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DEVELOPMENT OF TEACHING MATERIALS AIMED FOR RELEVANCE ON LEARNING MATHEMATICS BY THE MEDIUM OF COMPLEX NUMBERS

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Abstract

In educational technology, the ARCS model that Keller was proposed in 1983 is well known. It is a system model to assist instructional designers to address the problem of learning motivation. The model proposes the framework which organized as four factors: Attention, Relevance, Confidence and Satisfaction, the method of motivation corresponding to each factor and the procedure of the setting for problems and solutions of learning motivation. In the model, we can devise to improve motivation in the entire learning process, not only at the time of introduction.

While it is possible to learn the level of the first year of university from the first year of high school, relatively smoothly, because there is no need of guidance of entrance examinations in mathematics education of National College of Technology, the fixity of knowledge and the relevance of learning objects seems to be rarified since there is no opportunity for a student to relearn deeply what they learn as when they study mathematics for entrance examinations.

The main purpose of this work is to associate (mainly) a matrix with a complex number which is a learning object for the third year students and to adapt an inversion on a circle as a geometric application of complex numbers as learning objects.

The study focuses on relevant and attention in the ARCS model and aims to tie what has been learned as dots so far across the subjects or grades by the medium of a complex number and to deepen the understanding of the learners.

This work consists of a proposal of teaching materials of complex numbers using matrices and geometric figures, and a report of class practice that has been performed on the third grade students of Department of Electrical and Electronics Engineering and Department of Control and Information Systems Engineering from January to February in 2014. The result of a questionnaire distributed to the students has shown that the teaching material has been evaluated positively.

Keywords: *ARCS model, mathematics education, matrix, complex number, inversion, relevance, attention*

§1. Introduction

The ARCS motivation model was introduced by Keller in 1984. The model consists of four categories: **Attention**, **Relevance**, **Confidence**, and **Satisfaction** that encompass the major factors that influence the motivation to learn.

Attention is defined as capturing the interest of learners and stimulating the curiosity to learn. If there is a movement of interests of learners like they think "it is interesting" or "there seems to be an interesting thing", Attention can be obtained.

Relevance is defined as meeting the personal needs/goals of the learner to effect a positive attitude. If learners know what the learning task is and think that there is a rewarding thing, then Relevance (of learning activities) is improved.

Confidence is defined as helping the learners believe/feel that they will succeed and control their success. They obtain Confidence like "I can do it" if they repeat the experience of success at the begining of learning or they can consider that the success is due to their devise.

Satisfaction is defined as reinforcing accomplishment with rewards (internal and external). If they look back over lessons and think that "It was good to do it", they achieve Satisfaction that leads to motivation for learning the next.

It is not necessary to devise for improving motivation that satisfies all the four factors. It is known that it is sufficient to design efficiently with emphasis on one of the factors in this model.

Our aim is to tie what has been learned so far across the subjects or grades by the medium of the complex numbers and to deepen the understanding of learners, focusing on Relevant and Attention in the ARCS model.

§2. Outline and organization of classes

We have organized classes as in the following summary and flow.

Summary. The operations for the complex numbers, which have not been treated in classes after students were learned when they learned in the subject of the discriminant of a quadratic equation, are illustrated by using vectors and matrices.
Furthermore, by conversion on the complex plane called inversion, it is learned how figures, such as a circle and a straight line convert.

A setup of the flow of a class

1. We describe the sum, difference, and the multiple of complex numbers with a real number and compare with the operation of vectors.
2. We explain the product of complex numbers by using matrices. Specifically, we explain the geometrical meaning for multiplying a complex number with 2 or i.
3. We explain the definition of an inversion with respect to a circle using figures.
4. Students address an exercise to find out the point on the xy-plane that a point on a circle is converted to by figuring out exercises.
5. We extend the content of exercises imposed in step 4 to the complex plane.
6. We compare the results of the exercises in the above 4 and 5.
7. We give problems about a formulation of an inversion and the image of circles and straight lines.

Result of practices

The class was practiced in 2 steps as follows.
Place: Kurume technical college ES1 classroom and ES4 classroom
Date:
The 1st time: February 5 (the third-year-students of Department of Control and Information Systems Engineering), February 6 (the third-year-students of electric electronics Department)
The 2nd time: February 7 (the third-year-students of electric electronics Department), February 10 (the third-year-students of Department of Electrical and Electronics Engineering)
Target students:
46 third-year-students in Department of Electrical and Electronics Engineering
47 third-year-students in Department of Control and Information Systems Engineering

In the first practice, we have explained the addition and difference, and multiplication of real numbers to complex numbers as a review of a subject learned in the first grade. In particular, we have explained them by relating with plane vectors.
Next we have asked what the product of complex numbers corresponds to for urging students' attention.
Furthermore, we have explained the product of two complex numbers α and z as follows.

Set $\alpha \cdot z = z'$.

If we put $\alpha = a + bi,\ z = x + yi,\ z' = x' + y'i$, then we have

$$z' = \alpha \cdot z \Leftrightarrow x' + y'i = (a+bi)(x+yi)$$

$$\Leftrightarrow x' + y'i = (ax - by) + (bx + ay)i$$

$$\Leftrightarrow \begin{cases} x' = ax - by \\ y' = bx + ay \end{cases}$$

$$\Leftrightarrow \begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} a & -b \\ b & a \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$

Thus, students have found out that the product of complex numbers can be expressed by a linear transformation. Next, we have given examples of the linear transformations in two cases of a real number and a pure imaginary for students to understand such linear transformations .
In the case of $\underline{\alpha = 2}$, we have

$$z' = \alpha \cdot z \Leftrightarrow \begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 2 & 0 \\ 0 & 2 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}.$$

Thus we know that it expresses a linear transformation to magnify two times.
In the case of $\underline{\alpha = i}$, we can find that

$$z' = \alpha \cdot z \Leftrightarrow \begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}.$$

In order to clarify what kind of conversion this linear transformation expresses, we have a modification of a formula by using, $i = \cos\frac{\pi}{2} + i\sin\frac{\pi}{2}$ and the polar form.

$$z' = \alpha \cdot z \Leftrightarrow \begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} \cos\frac{\pi}{2} & -\sin\frac{\pi}{2} \\ \sin\frac{\pi}{2} & \cos\frac{\pi}{2} \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$

It turns out that the expresses linear transformation which rotates π/2 with respect to the origin. By generalizing the above, we have
In case of $\underline{\alpha = r(\cos\theta + i\sin\theta)}$ we have

$$z' = \alpha \cdot z \Leftrightarrow \begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} r\cos\theta & -r\sin\theta \\ r\sin\theta & r\cos\theta \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$

$$= \begin{pmatrix} r & 0 \\ 0 & r \end{pmatrix} \begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$

$$= \begin{pmatrix} cos\theta & -sin\theta \\ sin\theta & cos\theta \end{pmatrix} \begin{pmatrix} r & 0 \\ 0 & r \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}.$$

We know that it expresses a linear transformation which is obtained by the composition of a rotation in θ θ degree with respect to the origin and magnification (or reduction) r times.

An exercise was imposed in the end of the explanation for fixing of knowledge.

Exercise 1. Do the next calculations using matrices.

(1) (2+5i)(3+4i)
(2) $(2+3i)^2$(2+3i)^2

In the second practice, after performing the exercise which asks for the loci (of a straight line and a circle, etc.) in the complex plane, an inversion with respect to a circle was introduced as a graphical application.

Definition of an inversion. Let C be the circle of the radius R centered at a point O on the plane.
Points P and Q on the plane are on a straight line in order of O, P, Q or O, Q, and P, and satisfy that
OP・OQ = R^2.
Then the correspondence from P to Q is called a *inversion* with respect to the circle C and denote it by α : P→Q.
Moreover, we say that *the point P moves to the point Q by an inversion with respect to the circle C*.
First, we have explained the definition of an inversion using figures and on the inversion especially with respect to a unit circle, we have illustrated what kind of points can be obtained by the inversion of points, such as $\left(\pm\frac{1}{2},\ \mathbf{0}\right)$, $\left(\mathbf{0},\ \pm\frac{1}{2}\right)$, and imposed the following exercises.

Exercise 2. Find the points which the next points on the plane move to by an inversion with respect to the unit circle.

(1) $(\pm\frac{\sqrt{2}}{4}, \pm\frac{\sqrt{2}}{4})$
(2) $(\pm\frac{\sqrt{2}}{4}, \mp\frac{\sqrt{2}}{4})$

Next we have imposed the following exercise for letting students confirm what kind of points the points in the complex plane corresponding to the exercise 2 move to.

Remark. *An inversion with respect to the unit circle in the complex plane* can be defined by the complex function w=1/z. However we avoid using the terminology "complex function" because we need to consider the level of the knowledge of students.

Exercise 3. Confirm what kind of points the next points in the complex plane move to by an inversion with respect to the unit circle.

(1) $\pm\frac{1}{2}$
(2) $\frac{\sqrt{2}}{4}(1 \pm i)$

Following this exercise, we have explained that all of the points in the exercise are on the circle of the radius 1/2, and the points are moved to the points on the circle of the radius 2 by the inversion.
At the end of practice, we have given the following problems and given a hint for making the formula for the inversion with respect to the unit circle.

Problem 1. Find the point that Q (x', y') moves to by an inversion with respect to the circle C.
Problem 2. Express point z' that the point z on complex number plane moves to by an inversion with respect to the circle C in terms of $\bar{z}$ and R.
Problem 3. Investigate how the circle of radius 1 / R centering the origin moves by an inversion with respect to the unit circle.
Problem 4. Figure out answers to the following questions.
(1) Consider a figure that the formula $|z-1| = |z+1|$ expresses and describe the result that the figure moves to by an inversion with respect the unit circle.
(2) Consider a figure that the formula $|z| = |z-3|$ expresses and the result that the figure moves to by an inversion with respect the unit circle.

The hint of Problem 1: Denote the image of the point P by an inversion with respect to the unit circle by Q, then the inversion can be expressed as follows.

$$\begin{cases} \overrightarrow{OQ} = k\overrightarrow{OP}\ (k > 0) \\ |\overrightarrow{OP}||\overrightarrow{OQ}| = 1 \end{cases}$$

Then we find the positive constant k which satisfies the above.

The hint of Problem 2: When we denote the image of the complex number z by an inversion with respect to the unit circle by z', then the inversion can be expressed as follows.

$$\begin{cases} z' = kz\ (k > 0) \\ |\vec{z}||z'| = 1 \end{cases}$$

Then we find the positive constant k which satisfies the above.

An additional subject

It is known that an inversion is a conformal mapping.
Although it is not treated in this practice, we give an additional problem relevant to such a property of inversions here.

Problem 5. We denote the figures given by $\bar{z}$+iz=0, z-$\bar{z}$=0, z+$\bar{z}$+i=0 by A, B and C respectively.

(1) Describe A, B, and C in the complex plane and evaluate the angles between A and B, and A and C respectively.

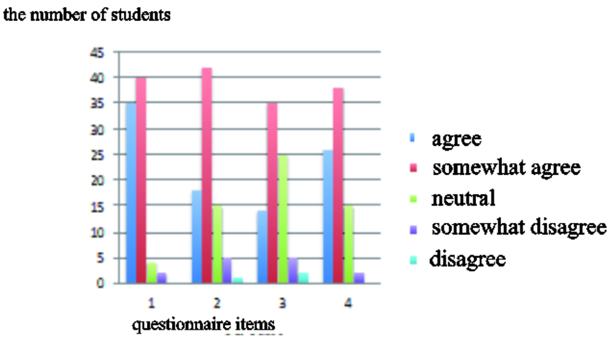
(2) Let A', B', C' be figures obtained from A, B, C by inversions with respect to the unit circle. Then evaluate the angles between A' and B', and A' and C' respectively.

§4. Result and consideration of the questionnaire

The questionnaire of Questions 1-4 for students as in the following has been performed about the complex numbers after their submissions of answer papers to the problems.
The number of effective replies is 81, and the following result was obtained (Table 1).
We consider the degree of achievement by the reply later.

(1) The items of questions and the result of each of them

Question 1. Did you find that the complex number relates to mathematical various fields?
Question 2. Did you obtain an interest about the problem of the mathematics relevant to the complex numbers?
Question 3. Do you want to know more about the problem of the mathematics relevant to the complex numbers.
Question 4. Did you obtain a motivation to learn for mathematics?



(2) The result of the questionnaire is as follows:

When we asked the students describe comments about the lessons concerning to the complex numbers according to free form, there were the following replies (partially extracted).
- Since the complex numbers appear in broad field, it was good that it could be restudied once again through Mathematics IIIA.
- I also wish to know more about a transformation other than an inversion.
- A lesson about vectors was interesting. An understanding to a special subject was deepened.
- My concern about the complex numbers was increased. Since they are also used by engineering, I thought from now on that the complex numbers were important.
- I was surprised to know the point connected with trigonometric functions.
- Since there was a part which leads to the special subject, it was easy to understand. It was good that the relation with a matrix was also found.
- Although there were many things that I had already known, since I did not know neither De Moivre nor an inversion, it was pleasant.
- Since I have learned in lectures on electric circuit, I could easily understand the problems. Both of understandings are deepened.
- Since there was relation by a special subject, it was able to learn with interest.
Moreover, since there was also relation by the mathematics B, it was good to become a review of learned things.
- Since the complex numbers were learned by the special subject from the first grade, I has understood immediately.
- Since I did not know the law of the complex numbers, an understanding was deepened by this lesson. I would like to exploit it in a special subject.

(3) The degree of achievement of lectures

In the question items 1 and 2, although we have many opinions that students found that the complex numbers are concerned with various mathematical fields and had interests, according to the question item 3, we know that the needs for the problem of the mathematics relevant to the complex numbers are comparatively low.
It is guessed that the fusion problem tends to be difficult on the characteristic, a student who is not good at mathematics thinks that the independent problem is more desirable.
However, in the question item 4, since many students has been motivated to learn mathematics, we can say that this trial has been effective in a certain level for a student poor at mathematics.

§ 5. The conclusion of this trial, and a future subject

The author has so far created teaching materials dealing with the knot theory which is the recent mathematics field and gives a fusion problem with a special subject and an application of linear algebra paying attention to Relevance in the ARCS model for a student's improvement in motivation to learn (e.g., Sakai, Tanaka and Nakabo, 2012; Miyaji, Sakai, Narasaki, Kawamoto and Shinohara, 2011).
The trial of this time is aimed that students notice the complex numbers are closely related with various contents of mathematics and understand them deeply, paying attention to Cautions and Relevance in the ARCS model.
Moreover, although there was certain research which treated an inversion of a object in the Euclidean space (plane) (e.g., Ando, Tsuge and Yamada, 2011), we considered an inversion as graphical application of the complex numbers in this study (e.g., Baba and Takasugi).

Although a certain good result was achieved as in the questionnaire result, since the explanation of relevance with special subjects, such as an electric circuit for example, is insufficient, it has not come to create the teaching materials in which all the students were satisfied. We would like to carry out preliminary survey and cooperation with a special subject of study more in the next trial.

Acknowledgement

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DEVELOPMENT AND PRACTICE OF AN ATTRACTIVE ELECTRONIC DEVICE FABRICATION EXPERIMENT AS PBL

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Abstract

We have developed a new engineering experiment related to the fabrication of electronic devices for Fourth Year students majoring in electronic engineering in Kosen. It is the fabrication of the organic light emitting diode (OLED). The students perform the OLED fabrication experiment in class for 15 weeks. We chose to focus on the OLED for two reasons. - (1) the fabricated device is attractive and well known (2) facilities to fabricate OLED are relatively inexpensive and some of these facilities such as the vacuum evaporation system is already available in each Kosen.

In the first week, teachers explain to the students the several experiments available for selection. The students subsequently select the experiment they want to work on. From the second week, a group of four students will try to fabricate the OLEDs by changing the fabrication condition and the fabricated OLEDs are evaluated by measuring current-voltage characteristics and emission spectra. In the final week, the students give a presentation on the fabrication process and are graded by both teachers and fellow students.

Throughout this experiment, the students learn about various device fabrication techniques such as spin coating and vacuum evaporation for thin organic films. In the OLED fabrications, some of the fabricated devices would emit light by current injections. Depending on the fabrication condition, on the other hand, the OLEDs may fail to emit light. In the latter case, the students have to reconsider why the fabricated device failed to emit light. Through this failure, the students will learn how to determine the performance of the device. Furthermore, most students were surprised to find that it was easier to fabricate than they had expected and were impressed by the emissions from the OLEDs fabricated by them. 60% of the students who engaged in this experiment found that it was very interesting while 30% of the students found it to be fairly interesting. 70% of students who conducted the experiment indicated that their interest in the field of electronic devices has been enhanced after the OLED experiment.

As described above, the OLED fabrication experiment is just a Project-Based Learning. This experiment also incorporates an aspect of Practice-Based Learning.

Keywords: *Education, Engineering education, Project-Based Learning, Practice-Based Learning, Organic LED, Technology education, Semiconductor devices, Experiment*

Introduction

A Japanese education system known as Kosen, National College of Technology (although English notation of Kosen have changed from “National College of Technology” to “National Institute of Technology” April this year, we use the former one in this paper), is a unique education system in Japan or even in the world. The graduates from Kosen have made a great contribution to the development of Japanese industry in the 1970s and 1980s. Kosen accepts junior high school graduates who have chosen one of several departments in each Kosen at that time, and educates them few specialized subjects from the 1st year to foster practical and creative engineers. In the department of electrical engineering in Kosen, a wide variety of related technologies such as electronic power engineering, control engineering, communication engineering, electronic engineering including semiconductor technology, and computer engineering including programing technique are being taught for students. Among them, the electronic engineering, especially semiconductor device technology, is not so popular for recent students. Because Japanese semiconductor industry loses its competitiveness in progress of globalization and many related companies result in a decrease in the number of recruits. However, semiconductor industry is still one of important industries in Japan and Kosen’s teachers therefore continue to give a lecture on semiconductor engineering as one of attractive research fields in electrical or electronic engineering. In our college, three and four year students learn about a wide variety of semiconductor devices: from basic active devices such as *p-n* junction diode and bipolar or unipolar transistors to advanced devices such as solar cell, light emitting diode (LED), laser diode and integrated circuits (ICs) etc.

On the other hand, we have been doing a laboratory experiment related electronic devices like deposition of gold thin film by vacuum evaporation method in our college. During this experiment, students have also measured exhaust velocity of a rotary pump through the time dependence of pressure of vacuum chamber. However, it is hard to say that the experiment is attractive for students. Because the deposited metal thin film is not work as active electronic device and is just used as metal electrodes in electronic devices. To make the contents of the electronic device experiment more attractive, we have introduced a new laboratory experiment related to an electronic device fabrication. It is an attractive experiment based on fabrications of organic light emitting diode (OLED) (Seto and Yamada, 2013). OLEDs are well known as high-technology device and are relatively easy to fabricate the device. The reasons why we chose this subject is that the equipment used in this experiment is not so expensive and some apparatuses have already been introduced and utilized in almost all Kosen. Furthermore, the fabrication process of OLED is safer than that of silicon based devices, namely no high temperature process and no use in dangerous etching process like hydrogen fluoride.

In this paper, we describe the device structure we adopted and then explain how to fabricate OLEDs, where we also mention what kinds of facilities and equipment used to fabricate. We also report responses from students after doing the new laboratory experiment and discuss educational effects on the OLED fabrication experiment.

Method

A schematic device structure we adopted is shown in Fig. 1 (e.g., Michelottia et al., 2000). The reasons why we adopted this device structure are as follows:

1. OLED is well known and an attractive electronic device for students.
2. The fabrication process is relatively easier than silicon-based devices and the facilities and equipment needed are inexpensive. Some of them have already been equipped with each Kosen.
3. The fabrication process of OLED is safer than that of silicon-based devices, in which students need not use hazardous materials like hydrogen fluoride and not perform a heat treatment under high temperature.
4. Through the device fabrication, students can experience typical device fabrication techniques such as substrate cleaning using various organic solutions, spin coating, vacuum evaporation, etc.
5. The organic materials we used are popular and inexpensive; Tris(8-hydroxyquinoline)aluminum (Alq3) is famous green emissive organic material, which acts as electron transport layer in addition to the emissive layer in our device structure. Poly(N-vinylcarbazole) (PVK) is polymer material and acts as hole transport layer. PEDOT:PSS acts as hole injection layer.
6. Each process can perform at short time except for vacuum evaporation for aluminum electrode.

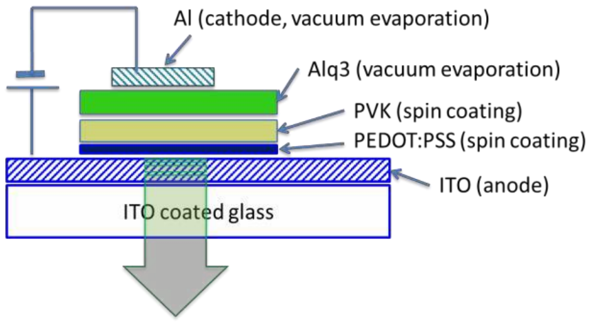

Figure 1. A schematic device structure of OLED we adopted.

