K-SEC project and related activities at NIT Tomakomai College. The K-SEC project aims to have teaching materials used by all colleges in NIT. NIT Tomakomai College cooperates fully with the project.

Now NIT Tomakomai College is going to plan special lectures related to information security and the K-SEC project. We hope that the education of information security will be widespread.

References
Abstract

The social service is a mandatory training activity for every student at Guanajuato University. It is linked to social responsibility and it allows students to join the social groups that require their contribution.

We are proud to share in this paper the foundation of a new social service program called Spatial exploration, the first one of its kind in the State of Guanajuato, which purpose is to allow students to conceive and present pieces of performance art. The program was accepted by the Salamanca Highschool academy on June 29th, 2017, but students from the whole Guanajuato University are welcome to enroll. The group can be formed each semester by twenty students from different high schools and departments, and the methodology used to support their production, is the one called artistic process by Lluis Racionero. As a result of the group work in 2017, three pieces, described briefly in this text, were developed, ¡Tepalcates!, Type AB blood retribution and Plant death. An article about the first one was published at the Universidad Autónoma de México (UNAM) .925 peer-reviewed journal and two articles were written about the other two performances for the Radar magazine. The third piece was presented in the Death on billboard festival, held in Guanajuato city. In 2018, a piece that is also depicted in this essay, Holy Mary of confetti, was done, which was presented by the group in Salamanca and Guanajuato city in two different dates. An article about this last piece was written for .925 as well. The conclusions section explains how performance art has proved to be a very powerful tool to help students and citizens reflect on social issues, presenting some of the students’ testimonies on one piece. Finally, this paper strongly recommends professors from other universities and countries to create and promote new activities that make students think about how we must all commit to solve those issues to move towards a fairer and more humane society.

Keywords: social service, performance art, Mexico, Guanajuato, social issues

Introduction

This text has been structured in three sections. The first one is called Materials and pedagogy, in which two concepts that are fundamental at Guanajuato University are reviewed according to its academic bylaw, extension and social service. Also, the four objectives of social service and some of its main characteristics are revised. Once this background has been set, spatial exploration, a new social service program, is presented, as well as its objective and features. At the end, the methodology to create each of the performance art pieces, the one created by Lluis Racionero (1986), is briefly described.

The second part is named results and discussion. Here, four performance art pieces that were carried out by some of the members of spatial exploration are portrayed. The first two, ¡Tepalcates! (2017) and Type AB blood retribution (2017), were restitutions of actions that had been done before. The last two, Plant death (2017) and Holy Mary of confetti (2018), were new. Moreover, the articles that have been written about each one of the pieces for the .925 peer-reviewed journal or for the Radar magazine are mentioned. Three of those articles have been published and the fourth one has already been accepted.

Finally, the Conclusions section recalls the topics that were analysed in each one of the actions that were done. Furthermore, some testimonies of some of the students enrolled in spatial exploration about Holy Mary of confetti are presented to support that in our new social service program, performance art has proved to be a very powerful tool to help artists and citizens reflect on certain social issues.

Materials and Methods or pedagogy

Guanajuato University has three substantive functions, according to its academic bylaw, teaching, research and extension. That same document points out that extension “relates the University to its social context though the
diffusion of culture and services” 1. Also, that text mentions that there are ten programs for the extension development, among which, the first one is social service. “Social service is the set of activities that train the students in the commitment toward the community and that project their action to benefit it.” 2. and it has four objectives: “I. to favour the integral training of the college student and to raise awareness of his/her commitment toward the community; 2. to generate academic projects, based on concrete social issues, that support the substantive functions and contribute to solve the community, the region, and the country needs; 3. to be a means that links the university to the public, private, educative and social sectors; and 4) to enable the student to get knowledge of reality and its issues.” 3

At Guanajuato University, college students and high school students must join a social service program. They can freely choose it or even bring one forward. Professors can also propound a social service program and must advise students to carry it out properly. Social service is temporary, it must be accomplished during each school cycle, and it can be individual or collective; interdisciplinary or multidisciplinary; and it can be done at any campus or school of Guanajuato University or be interinstitutional.

Having this background, a new social service program called spatial exploration, which main objective is to favor the enrolled students reinstate or create new performance art pieces, was proposed last year at Salamanca high school. It was approved on June 29th by that school academy, and now it is the first social service program devoted to the production of performance art pieces at Guanajuato University and in the State of Guanajuato.

The top number of students that can join the program is twenty and they can come from any Guanajuato University campus or school. During the 2017 August-December semester, spatial exploration had ten members, eight from Salamanca high school and two from college (Digital art department). In the 2018 January-June semester seventeen joined the program, ten from Salamanca high school and one from college (Visual art department).

The reinstitution or creation of each performance art piece requires research, which is supported by the methodology called artistic process, proposed by Lluis Racionero (1986) and formed by four basic steps: 1) Reality. The artist takes some phenomena and relates them to each other to create a metaphor; 2) Shapes. The artist selects some data and turns them into shapes, intensifying some details of the reality. He/she translates information into matter (words, sounds, movements, etc.); 3) Work of art. It must generate a reflection on the viewer, and; 4) Spectator. He/she perceives the work, internalizes it and reaches the same or a different reflection than the artist. The spectator sets his/her reflection against reality and approaches it with a different frame of mind caused by the artwork.

Results and Discussion

From its creation, in June 2017, to the present day, June 2018, five actions have been done by the members of spatial exploration. In this text we will describe the three performance art pieces that were developed in 2017 and the first one that was done in 2018. The first action is called ¡Tepalcates! and it was presented by some of the members of spatial exploration on September 12th 2017 at Salamanca high school in Mexico. ¡Tepalcates! was the reinstitution of the original action called ¡Tepalcates! that was done by the artists Santiago Rusiñol and Ramón Casas in 1889 in Olot, Catalunya. An earlier reinstitution of ¡Tepalcates! was done by the artists Juan Castellas and José Juan Martínez in 2012 in Valencia, Spain.

For ¡Tepalcidesa, Rusiñol and Casas bought a clay pots stall at the Olot market and put the items on sale at exorbitantly cheap or expensive prices. If a client thought that an item was too cheap, the sellers complained that the business was not working and said that it would be better to finish it, throwing the pot to the floor. If a client offered a lower price that the one asked, the sellers said that they would rather break that pot than selling it at such a low price, tossing it away. All the pots ended up broken. Molina (2015) explains that this action was carried out to generate a reflexion about the prevalence of the creative interest over the economic interest of the craftsmen, as well as to consider the value that the buyers give to crafts.

Having ¡Tepalcidesa (1889) and its reinstitution (2012) as a benchmark, a fact that inspired us to reinstate that action for the first time in America was a conversation that we listened between professors Rosa del Carmen Regalado and Cuitláhuac Rodríguez about how cathartic it would be to break plates. We proposed them to do ¡Tepalcates! in collaboration with some of the students enrolled in

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spatial exploration, Abisai González, Itzamara Vázquez, Jesús Galavizo and Alejandra Jiménez.

The mexican context strongly fed the 2017 reinstitution. First, the new name. *Trencadissa* means breakable in Catalan, while *Tepalcates* comes from the náhuatl word *tepalcátl*, which means “a piece of any clay pot”.  

Second, the location of the 2017 reinstitution. *Trencadissa* and its 2012 reinstitution took place in a market, but *¡Tepalcates!* was presented on a sidewalk close to one of the pedestrian access of Salamanca high school, where street vendors are commonly located.

A street stand was set up, in which fifteen vitrified clay jugs were put up for sale. The jugs were made by craftsmen from the State of Michoacán and they were bought at Guanajuato city crafts market. After collecting these and other elements for the performance and making the arrangements with the school authorities, *¡Tepalcates!* was presented on September 12th, 2017 at Salamanca high school. All the pots were broken as in *Trencadissa*. The action was registered in video by Itzamara Vázquez and an article called as the action was published in the Universidad Autónoma de México (UNAM) peer-reviewed journal in 2017.

The second action of 2017 was named *Type AB blood retribution*. This action was also a reinstitution of another performance art piece called *Blood retribution*, which was presented on September 21st, 2017 at Ngee Ann Polytechnic in Singapur while the ISATE was being held there.

The original piece reflected on the blood type discrimination or *bara-hara* in Japan, a theory supported by authors such as Tokeji Furukawa (1927), who states that there's a relationship between the people's blood type and their personality. According to Furukawa, the worst blood types are AB, that belongs to people who have a mixed temperament; and B, that corresponds to the people who are impulsive. The goal of *Blood retribution* was to make up for any discrimination that people with type B blood may have suffered. The B type was chosen as a matter of empathy, since my blood type is B. *Blood retribution* was planned as an exchange. The participants had to demonstrate their blood type was B with any ID, and in return they would get a melon slice, something valuable, expensive, in Japan. The proposal to do this exchange was written in Japanese (so it could only be understood by people who spoke that language) in the front and back of the red t-shirt that I was wearing: 血液型がB型の方、証明書を見せて賞品をゲットしよう Five people’s reaction was a strange look and asking some questions like “do you know what your t-shirt says?” “where did you buy your t-shirt?” or “why are you wearing that t-shirt?” Only two people proved to have type B blood.

Figure 1. Professor Rosa Regalado (right) in ¡Tepalcates! Salamanca, Mexico, 2017

The second action of 2017 was named *Type AB blood retribution*. This action was also a reinstitution of another performance art piece called *Blood retribution*, which was presented on September 21st, 2017 at Ngee Ann Polytechnic in Singapur while the ISATE was being held there.

It was proposed to the spatial exploration members to reinstate the original action within a different context, in Salamanca, Mexico, where a Japanese community is living. *Blood retribution* changed its name since it was no longer a piece with which I was personally related, and considering people with AB blood type has been the

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5 Demonstrate with an ID you have blood type B and get a prize for free. [Translation by Miyuki Takahashi]
most affected by discrimination. The t-shirts reminded written in Japanese because the action was specially designed for Japanese people, and because blood type discrimination doesn’t exist in Mexico. The melon reminded as an element of the action, but half melon was offered. *Type AB blood retribution* was carried out outside Walmart Jardines del country, Salamanca (Japanese people who live in Salamanca frequently visit this supermarket) on October 30th, 2017 by two of the students enrolled in *spatial exploration*, Judith Flores and Sergio Baca. Any of the Japanese approached the students, but their look was clearly affected by the action. An article called the message on the t-shirt was published in the *Radar* magazine.

**Figure 3.** Sergio Baca (left) and Judith Flores (right) in *Type AB blood retribution*. Salamanca, Mexico, 2017

The third piece of 2017 was named *Plant death* and it was presented by some of the students enrolled in *spatial exploration*, Abisai González, Guadalupe Villegas, Itzamara Vázquez, Sergio Baca, Monserrat Flores, Jesús Galavizo, Alejandra Jiménez, Azalea García, Carla Vázquez and Jacqueline Gallardo, on November 2nd, 2017 in the *Death on billboard* festival in Guanajuato city. To participate in the festival, it was necessary to fulfil three requirements. First, every artwork should be about death; second, every piece should fit a two-dimensions format of a maximum of one square meter, and; third, every artwork should be ephemeral. A performance art piece didn’t seem to match the festival’s conditions, but it was accepted because our proposal was about the death of a tree (a rare topic, considering most of the projects concern about the human or the animal death); because our action consisted on the distribution of flyers (two-dimension pieces); and, because the flyers disappeared at the moment they were delivered, a feature that was emphasized as the flyers were eatable.

This action’s goal was to reflect on the mezquite protection, a native Mexican tree. Many of these trees have lately been infected by a parasite, a mistletoe variety, which bright orange flowers can be easily seen. When the mistletoe infests the mezquite, it causes its death. According to the León cultural institute, the city’s growth has caused 65% of the urban trees of our State to get affected by the mistletoe plague[^6]. Our action consisted in delivering 200 10x10cm-flyers. We wanted the flyers to be eatable, so we didn’t make them on paper, but on a wheat wafer. On the front of each flyer we drew a dead mezquite tree using mezquite syrup and on the back, we added some facts about the drawing and about the lack of actions to protect the mezquites. An article called “Death, two-dimensionality and caducity” was published by the *Radar* magazine in 2017.

**Figure 4.** Jesús Galavizo (right) in *Plant death. Death on billboard* festival. Guanajuato city, 2017

**Figure 5.** *Plant death* production process. Salamanca high school, Mexico, 2017.

Finally, the first performance art piece done in 2018 was *Holy Mary of confetti*, which was done in two different places and dates. It was presented on February 25th, 2018 at the Constitution garden in Salamanca by Fátima Hernández, Elián López, Cristo Banda, Itzel Ramirez, and most affected by discrimination. The t-shirts reminded

Leonardo Serrano; and then, on mars 9th 2018, at the Baratillo plaza in Guanajuato city by Jorge Villaseñor.

Although this action was new, it had its referent in a popular custom. Every year, on February 2nd, there’s a party to celebrate the Candelaria virgin in Pueblo Nuevo, Mexico. The oldest document that registers the presence of the virgin sculpture in the town church was written on February 2nd, 1773. Each year, the party begins with the serenades nine days before the 2nd of February, in which single women walk counterclockwise around Pueblo Nuevo’s main plaza, while single men are distributed in two rings, one inside and another one outside of the circumference formed by women. In certain locations, close to men, confetti, flowers and beer sellers are placed, as well as musicians. While women walk, men watch them and throw confeti over the head and shoulders of those that men consider to be beautiful. Confetti can be only one color or multicolor, and it is always used by one person (a man) to comunicate that his personal appreciation about the beauty of another person (a woman) is positive, having as a witness a meaningful part of the community. This fact is an analysis topic from different perspectives as it originates questions like “why is only the femenine beauty pointed?” or “who is allowed to point beauty?” It is interesting to see in the restrooms, how women look at themselves in the mirror to touch up their make-up and to make sure the confetti is still on their head and shoulders. They expect to be marked, recognized as beautiful, and to show the community that someone has seen in them this value. Some women even cheat and put confetti on themselves. Other facts surround the celebration, for instance, in Pueblo Nuevo, not few children are baptised with the name of Candelario or Candelaria.

Our performance aimed to help the spectators setting the questions mentioned above, but also others, broadening the perspective to a more artistic one, such as “who decides what is beautiful?” “Who decides what has artistic value?” pointing at the white cube aesthetics that was born at the beginning of the 20th century among the Bauhaus and the De Stijl artists, and that was interested in highlighting their pieces by showing them in front of white walls. Since then, the exhibition spaces have sacralised what is shown in them.

All the students that participated in Holy Mary of confetti were dressed in white as a gesture to the white cube aesthetic, that was reversed in our action. The white is outside instead of inside, the artist decides what is valuable, not the institution. Also, each student has a mirror on his/her front and/or chest, having as a referent the women we saw standing in front of the mirror in Pueblo Nuevo and hoping spectators could see themselves being pointed with confetti as someone valuable.

During Holy Mary of confetti, students approached people in the two public places mentioned before and asked their permission to put confetti on them to mark them as someone valuable. Confetti was also put on animals, spots or things. This can also be related to the baptism ritual. After, students gave the spectators a bag containing confetti and the instructions “Put the content of this bag on someone or something that you consider to be valuable”. Spectators took control and marked who/what they chose. An article named after the action was written for .925 peer-reviewed journal. It has been accepted, and it will soon be published.

Figure 6. Jorge Villaseñor (not in the picture) putting confetti on a spectator in Holy Mary of confetti. Baratillo plaza, Guanajuato city, 2018.

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8 http://www.tate.org.uk/art/art-terms/w/white-cube
Figure 7. Two spectators putting confetti on each other in Holy Mary of confetti. Revolución walkway, Salamanca, 2018.

Conclusions

The four topics that were analyzed through actions were the rapport between the profitable and the creative value of handicrafts in ¡Tepalcates!; blood discrimination in Type AB blood retribution; the lack of protection of mezquites, a particular species of a native Mexican tree, in Plant death, and; beauty and value through borrowing elements from a specific popular custom in Holy Mary of confetti.

Though spatial exploration, performance art has proved to be a very powerful tool to help artists and citizens to reflect on some social issues. A good way to prove that the students enrolled in spatial exploration achieved this reflection on the actions they carried out is by sharing their testimonies. These are some of the students’ experiences about Holy Mary of confetti:

““This was a new experience to me, I had never done something like this before. I liked to observe the people’s behaviour and how they react to situations related to a topic” Elián López

“It was a fun experience for me. The best part of this program is that we are able to see the people’s reaction to unexpected events” Cristo Banda

“It was a very fun experience for me and I would like to repeat it. Something that drew my attention was that you can find people with different personalities. Some couple and families were very nice and flexible, while some others just said no. When I asked a woman if I could carry on an action with her she told me she had no money on her” Fátima Hernández

“It doesn’t matter if people forget about us when time goes by. What matters is that the people who we put confetti on don’t ever forget their value as human beings” Itzel Ramírez

We are satisfied with the results we have gotten so far from spatial exploration. We are very proud to have been the first in our State to propose a social service program that approaches students to an artistic genre such as performance art to help them appreciate it and to widen their conception of what art is.

We strongly recommend professors from other universities and countries to create and promote new activities that encourage students think about how we must all commit to solve those issues to move towards a fairer and more humane society.

Acknowledgements

I want to thank my family for their constant support and encouragement.

I would also like to express my gratitude to Guanajuato University for believing in this project and for allowing me to present many of the performance art pieces within its facilities.

I am also thankful to ISATE, at its different seats, for its openness toward topics that are related to education from a different standpoint.