We conducted the fabrication of this OLED in a experiment class called Creative Engineering Laboratory for 4th year students. This experiment class is a Project-Based Learning and the students as a member of team struggle against a successful fabrication of luminous OLED for about 12 weeks. The procedure of the class is shown in Fig. 2. Five teachers conduct the experiment class and explain the theme of each experiments whom they will take charge on the first day of the class. In the followings, we decribe briefly the process of the experiment of the OLED fabrication:

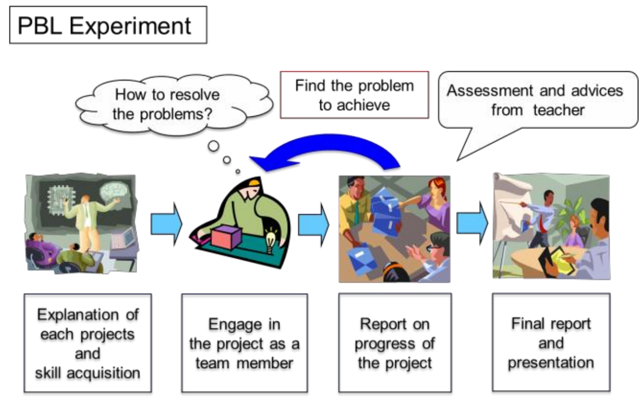

Figure 2. Schematic diagram of PBL experiment in Ishikawa NIT.

1. In the first week of the class, teachers explains themes of experiments which each teacher takes charge for students. After that a student choses one theme that the studnet is interested in.
2. Before starting the OLED experiment, the students experience how to use some machine tools such as a lathe and a milling machine as skills needed to fabricate something in the experiment.
3. In order to master some equipment to fabricate OLED such as spin coater and vacuum evaporation machine, students practice twice the fabrication of OLED together with teacher. During these proctices, the stutents search for structure and lumenous

mechanism of OLED and submit them as a short report to teacher.

4. Next, the students do experiments themselves and discuss the experiment plan hereafter; what should we change the device fabrication parameters, for example, temperature o heat treatment or thickness of each organic film.
5. Subsequently, the students continue to do experiments on the device fabrications changing systematically the fabrication parameter. The teacher watches carefully not to make a mistake in operation of the facilities and gives a suggestion to the students.
6. Finally, the students have to compiles the experimental process and results in a final report and make a presentation in front of the other students and teaches.

Figure 3 shows a picture of OLED fabricated by students. The fabricated OLED is emitting a green light by applying a forward bias voltage. The students have been very impressed by the moment when they looked at a luminous OLED as seen in Fig. 3. Throughout the experiment, students experience repeatedly how to use the evaporation. In addition, we consider this experiment has an aspect as Practice-Based Learning. Because the students can get experience of some typical facilities for fabrication of electronic devices.

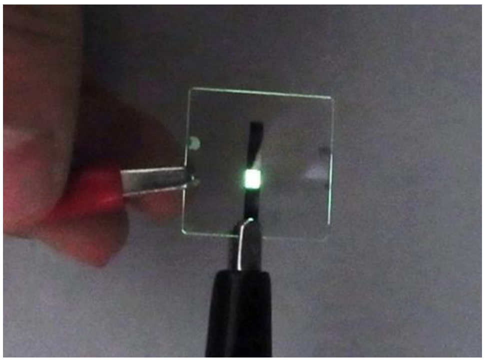

Figure 3. A picture of a luminous OLED fabricated by students.

Responses from students

In this section, we describe results of questionnaire survey that have been taken to confirm the effectiveness of the new device fabrication experiment on students.

1. Were you interested in fabricating something before you did this device fabrication experiment?

Table 1. Summary of responses to question 1

Strongly interested	30%
Fairly interested	40%
Not interested so much	20%
No interest	10%

2. Did you have interests in fabrication of electronic devices during the experiment?

Table 2. Summary of responses to question 2

Strongly interested	60%
Fairly interested	30%
Not interested so much	0%
No interest	10%

3. Did you change your interest in semiconductor device engineering after doing this device fabrication experiment?

Table3. Summary of responses to question 3

Enhance interest	70%
No change	20%
Lose interest	10%

70% of the students responded that they were interested in manufacturing something before starting the experiment class. Most of students who enter Kosen at the age of 15 years are originally interested in fabricating something. They learn about few specialized subjects from the 1st year to foster a practical and creative engineer. In our college, a new education method called "*in situ* experiment" have been performing in some specialized subject classes to keep their interests in fabrications ("Monozukuri" in Japanese) as an early-stage of engineering education (Tokui et al., 2011). The *in situ* experiment is an education method based on simple experiments performing in classroom to check and confirm basically physical laws or rules just after learning them. 90% of the students have performed the experiment with interest (see Table 2). This response from students show the OLED fabrication experiment is attractive for students. Furthermore, 70% of the students responded that their interest in semiconductor device engineering enhanced after doing the new device fabrication experiment (see Table 3). These results show that the fabrication experiment of OLEDs is effective to inspire the spirit of fabrication. In addition, this device fabrication experiment can be performed with fundamental facilities. Therefore, the OLED fabrication experiment can be applied to most NCTs in Japan or Polytechnics in Singapore to inspire their interests in the field of electronic devices. However, 10% of students did not have their interests in the electronic devices. Conversely, this experiment class provides an opportunity for such students to reconsider their interests, and therefore we expect that the experiment class leads to an appropriate selection of graduation research among various research areas in the next academic year.

Conclusions

We have reported a new device fabrication experiment for 4th year students at Department of Electrical Engineering in Ishikawa NCT. This experiment based on fabrication of OLEDs enhanced their interests in the field of semiconductor engineering. Through the device fabrications, the students have experiences of typical deposition techniques of thin film such as spin coating and vacuum evaporation. The OLED fabrication experiment presented in this paper has an aspect of Practice-Based Learning as well as Project-Based Learning. Furthermore, the new device fabrication experiment can be introduced into the other Kosen, in which has a related department teaching semiconductor devices, and can also be applied to another electronic device experiment using organic films like organic solar cells.

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THE PEDAGOGY OF TEACHING JAPANESE STUDENTS TO MAKE PRESENTATIONS IN ENGLISH — THE EVOLUTION OF A SYLLABUS FOR STUDENTS OF ADVANCED COURSES AT NATIONAL INSTITUTE OF TECHNOLOGY, HAKODATE COLLEGE

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Abstract

This paper describes the evolution of a syllabus to teach Japanese engineering students how to make presentations in English, by tracing the changes and innovations from Initial Phase to Intralaboratory Phase to Integrating Phase, over the past nine years.

Keywords: *syllabus design, initial, intralaboratory, integrating, teaching goal, global English*

Introduction

Business English II is a mandatory class for second year students of Advanced Courses in the Engineering Department at Hakodate National College of Technology (NCT) in Hakodate, Japan. The class is part of the curriculum relating six educational goals of the school[*1], with the overall aim of producing engineers who possess a multifaceted ability to communicate in English. The teaching goal of Business English II is that all students will be able to do their final presentations in the English language on their engineering research, which would be acceptable for an international conference. When first proposed, it was said to be "impossible in a big class!" This paper describes how the syllabus has evolved through Initial, Intralaboratory and Integrating phases, and has been improved to achieve the teaching goal of Business English II by tracing the innovations and changes in the syllabus over the past nine years.

Initial Phase: 2004-2010

When the Advanced Courses started in 2004, all students in the Kosan system were required to achieve a score of 400 or above on the Test of English for International Communication (TOEIC) to complete the program. Many students, however, preferred to focus solely on passing the TOEIC test, and resented the time required to prepare a presentation in English. Lessons mainly focused on TOEIC listening and reading skills, and consequently, there were few opportunities to train students to do presentations in English.

In April 2005, two engineering students (Shunzo Kawajiri and Arisa Fukushi) each volunteered to do a presentation abroad in English. Okuzaki, an English teacher in the General Department, acquired a grant from the school to investigate how to teach these students to do a presentation in English on their research in collaboration with their academic research supervisors. Okuzaki gave the two students individual lessons (about 30 hours each) on making a presentation in English including how to prepare slides, deliver a speech and answer questions in English.

Okuzaki obtained the co-operation of teachers in the School of Engineering at San Francisco State University (SFSU) to participate in evaluations of Japanese students. (Okuzaki was a visiting scholar at SFSU for 10 months from 1998 to 1999, and had made contacts in the School of Engineering.) On March 2, 2006, in San Francisco, California, the first evaluation was done by four teachers from SFSU's School of Engineering. Kawajiri and Fukushi gave their presentations in English about their research projects. They were assessed based on SFSU student evaluation scores with a range of 0 – 6 [0: not attempted, 1: unmet, 2: less than competent, 3: minimally competent, 4: competent, 5: skilful, and 6: highly skilful]. The students received 4.0 and 4.3 respectively which meant their presentations were assessed as competent.

Between 2006 and 2010, the project involved 11 students who volunteered and their 11 research supervisors at Hakodate NCT, and 15 faculty from SFSU's School of Engineering, as well as Engineering students as an audience. The project involved Japanese students and supervisors going to San Francisco in 2006, 2007, 2008 (twice), and 2010 (the project was interrupted in 2009 due to a swine flu outbreak).

Figure 1 below shows how the average of overall evaluation scores by SFSU teachers gradually increased during the five years of evaluations in San Francisco (Okuzaki, Sawamura, and Honmura, 2006), (Okuzaki, Mizukami, and Akiba, 2007), (Okuzaki, Mizukami, Akiba, Honmura, and Sawamura, 2008a), (Okuzaki, Hama, Obara, and Kawakami, 2008b), (Okuzaki, 2009), (Okuzaki, 2010), (Okuzaki, Moriya, Oyama, Kudo, and Kimura, 2011).

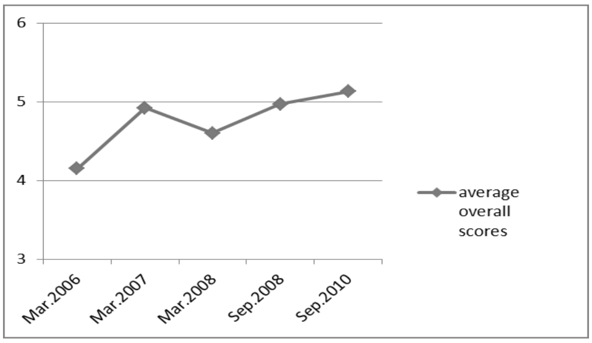

Fig. 1 Averages of Overall Scores of Japanese Students' Presentations in English in San Francisco Evaluated by SFSU Teachers

The following (a) to (e) are the findings related to the Inquiring Phase with student volunteers, their research supervisors, and SFSU faculty.

(a) Japanese students are able to do presentations in English successfully with 20 - 30 hours of training.
(b) In preparing PowerPoint slides, Japanese research supervisors should collaborate with the Business English II teacher to verify the presentation is organized and comprehensible.
(c) Students who have a TOEIC score lower than 450 (especially if lower than 200 in the reading score) often need extra help to finish their slides and speech scripts.
(d) Japanese students are able to compensate for their poor English listening and speaking skills with well-organized slides and non-verbal expressions.
(e) Japanese students should have the opportunity to practice their presentations at least three to four times, to ensure a successful presentation and question and answer session between evaluator, faculty and audience. Students should practice vocal variety, posture, eye contact with audience, and facial expressions, as well as pronunciation in English.

Intralaboratory Phase: 2008-2010

In 2008, a change of strategy was needed to deal with the costs of traveling to San Francisco. Some teachers proclaimed that school money should be used for the majority of students, not for selected ones. Okuzaki, as a member of the International Committee, proposed to invite teachers from SFSU to Japan as an international academic exchange and to visit each individual student's research lab at HCNT. Each student would have a chance to make a presentation in a familiar environment. It was also expected this would build a stronger relationship between SFSU teachers and Japanese teachers in the Engineering Department.

Between 2008 and 2010, which overlapped with the Inquiry Phase, teachers affiliated with SFSU visited Hakodate NCT. In 2008, Mike Strange (Mechanical Engineering) visited 21 labs and evaluated 26 students. In 2009, Dr. Wenshen Pong (Civil Engineering) and Anthony Marzo (Engineering Economics) visited 20 labs and evaluated 28 students. In 2010, Larry Klingenberg (Electrical Engineering) and Ms. Lou Ann Bassan (TESOL) visited 20 labs and evaluated 28 students.

Contrary to expectations, this intralaboratory phase did not have a positive outcome with the Japanese teachers and students. The following (f) to (m) are findings analysing the answers by teachers and students from questionnaires involving the intralaboratory phase.

(f) Without having met previously, Japanese students and teachers found it difficult to foster a learning atmosphere with SFSU teachers during their 15 to 20 minute visit, including the evaluation in a laboratory. (cultural aspect)
(g) Japanese research supervisors were required to guide students for their research presentation in a Japanese context, not English. It was rather an extra burden for many Japanese teachers to have SFSU teachers in their laboratories, especially when the SFSU teachers' areas of expertise were different from the ones of Japanese teachers. (work condition)
(h) For students, it was too demanding to do their English presentations in their labs for SFSU teachers as a volunteer project of the International Committee, after having already finished examinations and acquired credit for Business English II. The students did not like being required to study an additional period <u>after</u> the course completion. (curriculum)
(i) In a closed laboratory without any interpreter, Japanese students and teachers became highly anxious about their communication being correctly understood by SFSU teachers. (language barrier)
(j) Some Japanese teachers and students doubted that their research would be understood and fairly evaluated by the SFSU teachers, if the SFSU teachers were not familiar with the discipline or the particular area of

research. This was especially true because the Japanese teachers and students generally had a very narrow specialty within their discipline. The students influenced the teachers with their concerns, and the teachers themselves were intimidated by the SFSU teachers and their broader knowledge. (research motivation)
(k) Japanese students tended to feel complacency for their English presentations in a closed laboratory where they had no peer pressure or rivals. (learning model)
(l) Unless the project to do a presentation in English was established as a mandatory part of the course curriculum, many Japanese teachers and students did not understand the benefits of voluntary participation. Instead, the project was viewed as having to do extra work after having completed the Business English II course. By making the presentation in English a mandatory part of the curriculum, it was no longer viewed as "extra work." (learning motivation)
(m) In a closed environment, Japanese students were encouraged to speak English by SFSU teachers. (positive attitude fostered by SFSU teachers)

Through these findings, some new ideas (n) to (r) were developed to change the syllabus for teaching presentation skills in English to Advanced Course students on their research.

(n) An evaluator who has fundamental knowledge and interest in the individual engineering disciplines being evaluated is preferred by Japanese students and their research supervisors.
(o) Classroom setting rather than a closed laboratory cultivates student learning models and helps students learn from each other by activating peer pressure.
(p) A final presentation in English should be mandatory within the syllabus of Business English II. The presentation should involve both students and their research supervisors, so that the Japanese teachers, too, can learn from SFSU teachers, and be motivated to use their communication skills in English.
(q) In order to have Japanese research supervisors be involved in the English presentations project, the work requirement should be feasible and announced beforehand, at the beginning of the fiscal year.
(r) Developing a rapport between Japanese students, Japanese teachers and SFSU evaluators is necessary before the presentations in English are evaluated. Being evaluated by a visiting English-speaking faculty creates tremendous tension among teachers and students. It is necessary to foster a trusting educational environment before evaluation. Without a rapport, students are afraid of questions posed by the visiting teachers; and some Japanese teachers are afraid of making a mistake (in English) in front of their students and losing face.

Integrating Phase: 2011-2013

With findings and ideas acquired through the Initial and Intralaboratory phases, the syllabus was changed to be more "holistic" so that each student participated in an intensive workshop under the guidance of the SFSU teachers, prepared and revised his or her presentation materials in English, and mad the presentation to a full audience of faculty and peers. In 2011, 23 students were evaluated; in 2012, 29 students were evaluated; and in 2013, 19 students were evaluated. Some of the unique changes are described below from (s) to (x).

(s) Starting in 2011, the course time frame was changed from a 15-week course (April to August) to a 10-week course (May to July) with an additional intensive week in November. The first 10 weeks is taught by a Japanese English teacher, and the intensive week is team teaching, mainly instructed by SFSU teachers, assisted by the Japanese English teacher.
(t) In the first 10 weeks, Japanese students learn the fundamental aspects required for a presentation in English, focusing on the physical message, the visual message and the story message, in addition to English vocabulary and grammar, using two textbooks (Kiggell et al. 2008, Harrington & LeBeau 2009).
(u) Through peer evaluation of text presentation, students acquire an objective perspective about other classmates' presentations, which help them monitor and assess their own presentation. This is called peer effects (Hattie 2002, Mawlawi Diab 2010, Zainab Abolfazli Khonbi and Karim Sadeghi 2013).
(v) Putting an 8-week summer vacation between the first 10 weeks and the intensive week, students who are behind in their preparation for their presentations in English can be given supplemental coaching. Summer vacation provides flexible time for Japanese supervisors to guide students' research and their presentations in English, especially organization and expression of scientific concepts.
(w) School e-learning environment enables students to access former students' presentations in English on-line anytime through WebClass to familiarize themselves with the expectations of the learning goal by watching previous students' presentations.
(x) Also starting in 2011, the school policy changed so that all evaluations must be done by native English speaking teachers.

As for the intensive learning week, Klingenberg and Bassan, the teachers who participated in the final intralaboratory project in 2010, applied to teach the 2011 intensive week class. From 2011, they have been teaching the intensive workshop class collaboratively with Okuzaki. They understand Japanese students' English level, and are dedicated to teaching students with their professional teaching expertise. For example, they do not speak too fast, and they apply Krashen's theory of "i+1", and use simplified academic English (Larson-Freeman & Long, 1991). While teaching students how to make their presentation slides, Klingenberg focuses on checking students' slides if they make sense from the engineering professional's viewpoint, Bassan gives advice on using, and Okuzaki works as an interpreter between SFSU teachers and Japanese students. The intensive-week teaching has been implemented three times: 2011, 2012, 2013.

Although the time frame is limited to one week, the innovations by the SFSU teachers have made the students' learning styles and the atmosphere change positively and productively. The unique aspects which makes the intensive week teaching activity successful are described below from (y-1) to (y-14).

(y-1) On the first day, there is a formal introduction of teachers and students in the classroom. Each student gives a very brief autobiography and description of his or her project (in English). The teachers then give an overview of the intensive course and give interesting general reading material (in English) to the students, to encourage reading and speaking ability in English and to cultivate English language and American culture. Next the teachers give a lesson on the "do's and don'ts" of PowerPoint presentations, focusing on *the message* (what to say), *the medium* (how to use PowerPoint and various techniques and information organization), and *the mechanics* (body movement, voice and eye contact).
(y-2) In the classroom, each student sits at a network computer, with an empty chair next to him or her for a teacher. The teachers start at different points in the room. The teachers will sit next to a student and discusses his or her slides facing the computer monitor but not each other, thus lowering the anxiety by not staring at the student directly. Comprehensible input can have its effect on acquisition only when affective conditions are optimal. (Omaggio Hadley 1993)
(y-3) Once a student's presentation has been reviewed and approved as to engineering aspects by Klingenberg, a blue sticker will be attached to his or her computer. After review and approval by Bassan as to English proficiency, a pink sticker is attached. When both a blue and pick sticker are attached, it indicates project completion.
(y-4) In 2011, the intensive week was Tuesday – Friday. Presentation revision was done on Tuesday and Wednesday, and presentations were done on Thursday and Friday. It was too intense for everyone involved, and a solution was to change the days. Starting in 2012, the intensive week starts Wednesday – Friday, then Monday – Tuesday. Now, each student learns from both teachers on a one-to-one basis for three days from Wednesday to Friday for revision and practice.
(y-5) Students who have finished making their slides (and have been approved by Klingenberg and Bassan), practice Q&A session in a group with Bassan for the rest of the day. This activity is named "Hot Seat." This started in 2012 as in improvised activity. The group makes a circle and a chair is put in the center – the "Hot Seat." A student voluntarily takes the Hot Seat and answers questions from the group members. (At first, the students are afraid, shy, and embarrassed, but once the first brave volunteer is in the seat, the group relaxes and soon everyone is having fun and laughing!) Personal questions and research-related questions are provided by Bassan on slips of paper and participants draw one or two questions and read them out loud. The student sitting in the Hot Seat has to answer the questions, and make eye contact.
(y-6) In 2013, another innovation was started: Students who progress quickly on completing their projects are given a role as tutors helping classmates by asking questions on their slides, and preparing for discussions.
(y-7) SFSU teachers exhibited a flexible and fluid teaching style that was conducive to whole class management. It included adapting to students' learning styles and changing their teaching methods as needed, from individual setting of one-to one, to peer learning, to tutoring, to "Hot Seat," or to an *en masse* style whenever they assessed it was appropriate for students' learning opportunity.
(y-8) SFSU teachers offer English seminars after the end of the regular school day to Hakodate NCT faculty and staff depending on their needs. Through this academic opportunity, SFSU teachers help Hakodate faculty and staff to improve their English skills and to become more at ease with them and to bond with them. Each seminar is voluntary, small, intimate, informal and more friendly and less stressful to attendees.
(y-9) After three days of classes, the weekend follows, providing review and practice time for students.
(y-10) After the weekend, Monday and Tuesday are used for the presentations and the evaluations. Students are asked to dress more formally in business clothes. Each student's presentation is scheduled so that the research supervisors can be present to observe their student's final capstone presentation which should reflect well on the professors when their students receive really high scores. Japanese professors are encouraged to be present to observe their students.
(y-11) Students make their presentations in English, and engage in a question and answer session with the SFSU teachers, Japanese faculty who are present, and their peers – all in English. The written evaluation on their presentation is also in English by SFSU teachers. The presentations and evaluations are open to the public and the audience also asks questions in English.
(y-12) In 2011, students would arrive a few minutes before their presentation, make the presentation in a classroom, then leave, so there was no audience for the next student. In 2012, the syllabus was changed so that the presentations take place in the auditorium with a large screen, microphone and lectern. The entire class is required to participate as an audience by being in attendance for the presentations and evaluations all day together. Students are now required to attend the entire day of their presentation (optional to come for both days) in order to learn from the presentations by their peers, and to give moral support and to be an audience. Students from lower level classes are invited to observe the Advanced Course students' presentations in English as part of observing what will be required of them when they reach the Advanced Course level.
(y-13) At the end of each presentation, each student has a formal ceremony to receive a Certificate of Completion by the SFSU teachers, receives a gift, and has memory photos with shaking of hands.
(y-14) SFSU faculty has approved Mr. Klingenberg and Ms. Bassan to come to Hakodate NCT every year since 2010. These teachers have proved very effective for team teaching and are adaptable and innovative.

They are very sociable in the expected usual American custom, and open and friendly. It is appreciated due to Japanese conventionalism. The Japanese faculty are comfortable with the team teaching approach and now look forward to it every year.

Results and Discussion

In the past three years of the Integrating Phase, all the students taking Business English II have acquired credit and passed the evaluation by Klingenberg and Bassan on their presentation in English of their research project. Although a few students still have some difficulty during their presentation or in the Q&A session, most of the participants finish up their presentations with confidence and gain positive remarks by the SFSU teachers. Figure 2 shows the class size of 2011, 2012, 2013 and the standard deviation (STDV) of the evaluation scores respectively. The vertical axis shows the number of students and the STDV, and the horizontal axis shows the class year. As the STDV indicates a similar value every year, the evaluation process is not affected by the class size.

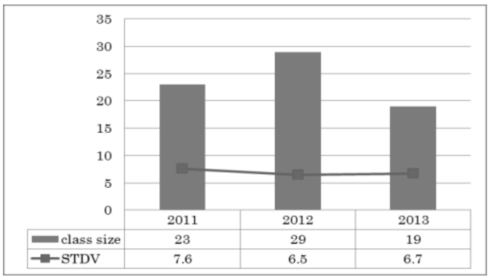

Fig.2 Class size and STDV between 2011and 2013

Figure 3 shows the average scores of the presentation evaluations between 2011 and 2013. Since 2002, every class taught at Hakodate National College of Technology has been assessed by a survey given to students. Students are given a questionnaire and asked to rate their overall satisfaction of the class, to rate the efforts of the teacher(s), and to give an honest self-assessment of their own individual effort in the class. (The school changed the questionnaire format in 2007.)

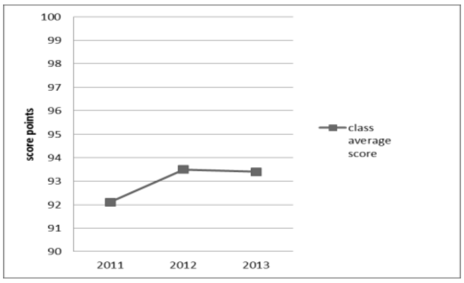

Fig.3 Average between 2011and 2013

Figure 4 shows the comparison of the results of Business English II questionnaire from 2007 to 2013. The vertical axis indicates a five-point scale (1-5) of the assessment. The horizontal axis indicates the year. (The overall score of about 4.5 is very good, as the average in other classes is usually only 2.5.) In 2012, the teachers' efforts were assessed lower than 2011 and 2013.

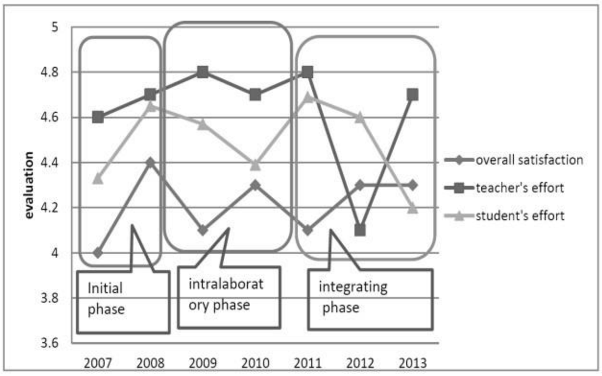

Fig.4 Students' Satisfaction Questionnaire Results

In 2012, there were 10 more students than usual (in integrating classroom situation). Also, starting in 2012, the school policy changed and a passing TOEIC score of 400 was no longer required. Therefore, some students were reluctant to study how to make a presentation in English. They thought it was beyond their ability to do a presentation in English about their research. They became unmotivated and fell behind. Then, teachers had to focus on students with a negative attitude toward learning English and encourage them. Consequently, students with a positive attitude were asked to do more by themselves during the class. In 2013, the class size became 10 students fewer than 2012, back to the normal number, and teachers made efforts to get closer to students through tasks individually and within groups. As a result, the teachers' efforts were appraised more highly than the previous year. In 2013, students' assessment of their own efforts were the lowest of the seven years of feedback. The students' written feedback in 2011 indicated students were satisfied with "doing" their first English presentation. The experience was rather the event of a lifetime for them. However, students in 2013 had a clearer vision about their future and anticipate they would do presentations in English more often in a work place or in an academic field. Students marking lower scale were not satisfied with their results. Students have given low self-assessment of their own individual efforts because they are aware of the importance of learning this skill, and students have become more aggressive and motivated in the past three years. Students had high expectations of themselves and their ability to present in English, and were disappointed in their scores and thought they should have done better. As a result, students realize they must try harder and be less complacent, and they are therefore more self-critical about their individual efforts in Business English II class.

Conclusion

Over the past nine years, with numerous innovations, Business English II has been recognized as the class which cultivates English presentation skills in Advanced Course students. Team teaching has been shown to be successful, mostly owing to the SFSU teachers' dedication and collaboration, and cultural awareness and adaptability. The key to success is not only the syllabus but the teachers who implement the syllabus. There is a great deal of cultural collaboration and contribution which is not expressed in the syllabus. The teachers make the lessons in English interesting and meaningful to complement the syllabus. The teachers are an essential role in the success of this class. It is much more cost-effective to have native English speaking teachers come to Hakodate because each year an entire class of 20-30 students prepares and makes a presentation in English. When students volunteered to go abroad, only three at most (March 2008) could go.

It is anticipated that there will be more innovations in 2014. First, the PowerPoint slides should be in a more completed version by the time the intensive week starts. Students will be encouraged early in the school year to become independent and to show initiative, which is not a typical Japanese personality trait, and to not be so reliant on supervisory professors and the English teacher. Second, a consistent flaw has been identified in that Japanese students write their text in Japanese, then use a computer to translate, leading to bizarre results in English. There has been an expectation that the native English speakers will "fix" the translations. The English text will be re-translated into Japanese so students can see the absurd result. Third, students in the same discipline will do peer review of each others' slides and English text. Fourth, supervisory professors will be encouraged to participate a great deal more and to practice interaction with foreigners to dispel some of the complacency that can happen from familiarity. This is important because at some point, the teachers may change and the stress factor must be minimized.

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Hakodate NCT/ Educational Aims:

A. Engineers possessing creativity and implementation ability

B. Engineers possessing fundamental knowledge of specialized technology

C. Engineers mastering information technology

D. Engineers understanding social history, culture and engineering ethics, and behaving themselves based on that understanding

E. Engineers possessing multifaceted communication ability

F. Engineers possessing design ability for problem-solving

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EFFECT OF ABDOMINAL BREATHING TRAINING ON JAPANESE STUDENTS' ENGLISH LEANING

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Abstract

Practical and sustainable training for abdominal breathing was developed to help Japanese students improve their English oral reading skills. This paper describes the purpose and objective of the training and reports the results of two months of practice with advanced course students in an English class. As the conclusion, the abdominal breathing training affected the students' postures, but did not affect their breathing expiratory flow rate.

Keywords: *abdominal breathing training, Japanese students, oral reading, English classes*

Introduction

For Japanese KOSEN (Colleges of Technology) students, English is an important mandatory subject because it is a requisite to become global engineers. However, students experience some difficulty learning English. English expression requires stress and rhythm to accurately convey meaning. On the other hand, Japanese is a mora language, mainly requiring pitches (Nakamori, 2010). For example, the Japanese pronounce the word, [ni · tsu · po · ng · go], with five units; however, native English speakers comprehend the word as having three syllables, that is, [nip-pon-go] (Torii & Kaneko, 1979). When learning a foreign language, many people experience interference from their mother tongues. (Nariai & Tanaka, 2010).

When the authors of this paper conducted an oral speed reading test to examine students' reading skills, several of them ignored the sound chunks[*1)] when they read the text(Shikano et.al., 2005) aloud. (See the examples below. [/] indicates a breath.)

Example1: Everyone should meet first in the gymnasium. Some/ final instruction will be given then.
Example2: we will raise a lot of much-needed funds for the / bands, the drama club, and our sports teams.

A hunched back[*3)] was a commonly observed feature among those students while reading. According to them, they took breaths at the [/] marks because they felt like they were suffocating. On hearing this feedback from the students, the authors arrived at the assumption that the students prioritized either the rhythm of their native Japanese or their ordinary breathing rhythm when reading and listening to English. According to Chafe (1988), a writer writes using the phonemes of his/her "inner voice" to express a personal auditory image employing the rhythm and tone of voice. On this basis, it can be assumed that the reader approaches writing using his/her inner voice to understand the writer's meaning. Denny (2000) explains that a control mechanism to regulate inspiratory volume during quiet breathing also influences breathing during speech. In addition, Nakamura (2009) shows that pauses while speaking in the Japanese language are noticeably longer than those when speaking in English. If the Kosen students apply the shallow and rapid breathing rhythms to their own inner voice while listening to and reading English, their inner voice would not be able to fully process English because of its deep and prolonged breathing rhythms. This situation might cause unnatural pauses in English sentences such as those seen in the above examples. Therefore, the authors established the hypothesis that Japanese students with shallow and rapid respiratory rhythms caused by their hunched backs cannot effectively listen to or read English because English words are pronounced with deep and long respiratory rhythms. In investigating this hypothesis, the authors also developed training to improve students' abdominal breathing for deep and prolonged English oral reading. This paper discusses practical and sustainable training for Japanese students' abdominal breathing, which was developed to better their English oral reading skills. This study describes the purpose and objective of the training and reports the results of two months of experimental practice with advanced course students in a 90-minute English class held once a week.

Development of abdominal breathing training

According to Tanigawa and Kato (2012), there are various breathing methods, such as the Western method, Buda method, and Yoga method. In this research, a yoga breathing method proposed by Gilbert(1999) was referred to because the theory emphaseized deep and prolonged abdominal breathing. Ms. Asami Shikauchi, who had been active as a professional yoga trainer in

Hakodate was hired for this research, and experimental practices were conducted from 2011 to 2012. In 2011, a group of six students in advanced course voluntarily participated in the experimental yoga practice four times after school from September to December (Okuzaki & Moriya, 2012; Okuzaki, Yamaya, & Moriya, 2012). In 2012, another group of six students participated in the experimental yoga practice five Saturday mornings from June to July (Okuzaki,Takeuchi, & Moriya, 2013).

Figure 1 Students at the abdominal breathing raining in 2011

Figure 2 Students at the abdominal breathing raining in 2012

Through the two-year-experimental practice of yoga training, effective poses were examined and 11 poses were selected for a classroom setting, about 40 students sitting at individual desks which are positioned near each other so that there is little room for standing or sitting on the floor. Figures 3¯13 show the 11 poses developed for the classroom training.

Figure 3 Maintaining a basic posture

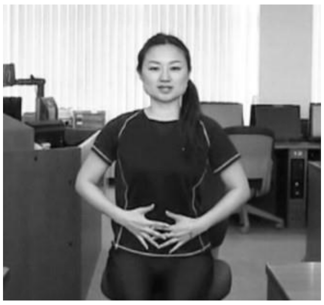

Figure 4 Abdominal breathing

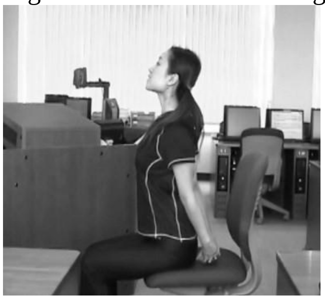

Figure 5 Stretching breast and back(1)

Figure 6 Stretching breast and back (2)

Figure 7 Stretching Shoulder joints (1)

Figure 8 Stretching Shoulder joints (2)

Figure 9 Stretching neck and elbows

Figure 10 Stretching body side (half-moon)

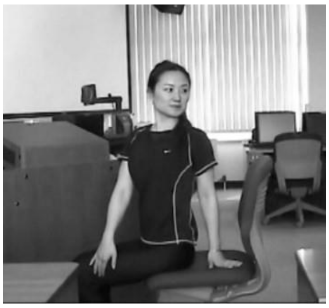

Figure 11 Twisting torso

Figure 12 Stretching body front (Fish pose)

Figure 13 Stretching Shoulder joints (3)

Each movement takes about four minutes to complete. As Hakodate National College of Technology provides 90 minutes for each one-credit class in advanced course curriculum. Therefore, the duration of each movement was carefully planned so that the entire practice and the English lesson do not exceed the allotted time for the class.

Experimental training for abdominal breathing

Experimental practices were conducted in 2013 with 19 students in their second year in an advanced course. The training was conducted 8 times from May 23 to July 9 in 2013. All of the students were informed of and agreed with the training objective to better their breathing function and participated in the exercise during their mandatory English class. Figure 14 and 15 show how they participated in the training during their class.

Figure 14 Exercising in class (1)

Figure 15 Exercising in class (2)

Some of the students' feedback on the training is as follows.

Student A: I learned a breathing method and about English presentation in today's lesson.

Student B: I felt tiredness while practicing abdominal breathing. I should keep in my mind to always breathe deeply.

Student C: I became aware of how to take a breath for English oral reading.

There was no negative feedback from the students on the training during their English class. The training objective was to let students reflect on their own breathing habits and gain practical knowledge of breathing exercises. The training seems to have achieved its objective for the students.

Effectiveness of abdominal breathing training

The students' postures were observed during the classes to see how they can be improved through the training. The training was conducted at the beginning of each class, and for the 85 minutes after the training until the class was over, the students were asked to maintain a good sitting posture. One student in particular, identified in this report as Student D, had a strong tendency to hunch his back while sitting on a chair (Figure 16), but kept his back rather straight throughout the class (Figure 17).

In addition, during the presentation performance at the end of July, Student D stood up straight, performed well, and spoke in a loud voice (Figure 18).

Figure 16 Student D’s hunched back in 2012

Figure 17 Student D’s straight back during class in 2013

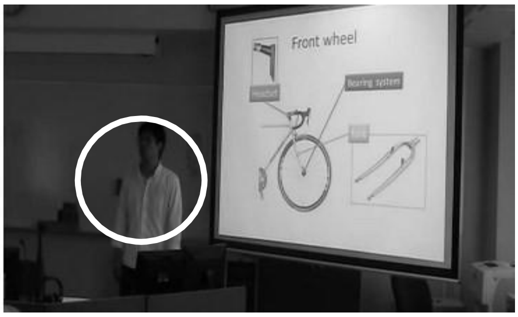

Figure 18 Student D’s posture during his presentation in July, 2013

However, during the second presentation held in November, three months after the abdominal breathing training, Student D reverted to his tendency to hunch his back (Figure 19).

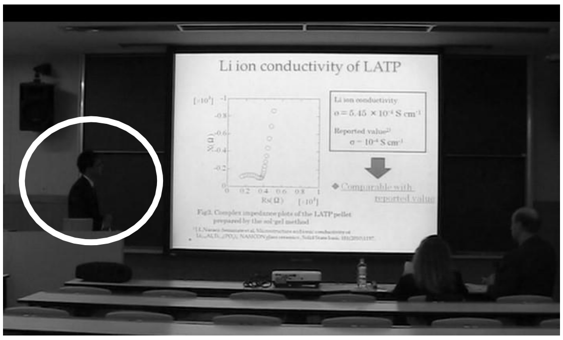

Figure 19 Student D’s posture during his presentation in November 2013

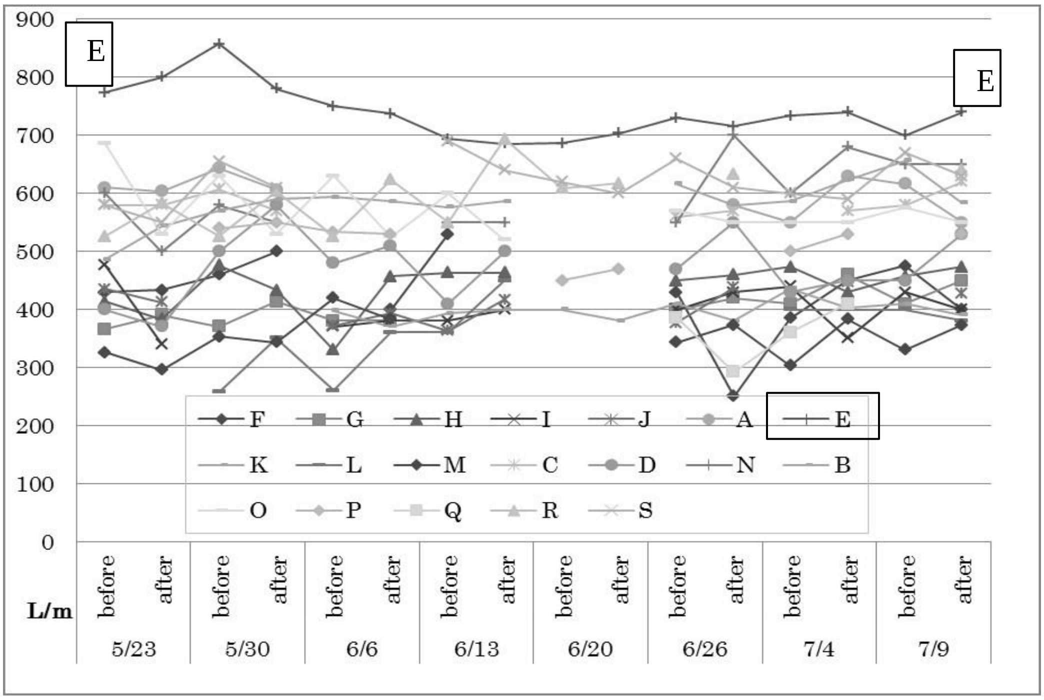

Figure 20 Students’ peak expiratory flow rate changes during each English class

The observation showed that the abdominal breathing training helped the students maintain straight postures only during the class, but after the class, the effect did not last on Student D. This implies that the training objective was not achieved for Student D, that is, it did not motivate him to keep his posture straight after the class was completed.

Figure 20 indicates the students' peak expiratory flow rate (PEFR) [*4)] changes during each class between May 23 and July 9 of 2013. In this study, a subject's PEFR was measured because it depends on the patency of the bronchial pathway of the subject (Sasaki 2008). A decreasing PEFR results from a weak breathing muscle (Takamasu & Ando 2008). Each subject's PEFR was measured three times, and the average value was recorded as his/her PEFR data. During each class, abdominal breathing training was conducted in the first 5 minutes, then was followed immediately by the English lesson. In Figure 20, *"before"* refers to the peak flow measurement right after the class started, and "*after*" refers to the peak flow measurement right after the class ended. On June 20, 14 students were absent from class because of their job interviews and university entrance examinations. Therefore, the figure does not show the data for those students.

Only one student, identified in this paper as Student E, completed the entire abdominal breathing training from May 23 and July 9 (framed explanatory item ─┼─). His peak flow rate ranged from 690 to 850 liters per per minute. An analysis of his data showed that the abdominal breathing training did not affect his PEFR because the values increased and decreased after each class and did not follow a specific pattern. There were no remarkable increases or decreases after class for the students during those eight weeks. Therefore, it is concluded that the abdominal breathing training affected the students' postures, but did not affect their breathing expiratory flow rate.