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DEVELOPMENT OF EFFECTIVE FRAMEWORK FOR SOCIAL IMPLEMENTATION
PBL EDUCATION FOCUSING ON
PRACTICAL AND AGILE PROTOTYPING PROCESS

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Abstract

A promising framework for “Social Implementation Education” is proposed. The social implementation education framework is intended to provide the participating students with opportunities of facing up to real social issues and creating value in cooperation with diverse users in society through dialogue and engineering solutions. Those opportunities are expected to be enhanced PBL themes corresponding to the effective experiences for future engineers in learning competencies to make innovation happen. On the basis of specialized skills in the fields of engineering, social implementation education focuses on the strengthening of communicative competence as engineering literacy, independent-minded stance against facing real social problems, and creativity that connects science technology with new values through practical and agile prototyping. The real aim of this education framework is to give students a situation in which the students must communicate with trial users, because the realization of higher value production needs to be achieved by producers and users mutually communicating their intents and perceptions. This framework also provides very good opportunities for students to apply their engineering knowledge and sense to solve problems with no correct answer in real society. To analyze the process generated through the framework, we focus on the frequency of student-user interaction and adopt a classification of the process according to the development method type of “Agile” or “Waterfall” for estimation of the characteristics of each social implementation approach performed by students. In order to steadily and effectively overview the process of social implementation, we defined an evaluation index "Agile Index" which indicates the degree of cooperation between a students and users. After analyzing the performance of students through the index, the relationship between expert evaluation (evaluation of educational outcomes) and agile index score is checked and the applicability of the agile index is validated. In addition, as an example of promotional attempt, we introduce a mobile robot development whose platform is designed and prototyped through multi-laboratory collaboration in order to lower technical hurdles faced through robotics social implementation approach. The realized robot platform consists of two low-end in-wheel motors for the sake of simplicity of the design and assembly of the drive unit.

Keywords: Social Implementation Education, PBL, Prototyping, Agile Index, Robot Platform

Introduction

In today's drastic industrial structure change, there is an urgent need to improve frameworks of industrial might foundation to make science and technology innovation happen, that is, directly linked to social reformation with dynamism, by means of science and technology-driven new value-creation. With progress in industrial structure change, as a promising approach to innovation, prototyping activities cooperated with users, custom design in order to best meet user's needs and so on have received a lot of attention in recent years (e.g., Prahalad, C. K. and Ramaswamy, V., 2004; Hippel, E. V., 2006). It seems that it is more and more important for manufacturing education to recognize the trend of innovation by approaching to different needs of users with mutual collaboration between users and creators.

Against this background, since 2011 “Social Implementation Approach Based on Robot Education” preliminary project was proposed and performed (Tarao, S., Asano, K. and Sato, T., 2015). The aim of this project is to give students a situation in which the students must communicate with trial users, because the realization of service robots needs to be achieved by creators and users mutually communicating their intents and perceptions. Following the feasibility study through the preliminary “Social Implementation project”, since 2012 to 2016 "Innovative Japan Project by KOSEN" (NIT, Tokyo College, 2012) had been performed in collaboration with
seven KOSEN colleges (Ichinoseki, Oyama, Tokyo, Nagano, Numazu, Wakayama, and Okinawa). The project activities were finally joined by 21 KOSEN colleges (Hakodate, Sendai, Fukushima, Gunma, Ishikawa, Suzuki, Maizuru, Kure, Anan, Ube, Kitakyushu, Sasebo, Kumamoto, and Miyakonojo in addition to the seven collaborating colleges) showing a notable increase from the seven collaborating colleges in the first project year. More recently, from 2017 the project has been newly positioned as the KOSEN 4.0 Initiative, though the management structure has been changed, the project is going well continuously.

This paper describes the outline of the education for social implementation: “Social Implementation PBL Education” as an enhanced PBL method to effectively learn the innovative design. Next, an evaluation index “Agile Index” (hereinafter referred to as "AI") indicating the degree of cooperation between a students and users is introduced in order to steadily and effectively grasp the progress of social implementation activities. Finally, we analyze the relationship between expert evaluation (evaluation of educational outcomes) and AI score and discuss the effectiveness of our approach.

**Framework for Social Implementation PBL Education**

Social Implementation Education has a PBL element and consists of characteristic four steps: 1) Grasping practical problems to be solved, 2) Creating new values to be provided, 3) Implementing those in the social world, and 4) Receiving feedback directly from users. It is marked by the process to develop students’ competencies to self-identify problems and get feedback directly from the real social world as compared with standard PBL.

Figure 1 shows an example of an electric wheelchair type robot development through Social Implementation Education process. The figure shows three phases reconstructed with typical stages to be especially experienced through the above mentioned four steps. The most vital point of the whole process is getting effective cooperation from the real social world as users.

![Figure 1: Three main phases of the characteristic advance of “Social Implementation PBL Education”](image1)

Figure 1: Three main phases of the characteristic advance of “Social Implementation PBL Education”

Figure 2: Appearance of an open experiment of an autonomous mobile robot demonstration with users

Figure 2 shows a scene of an open experiment of an autonomous mobile robot with the cooperation of users. The students obtained comments about the robot’s autonomous behaviour in a real human environment from users as effective feedback.

The autonomous mobile robot consists of a platform (See Figure 3) designed by our projects for mobile robot development in a short period of time. The hardware and software of the platform are suitable for prototyping with flexibility through a trial and error process (Tarao, S., Hayashi, T. and Ohtsuka, T., 2017).

![Figure 3: Appearance of the platform of autonomous mobile robot designed by our projects](image2)

Figure 3: Appearance of the platform of autonomous mobile robot designed by our projects
In addition, as an example of promotional attempt, we introduce a mobile robot development whose platform is designed and prototyped through multi-laboratory collaboration (three KOSEN colleges collaboration) in order to lower technical hurdles faced through robotics social implementation approach. Figure 4 shows a scene of experiment through a laboratory prototyping phase.

There are three robots developed in NIT, Ichinoseki College, Tokyo College and Wakayama College, respectively. The three development teams in the three colleges are connected utilizing SNS for discussion and sharing information (See Figure 5) and are prototyping the mobile robots using the common platform.

As previously mentioned, the Social Implementation Education process is marked by the process to get feedback directly from the real social world, and it is very important in the conduct of the practical approaches. Quick and effective prototyping is key to ensuring the steady progress is made in the process. Therefore, an ingenuity is needed to ease time and technical constraints at the stage of prototyping. Specially in the field of mechanical engineering, a relatively large and heavy-duty mechanism may be needed to solve the problems in some situations, for such occasions, students anticipate difficulties in the prototyping as compared with different fields. As an example solution in the field of robotics (in mechanical engineering) the platform (See Figure 3) of autonomous mobile robot designed by our projects. Figure 6 shows an example of following the original approximately quite well, there are two LRFs (laser range finder) allocated diagonally to the front and back of the robot body in addition to an IMU and a GPS. Figure 7 shows an example of a guidance robot which is equipped with a handle for guide and a joy-stick-type intuitive user interface. Figure 8 shows an example of an improvement of the self-localization function by means of a LRF stabilizer which can move in synchrony with the robot’s body configuration using 2DOF motion mechanism. The robot with the LRF stabilizer is repeated tested for stability improvement of autonomous running. Figure 9 shows the scene of the autonomous running experiment.
Evaluation approach for Social Implementation PBL Education

In the Social Implementation Education program, the “Social Implementation Contest” is held as final event every March, which means that the program has also an element of competition. Each student participating team should give presentation on the result, new knowledge and achievement process obtained through the social implementation activities. Each team is judged on development concept, developed technology, performed experiment in social implementation and the quality of presentation. Fourteen teams in 2012, 30 teams in 2013, 38 teams in 2014, 48 teams in 2015, 59 teams in 2016 and 50 teams in 2017 have participated in the Social Implementation Contest before this.

In this section, an endeavour to measure and evaluate the progress and performance of each participant team in social implementation education in a subjective way and in an objective way, and to view activity status as a whole project is described.

Each student participating team is oriented to facing different problems without clear answer and is expected to solve the problems in cooperation with users in the real social world. As a reasonable approach, the strategy that participating teams create maximum value in a bounded time frame, repeat this procedure several times, and as a result, create greater overall value steadily is promising. An effective prototyping approach to be taken in the above situation has something in common with “Agile development” approach (The Agile Manifesto authors, 2001) which has received attention in recent years. This development approach has a conscious collaboration with users, through the promotion with repeating creation and evaluation in a comparatively short time interval, for much refined prototyping target in collaboration with users to accommodate changes in users' demands.

To analyze the process generated through the Social Implementation Education program, we focus on the frequency of student-user interaction and adopt a classification of the process according to the development method type of “Agile” or “Waterfall” for estimation of the characteristics of each social implementation approach performed by students.

In order to steadily and effectively overview the process of social implementation, we defined an evaluation index “Agile Index” which indicates the degree of cooperation between a students and users. Table 1 shows the definition of Agile Index (AI).