Next steps

According to Kashima and Hashimoto(2009, 2010), in teaching Japanese as a foreign language, the expiratory volume of a foreign Japanese learner differs from that of native Japanese speaker. They analyzed learners' inherent rhythmic phenomenon by focusing on their expiratory pressures and expiratory flow rates as physiological valuables. Foreign Japanese learners have a different average expiration rate transition and breath sustaining period from native Japanese speakers. They found that a native Japanese speaker fixes the total volume of pronouncing a word in advance and decides the air distribution values depending on his/her rhythm appealing condition and types of special mora in a unit involving the word. Mizuguchi & Yuzawa(2012) study the "audio-plasticity" of native Japanese speakers, who perceive English as a mora-counting language such as Japanese. Their study shows cases in which native Japanese speakers are not able to repeat some English words with one syllable and a complicated phonological structure. For example, a word "help"[help] is perceived as [he-lu-pu], with three syllables. Considering the expiration distribution value and the audio-plasticity of the students, the students took a meaningless pause for breath during their oral reading because of either a miscalculation of their total expiratory distribution or their listening problem. Those probabilities will be investigated in authors' next study. This study did not examine if the abdominal breathing training would have a positive effect on the four English language skills (i.e., listening, speaking, reading, and writing). The relationship between students' PEFR and oral reading should as well as the effect of abdominal breathing training on oral reading should also be examined.

Acknowledgement

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Additional Statement

This research was approved as making adequate provisions for the safety and privacy of subjects by the Life Ethics Committee of Hakodate National College of Technology.

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*2) My Trainer: English Trainer for School Use, (2005). *ICC*, p.39

Notes

*1) A current definition is given by Gobet et al. (2001): a chunk refers to “a collection of elements having strong associations with one another, but weak associations with elements within other chunks” (p. 236).

*2) O’Sullivan, K., O’Sullivan, P., O’Sullivan, L., and Dankaerts, W. (2012) find that the choice of the best sitting posture varies between countries, and disagreement remains on what constitutes a neutral spine posture and what is the best sitting posture (2012). However, in their paper, two out of nine sitting posture options were completely ruled out as the best postures by 295 physiotherapists. One of the eliminated postures was that with 32.7degrees of thoracolumber, 28.9 degrees of thoracic, and 7.6 degrees of lumbar and the other was that with 30.6 degrees of thoracolumbar, 26.9 degrees of thoracic, and 7.5 degrees of lumbar. In this study, postures similar to either of these, as identified visually by the authors, are referred to as a hunched back.

Example of a hunched back

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INVESTIGATION OF MECHANICAL SHOP BASIC PRACTICE FOR ENGINEERING EDUCATION IN NATIONAL COLLEGE OF TECHNOLOGY

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Abstract

Recently, engineering education programs are highly considered in some universities and national colleges of technology. Especially the practical engineering education of mechanical engineering in national college of technology which is required for the preservation of the Japanese high skill level in "monodukuri (=manufacturing)" fields. In recent years, older people who have supported Japanese monodukuri skills have retired from the field, and younger people do not have interest in monodukuri. This will cause big problems for the industrial fields in future. In this light, the best mechanical shop, the basic practice curricula are included to make young students of national college of technologies be interested in "monodukuri" fields. The authors have executed more practical mechanical shop educational curricula of "manufacturing hacksaw program" for the past seven years. During this time, creating a new type of educational program, the curricula of mechanical shop basic practice in 47 national colleges of technology, were investigated by using homepages and syllabuses of every college.

In the department of mechanical engineering of 47 national colleges of technology, the mechanical shops of more than three credits have been executed until the third year. 30% of the national colleges of technology are executing mechanical shops that are more than nine credits. The students there learned many practical themes like "lathe", "milling machine", "welding", "casting", "hand finishing", "NC machine". The results that the authors are most interested in are the curricula of 13 Colleges that have manufacturing programs to make products such as "hacksaw", "sterling engine", "table vise" and "can press machine". This research shows the direction of mechanical engineering education in the mechanical shop's basic practices. In conclusion, many national colleges of technologies have executed very practical programs to interest and educate students to become engineers who will support the Japanese monodukuri fields in the future.

Keywords: mechanical engineering, basic technique, mechanical shop basic practice, practical engineering education, lower year student, monodukuri (=manufacturing)

Introduction

Young people who have learned in national college of technology, especially have to take a skill of "monodukuri (= manufacturing)". Because technicians that graduated from national college of technology are expected to become an immediate contribution to companies in the future. So to train great students that take high level skills, teachers have to consider the education program of monodukuri. In our previous trials, teachers of Ariake national college of technology considered some programs of "Mechanical shop", "Experiment in mechanical engineering", "Graduation research" and "Mechanical design" to make students that take those abilities. When we consider that, three important key words that they have to remember are "practical", "special" and "creative". Many creative subjects have been tried by many national colleges of technologies and universities and so on. Now we say that "creative subjects" are executed as a "mechanical design" and "mechanical practice" in department of mechanical engineering of Ariake national college of technology especially too.

In these background, authors have executed more practical and educational mechanical shop basic practice curriculums of "manufacturing hacksaw program" for 7 years (since 2007). In this time, teachers considered an other mechanical shop curriculum to make better curriculums than "manufacturing hacksaw program" one. Then a graduation research student researched curriculums of mechanical shop basic practice that have executed at kinds of department of mechanical engineering in 47 national college of technology by using homepages, website and syllabus.

In this paper, the results that investigated about mechanical shop basic practice of 47 national college of technologies are reported.

Results and Discussion

Investigation about mechanical shop basic practice in 47 national colleges

At first, we investigated homepages and websites that show each subject curriculums and syllabuses of 47 national colleges of technologies which have department of mechanical engineering. Then we noticed that almost of national colleges have opened the syllabuses to the public.

Table 1 shows the results of credits and class execution conditions etc. of mechanical shop practice in 29 national colleges of Kyusyu area, Chugoku area, Tokai - Hokuriku area and Kanto - Koshinetsu area. In Kyusyu area, 9 national colleges which have department related to mechanical engineering execute “mechanical shop practice”, “manufacturing practice” and “monodukuri practice” since 1st year to 2nd year. For 3rd year student, only 4 national colleges execute that. Moreover, the credit number of each national college is almost “3” or “4” credits, the total credits until 3rd year is “8” or “9”. It is understood that mechanical shop practice of national college in Kyusyu area is very active since younger grade, as these results. At the case of Chugoku area, same tendencies are observed until 3rd year students.

On the other hand, in Tokai - Hokuriku area and Kanto – Koshinetsu area, 8 national colleges among 14 national colleges have executed the mechanical shop practice for 1st year student. Then its credits are “3”, this is a same number with Kyusyu area. At all of national college, a mechanical shop practice is executed for 2nd year student. Moreover, a mechanical shop practice for 3rd year student is keep executing with “3” or “4” credits.

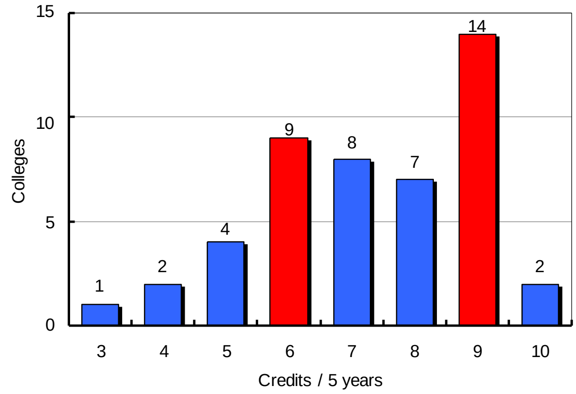


Figure 1 Credits number of mechanical shop practice for 5 years in 47 national college of technologies

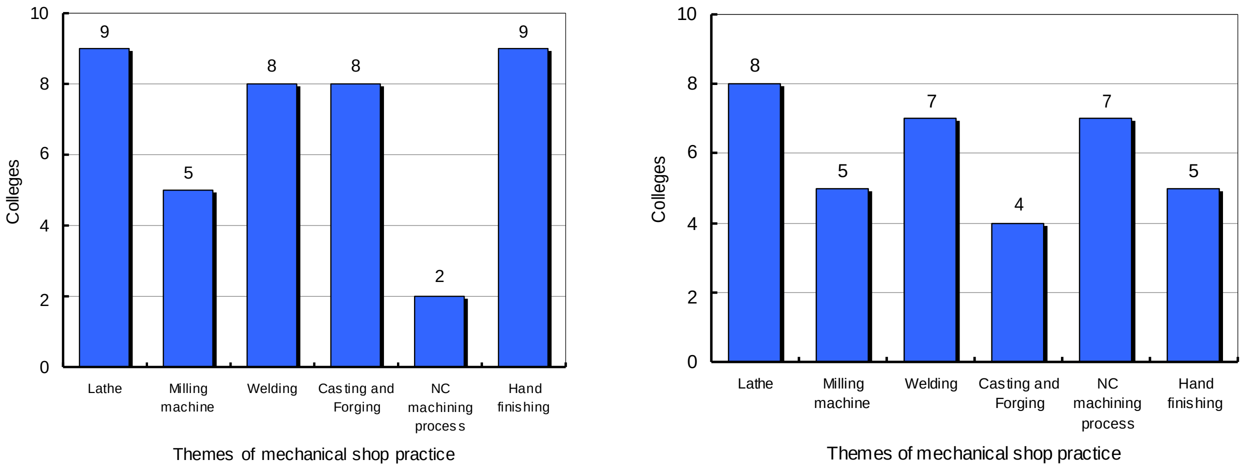
Figure 1 shows the credit numbers of mechanical shop practice for 5 years in 47 national college of technologies. National college of technologies that execute mechanical shop practice more than 6 credits are 85 % colleges. 16 national college of technologies are more than 9 credits, and these classes had executed since 1st year to 3rd year students. In the case of Ariake Kosen, the credit number of mechanical shop practice is “9” since 1st year to 3rd year, we can say that it is standard size. The reasons that national college have

Table 1 Credits and class execution conditions etc. of mechanical shop practice in a part of college of technologies

Kyusyu	1st year			2nd year			3rd year		
Kurume	機械加工実習1	3 credits	90h	機械加工実習2	3 credits	90h	機械加工実習3	3 credits	90h
Ariake	機械基礎実習	3 credits	30w / 90h	機械基礎実習	3 credits	30w / 90h	機械創造実習	3 credits	30w / 90h
Kitakyusyu	工作実習1	2 credits	2nd semester 15w / 60h	工作実習2	3 credits	30w / 90h			
Sasebo	機械工作実習	1 credits	1st semester 2h / week	機械工作実習	3 credits	3h / week	ものづくり総合実習	6 credits	6h / week
Kumamoto Yatsushiro C.	ものづくり実習１	4 credits	120h	ものづくり実習１	4 credits	120h			
Oita	機械実習1	3 credits	78h	機械実習2	3 credits	78h			
Miyakonojyo	工作実習	3 credits	90h	工作実習	3 credits	90h			
Kagoshima	工作実習1	3 credits	150m × 30w	工作実習2	3 credits	150m × 30w	工作実習3	3 credits	150m × 30w
Okinawa	材料加工システム1	3 credits	60h	材料加工システム2	3 credits	90h			

Chugoku	1st year			2nd year			3rd year		
Yonago	機械工学実験実習1	3 credits	30 weeks	機械工学実験実習2	3 credits	30 weeks	機械工学実験実習3	3 credits	30 weeks
Matsue	機械基礎実習1	1 credit	15 weeks	機械工作実習1	2 credits	15 weeks	機械工作実習3	2 credits	15 weeks
	機械基礎実習2	1 credit	15 weeks	機械工作実習2	2 credits	15 weeks	機械工学実習	1 credit	15 weeks
Tsuyama	機械工学実験実習1	2 credits	30 weeks	機械工学実験実習2	2 credits	30 weeks	機械工学実験実習3	3 credits	30 weeks
Kure	工作実習（ものづくり実習）	3 credits	30 weeks	工作実習	3 credits	30 weeks	工作実習	3 credits	30 weeks
Tokuyama	工作実習1	2 credits	5h × 6w	工作実習2	2 credits	5h × 6w	工作実習2	2 credits	90m × 30w
Ube	工作・電子実習1	3 credits	135m × 30w	工作・電子実習2	3 credits	135m × 30w	工作・電子実習2	3 credits	135m × 30w
			2nd semester 180m × 15w						
Fukui				機械工作実習	4 credits	100m × 30w	創造工学実習	3 credits	75m × 30w
Gifu	ものづくり入門	3 credits	30 weeks	機械工学実習1	3 credits	30 weeks	機械工学実習2	3 credits	30 weeks
Numadu				機械工作実習1	3 credits	30 weeks	機械工作実習3	3 credits	30 weeks
Ishikawa Toyota	機械工作法1A	3 credits 1 credit	1st semester 30h	機械工作法2A	1 credit	1st semester 30h			
	基礎実習	3 credits	90h	メカトロニクス実習	3 credits	90h			
Suzuka	機械工作実習	2 credits	30 weeks	機械工作実習	3 credits	6groups × 5w	総合実習	4 credits	30 weeks

Kanto and Shinetsu	1st year			2nd year			3rd year		
Ibaraki				機械システム工学実習	2 credits	32 weeks	機械システム工学実習	3 credits	32 weeks
Oyama	工作実習	3 credits	5groups × 5w	工作実習	3 credits	90 weeks (5groups × 6w)	工作実習	3 credits	90 weeks (5groups × 5w)
Gunma	工作実習	3 credits	5groups × 5w	工作実習　4単位	4 credits	5groups × 5w	工作実習	2 credits	5groups × 5w
Kisaradu	②製作実習1	2 credits	60h	③製作実習	2 credits	60h	④製作実習	4 credits	1st semester 30h
Tokyo				機械製作実習A	2 credits	60m / 2times in a week	機械製作実習B	2 credits	1st semester 4h × 15w
Nagaoka	機械工学実験実習	3 credits	30w / 90h	機械工学実験実習	3 credits	30w / 90h			
Nagano				工作実習1	4 credits	120h	工作実習2	4 credits	120h



(a) 1st year student (b) 2nd year student

Figure 2 Comparison of mechanical shop practice themes numbers in 1st and 2nd year student of Kyusyu-area

(a) Lathe (b) Milling machine (c) Casting (Sand molding die) (d) Hand finishing

Figure 3 Overview of mechanical shop basic practice for 1st year students in Ariake Kosen

Table 2 Themes of mechanical shop practice in national college of technologies of Kyusyu, Kanto, Shinetsu and Tohoku

Kyusyu	1st year						2nd year						3rd year					
	Lathe	Milling machine	Welding	Casting and Forging	NC machining process	Hand finishing	Lathe	Milling machine	Welding	Casting and Forging	NC machining process	Hand finishing	Lathe	Milling machine	Welding	Casting and Forging	NC machining process	Hand finishing
Kurume	●		●	●		●	●			●		●	●	●			●	●
Ariake	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●
Kitakyusyu	●		●	●	●	●	●	●	●		●	●	No class					
Sasebo	●	●	●	●		●	●	●	●	●		●						
Kumamoto Yatsushiro C.	●	●	●	●		●	●	●	●		●	●	No class					
Oita	●					●	●		●		●		No class					
Miyakonojyo	●	●	●	●		●	●	●			●		No class					
Kagoshima	●		●	●		●	●		●		●						●	
Okinawa	●	●	●	●		●			●	●	●		No class					

Chugoku	1st year						2nd year						3rd year					
	Lathe	Milling machine	Welding	Casting and Forging	NC machining process	Hand finishing	Lathe	Milling machine	Welding	Casting and Forging	NC machining process	Hand finishing	Lathe	Milling machine	Welding	Casting and Forging	NC machining process	Hand finishing
Yonago	●	●	●	●		●	●	●	●		●	●	●	●		●	●	
Matsue	●					●	●					●						
	●							●			●							
Tsuyama	●	●	●	●	●	●			●	●	●		●	●	●	●	●	●
Kure	●	●	●			●	●	●	●		●		●			●	●	
Tokuyama	●	●			●	●					●		No class					
Ube	●	●	●		●	●	●	●	●		●		●	●	●		●	●

less than 6 credits is approximately 35%, it is thought that a department of a national college that students are belong in 1st year is only 1 department. Therefore mechanical shop practice for department of mechanical engineering students can not execute in 1st year. And cause that starts since 2nd year to 3rd year, so credits of mechanical shop practice is less than 6. This is very important problem for us, because our colleges have to consider a restructure of subjects. Then teachers have mechanical shop practice have to remake the curriculums of that for 2nd or higher year students. Therefore, we think that the keyword of this problem is "model core curriculum for lower year students".

Figure 2 shows the theme numbers in mechanical shop practice for 1st and 2nd year student of national college of technologies in Kyusyu area.

In our previous consideration, teachers thought themes for lower grade students as 1st year and 2nd year students of national college. As this results, in 1st year students, shops of lathe and hand finishing are executed in all of national college as shon in Figure 2 (a). At next, shops of welding and casting and forging are executed in 8 national colleges. From these results, it is found that these themes are very important for manufacturing fields, because these are basic technics in their future work. A shop of NC machine process is executed in only 2 national colleges including Ariake Kosen. We have made a curriculum of NC machine process since 7 years ago, because teachers wanted students to take a skill making and reading NC codes from 1st year.

On the other hand, in 2nd year students, shops of lathe, welding and NC machine process are mainly executed, as shown in Figure 2 (b). It is understood that a shop of hand finishing decreased to the half colleges. As these results, national colleges that completed a curriculum of hand finishing for 1st year students start a curriculum of NC machine process for 2nd year students.

Figure 3 shows a overview of mechanical shop basic practice for 1st year students in Ariake Kosen. It is found that every students operate and work with each machines, tools and instruments. As shown in Figure 3 (a), students machine workpieces with a lathe. Students can acquire high technologies and skills by such an execution method of national colleges.

Table 2 shows the comparison of themes have executed in Kyusyu and Chugoku area. In national colleges of Chugoku area, a mechanical shop practice has been actively held too. Until 2nd year, 5 or 6 themes as lathe, milling machine, welding, NC machning and hand finishing process mainly execute, and in 3rd year, 50% colleges do not do the mecanical shop practice classes.

Themes of total manufacturing in mechanical shop practice

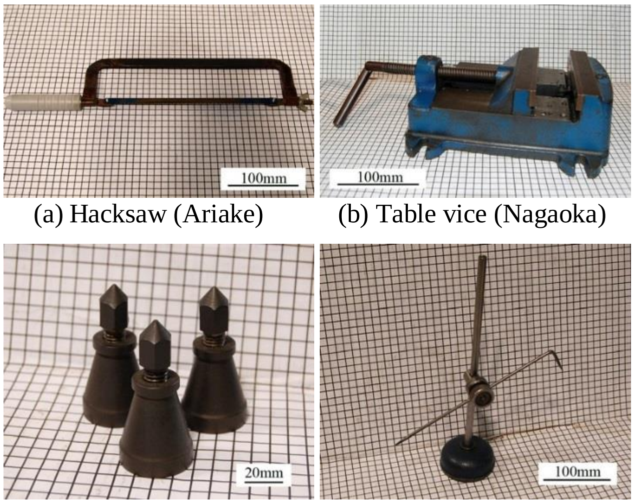
Table 3 shows the themes of total manufacturing in mechanical shop practice in 14 national colleges. When we investigated syllabuses of 47 national colleges, it found that 14 national colleges have curricurums of total manufacturing program for mechanical shop practice. These themes are table vice, small jack, scribing block, stering engine and so on as shown in table 3. In addition, these total manufacturing programs are executed for minimun 5 weeks to maximum 30 weeks (1 year), each college have an original execution method.

Figure 4 shows the overview of products manufactured in total manufacturing curriculums in mechanical shop practice of national colleges. These products are not real products manufactured in each college, these are similler products are in Ariake Kosen. Hack saw is the manufactured products in Ariake Kosen, it is consist of 6 parts machined by a lathe, milling machine and auto spot welding machine, and assembled in hand finishing process. Table vice is consist of 4 parts, small jack is 3 parts and scribing block is 5 parts. It is thought that the common points selected as the product of total manufacturing program are few parts and many machining processes to manufacturing each parts as shown in table 2. By these total manufacturing programs, students are able to learn the machining and finishing process to make one product. However they have to take a basic skills to execute total manufacturing in mechanical shop practice of lower year.