<table>
<thead>
<tr>
<th>Evaluation index</th>
<th>AI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have the prototype used by users, be assessed by users, and refine the prototype with feedback</td>
<td>3</td>
</tr>
<tr>
<td>Have the prototype used by users and be assessed by users, but have not yet led to refinement</td>
<td>2</td>
</tr>
<tr>
<td>Contact users or experts, etc. and receive comments from them.</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 1: Definition of Agile Index (AI)

![Figure 10: The numbers of student participating teams of each agile index (2012-2017)](image)

Table 2: Evaluation by contest judge consisting of experts and intellectuals

<table>
<thead>
<tr>
<th>Judging items</th>
<th>Aspects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power of idea</td>
<td>Excellence of setting up target for social implementation, idea and concept to solve the issue</td>
</tr>
<tr>
<td>Power of specialty</td>
<td>Excellence of technology (hardware/software) built for social implementation</td>
</tr>
<tr>
<td>Power of action</td>
<td>Excellence of way of link to society, feedback from society, or experience of social implementation</td>
</tr>
<tr>
<td>Power of expression</td>
<td>Excellence of presentation with convincing and understanding of audience</td>
</tr>
</tbody>
</table>

Table 3: The correspondence relation between Pr-value and AI-value in 2016

<table>
<thead>
<tr>
<th>Pr/AI</th>
<th>AI=3</th>
<th>AI=2</th>
<th>AI=1</th>
<th>AI=0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pr:0</td>
<td>9</td>
<td>9</td>
<td>7</td>
<td>17</td>
</tr>
<tr>
<td>Pr:1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Pr:2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Pr:3</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Pr:4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pr:5</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pr:6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pr:7</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Num. of teams</td>
<td>18</td>
<td>12</td>
<td>10</td>
<td>19</td>
</tr>
<tr>
<td>Pr × AI</td>
<td>25</td>
<td>5</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>AI avg.</td>
<td>1.39</td>
<td>0.42</td>
<td>0.40</td>
<td>0.21</td>
</tr>
</tbody>
</table>
Figure 10 shows the number of participating teams and the distribution of AI-value during six years from 2012 (first year) to 2017. Though, because of the changes in the management structure, the number of participating teams slightly decreased in 2017, on the whole, the number is increasing yearly. The teams whose AI-value is three (AI:3) are successful at connecting to society and getting feedback from users, and the number of the teams have been increasing steadily over time except in 2017. On the other hand, the teams whose AI-value is zero (AI:0) which means that the teams are completely incapable of contacting users, and the percentage of the teams in every year is about 20-30 percent. It indicates that it is by no means easy to build a creative relationship oriented social implementation with society.

Next, an evaluation system by contest judge consisting of experts and intellectuals in the Social Implementation Contest is described. It is a kind of subjective evaluation whereas AI-value as previously indicated is a kind of objective evaluation. Table 2 shows the evaluation items of used by the contest judge. Those items are corresponding to the developments of “general aptitude” of the participating teams. Each team is comprehensively evaluated for the process of value creation oriented social implementation. Talented and experienced teams are received the award for each appropriate item (power of idea, power of specialty, power of action, and power of expression) in addition to the grand prize which is the most prestigious award in the contest. The contest judge scores each team out of five item for item. The award winners are selected based on the total average score. As mentioned above, the score represents a kind of developments of general aptitude.

Here we focus on the relationship between the objective evaluation and the subjective evaluation, and consider the appropriateness of those evaluations for social implementation activity. For simplification of our consideration, Pr-value for the subjective evaluation by judge is defined and the elements are determined as follows: the grand prize/the peer review prize is three points, the social implementation prize/the support company prize is two points, and other prize is one point.

The Pr-value is integrated value dependent on every received prize for each team. One well-regarded team can receive multiple prizes except the grand prize and the social implementation prize. Table 3, 4, 5 show the relationship between the objective evaluation (by AI-value) and the subjective evaluation (by Pr-value) respectively in recent 2016, 2017, and the total during six years: from 2012 to 2017.

According to those tables, there is a tendency that the higher scoring teams for AI-value would also have higher score for Pr-value, with some exceptions. The tendency is also confirmed by the plot of the average of Pr-values on each AI-value shown in Figure 11.

![Figure 11: The relationship between the AI-value and the Pr-value of participating teams (2012-2017)](image-url)
Results and Discussion

As for AI-value during six years from 2012 to 2017, the number of the AI:3 teams have been approximately increasing steadily over time. On the other hand, the percentage of the AI:0 teams in every year was about 20-30 percent. There is a room for improvement to promote social implementation activity. Furthermore, there was a tendency that the higher scoring teams for AI-value would also have higher score for Pr-value, with some exceptions. The evaluation of social implementation process and performance using AI-value is comparatively easy, and appears to be an effective and efficient way to be applicable to a kind of “formative evaluation” discussed in the reference (Bloom, B. S., Krathwohl, D. R. and Masia, B. B., 1956), if the AI-value would be evolved to be a formative evaluation index for overcoming numerous hurdles and providing formative feedback to students from the standpoint of social implementation.

Conclusions

In this study, “Social Implementation Education” was proposed, which has a PBL element and consists of characteristic four steps:
1) Grasping practical problems to be solved,
2) Creating new values to be provided,
3) Implementing those in the social world, and
4) Receiving feedback directly from users.
It is marked by the process to develop students’ competencies to self-identify problems and get feedback directly from the real social world as users. In the creative process, quick and effective prototyping is key to ensuring the steady progress is made in solving different problems without clear answer. As an ingenuity to ease time and technical constraints at the stage of prototyping, in the field of robotics, the platform of autonomous mobile robot was also indicated.
To analyze the creative process generated through the educational framework, we focused on the frequency of student-user interaction and defined the evaluation index “Agile Index” which indicates the degree of cooperation between a students and users. The relationship between expert evaluation and agile index score was checked and the applicability of the agile index was validated. Consequently, the number of the AI:3 teams have been approximately increasing steadily over time. On the other hand, the percentage of the AI:0 teams in every year was about 20-30 percent. The relationship between the objective evaluation by AI-value and the subjective evaluation by Pr-value, there is a tendency that the higher scoring teams for AI-value would also have higher score for Pr-value.

Based on our prior approaches, we are planning to increase the scale of the participating teams and will add the Social Implementation Education to the curriculum in the fourth grade and fifth grade of NIT, Tokyo College from the next year (2019) in sequence.

Considering the present situation, one of the future works will be directed to development of educational tools for promoting effective teaching and learning of social implementation approach in addition to seeking to further improve the evaluation approach expanding the AI-value, Pr-value and so on.

Acknowledgements

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References


USING SELF-ASSESSMENT AND PEER FEEDBACK TO EVALUATE QUALITY OF INDIVIDUAL WORK IN A PROBLEM-BASED LEARNING SUBJECT: AN EXPLORATORY STUDY

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Abstract

In recent years, there has been a general shift in the educational landscape, particularly for our local tertiary institutions, to adopt more student self-directed activities to help their graduates acquire skills of a lifelong learner. A lifelong learner is able to reflect on his actions, consider gaps in his knowledge and skills, and then identify ways to close these gaps. These gaps could either be discovered through self-assessment using a rubric or highlighted by others through a peer feedback process.

In April 2018, the author attempted the use of these two processes within a Problem-based Learning (PBL) subject at a stage in the curriculum delivery where students were still new to the subject content. This stage is termed the Discovery stage in the PBL framework adopted by the school. At this point, students are expected to research information on new technical concepts independently, organise and present the information in the form of ‘teaching notes’ (termed as Discovery notes in framework context) for their peers before embarking on the peer-teaching session. During the peer-teaching session, the student-tutor imparts his newfound knowledge to his other peers using his Discovery notes as an aid. In the past, students only receive direct feedback on their notes from the facilitator prior to the peer-teaching session. In this study, the feedback is ‘given’ by the students themselves through the self-assessment and peer feedback processes.

This paper seeks to gather students’ perceptions of the benefits of the intervention, both from the perspective of authors as they develop the notes as well as from the perspective of peer reviewers when they read and give feedback on other students’ notes. The findings from this study report the benefits and weaknesses of the intervention. In the conclusion section, some recommendations to maximize the benefits and limit the weaknesses of the intervention are presented.

Keywords: Self-assessment, peer-assessment, peer review, peer feedback, problem-based learning

Introduction

Many educational institutions recognise the importance of producing graduates to be lifelong learners so as to enable them to achieve a higher level of personal success and to survive in this highly competitive and globalised world. Lifelong learners must be self-motivated, resilient and possess positive open mindsets to constantly seek for feedback to improve their performance. As a result, emphasis in tertiary education is now gradually moving from teaching to learning and from teacher-directed to student self-directed (Boud, 1995; Boud & Feletti, 1997; Knowles, 1984). This leads to a mounting interest amongst educators to create opportunities for students to assess their own work and performance (self-assessment) and that of other students (peer-assessment) instead of solely depending on teachers to give feedback. Self-assessment and peer-assessment aid in developing lifelong learning skills. Hanrahan and Isaacs (2001) postulated that both self and peer-assessment skills are needed to help students develop lifelong learning skills. While self-assessment helps students to set goals and self-reflect on their performance, peer-assessment encourages students to work constructively and collaboratively. In this paper, ‘peer-assessment’ is being used for the sole purpose of providing formative feedback on each other’s work and no summative grade is associated with the process. Henceforth, in order to better reflect the formative intent of the feedback process, the term ‘peer feedback’ is used rather than peer-assessment.

In this study, self-assessment and peer feedback processes were introduced into a Problem-based learning subject called Microcontroller Technology. The subject focuses on microcontroller-based hardware interfacing and programming and is offered to second-year students in the Diploma in Electronics.

Background

In this subject, students work in groups to produce a set of program codes that is capable of controlling digital electronic devices through a microcontroller. All groups, comprising four students each, are given different problem scenarios of different functional requirements to work on at the onset of the semester.
Each group works collaboratively through a series of stages in the PBL process (Figure 1) to produce a working solution that meets the required functional specifications. By the end of the semester, each group presents and demonstrates the functionality of their solution. The facilitator conducts an interview with every member to ascertain the level of his/her project involvement and the competency level of practical skills the student has achieved through the project. In addition, an end-of-semester written examination is put in place to assess the technical theoretical knowledge.

The list of learning issues (need-to-know content) to be covered is the same for all groups as the problem scenarios given to the students are intentionally designed around these issues. Within the group, the list is further distributed so that each member will be assigned to at least one issue to research on. The student organises the information found and presents it in the form of Discovery notes. The notes are used to aid peer learning. Group members can read the notes before the peer-teaching session and make reference to it when the peer-tutor shares, elaborates and teaches the new content to the group. Good quality notes mean that members will be able to understand the content quickly and thereby be able to apply the knowledge to the project more effectively during the Problem-solving stage. Discovery notes are graded and worth 10% of the entire subject mark.

In the past, feedback on the Discovery notes was provided by the facilitator only. Although the marking rubric was given, students did not consciously refer to it as they worked on the notes. Students relied heavily on facilitator’s feedback and approval to determine the quality of their work. They worked towards meeting the facilitator’s expectations rather than meeting the learning needs of their group members. If their peers had difficulty understanding the content ‘taught’ (usually when the notes were not pitched at their level of understanding), they would not be able to contribute as quickly or as effectively to the group project development as much as they wanted to.

In April 2018, self-assessment and peer feedback processes were introduced into a class of 24 students taking Microcontroller Technology at the Discovery stage where student were beginning to develop their notes for peer-teaching stage (Figure 1). Students self-assessed their performance as they developed their own notes. Peers in the same group then gave feedback on the first drafts produced by the other members so that the latter could revise their notes and produce a better second version of the Discovery notes for peer-teaching and for final grading by the facilitator. By the end of the peer-teaching session, it was anticipated that the entire project group would have good awareness of everybody else’s topics and therefore are more prepared to collaborate and apply these knowledge to develop the solution.

**Participants**

Participants were 24 second-year polytechnic students from the Diploma in Electronics taking a five credit-unit engineering subject which adopts the PBL pedagogy. This is their first experience with PBL. Prior to this subject, these students have had acquired knowledge in digital and analog electronics as well as C programming skills which form the fundamental knowledge and skills required for this subject.

Students are required to work in groups of four on a project. They were allowed to choose who they wanted to team up with.

**Rubric/Criteria**

Taking into consideration of the fact that the students were performing self-assessment for the first time, a detailed marking rubric with nine criteria was designed and provided to the students (Figure 2). The aim was to guide students on how they should organise the information so that the peers could understand the content better. Descriptions of standards and specific expectations of what the facilitator is looking for under each level of performance are explicitly made known to students so as to allay their anxiety and also to make this process more targeted and purposeful for them.
The criteria assessed are:

- **Content (4%)**
  - Relevance, Accuracy, Appropriate example or illustration used, Completeness

- **Effort (4%)**
  - Range of sources used, Concision, Organisation, Pitch

- **Originality (2%)**
  - Acknowledgement of sources used

### Summary of Work Done

Figure 3 shows the flow of work done by a student from the point when s/he embarks on the research to the point where s/he peer-teaches.

<table>
<thead>
<tr>
<th>7-segment Display</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Difference between a common anode (CA) and common cathode (CC) 7-segment display</td>
</tr>
<tr>
<td>2</td>
<td>Identify the type of display (CA or CC) on the lab target board / project board</td>
</tr>
<tr>
<td>3</td>
<td>Displaying a pattern or number on the 7-segment (using C program statements)</td>
</tr>
<tr>
<td>4</td>
<td>Count down from 9 to 0 on the 7-segment (using C program statements)</td>
</tr>
<tr>
<td>5</td>
<td>Identify the need for SL1 and SL2 on the project board (refer to schematic on LMS)</td>
</tr>
<tr>
<td>6</td>
<td>Displaying a 2-digit number on the project board (refer to schematic on LMS)</td>
</tr>
</tbody>
</table>

On Week 2, after the Learning Issues formulation stage, students were briefed on the purpose of self-assessment. They were informed that the self-assessment grade will have no impact on the final grade. Rubric for the Discovery notes was shown before students embarked on their research. In addition, they were given a checklist (Figure 4) containing questions that they needed to address in their notes. The facilitator then showed students three samples of past students’ work (poor, average and good quality) on the projector and matched them against the rubric so that students could have an idea what the facilitator was expecting from them. Students were given the opportunity to clarify about the details in the rubric. They were then asked to submit the first draft with accompanying self-assessment ratings to the facilitator by end of Week 3.

At beginning of Week 4, the first draft (without the self-assessment ratings) was uploaded to LMS and group members were asked to give their non-anonymous feedback on the quality of the draft by referring to the same rubric. The peers were asked to identify ‘what each member has done well’ and ‘what each member can improve on’. They were given slightly more than a week to input their comments online in Google Doc. Everyone in the group was able to read the feedback anytime during the week. Students were asked to look at the feedback, review, re-submit and upload the second version of their Discovery notes to the LMS 3 days before class on Week 5 for grading as well as for the other peers to read before the peer-teaching session on Week 5.

### Data Collection Methods

To gather students’ experiences on self-assessment and peer feedback processes, an online non-anonymous survey comprising seven open-ended questions was first administered prior to peer-teaching session. After the
peer-teaching session was completed, a focus group interview involving five students, randomly chosen from each of the five groups, was conducted a week later to elicit their responses on the usefulness of the notes in relation to their learning. Although there were six groups formed, only five students turned up for the interview. Participants were informed that their identity would be kept confidential and that their responses would have no impact on their subject grade.

The seven questions asked in the survey were:

- How do you think the rubric/criteria have aided you in the process of writing your Discovery notes?
- What do you think were the pros and cons of self-assessing your own Discovery notes?
- What were your thoughts as you self-assessed your work? Why? (e.g. was it difficult/alright and why)
- What do you think were the pros and cons of receiving peer feedback on your Discovery notes?
- What do you think were the pros and cons of assessing somebody else’s work?
- What were your thoughts as you peer-assessed your peer’s work? Why? (e.g. was it difficult/alright and why)
- Other than marks, what changes would you suggest to help you achieve a better quality of your work prior to grading, given the constraints that you have about two weeks to complete the assignment?

**Results and Discussion**

Responses received from both the online survey and interview regarding students’ experiences are categorised in the following themes.

**Using rubric**

All except one found the rubric detailed and useful. The criteria and what different levels of performance might look like on each criterion help them to “know what is needed in my Discovery notes”, “allow me to check what is missing from my notes” and “guide me to work closely with the tasks given”. Students learned how good quality work looks like, how to evaluate their work against these qualities, how to retreat from their work to assess their own efforts and how to generate feedback for themselves about where they need to make improvements (Reif, 1990; Wolf, 1989). These are qualities of self-directed learners, not passive learners.

Self-assessment helps students to set their goals and monitor their performance as they journey through the process (Boud, 1995) and make adaptations based on their analysis (Labuhn et al., 2010). One student shared that “I am now able to know how I could get a higher grade”. Another student commented that “I had to review my work one time more. I realised that I was not achieving satisfactory level for all the criteria”.

**Self-assessing own work**

While the rubric seems helpful in terms of providing a quality check reference when writing their notes, however, several felt giving a grade to one’s personal work was something that they were not used to despite the fact that the grades have no effect on the summative mark. While one felt it would seem too boastful to give himself a good grade, a couple of responses indicated that the grades shown might not be reflective of the quality of their effort put in as they were afraid of being judged as lousy in the eyes of others (even though they were told their peers will not see their self-assessed grade). However, Boud and Falchikov (1989)’s review of various quantitative studies on student self-assessment suggested that “there is no consistent tendency to over- or underestimate performance”. However, they suggested that one of the possible reasons for poor self-assessment ability could stem from students’ weak understanding of the assessment criteria used for measuring their performance.

A large number of students commented that they were unsure if they were on the right track, both in terms of whether they were meeting the actual expectations of the facilitator and whether the technical content that they put in was accurate, relevant and complete. Many students still expect facilitators to give feedback, citing that teachers’ feedback are more accurate and helpful since teachers are expert both in subject content and writing skills.

**Receiving feedback from others about their work**

In general, students felt that this process somewhat gave them an indication as to whether their group members generally like their notes. Seeing from another person’s perspective helps to identify areas where they might have overlooked. They liked the idea of getting multiple inputs from different members as different people could be looking at different things in the notes. The process also helps them gain better understanding of the criteria used for the summative assessment of their work as seen from the reader’s perspective (Wood & Kurzel, 2008). When it came to the portion on suggestions on areas for improvements, most of the students’ comments focused on criteria that are not related to the content per se (i.e. accuracy and relevance of content were not frequently mentioned). Some felt that some comments “tended to be less critical to the point of irrelevance” or were not specific to help them narrow down to what and how they could improve. Perhaps, students should have been taught how to give constructive and specific feedback in order to make this feedback process more effective and beneficial.