In Ariake Kosen, the "manufacturing hacksaw program" have executed for 2nd year students since 2007. This curriculum is consist of a half semester of

Table 3 Themes of total manufacturing in mechanical shop practice

College	Products	Times
Ariake	hacksaw	15 weeks (2nd semester)
Kitakyusyu	small jack	15 weeks
Sasebo	gear speed reducers	30 weeks
Kochi	face jack	15 weeks (2nd semester)
Yonago	scribing block	5weeks
Tsuyama	machine vise	30 weeks
Kure	bench drilling machine, press machine mogura tataki, UFO catcher	15 weeks (2nd semester)
Nara	scribing block, name plate leveling block, shaft, drop needle tool	30 weeks (6h × 5theme)
Suzuka	simple adjuster	5 weeks
Gunma	sterling engine	5 weeks
Nagaoka	table vise	15 weeks (2nd semester)
Sendai	sterling engine	30 weeks
Tsuruoka	universal ball joints	3 weeks
Asahikawa	oscillation Engine	90h



(a) Hacksaw (Ariake) (b) Table vice (Nagaoka)
(c) Small jack (Kitakyusyu) (d) Scribing block (Nara)

Figure 4 Products manufactured in total manufacturing curriculums in mechanical shop practice of National colleges

[Attention] These products shown in pictures is not real products that are made in each national college

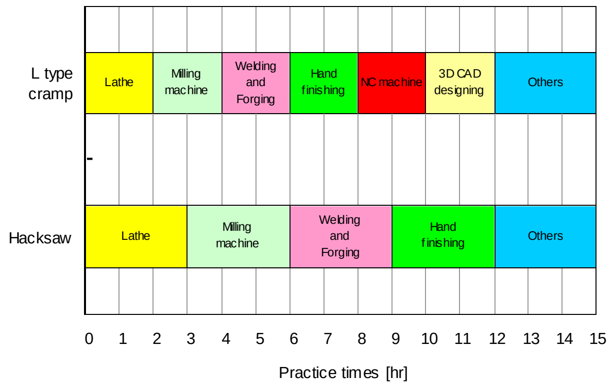


Figure 4 Changing of time allotment in total manufacturing practice of Ariake kosen

2nd year, students make 6 parts with lathe, milling machine and so on. To make more practical and effective total manufacturing curriculum that students can take skills and much interests teachers examined it with results as shown in table 2 and 3. The product is examined in this time is the "manufacturing L type clamp program". Figure 4 shows the time shift changing of L type cramp manufacturing curriculum and hacksaw one. As shown in figire 4 bottom, in manufacturing hacksaw curriculum, 4 themes that executed until 1st semester of 2nd year are done to make hacksaw. That total times are 12 hours and other 3 hours is used to design new type products with hand drawing. On the other hand, in manufacturing L type cramp curriculum, 6 themes that adding 3D-CAD design and NC machine to 4 themes of hacksaw manufacturing are executing to make one products. This curriculum is the plan to do at next time. If we have some kinds theme as total manufacturing curriculum, it is thought that teachers are able to lecture much skills to students, and students are able to have much interests for monodukuri.

Conclusions

In this paper, the results that investigated about mechanical shop basic practice of 47 national college of technologies are shown. The main conclusions obtained as follows;

(1) The mechanical shop practice of national college in Kyusyu and Chugoku area is very active since 1st year. At the case of Kanto and Tokai area, tendency to start mainly since 2nd year are observed cause of college system.
(2) The credit numbers of mechanical shop practice for 5 years in 47 national college of technologies are more than 6 credits are 85 % colleges. 16 national college of technologies are more than 9 credits, and these classes had executed since 1st year to 3rd year.
(3) Themes for lower grade students as 1st year and 2nd year students are shops of lathe, welding and hand finishing mainly. Since 2nd year, NC machine process starts instead of hand finishing that finish until 1st year.
(4) 14 national colleges have curriculums of total manufacturing program as kinds of products can manufacture for 5 weeks, 1 year for mechanical shop practice.

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STUDENT SELF-ASSESSMENT AND LEARNING STYLE PREFERENCE FOR TECHNICAL ENGLISH LANGUAGE ACQUISITION

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Abstract

This is a preliminary study that examines how students perceive their own English ability, and between the two types of learning styles employed, which they prefer. This paper also examines correlations between a student's self-assessment, peer-review, and teacher's assessment. Two different learning styles are adopted in the English for Engineers course at the National Institute of Technology, Kagawa College. During the lesson block for English for Engineers class, two lessons are given. The first lesson is based on regular direct instruction and taught from a textbook in a lecture format. The second lesson is activity/project based in which student teams of two or three members are given a mock research task to create an invention, implement it with LEGOs and give a multimedia presentation in English on their invention. The presentation format is very similar to the NIT, Kagawa College graduation research presentations where the teams present background information, problem statements, methods, results, and a conclusion for their mock research project. There is also a short Q&A session in which other students may question the presenters in English. Students evaluate their own as well as all of the other students' presentations.

While the overall average score of the peer evaluations was very close to the instructor's evaluations, the students' individual self-evaluations were much lower than both the peer and instructor's evaluations. Further study is needed to determine the reasons for this inconsistency. As for their learning preference, students indicated on a scale from 1 to 5 their preference for the direct instructional lesson versus the activity and project based lesson and explained their choice. The survey showed that the students preferred the activity and project based lessons over the direct instructional lessons. However, when surveyed directly on which type of class structure they preferred, students preferred the current lesson block consisting of one direct instructional class and one activity/project based lesson. These findings could be applied by remodeling the NIT, Kagawa College first, second, and third grade English curriculum to something similar to the Advanced Course English for Engineers course.

Keywords: *English Teaching, English for Specific Purpose, Teaching Communication*

Introduction

Motivating Japanese engineering students to study English, everyday English and English related to their fields of study, remains a big hurdle for the English teachers at many engineering institutions. The lack of motivation in students seems to be the result of various social and cultural factors as well as previous personal experience (Burden, 2002; Falout & Maruyama, 2004; Matsuda, 2004; O'Donnell, 2003; Warrington & Jeffery, 2005; Yamashiro, 2001). The studies indicate that the root of lack of motivation stems from lack of self-confidence and a negative appraisal of one's own ability and that this, in turn, are the results of negative past personal experiences during junior and senior high school that include teaching-to-the-test based English curricula and other factors of a social and cultural nature (R. A. Brown, 2004; McVeigh, 2001; O'Donnell, 2003). In order to reduce or counteract some of these stigmas and to improve technical English language acquisition among the NIT, Kagawa College Advanced course students , an alternative curriculum including other than just the traditional direct instruction model was proposed. Alternative forms of assessment were also explored in hopes to build student self-confidence and reduce peer anxiety.

The English for Engineers Course at NIT-Kagawa

First year advanced course students at NIT, Kagawa College are required to take a one semester “English for Engineers” course. The class is a two 45 minute block held once per week. A few years ago, in an attempt to improve the effectiveness of the course, the two-period lecture was divided up into one period of lecture (teacher centred) direct instruction and one period of activity and project based learning (student centred).

Direct Instruction Period

The direct instruction period is based on and taught from the textbook, "Integrated Technical English", authored by Terry Phillips, Kenji Hitomi, and Eiichi Yubune and published by Seibido. Each lesson consists of three sections a vocabulary section, a reading section, and a listening section. The vocabulary and reading section are to be completed before the unit lesson for that period.

During the lecture period, technical English instruction is given and the answers for the vocabulary and reading sections are covered. In the going-over-the-questions time, students volunteer to give answers in English over a microphone to the rest of the class. In order to promote speaking more English during class, students are awarded a participation stamp for each time they volunteer. The decision to use this participation points system was based on the data acquired from a study done on the NIT, Kagawa College first grade English course (Fujii & Johnston, 2011).

Activity and Project Period

The activity and project period (Figure 1) is based on students building projects based on various LEGO sets while communicating in English. During the first four weeks of the course, in pairs, students take turns instructing the other in English, how to put the particular LEGO model together. Students switch every five minutes at which time everyone is asked with what words and phrases for how to say something are they having trouble. The rationale for this type of activity would engage students in active learning and not only be learning the English words and grammar but also patterns, relationships and application (Bonwel & Eizen, 1991).

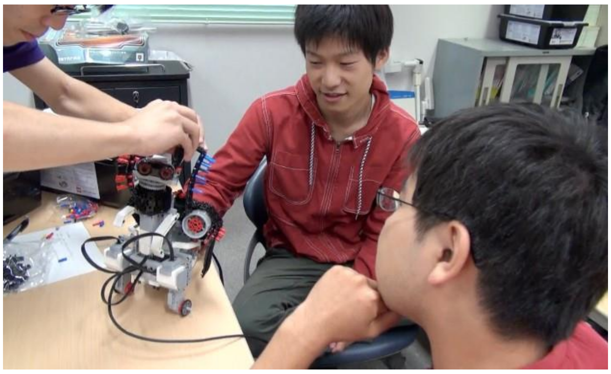

Figure 1. Activity Based Lesson.

Over the remaining 12 weeks of the semester, the students engage themselves in two six-week projects. Both projects have the same theme; To research and invent something new that would solve some problem or be economically stimulating for the local area and create and present a multimedia presentation about their invention in English (Figure 2).

Figure 2. English Presentation.

Data Acquisition

During presentations, along with the instructor, students evaluate their own as well as their peer's presentations. The presentation evaluation sheets are based on the NIT Presentation Contest judging sheet in which English, Organization, Visual Aids, and Teamwork are given weighted marks totalling 30 points (Figure 3).

Dr. Shiozawa
Mr. Johnston
English for Engineers

Student Administered Evaluations of 2014-2015 Presentation 1

Group #	English	Organization	Visual Aids	Teamwork	Total
Weights->	x3	x3	x2	x2	*(30)
1	2	2	3	3	24
2	3	2	2	2	22
3	2	2	2	2	20
4	2	2	3	2	22
5	3	3	2	3	28
6	2	2	2	2	20
7	2	2	3	2	22
8	3	3	2	3	28
9					
10					
11					

*Score each category from 1~3 and multiply by the category weights

[redacted]

Figure 3. Presentation Evaluation Sheet.

After mid-term exams, students were given a Mid-Term Student Self-Assessment (Figure 3) in where they rate their vocabulary and fluency growth for each of the two types of lessons as well as how they rate each type of lesson along with comments. Students were also asked to comment on whether they preferred two text based lessons, two LEGO activity based lessons, one lesson of each type for the course block or no preference.

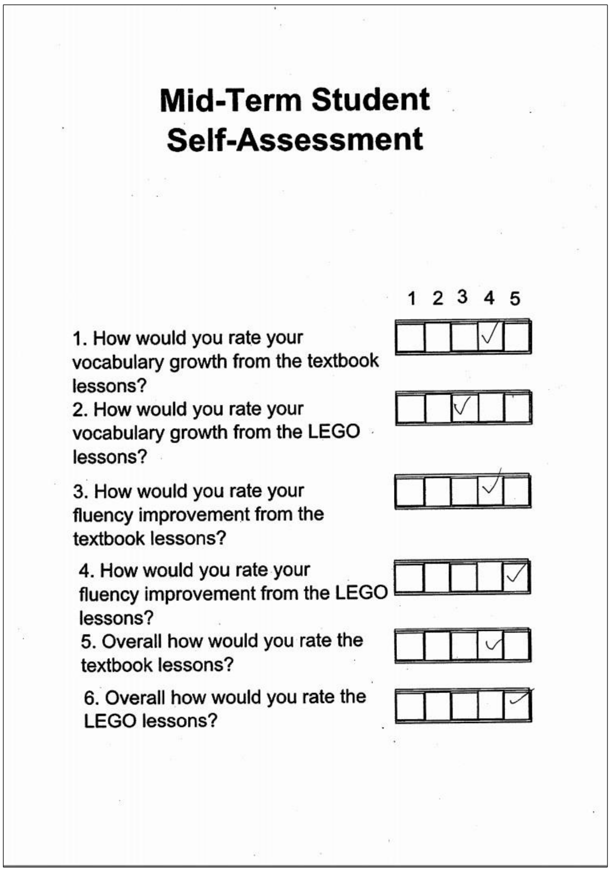

Figure 4. Mid-Term Student Self-Assessment.

Also a final learning preference inventory (Figure 5) for on a scale from 1 to 5, 1 being 100% preference for direct instruction and 5 being 100% preference for activity and project based instruction was administered.

Results and Discussion

English Presentation Results

Upon review of the English presentation data, the overall average score of the student peer and self evaluations averaged 26.33 points out of 30 with an average standard deviation of 3.56. The instructor's evaluations of the student presentations averaged 26.63 out of 30 points. Students' presentation self-evaluations averaged 22.94 out of 30 points (Table 1).

This data seems to indicate a few things. While there seems to be some deviation in the scoring among students peer evaluations over all, on average, students seem to evaluate their peers English presentation performance at very close to the same as that of the instructors English presentation evaluations. However, students English presentation self-evaluation scores were much lower than both the peer and instructor English presentation evaluation scores.

Table 1. English Presentaion Evaluation Scores.

ENGLISH PRESENTATION EVALUATIONS

GROUPS	AVERAGE	STDEV	INSTRUCTOR	SELF
1	25.76	3.65	25	24.50
2	26.19	3.62	27	21.00
3	25.76	3.80	27	20.67
4	25.76	4.16	24	27.00
5	28.82	2.01	30	25.00
6	24.76	4.45	25	19.50
7	24.65	5.06	25	21.00
8	28.94	1.71	30	24.50
AVERAGES:	**26.33**	**3.56**	**26.63**	**22.90**

While uncertain as to why, it could possibly be something related to cultural or social factors. Whether it has to do with East Asian culture or Japanese culture, country side culture or youth culture can't be determined from this data.

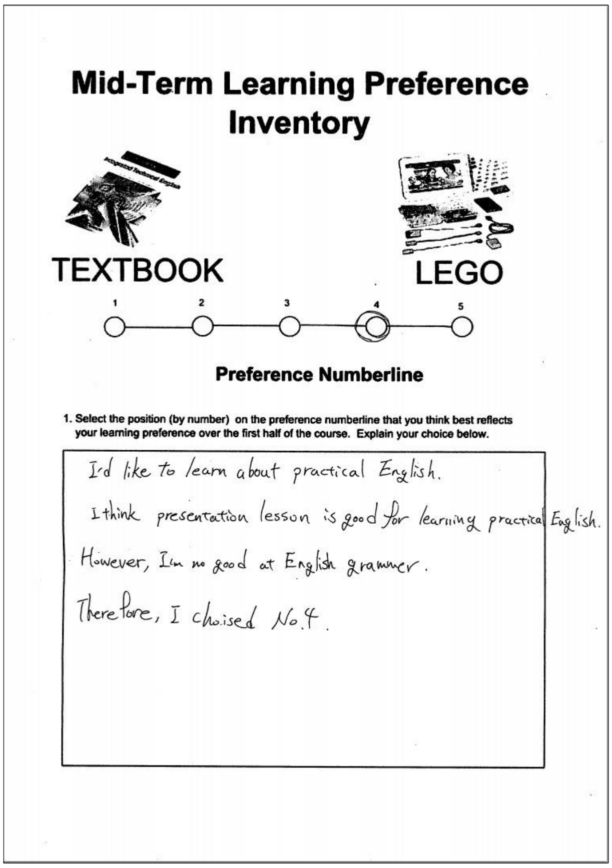

Figure 5. Learning Preference**.**

Mid-Term Student Self-Assessment

Upon review of the Mid-Term Student Self-Assesment data, some interesting trends can be observed. For self-evaluation of how well the students felt that they improved in vocabulary from the text book lesson, on a score of 1 to 5, the average was 3.6 with a standard deviation of 0.91 and for the LEGO class, the average was 3.53 with a standard deviation of 1.19. As for self-percieved improvement in fluency in the text based clase, the average was 3.40 with a standard deviation of 0.83 and for the LEGO class, the average was 3.67 with a standard deviation of 1.18. Finally, in an over-all rating of the text based lesson, an average score of 3.40 with a standard deviation of 0.74 was given and the LEGO lesson recieved an average score of 4.07 with a standard deviation of 0.96.

This shows that students felt that they achieved better growth in vocabulary in the text based class but felt that their fluency was most increased during the LEGO class and that students also gave the LEGO class a better over-all rating.

However, the difference in standard deviations show that the students tend to agree more on how they rate the text based class as opposed to the LEGO class. This could be due to the fact that the students are more accustomed to the text based class similar to those experienced in Japanese junior and senior high school. Similarly, that students have had limited experience attending an activity based classes could be the reason for the greater deviation in the ratings for the LEGO classes.

As for the comments as to the type of course block that they preferred, 11 students preferred one lesson of each type with many comments that they thought that the current course block was good or the best style for them. 3 students commented that they preferred 2 periods of the LEGO project based lesson, with comments that the lesson was very fun and that they felt it was easy to acquire more engish. One student replied that they had no preference.

Mid-Term Learning Preference

Upon examination of the learning preference survey it was found that with a standard deviation of 0.90 and an average of 3.67 on a scale from 1 to 5 with 1 being 100% preference for the text based lesson and 5 being 100% preference for the LEGO based lesson, students prefer the LEGO lesson by a small margin.

Conclusions

From looking at the results, it is clear that a few things can be inferred. From the presentation assessment data the students clearly seem to have the ability to accurately assess their peers English proficiency but appear more critical and reluctanct when assessing themselves. This raises some questions as to why this is so and also if this affects their own self-motivation to study English. Is this because of some culturaly based courtesy giving others higher praise than one's self or do they really see themselves as less proficient? If so, does seeing themselves as less adequate motivate them to study harder or turn off their desire to continue to grow in English proficiency.

From the learning style preference and mid-term self-assessment data it can be concluded with confidence that the students on average enjoyed the LEGO project based lessons more than the text book based lessons and on average felt more improvement in over-all English ability during the activity based class. However, the majority, when asked to comment on what type of course block they preferred, instead of stating that they preferred 2 periods of LEGO project based lessons, students stated that they prefer 1 period of each type over the two period block. Students' responses show that they felt that the text book lesson did better to improve vocabulary while the activity based lesson did more to improve fluency. As such, it appears that the students have a realization that while the activity based lesson is more enjoyable, they feel that learning English requires both styles of lessons to more adequatly cover these two aspects of English language acquisition. Since it appears that this style of one text based, one activity based two period-per-week course is preferred by the students of this course, it may also be preferred by the students of other two-period-per-week courses such as the high school 1st, 2nd, and 3rd year English courses.

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AN ATTEMPT OF "SOCIAL IMPLEMENTATION" STYLE FINAL PROJECT FOR ENGINEERING EDUCATION

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Abstract

Applying and extending of research and development results to address specific social problems is called "social implementation"(Editorial Board of Area results report (2013)). In this presentation, we are going to propose a social implementation type final project at National College of Technology (KOSEN): By ensuring the relationship between students and the real world, teachers are aiming to educate highly creative engineers with generating new value based on manufacturing technology. The implementation approach is similar to a manner of problem-based learning. Difference between these two education styles is that students have an experience of implementation process in the former case. In this symposium, our first trial to apply social implementation type research guidance will be reported. Through this project, students tried to resolve the request by repeating the discussions with the client in the real world and the search for solutions with their active learning and production work by trial and error. Furthermore, we will discuss the role of teachers should play to the success of the voluntary efforts of the students.

Keywords: *Social Implementation, Final Project, PBL, Active Learning*

Introduction

In higher education institutions, including colleges of technology (KOSEN), education various techniques which aims to break away from the education of conventional packing type has been attempted. A typical example is the introduction of Active Learning and PBL (e.g., Hasegawa et.al., 2010, Hayashi, (2010)). To date, there is an "social implementation (SI)" approach in one of the new initiatives. The social implementation is a approach that utilizes and develop social research and development results, to solve specific problems in society (Murakami et.al. (2013)). To sniff out the needs and potential problems, direct interaction with the user is required to engineer by visiting the site. In addition to that, while interpretation engineered the words engineer issued by the user, and to solve engineering technology is required. And, in the SI approach, the students experience the social implementation process consisting circulation of dissemination of information related to the solving process and user evaluation. Through this process, SI approach is aims to engineer training that can be created with society to a new value based on "monodzukuri" (e.g. Asano (2003)). Here, what bridge between the real world and students hold the success or failure of this approach. By faculty members actively involved in collaboration with off-campus organization or site where there are problems, it is possible for students to jump into the real world.

The authors practiced efforts of SI approach in last year final project. Target of the implementation was the students of elementary section (severe and multiple disabilities) 3rd course in Kumamoto Prefectural Kuroishibaru special needs school, which is adjacent to the Kumamoto National College of Technology. And we have set as a challenge to the development of auxiliary equipment and educational materials. Postgraduate research supervisor of our two people have cooperated and led the efforts of four technical college students. While repeated discussion with us and classroom visitations of special needs schools for needs assessment and problem identification, students were depth of theme. Teachers from teaching faculty and special needs school, a strong commitment to be cast questions or comments to various devices and services proposed by the student. Namely, As well as pay attention to not directed to a particular theme, teacher respected awareness of students. Research themes graduation students narrowed down finally, was something technically difficult for the teacher from a special needs school. In addition, it was be appropriate to exert the power of technical college students that specializes in "monodzukuri". In the development process, we were able to confirm that students learned new knowledge, and extended communication skills and the ability to solve problems through the development process.

In this paper, we aim to be a reference of education introduction of "social implementation", shows the history of cooperation with Kumamoto Prefectural Koroishibaru special needs school and the process of SI approach. Then, efforts leading up to the implementation of the development of educational materials and support equipment are described. Then, we discuss precautions when implementing SI type education and its effect.

Develop a Solution to Capture the Needs

Practice Process of "SI" approach : SI approach is the attempt to solve specific problems in society, largely composed of four steps, as shown in Figure 1. It progresses from left to right, a state in which phase of the implementation society has progressed.