**Giving feedback on others’ work**

Almost citing the same reasons as above, students felt ‘incompetent’ to give feedback on their peers’ work for two reasons; largely due to the lack of technical knowledge on peers’ learning issues and to a moderate
extent, their concern about 'face-saving'. As the content is new to them too, students did not know how else to help their peers to improve except to provide general comments on format and pitch. When students are faced with the task of criticising their peers' ability to write, they are sometimes more likely to withhold the advice to save face or to help their peers save face. Even if they do give some advice, they attempt to 'tone down' their comments so that they do not appear overly critical. Though there are advantages to keep the reviewers anonymous so that students are more willing to make more critical and constructive comments (Howard et al., 2010), however, identifying them forces the students to learn to give each other constructive and honest feedback responsibly when working as a team (Gulikers et al., 2009). Constructive and honest feedback helps the team to move in the same direction and to clearly communicate what they should be working towards for the benefit of the team.

In addition to giving feedback online, participants who were involved in the interview shared that they also gave face-to-face feedback to their peers. Face-to-face feedback facilitates immediate clarification and helps the authors locate the gaps in their notes quickly. Participants at the interview shared that it was not difficult for them to give honest feedback largely because most of them have known each other for a year and a certain level of trust was already present amongst them. Furthermore, they were given the choice to select their group mates. This made the task of giving honest feedback less daunting. However, they were wary to phrase the feedback in a more polite and constructive way in order to preserve their friendship. Surprisingly, when asked if they would prefer to replace online peer feedback totally with face-to-face, the participants preferred the former. They felt that online version gave them more time to think through and phrase their feedback carefully. This approach is more crucial if they are giving feedback to people whom they are not familiar with.

Understanding others' work

Interestingly, more than 75% of the students found reading others' work beneficial. The process not only helps the reviewer self-assess his own work by judging the work of others, he also gains insight into his own performance and learn good practices which the authors have used (Topping, 1996). In addition, reviewing others’ work and having to give constructive feedback meant that they need to analyse the work critically so that the feedback can be relevant. In so doing, students develop their reading and analytical skills.

Participants who were involved in the interview generally agreed that the Discovery notes were sufficient as a start to lead them into the peer-teaching session but not adequate to see how the information can be applied to the given problem scenario. They felt the knowledge gaps were somewhat filled in during the face-to-face peer-teaching session where there were opportunities for them to seek clarifications from the peer-tutor. The interview participants added that it was tedious to describe the applications of technical concepts in greater details in text. They felt the peer-teaching session was useful and more efficient as they could explain and draw at the same time. This approach suits many of them as they tend to learn better with sketches and drawings.

Conclusion and Recommendations

In view of the fact that Problem-based Learning by itself was not something that students could buy-in and adapt readily, this intervention represented a bold attempt to further challenge students to become independent and intra-dependent PBL learners. Most students found their experience in this intervention refreshing. They saw the value of peer feedback and the usefulness of ongoing self-assessment and self-monitoring of one’s performance during the development of the Discovery notes. Being constructive and specific but yet exercise sensitivity towards their peers was one thing that they learned to take note of when giving peer feedback.

There were a few observations and learning points derived from the findings. Recommendations on how the processes could be further improved are included in this section.

- Despite the fact that students knew they were not given any mark for self-assessment during the briefing, it was apparent that they took the process seriously. Students were using the rubric information as a tool to guide them to achieve a desired goal (Chappuis & Stiggins, 2002).

- Although the facilitator gave a briefing in relation to the use and interpretation of the rubric on the onset and make the criteria explicit by including very clear and detailed descriptors, it appeared that students might not have understood the criteria deeply. Misinterpretation of these criteria could arise as students might have pre-conceived prior experiences which shaped their expectations. Perhaps, some time should be set aside in class to get students to ‘assess’ the exemplars by themselves using the rubric and then justify their ‘grade’ in class so that everyone has a common understanding of what the facilitator is expecting. Besides, the facilitator can use this opportunity to clarify any misinterpretation students might have.

- Students found the checklist useful as it helped them to narrow the scope of their research areas. The checklist seems to complement the rubric well in this study, particularly in the context of PBL, as the students were new to the subject content.

- Despite that, several students encountered some difficulties evaluating the relevance and accuracy
of the content that they found on the internet. Besides the short amount of time that they had for research, students probably lacked the ability to critically evaluate the quality of information that they found. Hence, it might therefore be necessary to teach or demonstrate how good research skills look like before students embark on the research activity.

• Students in the same project group found it difficult to give comments on the ‘relevance and accuracy’ of their peers’ work since they themselves are not familiar with their peers’ learning issues. To mitigate the above in relation to ‘relevance and accuracy’ of the technical content, the first round of peer feedback could involve members from other groups who are working on the same learning issue. These students could give each other feedback based on the criteria relating to relevance and accuracy of content.

The second round of peer feedback involves the author’s own group members. Their responsibility could largely focus on content organisation and pitching which gear towards helping them read and understanding more easily.

• For peers to be able to give honest feedback, there must be a certain level of familiarity and trust amongst each other. Hence, it is suggested that some team-building activities could be introduced into a class if the students do not know each other well. A trusting and friendly environment can support the peer feedback process better.

• Students are generally willing to give constructive feedback to their peers but could lack the ability to do it effectively. The ability to give constructive feedback to peers and subordinates in a workplace is a professional skill that is highly valued by employer. Hence, the students would need to be given more practice to hone this skill well by intentionally providing these opportunities in other subjects.

In conclusion, apart from just fine-tuning the mechanics of incorporating these processes into the Discovery stage, implications on equipping students with process skills such as giving constructive feedback and research skills should also be considered by the subject team so as to better enhance the effectiveness of the implementation.

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References


NEW ENERGY STEM GENERATION: SUCCESS IN LEARNING WITH SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) PROJECT-BASED LEARNING (PBL) WORKSHOPS

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Abstract

The paper reviews the recent student learning outcomes with Science, Technology, Engineering, and Mathematics (STEM) Project-Based Learning (PBL) Workshop on New Energy STEM Generation (NENG) secondary school solar car racing challenge. Vocational Training Council (VTC) provides quality Vocational and Professional Education and Training (VPET) to nurture globally competitive individuals for the development of Hong Kong and the region. Marking the success of NENG 2017 with the 35th Anniversary of the VTC, the NENG 2018 provides the younger generation with immersive experiences in the application of solar power and smart mobility application.

NENG aims to inspire the younger generation on the use of renewable energy and deepen their knowledge of engineering and the STEM subjects in a fun and interactive approach. IVE Solar Car Team, develop the solar cars to demonstrate the viability of a renewable energy through the use of green transportation, and promote the awareness of environmental sustainability among the public. Proved the success of VTC STEM PBL project, IVE Solar Car Team with over 200 students from electrical and mechanical engineering field achieved the learning outcomes. To extend the STEM PBL core value to the younger generation, Team offers a series of NENG workshops on solar car technology to over 60 teams from local secondary schools, and provide students with board-based and deep engineering knowledge, skills, and value they need to build the deliverables as solar car with efficiency innovation, disruptive thinking and problem-solving skills within months, and work out the solar car for secondary school solar car racing challenge. It also provides students with an opportunity to put theoretical knowledge into practice, gain hands-on experience, and practice project management skills during development, and thus leading student to understanding science and new technology; and practicing engineering skills, and preparing for further smart mobility development in Hong Kong.

General observation and quantitative analysis was used to evaluate the extra-curricular and academic performance are affected by student participation in STEM PBL workshops. Simple questionnaire was used to gauge the effectiveness of the students taking part in the workshops to this with several parameters, include the gender, elective subjects, the STEM workshops experience, to see whether this had any effect on their learning outcome of the project.

Keywords: Science, Technology, Engineering, and Mathematics (STEM), Project-Based Learning (PBL), New Energy New Generation (NENG), Disruptive thinking, Problem-solving skill, Smart mobility

Introduction

Recalled the STEM education report, the Education Bureau of Hong Kong SAR, will keep impelling the renew and enrichment of the curricula and learning activities of STEM and allowing students to fully unleash their potential in innovation. It also stated that cross-disciplinary STEM learning activities are essential on producing synergies and make the learning activities become more effective.

VTC, as the quality Vocational and Professional Education and Training (VPET) provider, nurtures globally competitive individuals for the development of Hong Kong and the region. To inspire the young generation, STEM PBL project in IVE solar car team SOPHIE, and the New Energy STEM Generation campaign are established for promoting the STEM and develop their ability to integrate and apply professional knowledge, skills, and attributes (KSA), disruptive thinking, design thinking skills, and team management skills being applied in the smart city development, and the result showing that STEM give a positive influence to students.

**STEM PBL project in IVE solar car team SOPHIE**

Since 2010, the STEM PBL project – IVE solar car team SOPHIE is established by the Engineering discipline of Hong Kong Institute of Vocational Education (IVE), a member of the VTC Group, that focuses on the development of solar-powered vehicles. Until now, the 6th generation solar car – SOPHIE VI, is released and remarking the 35th Anniversary of the VTC,
team joining one of the international solar car race – World Solar Challenge 2017 (WSC2017), with 30-year history. Over 40 teams from around the world, including teams with universities, institutes and industries representatives from UK, US, Asia, and Europe. Team completed the whole journey and received 3rd runner-up awards from cruiser class.

Pic.1 The SOPHIE team with SOPHIE VI on WSC 2017

To achieve the goals, the education of STEM PBL is no doubt plays a vital role in SOPHIE team development, and more is now being done to increase the student learning outcomes on facing the challenge. As a cross-disciplinary project, team consists of students from the electrical engineering, mechanical engineering, and graduates from the Hong Kong Design Institute (HKDI), brought together cross-disciplinary perspective and expertise in engineering and design. Team members are being inspired and making use of the design thinking and disruptive thinking skills to design an innovative and sustainable solar-powered vehicle so called “SOPHIE” to demonstrate the viability of a renewable energy through the green transportation and smart mobility application, under the smart city development. So far, from 2010 to 2017, over 2 hundred students directly participated in solar car design and fabrication works. With the Triple Helix Support, the project is fully-supported by industries, government and IVE. As the deliverable, task and context, students are motivated to develop the solar car based on their own knowledge and experience, and work on the research on problem-solving during the solar car fabrication, which including the solar power technology and advanced application, high tech automotive design and fabrication, team management practice and cooperation with industries on latest technology development. The vehicle ‘SOPHIE’ also allow students to learn by doing and applying ideas, that is the features of project-based learning (Blumenfeld, Fishman, Krajcik, Marx, Soloway, 2000), students tends to gain a deeper understanding of materials when they actively construct their understanding by working with and using ideas. Till now, 7 ‘SOPHIEs’ were built under the massive effort of students. FOUR of them participated in 4 races under students’ leadership, including SOPHIE SEM in “Shell Eco-Marathon Asia 2012” in Malaysia, SOPHIE IV in “World Solar Challenge 2013” in Australia, SOPHIE V in “World Solar Challenge 2015” in Australia, and recently SOPHIE VI in “World Solar Challenge 2017” in Australia.

Through each races, student have demonstrated their possibility on building solar-powered vehicles. Team allows students to apply the key Knowledge learnt in classroom or work out the research outside class, Skills and Attitudes (KSA) on designing and fabricating the solar car for races and showed their confidence and interest on solar car vehicle. These experience broaden their view in terms of problem solving, design concept and technology application, thus self-confident was highly enhanced. From that, it is shown that STEM PBL has positively influenced student’s non-academic performances and match the result that STEM PBL showed positive attitudes toward learning itself, allowing effective feedback and reflection, and self and peer assessment (Howard Barrows, 1996). Furthermore, STEM PBL was examined with respect to increasing students’ interest, self-confidence, and self-efficacy, which was highly related to the components of STEM BPL such as collaborations in group work and contextual problems reflecting students’ real-world experiences.

In fact, design thinking process is also adopted to the team operation, the process is divided into five stages, including: Empathize, making use of Internet, Facebook, etc. and local visits to under the design challenges with effort to understand the way peoples doing similar projects and why, the needs are then identified; Define, through the empathizing stage, questions are uncovered and actionable problem statement of what needs to be built; Ideate, with the problem statement on hands, the team started to brainstorm and innovate on building the solar car; Prototype, these innovative ideas are realized by prototyping different parts of the solar car and were tested; Test, Improved version of these prototypes were put together for safe on road test (e.g. in campus parking lot), and to realize the target product is finally delivered, and the project outcomes are being demonstrated.

Workshop to secondary school

Received the positive resulting in STEM PBL project in IVE solar car team SOPHIE. Engineering discipline of Hong Kong Institute of Vocational Education (IVE) aims to inspire younger generation make use of their talents on the use of renewable energy and deepen their knowledge of engineering and the STEM subjects. To impel the transfer of knowledge, the New Energy STEM Generation campaign with SOPHIE team is formed for organizing a secondary school solar car racing challenge, and offer a series of NESG workshops on solar car technology to over 60 teams from local secondary schools students and provide students with board-based and deep engineering knowledge, skills, and value they need to build the deliverables as solar car with efficiency innovation, disruptive thinking and problem-solving skills within
months, and work out the solar car for secondary school solar car racing challenge. Deliverable including solar cars fabricated by the teams from secondary school after screening will have the opportunities for testing during the scrutineering and driving their solar car during the final competition. Team tasks including the worksheets, and technical submission will be required to submit by teams across the workshop session and are the important factor for screening process. Teams are required to perform the STEM subject knowledge, teamwork skill, disruptive thinking, design thinking skill, and team management skill on the competition.

The workshop introduces the basic solar car structure including solar panel working principle, energy conservation, mechanical system to the participants, with the real product demonstration, (i.e. SPOPHIE) and hands on a project of a small scale solar car model by divided them in group. From the workshop, it is observed that there are positive effects for students in content knowledge and attitude toward learning, the primary reasons are the workshop contains hands-on activities and field-based contexts. Moreover, students’ problem solving skills are improved since STEM PBL were required to solve problems embedded in the project.

To measure the effect of series of workshops, the following survey are prepared for students on evaluating the pre-event and post-event, during the first and last workshops. 150 set of student survey are distributed for the pre-event and post-event session. Here below is the base info for students, including the gender, secondary school year, and learnt of STEM subject, and participation of STEM activities. Survey included the questions related STEM knowledge, and related score will be calculated to find out the ratio of change after NESG workshops.

<table>
<thead>
<tr>
<th></th>
<th>Science</th>
<th>Technology</th>
<th>Engineering</th>
<th>Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-event: (%)</td>
<td>77.08</td>
<td>71.88</td>
<td>67.19</td>
<td>52.08</td>
</tr>
<tr>
<td>Post-event: (%)</td>
<td>83.33</td>
<td>83.33</td>
<td>83.59</td>
<td>60.42</td>
</tr>
<tr>
<td>Improved ratio: (%)</td>
<td>8.11</td>
<td>15.94</td>
<td>24.42</td>
<td>16.00</td>
</tr>
</tbody>
</table>

Table 1. STEM scores on pre-event, and post-event

The figures and the observation deliver that while STEM PBL was implemented, it is resulted in positive growth rate on students’ achievement especially in technology mathematics and engineering scopes on table 1, with over 15% improved rate. Collaboration, group projects, ill-defined tasks, and student-centered environments are inter-relationally function with each other. STEM PBL activities benefitted students to have additional opportunities to communicate with peers and teachers than would traditional lecture. It is believed...
that the students who learnt/ joined the STEM related activities may also bring the reason of resulting.

**Conclusion**

The effectiveness of implementing STEM PBL in terms of improving students’ STEM knowledge has not only demonstrated much improvement, but also improve their design thinking process. Founding of this paper assists teachers to rethink how to promote STEM to students out of the traditional classroom and how the STEM PBL varied the performance levels and benefit students from engaging in STEM PBL activities. STEM is an important key to nurture our next generation creativity, innovation, collaboration and problem solving skills for enhancing the international competitiveness of Hong Kong.

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SUSTAINING STUDENT INTEREST IN BUSINESS STATISTICS USING ICT-ENHANCED, APPLICATION-BASED BLENDED LEARNING

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Abstract

This research aims to evaluate if an ICT-enhanced, application-based blended learning approach is more effective in improving the module performance and sustaining student interest in learning business statistics as compared to the traditional approach. Under the traditional approach, business statistics was taught mainly in a lecture-tutorial setting with the teaching staff demonstrating standard textbook lecture examples and students practising standard textbook tutorial questions. The opportunity for the application of statistical concepts to the real business world was limited. The deployed intervention adopted a blended learning approach. The teaching materials for e-learning topics such as regression & correlation analysis and statistical estimation were enhanced using e-learning tools such as PowToon and Articulate Storyline to illustrate how these topics could be applied to solve business problems across industries. Besides that, relevant free-to-use computer simulation exercises on the internet, were also introduced during face-to-face lessons in topics such as the sampling distribution of the sample means to allow students to experiment and "play" with parameter values, visualize and see for themselves how statistical theorems work. In terms of results, the module performance for the experimental group taught under the blended learning approach was compared with the previous cohort taught under the traditional approach (the control group). The experimental group had shown improvement in their business statistics module passing rate and average mark. The group also displayed greater motivation to apply their learning in real-world situations. The ICT-enhanced computer simulations used in the face-to-face lessons enable students to learn by doing and seeing and promoted better understanding, retention and interest. In conclusion, ICT-enhanced tools and technology can provide effective ways to enhance module delivery. It is recommended that educators should deploy relevant and useful ICT applications to promote students’ understanding and learning. Besides that, the focus of educators should be on the application of knowledge and theories to real life to sustain student interest and motivation.

Keywords: ICT-enhanced, Application-based, Blended learning

Introduction

Business statistics is a module that trains students to solve problems in a systematic approach. Through solving business statistics problems, students can learn to sieve and extract useful and relevant information from the business problems at hand (during the input stage); think critically and assess various options and alternatives (during the processing stage); before coming up with the final business decision (during the output stage). Although the module can provide excellent training opportunities to enhance the information processing and critical thinking skills of students (two important 21st century competencies), the traditional teaching pedagogy adopted by educators usually fails to arouse student interest and motivation in learning the module.

Traditionally, business statistics was taught mainly in a lecture-tutorial setting with the teaching staff demonstrating textbook examples during lectures and students practising standard textbook questions during tutorials. The focus of the traditional teaching pedagogy was mainly to let students memorize and practise standard procedures and statistical formulae to obtain the required textbook model solutions. The opportunity for the application of statistical concepts to the real business world was limited. Besides that, there was little emphasis to let students fully understand the business problems at hand; weigh and assess possible alternative choices and options before coming out with a final business decision.