Step1 is the process to understand the needs and the discovery of the problem by the students travelled to the scene, and to interact with or observe the user. The role of the faculty is to promote awareness by students. There is a problem often encountered during the interviews. It is that there are students make mistake to capture the essence of the problem too listening to an intuitive user. Not only that, such students are apt to focus on eliminating the phenomenon superficial. In such a case, it must be guided students to study in depth the event since the user how appealing way. In addition, there is a need to encourage students to replace the representation engineering and logical words generated by the user. Teachers should be lecture to students in advance for information arrangement technique such as the KJ method and the brainstorming are valid to be the help.

Step2 is the process of the invention of equipment and services to solve the problem. At the same time, it is necessary to consider in advance how to evaluate the implementation of the future invented equipment. If it is determined that the understanding of needs is insufficient, to perform the extraction of needs again return to Step1. Furthermore, at this point, it is preferable to estimate a concrete schedule for the implementation. In the next stage Step3, students repeat the creation and evaluation of the prototype in the laboratory level, is fed back to the Step1, Step2 depending on the results.

After finishing the laboratory development level, students travelled to the site of origin needs to perform the evaluation and demonstration have implemented a prototype (Step4). Student attempts to implement beyond the repetition of improvement while being subjected to rigorous evaluation and joy of the user. Of course, it is possible to go back to Step1 ~ 3 as a result may also occur. However, by going through the process described above, students can go to refine their own problem-solving proposal.

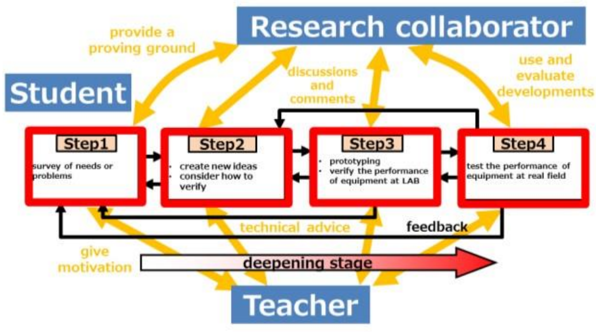

Figure 1 Social Implementation Process

From the point of view of implementation, it is considered Step4 as an important process, but we consider that the most important process of Step1 is a source that produces a solution to capture the needs in our effort. There was a tendency for students of our school prefer technology-oriented projects, while those project remains discussion of the ripple effect and impact of technology on socially has not been enough in many cases. In place to produce a solution by with discovering problems and specific needs, and adding new knowledge to the knowledge learned in the lecture, there is a charm of the SI approach.

Cooperation with Kumamoto Prefectural Kuroishibaru Special Needs Schools:

As it can be seen in Figure 1, in the education by SI approach, off-campus collaborators is deeply involved in all Steps from the needs assessment to implementation. Accordingly, the teacher should do first, is that, as may proceed smoothly process shown in Figure 1, to provide students with environment for information exchange densely External collaborators and students. In order to achieve this, two approaches of bottom-up or top-down can be considered. The top-down method, the conclusion of agreement or memorandum of understanding, such as the foundation of the cooperation with external organization can be considered. However, agreement relationship building difficult under the circumstances is not a reciprocity or if sufficient mutual understandings are not obtained. On the other hand, it is one approach bottom-up is that going to spread upstream to establish a trust relationship on the ground level, such as off-campus co-workers and teachers.

Upon SI approach, we examined the measures for organizing entity for the current situation and exchange of Kumamoto Prefectural Kuroishibaru special needs schools and NIT Kumamoto College, to deepen understanding of mutual recognition as follows.

(i) There is precedent technology provides ever, but was intended to be applied to continuity.

(ii) It can be classified into two categories of needs. Namely, a class of needs is required for responsiveness, and the other class of needs for which correspondence is difficult for teachers of special needs school but take longer.

Start time of this effort was the middle of June 2013. We determined that it is hard to wait for the conclusion of the exchange agreement, considering the time required for administrative procedures. So at first, our technical college principal makes a request for cooperation with the principal purpose description of Kuroishibaru special needs school. Next, the authors set the meeting vice principal of special needs schools, and teachers of Elementary, where we explained again the purpose of the SI approach education for KOSEN students. Thus, under the approval of both schools principal, the cooperation of the field level has been started.

First, the authors have been performed for solving the problems (i) as mentioned above to be a point of contact continuously. Further, by cross participate in ceremonies or cultural events both schools, the density of the interaction is enhanced between the parties concerned. Besides this, we visited frequently to take students in order to build a trust relationship, so as to feel free to contact each other at the opportunity of something. For example, in a cultural festival special needs school, students have made an exhibition of self-made equipment. By the article was published in the local newspaper, social awareness about this activity was enhanced (Figure 2).

For problem (ii), we decided that students working on SI type final projects do not correspond to the repair of equipment and materials in support school. Instead of those students, \ we arranged the cooperation of the students who were participating in the robot competition for such a consultation and repair of equipment already used in school support.

Development of Teaching Materials and Support Equipment

Four students led the authors to participate in SI type graduation study mount in last year. And they developed for three main themes.

Matching learning materials "HANTA-KUN":

In the special needs schools, matching learning activities represented by "figure matching" and "shape matching" has been carried out. The feature is that it is possible to enhance the recognition performance by using haptic and visual. However, the difficulty of the work to fit the block into a suitable flame for students with disabilities of the upper extremity is high. This learning activity is not easy task as well for student who recognize only to planar objects. Then, through discussions with the teachers of special needs school, college student thought stimulation from production by the image and voice might be leading to improve the ability and to encourage the motivation of students of special needs school. As a result, the general-purpose matching learning material "HANTA-KUN" has been proposed. Brainchild was carried out through a total of five times opinion exchange meeting and classroom visitations of July 2013. Target user of this equipment was a student of Elementary 3rd course. In developing, it was noted by college student that it is possible to change easily the learning method in consideration of the characteristics and capabilities of the learner. Scene in use is shown in Figure 3.

Teacher presents a target picture to the learner. Subsequent to it, teacher also presents to the learner several answer candidate pictures. Learner answer is placed in the location specified by selecting the picture the same picture of the problem. The equipment devised after Step2, technical solutions to be used for learning materials of interest is sought. It has been studied in detail by the student how to use a bar code reader and

共に学ぶ「ものづくり」

熊本高専（合志市）の学生４人

支援学校生用の教材製作

黒石原支援学校の教材を製作している熊本高専の（左から）平原慎也さん、松下良助さん、緒方研士さん、甲斐勇矢さん＝合志市

合志市須屋の熊本高専熊本キャンパスの学生４人が、隣接する県立黒石原支援学校で使う教材や支援機器の製作に取り組んでいる。９日に同支援学校で開かれる文化祭で試作品を展示する。

高専で取り組む、社会のニーズに合ったものづくりを目指す「社会実装プロジェクト」の一環。電子制御工学科５年の平原慎也さんら４人が支援学校を訪問。教員との意見交換を基に、発達や障害に合わせた４種類を製作している。

平原さんが取り組むのは、手足や顔のわずかな動きを関知するタッチパネルやレバーを使った、小物を拾い上げるクレーン機。数人が一緒に操作でき、協調性を学べるように工夫している。

手足を動かして手助けを呼ぶ通報機や、カードリーダーの仕組みを使った知育ゲームなどに挑戦しており、本年度中に完成させる。

文化祭では、最も製作が進んでいる平原さんのクレーン機を展示する。８日には支援学校生が実際に操作、中学部２年の兼田大輔さんは「うまくできた」と笑顔だった。

プロジェクトを担当する同高専の柴里弘毅教授(44)は「お互い学び合い、課題解決につながる」と話す。

文化祭は９日午前９時20分から。クレーン機展示は同11時半ごろから。同支援学校☎０９６（２４２）０１５６。

（林田賢一郎）

Figure 2: Article of Exhibition in Cultural festival (Kumanichi Newspaper 9th November, 2013)

Figure 3: Matching Learning Material "HANTA-KUN"

method for determining the matching by image processing. In the method according to the image processing, reduction in the detection accuracy when the arm of student and teacher are overlap between the camera and the picture card is concerned. In addition, it is difficult for only teachers of special needs school to deal with such a complicate equipment configuration. Additionally, in order to realize that learners with upper limb disabilities manipulate the card on own, non-contact type RFID reader application is proposed. In this proposal, it is considered to be possible a normal operation even in rough alignment of the card. Prototype of laboratory level was created in about two months with the cardboard. And, improvement and overview of the program's interface was added so as to be available at a special needs school over a period of one month further. However overview of pretty things of felt material had been initially assumed for the base portion, it is pointed out in response from the teacher to the appropriate material which is easy to wipe off the dirt. Then, the review efforts were made. To February 12, 2014 from October 30, 2013, in accordance with the learning progress of learners, the developed learning materials were used in the matching learning activities

11 times total. Target student is the one male and female. Using time for one are 10 to 15 minutes, and the learning frequency was 3 to 4 times during the above period, respectively. The student, who was in charge of development, visited as much as possible the class use the learning materials. And he has been observed as follows:

- Learners were interested in the reproduced sound and picture of the card. They were also very pleased to music to be played, especially when answer was correct.
- The line of sight of the learner was moving well. They were able to watch the card of choice and problem.
- There was a positive attitude to take in hand the card.

Initially, only the development of matching learning materials has been a goal. However, since the transition to implementation of the experiment in the field is advanced in a short period of time than expected from prototyping laboratory level, study with teachers of special needs schools have been performed again for the required functions. Such modifications are equivalent to the feedback loop to Step1 from Step4 in Figure 1. In the study discussions with teachers of special needs schools and the students, a record of matching learning activities had been carried out by a conventional video shoot. But, in this video comparison method, it had been revealed the presence of a problem that there sometimes exists difficulty for decision of growth by the third party. Thus, the function of the visualization by graph and record of learning is additionally implemented. Software that has been developed to automatically count, number of attempts and the date that made the learning activities, the number of correct answers will be automatically saved to learning at the end of them.

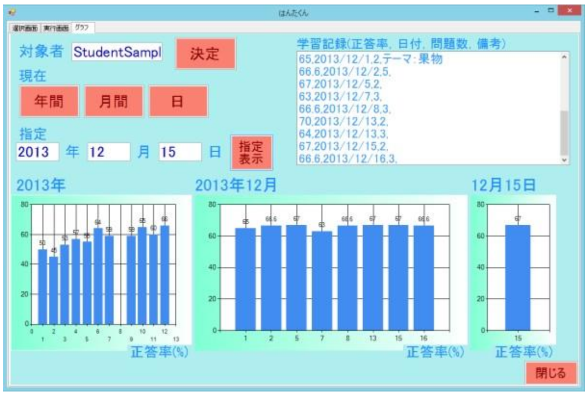

Figure 4: Visualization of Study Record

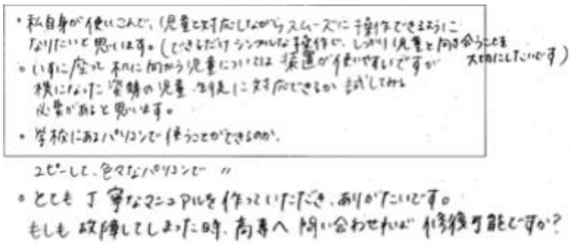

Figure 5: Teacher’s Comments

In addition, the percentage of correct answers in the daily and monthly for each year is displayed in a bar graph for the purpose of study record confirmation so. (Figure 4)

Through a trial period of about five months, a relative evaluation has been performed by the teacher of special needs schools in the conventional matching learning materials and a "HANTA-KUN". It was high praise compared to conventional materials, especially in the field of stage effects that learners and teachers can perform learning activities with fun. In addition, it was evaluated for versatility, that is, it can also be used in the matching learning of a three-dimensional object using stuffed animals, and the association learning such as “glass” and “toothbrush”. On the other hand, it has been pointed out that sense of accomplishment with a sense of touch that is a feature of conventional matching learning materials has been compromised slightly in HANTA-KUN. Specification setting that task may not be a form fitting between the block and the frame, is due to the consideration of matching learning of students with disabilities in the upper limbs. That effect resulted to be less desirable for students with high exercise capacity. It was a new discovery for students and authors. Shape change from the card to the three-dimensional object that is suitable for shape matching learning materials is not too difficult. It is considered to continue and it corresponds to a conventional shape matching learning materials or for replacement of the cover in accordance with the capabilities of the student.

In addition, cooperation teacher gave students the comments of appreciation and opinion based on her notice with a variety of improvements from the prototype stage. There is no doubt that the feedback from the cooperation teacher of special needs school was a big encouragement for the student who worked on this theme (Figure 5).

Development of cooperative learning support materials:

Self-made learning materials are also being used as a teaching tool for cooperative learning in the Kuroishibaru special needs schools. The learning material has the form to compete the score by rolling a ball that mimics a pinball game and bowling game. Pins are nailed to the plate that is installed at an angle. A clear plastic cups are put to the pins, the learner roll the ball in a downward direction from the inclined upward with the help of an assistant (teacher). A learning objective of this activity is a training of social and coordination of the learner. Two students worked on this problem and organize each problem with this learning material through the similar brainstorming about awareness of classroom visitations in July, as follows, in the same manner as the student described above.

- Lack of force production of the conventional learning materials
- Use of auxiliary equipment is required to students with upper limb disabilities that do not grasp the ball.
- When the learning of one person is using the learning materials, there is no cooperation work with students around.

In order to compensate for the above insufficient points of rolling balls, each have devised the two new similar type learning materials. One of them is the rolling a ball by tilting the plane and the other one is the target picking 2-DOF crane machine type learning materials. In the following, it is described about the latter. The student was conceived with an emphasis that attract the interest of the learners to give a fresh stimulus be to the production shape and not in the conventional learning materials, that to be able to learn the coordination more by the more than one operator. After setting the theme, prototyping has been completed over a period of about four months. From the fact that plants such as bitter gourd and green soybean has been used as the motif of the learning activities of 2013, likened to the green soybean target, frame of crane equipment has been decorated with vines. This learning material was named “Soybeans Catcher" by teacher of special needs schools and student (Figure 6). In order to control the equipment, PLC is used in consideration of the durability and convenience of ready-to-use after power-on. Various operation switches such as a touch type and slide type are deployed to be switched easily according to the characteristics of the handicap of each student. Prototype was used in the event that exhibited cultural festival that was held in Kuroishibaru special needs school in November 2013, introduced in Figure 2 (KOBUN-festival), to win grabbed the candy. This prototype has been lending over the 20 days after the cultural festival, implementation evaluation has been

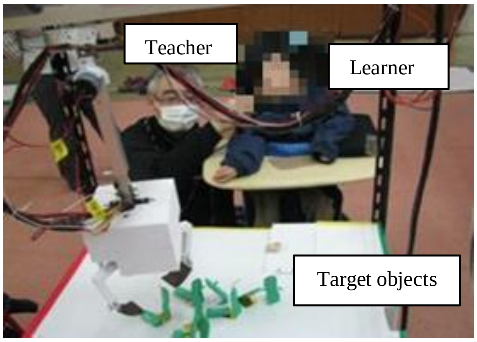

Figure 6: Soybeans Catcher

carried out with the cooperating teachers in special needs schools (Step4). Time use of learning materials of each class was about 90 minutes. After use, through a survey of questionnaire for them, the following matters were pointed out as improvements to be addressed in the next stage.

- The operation of the arm is unstable.
- It is hard to stop in a location that is aimed at.
- For learning materials is too large, moving and storage is inconvenient.

Drive machine unit has been handcrafted from aluminium plates, so low maturity of mechanical part of the prototype is the main cause of these indications. Therefore, in order to provide strength by increasing the processing accuracy of the arm mechanism, students to redesign it in CAD software “Solidworks”, and was re-produced by a 3D printer output. Furthermore, the latch function was added to handle even in difficulty of learner’s operation. As a result, the control device was improved so as to realize that the crane part could continue the movement for a few seconds after the operation switch was encased slightly by the learner. About the time of the move operation continues after the switch operation, teachers want to be modifiable to it easily, depending on the degree of handicap of learners. Therefore, students improved by use of the analogue timer which can adjust it instead of the internal timer of the PLC. The size of the prototype was reduced to be able to pass through the frontage of 90cm standard width of the entrance doors and an elevator doors. These improvements were achieved over a period of about 2 months. After that, the trial in the classroom of special needs schools has been done between 10 to 18 February 2014, and the comparative evaluation of learning materials between it and the conventional one has also been performed by two teachers. As a result, new learning materials were evaluated such that it has the same effect as the conventional one for communication between students. For the voluntary of activity, based on the observation of a state in which learners are enjoying, it was evaluated such that the new learning material is better. We noted that it did not reach a significant improvement for the challenges of the third issue. Student seemed keenly aware of the difficulty of implementation. From the fact that students were running at a sufficient level of achievement in activities of Step4, we also recognized the importance of careful scrutiny and review of Step1 and Step2 being just the migration stage to the equipment design and specifications development from the needs understanding. Namely, we consider that teaching staffs must pay attention for not only the achievement of the implementation but also the education effects in the implementation process.

Development of auxiliary communication tool for children with disabilities overlap:
One student is taking to communicate with parents and teachers by making a gesture of Yes in the swing direction of the face, studying at Kuroishibaru special needs schools. However, the student has a disability of overlap as well as immovable to think the limb and of the utter. Therefore, the student was in many troubles and unable to communicate to draw the attention of others who had distract once. Therefore, our student worked on the development of auxiliary tools that allow a challenge from the student side in a situation where parents or teachers around her are not paying attention to her. Figure 7 shows the developed system configuration. At first, developing activity of the student who embarked on this subject stagnated a long period in the stage of "the invention of equipment" (Step2).

However, Kuroishibaru school teacher gave him the pep talk at the end of December, it becomes the trigger for him and then he was clear technical problems. While being encouraged by the words of appreciation from the parents in the "Implementations of the off-campus", and he completed the auxiliary tool in Step4 (Figure 8). Equipment is provided to the parents so that they can also be used at home, it has been used to continue today after completion. We thought that the opportunities to phase of SI approach transitions are diverse, and we also felt impact and effect elements

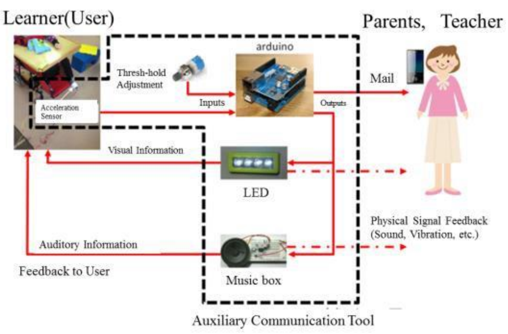

Figure 7: Auxiliary Communication System

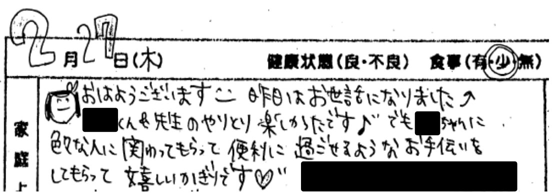

Figure8: Parents' Comment

appeal to emotional part of the student, such as that of pep talk from teachers and feeling, thanks voices and expectations of parents to lead the activity, is greater.

Afterword

In this paper, we reported the practices of "Social Implementation (SI)" style final project that produce their own solution captures the students needs. In that project, the target social field was a Kumamoto Prefectural Kuroishibaru special needs schools. Authors consider that students had dedicated to research actively while having a sense of responsibility and a clear awareness of significance of design meeting the needs of the real world. The point that we realized was in terms of a very large presence of off-campus collaborators. Even after the transition to the "Empirical evaluation of off-campus" of Step4, students were able to increase the completeness of the project by the addition of new features and improvements sucked up the opinion of off-campus collaborators. The evaluations of the implementations were moderate, but it was confirmed the well educational effects in the implementation process. So the authors consider that roll of college staff may focus on not only the technical guidance but also on the leadership to keep the density of communication with off-campus co-workers and create an organized environment for students to freely jump out to off-campus.

Acknowledgements

We would like to send our most appreciation to teachers including principal Mr.Kaneko, to every student in Kumamoto Prefectural Kuroishibaru Special Needs School from the bottom of our hearts.

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AN EFFORT TO ENHANCE STUDENTS' ABILITY VIA CLUB ACTIVITIES AND THESIS WRITING

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Abstract

Advantages of club activities and thesis are as follows: (i) Professors concentrate on educating only small numbers of students who opt to participate clubs and laboratories, (ii) Professors recognize degree of students' understanding via discussions and Q&A at the activities and laboratory seminars. The author has been a supervisor of club activities named "Programming Lab. Club", and encourages members to participate various programming contests. Fortunately, students won various awards. Most of the students have studied at the author's laboratory, and published papers in English. This paper introduces examples of the author's teaching methodology of enhanc- ing students' ability on club activities and research thesis.

Keywords: club activities, contest, thesis, small-group education, laboratory research, English education

Introduction

This paper describes an effort to enhance students' ability via club activities and thesis including advanced school in National Institute of Technology, Kurume College. The club activities and the thesis differ from lecture classes as the following view points: (i) Professors concentrate on educating only small numbers of students who opt to participate clubs and laboratories, (ii) Professors recognize degree of students' understanding via discussions and Q&A at the activities and laboratory seminars. The author has served for the supervisors of the club activity named "Programming Lab. Club", which aims at participating some contests on programming, about a decade. At the beginning of the activity, the club had not been organized, and the author had worked with a few students who were interested in some programming contests. The work was enjoyable, but the author realize the necessity to establish a club in order to take over skills through experience of supervision on some contests. Then, Kurume College established the club in 2005.

The students of the club tend to select the research thesis in the author's laboratory. They improved skills not only programming but also reasoning and problem solving abilities via various contests, which results in high scholastic marks. Then, the author has given advanced thesis for the students. Most of advanced school students in my laboratory go on to master courses of universities: then, the author encourages the students to submit papers to international conferences to improve their English and to achieve results. As for the English education, the author had stayed at KMITL (King Mongkut's Institute of Technology Ladkrabang) for four months in 2012 as Overseas Research Scholars Program of National Institute of Technology, and has researched some themes collaboratively with Assist. Prof. Dr. Kuntpong Woraratpanya. Whereafter, the author has worked to activate student exchange.

The rest of this paper is organized as follows. Section 2 explains brief introduction and achievements of programming contests. The thesis in my laboratory is shown in Section 3. Section 4 gives English education and student exchanges, and finally this paper concludes in Section 5.

TABLE I
SUMMARY OF PROGRAMMING CONTESTS

Name	Contestants
Programming Contest	All the NIT students
JOI	Senior high school younger than third year
APIO	Senior high school
Supercomputing Contest	Senior high school
PASOKON KOSHIEN	Senior high school
ACM-ICPC	Univ. and College

Programming contest

Table I summarizes programming contests for students of NIT (National Institute of Technology). The above contests are roughly divided into two forms: the contests compete applications, and those compete the numbers or scores of solved problems. The author regards "Programming Contest" and the programming division of "PASOKON KOSHIEN" are the former: then, the others and the mobile division of "PASOKON KOSHIEN" are the latter. Following subsections explain the contests and show our results. The last subsection describes the author's coaching scheme.

A. Programming Contest[10]

The grandest annual contest for NIT students held by NIT itself, and consists of three sections as follows: themed, original, and competition sections. In the themed and original sections, students submit documents to explain their ideas of applications for the preliminary round firstly. After the preliminary round, the students of accepted applications participate the final round. Less than or equal to five students make a team for an application. Our students submit proposals every year for the two sections and at least one application is accepted nearly every year. We won Special Prize in the original section in 2008 and 2011, and the award given by Broadleaf Co., Ltd. in 2013. To offer documents and application programs to the preliminary and the final rounds, our students discuss their idea via Wiki pages for club members, unfortunately the web site requires id and password, and they hold presentations on the ideas for all the members.

In the competition section, contestants prepare application programs for the final round, and the competition are held at the stage for given data. To win prizes, participants need the skills not only development but also algorithm and mathematics. Our students improves the algorithm skill via contests described in the following subsections; then, fortunately our college won the championship in 2005, 2006, and 2011.

B. JOI[11]

The JOI (Japanese Olympiad in Informatics) is the domestic contest for the IOI (International Olympiad in Informatics), and is one of the International Science Olympiad. The students participate individually, and solve problems in given time. The first round is held via Internet; then, about 60 students with high score go to the final round held in Tokyo. After the final, about 15 students are invited to the spring competition for the IOI again in Tokyo, and 4 students are selected as IOI contestants. Kurume College has participated the JOI since 2005. Three students were invited to the spring competition. Although no student is selected for IOI contestants, the unofficial highest ranking was sixth.

C. APIO[2]

The APIO (Asia-Pacific Informatics Olympiad) is a regional Informatica Olympiad held via Internet. Basically, only the contestants of the spring competition of the JOI and the same school students can participate. All of the Kurume College's three students, who was invited to the spring competition, participated the APIO, and two students are selected as Japanese delegates, which means their scores in Japan are higher than seventh. One of the delegates also won the bronze medal.

D. Supercomputing Contest[12]

At first, teams which consist of two or three students submit programs on C or C++ for the preliminary round to solve a given subject; then, Osaka Univ. and Tokyo Inst. of Tech. invite 10 students severally. This year is the 20th anniversary contest, and all the 20 teams are invited by Tokyo Inst. of Tech. The contest continues about three days. Kurume College has sent at least one team every year since 2007, and received the commendations of the IEICE (Institution of Electronics, Information, and Communication Engineers) and the IPS (Information Processing Society of Japan) in 2007 and 2008. Last year, our students won the championship.

E. PASOKON KOSHIEN[13]

This contest currently consists of three divisions: programming, mobile, and a piece of CG (Computer Graphics). A team of the programming division consists of two students. After the preliminary round division held via Internet, contestants participate the final round in Aizu University. Our college has participated the programming division every year except for last year since 2004, and won the second prize in 2004 and 2006. The mobile division is a new division, and began in 2012. Participants of the division compete new applications on mobile tablets developed under given subjects. At the first year, the division was held as an exhibition contest, and our team was invited to the division, where our college won the second prize. In 2013, the division turned to the official division. Our college successively won the third prize in 2013.

F. ACM-ICPC[1]

The ACM (Association for Computer Machinery) - ICPC (International Collegiate Programming Contest) is the world wide contests for college and university students; then, older than third year students of NIT and advanced school students can participate this contest. Each team consists of three contestants. Firstly, the Japanese domestic contest is held via Internet. Secondly, about 20 teams go to the Asian regional contest in Japan. The first prize team, and sometimes the second team, of the regional contest participate the world final. Our college has participate this contest since 2007. The highest mark of our teams in the Asian regional contest is 16th in terms of team ranking, which is equivalent to 12th in terms of school ranking, in 2009.

G. Coaching Scheme

The author has never taught programming skills for the members of the club activity. As for the scheme to improve students' skill, seniors and graduates prepare web site to share documents including slides for the following tutorials: game programming, optimization algorithm, how to program on contests, basic C++, and so on. The author is a mere adviser when students

TABLE II
STUDENT NUMBERS OF MY LABORATORY

School year	Regular (Club)	Adv. school (Club)
2009	3 (1)	3 (0)
2010	4 (2)	1 (0)
2011	4 (1)	4 (1)
2012	3 (3)	4 (2)
2013	4 (2)	2 (2)
2014	3 (2)	3 (1)

participate contests, and prepare documents for contests. Graduates, whose careers are described in the next section, visit our college during summer vacation, and enjoy talking with current students. Therefore, the author regards that the scheme to improve the students' skill by seniors and graduates has already established.

Thesis

The author leads students to participate most of the contests described in the previous section. During trips, the author talks many subjects with the students; for example, the review of contests, activities of graduates, my research themes, and so on. Such general talks seem to make students feel affinity to the author, many contestants tend to select graduation thesis in my laboratory. Table II indicates the numbers of students in my laboratory in the past five years, where the numbers of advanced school include first and second year students. The reader may think that the numbers of club students who work in the laboratory is few, but most of regular course students entered universities after their graduation as shown later. Of course, students who participated contests such as JOI and APIO are brilliant at not only programming but also mathematics; then, the author does not have to teach programming. The thesis activities concentrate on seminars about deeply expertized mathematics: stochastic process, signal process, optimization problems, pattern recognition, and so on. The text books can not be shown in the references since the books are written in Japanese. The books require deep specialization knowledge to understand. The seminars are held twice or three times per week, and a students is assigned to explain the books. The advanced school students also attend the seminars. Through the seminars in the first semester, the students improve their knowledge enough to understand research papers. The graduation theses propose improvement methods of the state-of-the-art papers; then, students who enter the advanced school translate the theses into English to submit international conferences. The theses of which students entered other universities are also translated into English by advanced school students, where the original authors of theses are listed as the first author. Fortunately, most of the submitted papers are accepted

TABLE III
PEER REVIEWED PAPERS OF STUDENTS

School year	Int'l Conference and Trans.
2009	APSIPA ASC in Sapporo × 3
2010	TENCON in Fukuoka † [8] WPCIP in Nagoya
2011	ISMAC in Sapporo VCIP in Tainan † [3] ISPACS in Chiang Mai † [4] IWAIT in Ho Chi Minh × 3
2012	MIRU in Fukuoka × 2 ‡ SISA in Bangkok × 2 ISTS in Bangkok ICPR in Tsukuba † [5] Trans. IEICE (Letter) † [7]
2013	VCIP in Kuching † [9] ISTS in Hong Kong × 2 IWAIT in Bangkok × 2 Trans. IEICE (Letter) † [6]

†: The Digital Object Identifier (DOI) or ISSN is assigned.
‡: Written in Japanese.

TABLE IV
CAREERS OF STUDENTS AFTER GRADUATE

School year	Regular	Adv. School
2009	Tsukuba Univ. † Fujitsu Ltd. Sumitomo Seika Chemicals Co., Ltd.	Nagoya Univ. Kyushu Univ. †
2010	Advanced School × 3 ‡ Osaka Univ. †	Nagoya Univ.
2011	Advanced School † The Univ. of Tokyo Kyushu Univ. Tsukuba Univ.	
2012	Advanced School † The Univ. of Tokyo † Kyushu Univ. †	Kyoto Univ. † Kyushu Univ. Hokkaido Univ.
2013	Advanced School Kyushu Univ. † Tsukuba Univ. † Tokyo Metropolitan Univ.	Waseda Univ. †

†: Members of "Programming Lab." club
‡: One student is a member of the above club

as shown in Table III, which tells us that some papers are accepted by high quality conferences and two journals. Please note that III shows only the papers written by students.

As shown in Figure IV, most of laboratory students including advanced course students, especially members of the "Programming Lab. Club", were admitted to high level universities and master courses. Currently, two and one graduates are pursuing the Ph.D degree in Univ. of Tokyo and Waseda Univ. respectively. Furthermore, one student decided to pursue the Ph.D degree after the

Master course.

English education and student exchange

The author is not a lecturer of English: then, what he does is to read English papers in laboratory seminars and to revise students' English papers. TOEIC scores of regular course students vary in range of about from 400 to 800. The average of the scores seems to be 450. Then, they struggle to write English papers. Laboratory students and the author share their papers using "dropbox" and the author revised students papers several times with comments on grammar mistakes and so on. From 2009, since all the advanced school students participated international conferences, they obtained the TOEIC score more than 600.

The author stayed in KMITL in 2012, and began collaborative research and education with Assist.Prof.Dr. Kuntpong Woraratpanya of Faculty of Information Technology. We involve Dr. Kuntpong as a co-author, and some papers not only shown in Table III have been published. Furthermore, nine NIT colleges in Kyushu and Okinawa islands launched a project of "Program for Promoting Inter-University Collaborative Education" supported by MEXT (Ministry of Education, culture, sports, science and Technology-Japan) in 2012. Then, the author also has served for the project, and invited Dr. Kuntpong last and this years for three and two weeks respectively. During the invitations, Dr. Kuntpong attended a lecture class named "English for engineers" of second year of the advanced school; then, he chaired aural presentations like international conferences. This year, the project accepted students of KMITL and Kasetsart Univ. in Thailand more than one month. Additionally, Kurume College invited 10 students of KMITL under a program of "Janan-Asia Youth Exchange Program in Science" supported by JST (Japan Science and Technology agency). The students of both projects also attend the lecture class this year. After his invitation of last year, students of the laboratory hold joint seminars about once a month to introduce research themes of both sides using Skype. The author has not estimated the effect of the projects yet, but a typical example is that a student, whose TOEIC score was less than 300, increased his score to 745 via the above-mentioned experiences.

Conclusion

This paper introduced an effort to enhance students' ability via club activities and thesis. Many programming contests are held recently, and many students improved their skill not only programming but also reasoning and mathematics. Most of the contestants carried out research works in the author's laboratory. The quality of theses has been high enough to be accepted by international conferences. The students of the library, especially advanced school students, also improves their English skill through the translation of papers into English, presentations in conferences, international student exchanges under various projects, and so on.

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REPORT ON THE INTERNATIONAL WORKSHOP ON INNOVATIVE PROJECT 2013

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Abstract

One hundred eight students from 5 different countries participated in the International Workshop on Innovative Project 2013 (IWIP2013), which was held in Nagano City, (Nagano Prefecture), Japan, August 27-30, 2013, with 37 presentations, and a workshop named "Rescue Robot". The international workshop offers the opportunity to communicate with students of other countries and brings students together to share their common interests and project and/or research results. This paper summarizes the student activities at the IWIP2013. In order to foster internationally minded students, the IWIP2013 had over 40 student staffs who are studying in KOSENs throughout Japan. The student staffs served as information guides, session chairs of presentations, technical assistants of the workshop and so on. Forty-one students were from Malaysia, Singapore, Taiwan and Thailand, and the other were from Gunma, Kagawa, Kisarazu, Maizuru, Nagaoka, Nagano, Niihama and Sendai KOSENs, Japan. Students gave 37 oral presentations. The speakers highlighted their project outputs and research experiences, and offered possible solutions to some of the problems. In the workshop, the students from each country were grouped together into international groups. The groups made the rescue robots using LEGO blocks and competed with each other. Of course, the IWIP2013 had some other programs such as introduction of school, banquet, Japanese cultural experience, tour to Zenkoji Temple and Matsumoto Castle and so on. Networking among students is definitely another important aspect of this international workshop. Students had a lot of discussion and communication through these programs. The student staffs could participate in the IWIP2013 well prepared. We think that the international workshop was fruitful for students and has become a good stimulus for their future student lives and researches.

Keywords: *International Workshop, International Exchange Program, Global Education, Innovative Project, Presentation, Robot Competition, Student Staff*

Introduction

Students realized that English is necessary to collect and transmit information, with the rapid progress of globalization. They also realized the importance of knowing and understanding other cultures. Therefore, many students have participated to the international symposium. The International Symposium on Technology for Sustainability (ISTS) is one of its kind symposium dedicated to the undergraduate students (ISTS 2014). It aims to provide a general forum for enhancing interdisciplinary interactions, dialogue, and collaborations among students and their teachers. The international nature of the symposium also provides an opportunity to communicate with students from around the world and makes them aware of the differences between the practices followed in different countries. We think that being engaged not only in presentation during the symposium but also in the management of the workshop, helped students to expend their knowledge.

We organized the International Workshop on Innovative Project 2013 (IWIP2013). The international workshop seeks to enhance the internationalization of the educational experience of the student through global awareness, social impact and creation of cultural competence by instilling a broader world perspective through global participation. It consists of two subjects: the international workshop itself and the communication and cooperation between students in different countries. This paper summarizes the student activities at the IWIP2013.

Overview of IWIP2013

National Institute of Technology (NIT), Nagano and Kisarazu Colleges (KOSENs) organized the International Workshop on Innovative Project 2013 (IWIP2013) on August 27-30, 2013 at Nagano City, Japan, with support by Kagawa, Maizuru, Niihama and Okinawa KOSENs. The purpose of the international workshop is to provide the students with the opportunity to communicate with students of other countries and to bring students together to share their common interests, and project and/or research results.

Table 1 shows the number of participants. Participants included 108 students from 5 different countries (Japan, Malaysia, Singapore, Taiwan and Thailand). The Organizing Committee of the IWIP2013 was pleased to invite students from Asian countries to present and discuss the results of innovative projects. We were also invited 60 foreign students (Tokyo Japanese Language Education Center) will go to KOSENs in the future.

Figure 1 shows the program. The most important part of the four-day program was oral presentations and a workshop named "Rescue Robot Competition" by students. It was included 37 oral presentations (15min. including discussion) by students. Variety of topics was welcome such as engineering, science, agriculture, tourism and so on. The workshop entitled "Rescue Robot Competition" was intended to help students gain experience in sharing their ideas and plays a large role

Table 1 Number of participants

Country	Institution	Presentation	Student	Faculty Member
Japan	NIT, Kisarazu College	4	9	2
	NIT, Okinawa College	1	4	1
	NIT, Kagawa College(Takamatsu Campus)	1	1	1
	NIT, Kagawa College(Takuma Campus)		3	1
	NIT, Niihama College	2	2	2
	NIT, Maizuru College	2	2	2
	NIT, Gunma College	1	1	1
	NIT, Sendai College(Natori Campus)	1	1	1
	NIT, Nagaoka College	1	1	1
	NIT, Nagano College	2	2	18
	Student Staff		41	
	Subtotal	15	67	30
Thailand	OVEC			14
	Science Based Technology Vocational College (Chonburi)	2	4	1
	Lamphun College of Agriculture and Technology (Science Based Technology College)	2	4	1
	Phang-nga Technical College (Science Based Technology College)	2	4	1
	Suranaree Technical college (Science Based Technology Vocational College)	2	4	1
	College Singburi Vocational (College Science Based Technology)	2	4	1
	King Mongkut's Institute of Technology Ladkrabang(KMITL)	2	4	1
Singapore	ITE College East	2	4	1
	ITE College West	2	4	1
Taiwan	National United University	2	5	1
Malaysia	Kolej Kominiti Batu Pahat	4	4	2
	Subtotal	22	41	25
	Total	37	108	55
Vistor	NIT, Japan		1	
	Ministry of Education , Thailand		7	
	Tokyo Japanese Language Education Center		60	
	NIT, Nagano College			6
	Citizen		8	
	Press Relations		4	
	Total		249	

Time	27th August	Time	28th		Time	29th		Time	30th
		7:00~8:30	Breakfast		7:00~8:30	Breakfast		7:00~8:30	Breakfast
		9:00~9:45	Opening Ceremony (Registration)		9:00~11:30	Zenkoji Temple Tour		9:00~14:00	Technical Tour Matsumoto Castle
		9:45~10:00	Break						
		10:00~11:00	Presentation	Presentation					
		11:00~11:30	Break						
		11:30~12:30	Presentation	Presentation	11:30~12:45	Lunch			
13:00~14:00	Staff Meeting	12:30~13:30	Lunch						
		13:30~14:45	Presentation	Presentation	12:45~14:00	Presentation	Presentation		
14:00~15:00	Committee Meeting	14:45~15:00	Break		14:00~14:30	Break			
15:00~21:00	Registration	15:00~18:00	Workshop	Introduction of School	14:30~18:00	Workshop			
		18:30~19:30	Dinner		18:30~20:30	Banquet		17:00	Airport or Tokyo
		19:30~21:00	Workshop						

Figure 1 IWIP2013 Program

in building a sense of communication. Therefore, the students from each country in different fields were grouped together into the international groups. Each group made the rescue robot using LEGO blocks and three motors, and competed with each other. Three motors were used to move the arm and the running of the robot. The group members were required to cooperate to complete the workshop.

Of course, the IWIP2013 had some other programs such as introduction of school, banquet, Japanese cultural experience, tour to Zenkoji Temple and Matsumoto Castle and so on. Students had a lot of discussion and communication through these programs. Networking among students was definitely another important aspect of this international workshop.

Student Activities

The student staffs played an active part in this international workshop. They served as registrations, information guides, chairs of opening ceremony, presentation session and banquet, technical assistants of the workshop, taking videos and photos, helping participants, and so on. Therefore, they have learned in advance the culture of each country and English for communication.

In the workshop entitled "Rescue Robot Competition", the international group members need to communicate and cooperate with each other. Thus, the student staffs also served as the organizers of the groups. The student staffs knew the working and thinking styles of foreign students, and learned how to cooperate with foreign colleagues.

School year, age and gender of student staffs are given in Table 2. There were 26 males (63.4 %) and 15 females (36.6 %). The student staffs comprised 33 (85.5 %) regular course (5 years of consistent engineering education from 15 years old) students and 8 (19.5 %) advanced course students. Considering the percentage of female students in our college (13.4 %), the proportion of female students to the total student staff (36.6 %) is high. Participation from the lower grades is also high.

Questionnaire to Student Staffs

The student staffs were asked to complete an evaluation questionnaire (Figure 2). The survey used a 5-pint Likert scale (1 = strongly disagree to 5 = strongly agree) with 10 components to measure students' responses.

Table 2 Number of student staffs

	Regular Course					Advanced Course	
School Year	**1st**	**2nd**	**3rd**	**4th**	**5th**	**1st**	**2nd**
Age	**16**	**17**	**18**	**19**	**20**	**21**	**22**
Male	-	3	3	8	4	8	-
Female	1	3	4	-	7	-	-

1. Prior training was enough.
2. I understood the my work.
3. I was able to carry out my work.
4. I was able to communicate with students in other countries.
5. I was able to communicate with students in other KOSENs.
6. How much the level of English communication?
7. I have improved communication skills after the IWIP2013.
8. I want to improve the communication skills in the future.
9. I am continuing to exchange with foreign students by the Internet.
10. I would like to continue international exchange activities.

Figure 2 Questionnaire to student staffs

As shown in Figure 3, only 13 % were enough the prior training. However, the student staffs indicated that they understood own work and executed the work. Twenty five percent strongly agreed and 21 % agreed that they were able to communicate with students in other countries, whereas 76 % of respondents were either strongly agreed or agreed to communicate with students in other KOSENs.

They had felt lower level of English communication. This international workshop slightly increased their skill of English communication. The students expressed favorable opinions toward the active learning.

Conclusions

The student staffs have been enjoying the exchange with foreign students through the internet. Some of student staffs have actively gained experience overseas. For example, two students have participated in Student Organizing Committee of ISTS2014.