The study aimed to evaluate if an ICT-enhanced, application-based blended learning teaching pedagogy was more effective in improving the module performance and sustaining student interest in learning business statistics as compared to the traditional approach. Based on the results obtained, the study hoped to offer pragmatic suggestions for educators and course designers to consider when they were developing learning materials for their modules.
Literature Review

The use of technology in teaching and learning was a valuable practice for supporting student learning and engagement (Cydis, 2015). Technology and ICT tools were also increasingly used in statistics education due to its many advantages in facilitating students’ learning of statistical concepts. Chance et al. (2007) highlighted that technological tools could support the teaching and learning of statistics by providing automation of calculations, visualization of abstract concepts, emphasis on data exploration, and investigation of real-life problems. The automation of calculations allowed students to spend more time focusing on understanding and interpreting statistical results rather than burdening them unnecessarily on complicated calculations using statistical formulae. The visualization of abstract statistical concepts such as probability distributions and the Central Limit Theorem using computer simulations allowed students to experiment with different parameter values and analyzing the effects of the different parameter values on conceptual ideas. Thus, these computer simulations facilitated student learning by allowing them to learn by doing and seeing and not just memorizing abstract concepts. Zieffler et al. (2008) also encouraged the use of computer simulation tools and web applets to correct the faulty statistical reasoning by students.

Besides the use of technology, authentic learning was also highlighted by previous researchers as an effective instructional approach for teaching business statistics. Authentic learning allowed students to explore and discuss meaningful concepts in contexts that involved real-world problems relevant to the learner (Donovan, Bransford, & Pellegrino, 1999). Harrington & Schibik (2002) concluded that application-based learning by using business case studies was an effective tool for increasing student engagement in learning business statistics. Gandhi (2006) also suggested educators to promote the use of active learning through real-life project data to improve student statistical thinking.

Methodology

Based on the results and suggestions by the studies above, an ICT-enhanced, application-based blended learning approach was adopted in the teaching of the BM3034 business statistics module in 2017 semester 2. BM3034 business statistics module is a 60-hour compulsory core module for all year-one business students from the School of Business Management (SBM), Nanyang Polytechnic. In terms of module delivery, e-learning lessons constituted 18 hours (30%) of module delivery hours while face-to-face lessons constituted the remaining 42 hours (70%) of module delivery hours.

442 year-one students from the Diplomas in Business Management and Food & Beverage Business, who took the same module in 2017 semester 2, were assigned as the experimental group. The control group was taught using the traditional approach while the experimental group was taught using the blended learning approach. The 2 groups of students were homogenous across characteristics such as gender, age and mathematical abilities. (All students must obtain at least a GCE ‘O’ levels C6 grade in mathematics, or a GCE ‘N’ levels B4 grade in mathematics and a pass in mathematics in foundational bridging programmes.)

A comparison between the blended learning approach adopted and the traditional approach used for both e-learning lessons and face-to-face lessons in the module was shown in table 1 and 2 respectively below.

Table 1. Blended Learning Vs Traditional Approach for E-Learning Lessons

<table>
<thead>
<tr>
<th></th>
<th>Blended Learning Approach</th>
<th>Traditional Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Materials</td>
<td>E-learning content in descriptive statistics, regression &amp; correlation and statistical estimation topics were enhanced using e-learning design tools such as PowToon and Articulate Storyline to illustrate how these topics could be applied to solve business problems across industries such as banking &amp; finance, food &amp; beverage, retail and entrepreneurship. The focus was on the application of theories and concepts to the real business world.</td>
<td>Content in the e-learning topics were focused on the replacement of physical lessons towards e-delivery. Few attempts made to illustrate how these topics could be applied to the real business world.</td>
</tr>
<tr>
<td>2. E-Quiz</td>
<td>Quiz questions related to the e-learning content were designed to let students probe deeper into the business problems to sieve and extract useful and relevant statistical data and information, interpret meaning and implications of the calculated statistical results, think critically and consider all options and alternatives before reaching the final business decision.</td>
<td>Quiz questions were mainly asked to let students practise standard procedures and statistical formulae to obtain the required tutorial model solutions.</td>
</tr>
</tbody>
</table>
Table 2. Blended Learning Vs Traditional Approach for Face-to-Face Lessons

<table>
<thead>
<tr>
<th>Blended Learning Approach</th>
<th>Traditional Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Lectures</td>
<td>1. Lectures</td>
</tr>
<tr>
<td>Lecturers used relevant computer simulation exercises available on the internet in topics such as the sampling distribution of the sample means and continuous probability distribution to demonstrate how abstract concepts such as Central Limit Theorem (CLT) and normal distribution work.</td>
<td>Lecturers explained abstract statistical theorems and demonstrated standard lecture examples.</td>
</tr>
<tr>
<td>2. Tutorials</td>
<td>2. Tutorials</td>
</tr>
<tr>
<td>Students experimented and &quot;played&quot; with parameter values using computer simulations of statistical theorems and learned by doing and seeing.</td>
<td>Students memorized the statistical theorems and practised standard tutorial questions to obtain the required tutorial model solutions.</td>
</tr>
</tbody>
</table>

Under the ICT-enhanced, application-based blended learning approach, the content for e-learning topics such as descriptive statistics, regression & correlation and statistical estimation were enhanced to be application-based. The focus was on how the concepts learnt in these topics could be applied to solve real-world business problems across industries. The shift towards the application of statistical knowledge to solve business problems allowed higher-order thinking questions to be administered for students in the e-quizzes that followed. These quizzes trained students to probe deeper into the business problems at hand to sieve out useful and relevant data and information, interpret the implications of statistical calculations and assess alternative options and solutions before making the final business decision. In contrast, under the traditional approach, the e-learning lessons (content and e-quiz) were made to merely transfer the delivery mode from physical lessons to e-delivery.

For the face-to-face lessons, the new blended learning approach utilized relevant computer simulations of abstract statistical concepts in topics such as continuous probability distribution and sampling distribution of the sample means. One of the web applets used during the face-to-face tutorial lessons was the illustration of the Central Limit Theorem (CLT) by the “Rice Virtual Lab in Statistics”. During the tutorial, students could experiment and "play" with parameter values such as different shapes of the parent population, and different sample sizes (n) chosen from the parent population to derive the shape of the sampling distribution of sample means through repeated sampling using the computer simulation generated by the applet. The students could learn the theorem, not just by memorizing it, but through experimenting with the web applet and seeing the results generated. Being able to generate and see the results from the computer simulation exercises by themselves, students could understand the theorem better and were more confident in applying it since they had convinced themselves that the theorem really worked through the simulation exercises. In contrast, the focus of the traditional teaching pedagogy was merely to let students memorize the theorem, and practise standard procedures and statistical formulae to obtain the required tutorial model solutions.

**Results**

The module performance (passing rate and average mark) and the semester module feedback of the experimental group (in 2017 semester 2) was compared with the control group (in 2017 semester 1). The experimental group had shown improvement in the business statistics module passing rate (from 95.09% to 95.92%) and average mark (from 64.02 to 65.55 marks) compared to the control group.

Based on the compulsory end-of-semester feedback data collected from all students taking the module in both semesters (measured on a 4-point ordinal scale: 1-Strongly Disagree, 2-Disagree, 3-Agree, 4-Strongly Agree), students had found the blended learning approach to be more effective in helping them learn the topics as well as interactive and engaging enough to sustain their interest (Figure 1).

The e-Learning for this module is effective in helping me learn the topic.

![2017 Semester 1 Average Feedback Score 3.09](image1)

The e-Learning for this module is interactive and engaging.

![2017 Semester 1 Average Feedback Score 3.06](image2)

Figure 1. Semester Feedback Score for 2017 semester 1 and 2.

**Discussion**

Based on the improvement in module performance and module feedback in 2017 semester 2 as compared to 2017 semester 1, the ICT-enhanced, application-based blended learning approach is a more effective teaching pedagogy to sustain student motivation in learning as compared to the traditional approach of teaching. The new approach enabled students to appreciate that the topics they had learnt could be applied in the real business world. This created and sustained intrinsic motivation for students since they were now convinced of the value in their learning. The ICT-enabled computer simulations during face-to-face lessons...
enabled students to learn by doing and seeing. These hands-on experiences deepened their understanding, retention of knowledge and interest in learning business statistics. The improved motivation, interest and understanding had also translated into better module performance in terms of passing rate and average marks.

Conclusion

ICT-enabled tools and technology can provide effective ways to enhance module delivery as seen in the study above. Educators need to focus on the users' and students' needs and learning styles to deploy relevant and useful ICT applications to promote their understanding and learning. This can be in the form of computer simulations and web applets which allowed students to learn by experimenting, visualizing the results obtained, forming their own conclusions to deepen their understanding. Besides that, technology and e-learning development tools can facilitate the creation of interesting and relevant e-learning content to enhance students' understanding. In this respect, the focus of educators should be on the creation of content that is related to the application of knowledge and theories to real life to create and sustain student interest and motivation in learning.

References