The organizers felt that it would be valuable to understand what motivated students to become involved as staffs or participants and how participation in this type of event impacted their experiences. Additionally, we hoped that participation in this international workshop would enhance the internationalization of the students.

Acknowledgements

The organizers of the IWIP2013 would like to thank all participants for their valuable contributions to the international workshop. It was financially supported by the NIT, Japan.

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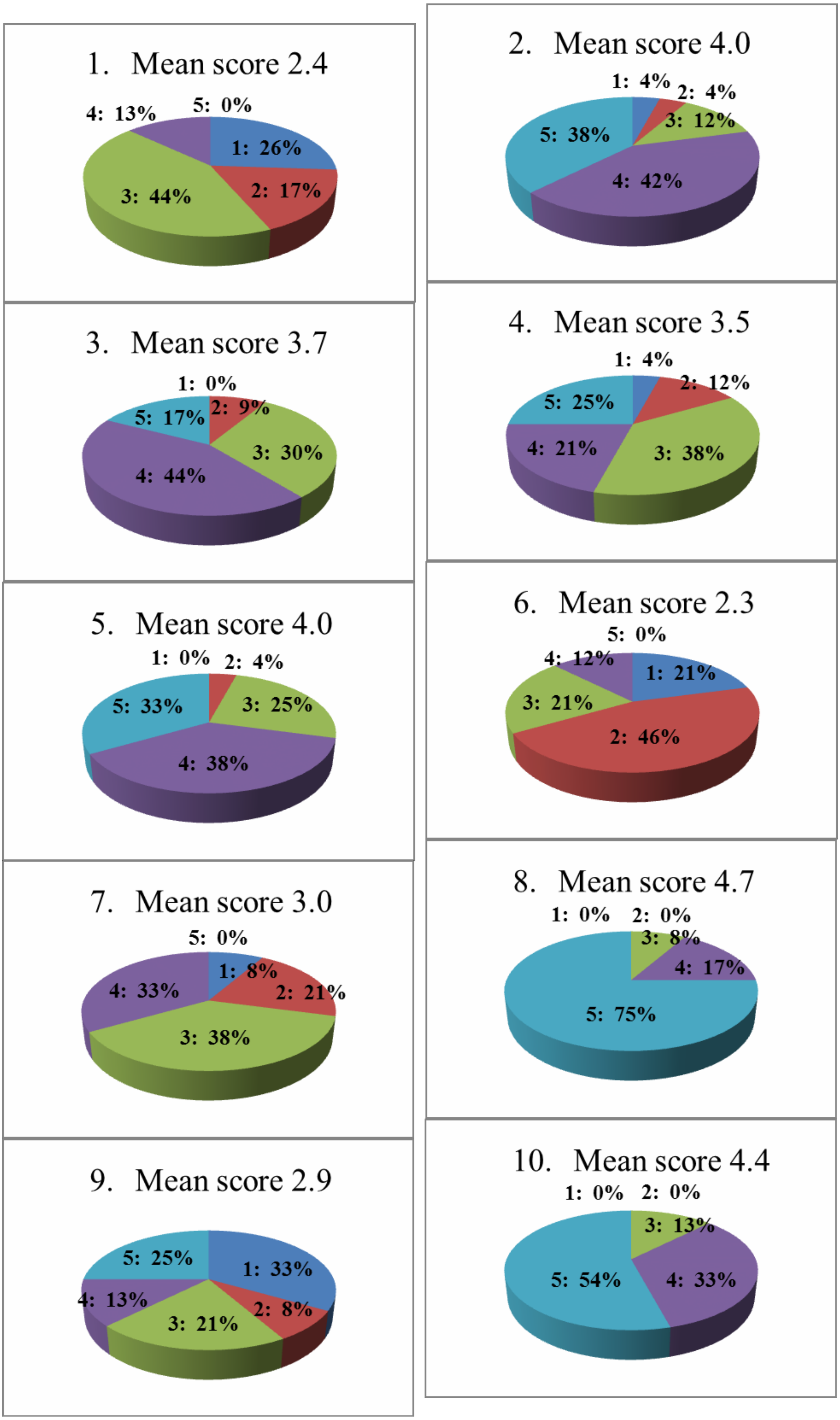

Figure 3 Diagram showing the scoring by student staffs

TEACHING ETHICS ACROSS THE CURRICULUM: A PEDAGOGICAL METHOD FOR FOSTERING OF PRACTICAL ENGINEERS

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Abstract

In Kurume National College of Technology, the word "ethics" seems to be intentionally highlighted in the academic curriculum. For example, "Engineering Ethics" is a subject offered to third year students enrolled in the Department of Biochemistry & Applied Chemistry, it aims to inculcate two essential qualities in their engineering students, which are good ethics and practical problem-solving competency, which are regarded as essential attributes for engineers.

To achieve this goal, the subject is taught across 15 lessons in total, including discourses and exercises. Students are assigned to investigate and do a short presentation on an arbitrary case related to engineering ethics in trios. The presenters receive both positive and negative feedback from an audience in a question-and-answer session. After that, the lecturers take turns to give some comments to share the viewpoints from various fields of engineering.

In order to verify the effectiveness of the class, students have been asked to fill out questionnaire surveys across several years. Around 80-90% students from every academic year have responded positively to the questionnaire. Through the class, they have successfully developed their communicative competence and have recognized the necessity for ethical imagination to be autonomous engineers. However, we are unable to confirm that their practical abilities to take an ethically appropriate action have been sufficiently cultivated. According to the survey carried out in the final lesson in the last year, more than 80% students responded negatively to a particular questionnaire item: "Do you have practical ability to take an ethically appropriate action, whenever you become a stakeholder in a certain case?" One possible explanation is a recent and trivial modification of the syllabus. Last year, unlike common practice, the syllabus did not teach the practical methods for solving ethical problems. We hypothesized that the students did not feel that they were competent in solving ethical issues in real practice as they have not learnt specific methods for solving an ethical problem, such as the seven step guide, creative middle way solutions, line-drawing method, and so on.

In conclusion, the questionnaire results show us that we have to teach the practical methods for solving ethical problems if we wish to nurture practical engineers.

Keywords: *ethics across the curriculum, Seven-step guide, teaching engineering ethics with other applied ethics, teaching ethics by engineer and philosopher*

Introduction

In these over 20 years, engineers' grounding of ethics has been re-evaluated and regarded as quite important. For example, *the graduate attributes and Professional competency profiles* announced by International Engineering Alliance (IEA) includes ethics as one of necessary competency for engineers. The CDIO Initiative, an innovative educational framework for producing the next generation of engineers, presented *CDIO Syllabus* in 2001 (revised in 2011) and stated clearly that young engineers have to acquaint themselves with ethics, equity and other responsibilities. The Japanese Accreditation Board for Engineering Education (JABEE) and the Institute of National College of Technology, Japan (INCTJ) also reached basic agreement on these principles. INCTJ especially attaches a great deal of importance to practical ethics education for engineering students because one of the main purposes of INCTJ is to foster the practical engineers in response to a strong demand from the industrial sector.

According to the policy of them, faculties of national college of technology attempt to teach ethics to the students in their curricula these days. Authors also offered a series of lectures on engineering ethics in order to foster the practical engineers in Kurume National College of Technology (KNCT).

In this paper, we will give a suggestion concerning how to teach ethics to the engineering students to cultivate their ethical receptivity only in a half-year lecture class. To achieve this purpose, we have introduced a challenging approach by describing the detailed content and outcome of the course work. And we have also summarized the findings of the questionnaire surveys conducted to the students in order to verify the effectiveness of the class.

Materials and Methods or pedagogy

There are several lecture classes related to ethics in the different academic years in KNCT. The composition of this curriculum is partly based on the idea of *micro-insertion* and *the pervasive method* (Rhode 1992; Davis 2002; Davis 2006). *Micro-insertion* is a subcategory of *the pervasive method* to integrate ethics into engineering and science education. *The pervasive method* presents ethical instruction both in separate subjects on ethics and in the context the material taught in core subjects. Therefore, students who belong to specific course receive ethical instructions again and again through some different subjects associated with ethics while at college. In KNCT, three regular courses and all advance courses have multiple classes related to ethics.

One of the authors teaches general ethics to the 1st year freshmen in all five regular courses. The contents of this lecture class are not particularly limited to the students hoping to become engineers. All the students going on to the two-year advanced course have to attend the two lecture classes named *environmental ethics* and *advanced engineering ethics* as required subjects. These two lecture classes are more theoretical and abstract than *general ethics* in the 1st year and *engineering ethics* in the 3rd year. As space is limited, hereafter we will limit the discussion to the practice of this *engineering ethics* class for the 3rd year students who belong to the department of biochemistry and applied chemistry.

Table 1. Ethics across the curriculum in KNCT

Advanced Course 2				
Advanced Course 1				
A5	E5	S5	C5	M5
A4	E4	S4	C4	M4
A3	E3	S3	C3	M3
A2	E2	S2	C2	M2
A1	E1	S1	C1	M1
A	**E**	**S**	**C**	**M**

A: Department of mechanical engineering
E: Department of electrical and electronics engineering
S: Department of control and information systems engineering
C: Department of biochemistry and applied chemistry
M: Department of material science and engineering

■:Courses and grades which have subjects including the word *ethics*
■:*Engineering ethics* class reviewed in this paper

As stated above, *engineering ethics* is a subject offered to the 3rd year students enrolled in the department of biochemistry and applied chemistry. The aims of this class are to foster students' ethical receptivity and to enhance their practical problem-solving competency. To achieve that goal, 15 lessons in total consist of discourses and exercises shown as below.

Table 2. Syllabus of *engineering ethics*

Schedule	Contents
Week 1	Guidance
Week 2	Lecture: Why and how should we study engineering ethics?
Week 3	Grouping after watching the DVD on the skills of case research and presentation.
Weeks 4 & 5	Case research and slide production for the presentation by each group
Weeks 6 to 10	Presentation, discussion and the mutual evaluation by each group
Weeks 11 to 14	Lecture: Case study on environmental ethics and bioethics for the engineers
Week 15	Summary of the class

The main part of this subject is the exercise. After learning why and how should we study engineering ethics and the concrete methods for investigation of any cases in weeks 2 and 3, students are given an assignment to investigate an arbitrary case related to engineering ethics by threesome and to make a short presentation. Presenters receive both of positive and negative feedback from audience in question-and-answer session. After that, faculties give some comments on their effort one after the other from the viewpoint of their different specialized field. Faculties give a series of lectures on *environmental ethics* and *bioethics* for engineers after the students' exercises between the week 4 and 10 just to help promoting an understanding of the lesson contents.

To cultivate an ethical receptivity required as engineers, faculties give students guidance shown as follows.

When you make a presentation, you have to show clearly these three points:

1. What is the ethical issue?
2. Who is the "engineer" in this case?
3. How do you take an action as engineer?

Bringing students to follow these simple guidelines, we try to make them conscious that they have to behave as a member of engineering profession in the near future. We believe that developing a professionalism of students contributes for fostering the practical and ethical engineers, and also believe that these guidelines would be the effective way to attain that purpose.

In order to verify effectiveness of the class, some questionnaire surveys of the students have been conducted for several years. These two surveys consist of several ranking questions using 4-point Likert scale ranging from the most positive to the most negative. Questionnaire items are shown as below:

A. Questionnaire distributed after the first class

1. Do you think some accidents or incidents may happen resulting from a lack of morals normally assumed in the engineers?
2. Can you understand what are the inevitable responsibilities of engineers, when they take part in research, development, manufacture and operation of industrial products?
3. When you see the media report of an accident or incident as a result of the defect of products, how often do you think about it from the viewpoint of engineering ethics?
4. Do you have a capability to think and analyze the daily matters ethically at this time?
5. Do you think that you can take ethical action giving priority to profit of the public, not of the company you belong to or your own convenience, when you take part in research, development and manufacture process as engineer?
6. Do you take this lecture class with interest?
7. Do you think that the class related to the engineering ethics is necessary?

B. Questionnaire distributed after the last class

1. Can you understand some accidents or incidents can happen resulting from a lack of morals normally assumed in the engineers?
2. Can you understand every engineer should take the social responsibilities such as environmental consciousness and safety of the products?
3. When you see the media report of an accident or incident as a result of the defect of products, can you think about it from the viewpoint of engineering ethics?
4. Does your ethical ability to think and analytical was improved?
5. Do you have practical ability to take an ethically appropriate action, whenever you become a stakeholder in a certain case?
6. Did you take this class with interest as a whole?
7. Do you think that the class of engineering ethics is necessary?

Results and Discussion

Around 80-90% students positively responded to the all questionnaire items in every academic year. They have successively developed their communicative competence and have recognized the necessity of ethical imagination for behaving as an autonomous engineer through performing a series of exercise in this class (Compare A-2 and A-3 with B-2 and B-3).

However, we cannot insist that their practical abilities were sufficiently cultivated. According to the survey carried out in the final lesson in the last year, more than 80% students responded negatively to the particular questionnaire item *B-5* (see Figure 2). That is, they think that their practical ability to take an ethically appropriate action is not well improved or stays pretty much the same before and after taking this class.

One possible explanation is that a trivial modification of the syllabus caused this difference. As usual, we taught practical methods for solving an ethical problem such as the *seven step guide*, but only in the last year, we did not. *Seven step guide* is a guideline of the practical procedure for ethically right decision-making invented by Prof. Michael Davis in Illinois Institute of Technology (Davis 1999). In other words, it exhibits us proper procedure for ethical decision-making.

We suggest that students didn't actually feel that they were able to acquire practical problem-solving competency for ethical conduct, if they had not have learned specific methods for solving an ethical problem, as typified *seven step guide*, *creative middle way solutions, line-drawing method*, and so on (Harris et al. 2008). So if we wish to foster both ethical and practical engineers, these concrete methods for the analysis of the cases should be taught to the students. Of course, whether this hypothesis can be appropriate for the other students and courses are open to discussion.

Conclusions

The questionnaire results lead us to the conclusion as following. First, performing a series of exercise is effective way to develop students' communicative competence and recognition of the necessity of ethical imagination for behaving as an autonomous engineer. Second, we have to teach some practical methods, as typified *seven step guide*, for solving an ethical problem as much as we can, if we wish to foster the practical engineers..

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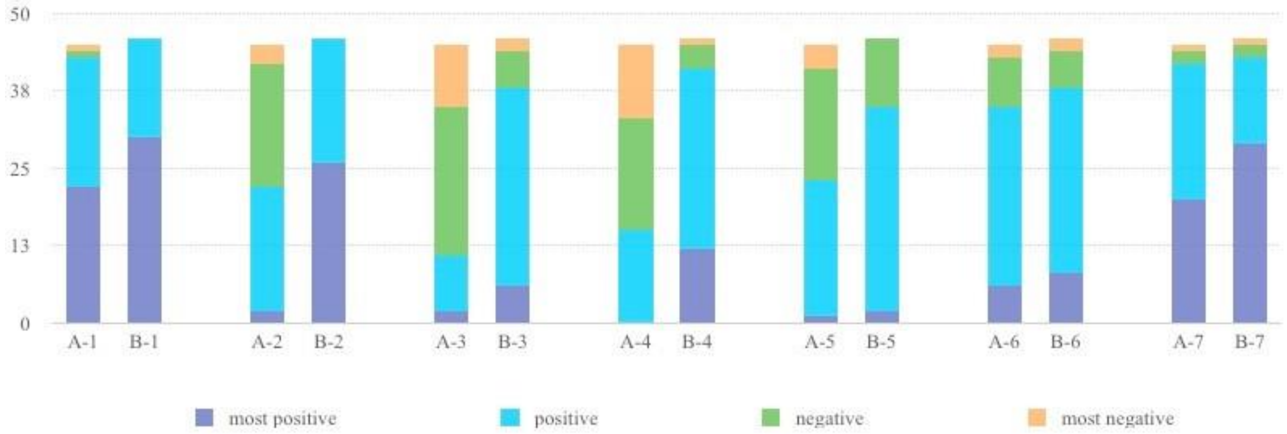

Figure 1. Result of questionnaire in 2012

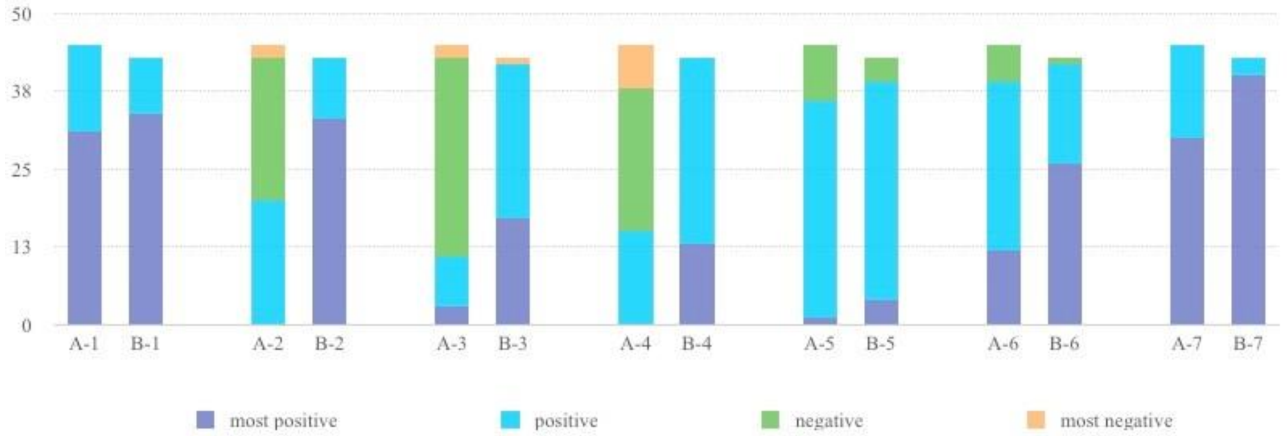

Figure 2. Result of questionnaire in 2013

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PROJECT BASED LEARNING EFFECTS IN EARLY STAGE ENGINEERING EDUCATION

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Abstract

The purpose of this study is to motivate the learning and mastering of the engineering skills of 15-year--old students who have just begun to take lectures for a specific specialized field of engineering in our college. As students in various departments attend lectures such as mechanical systems engineering, information and communication systems engineering, media information engineering and bio-resources engineering, and a mixed class system is introduced for the first and second grade students in our college, an initial introductory program for engineering education should be designed by taking the following into account. The program should not be biased to the specialty of a specific subject. Therefore, it should be related to basic common skills such as IT literacy.

Our program was designed by focusing on communication skills through an engineering practice known as a Project Based Learning (PBL). In order to evaluate the education effects of our approach, we took student's attitude, situation of action and reaction into account. For a more objective approach, we also prepared a questionnaire based on a student's direct impression and comments with self-evaluation in addition to the teacher's evaluation. The investigation with a program of the same content has been carried out for three years to assess the difference among generations. An open-ended questionnaire was taken from about 160 students in total every year for inspection of effectiveness. The answer rate varies, 70%, 100% and 49%, in 2011, 2012 and 2013, respectively. There were many affirmative opinions for the communication among team members, acquisition of basic knowledge and skills, and effectiveness to widen the field of vision. In addition, there were many opinions that acquired knowledge and skills would be very important and helpful for their future work. From the above, our PBL approach seems to be effective in the early stage of an engineering education.

Keywords: *Project Based Learning, enhancement of learning motivation, self evaluation, communication skills, presentation skills*

Introduction

The institute of national colleges of technology (NCT) in Japan has been established in 1962 in order to respond to demands for skillful engineers with knowledge from the industry. There are 55 campuses in the all over Japan, and five-year engineering education is practiced for students from 15 years old. Recently, the number of students who enter a higher education school in science and technology is decreasing in Japan. Therefore, in order to obtain excellent new students, outreach activities are important. In the US, the importance of outreach activities to K-12 schools is mentioned and various approaches have been practiced (Orsak, G. C. 2003; Brophy, S., Clein, S., Portsmore, M. and Rogers, C. 2008). We have done many outreach activities to elementary schools and junior high schools for attracting students to engineering science and technology as well. Even if they are students who entered NCT, it is necessary and important to highly motivate their learning and mastering engineering skills. Since students in various departments take lectures, such as mechanical systems engineering, information and communication systems engineering, media information engineering and bio-resources engineering in our college, an initial introduction program under a mixed class system should be designed by paying attention in particular not to make it the one that is biased to the specialty of the specific subject. So, it should be related to the basic common skill such as IT-literacy. And PBL approaches (Breiter, A., Fey, G. and Drechsler, R. 2005; Fernandez-Samaca, L. and Ramírez, J.M. 2010) were reported and the importance of communication skill development was pointed out. So, we designed the program as a PBL and it was carried out by 4 or 5 students a group. The decision of each team was made through discussion by the group unit, for division of roles, the concept of the group work, the group work production, presentation form and so on. And the education effects of our approach should be evaluated based on the student's direct impression and comments with self-evaluation that can be obtained as answers for questionnaires in order to prevent an evaluation from becoming a subjective one of teacher's side. And in order to check presence of the difference between generations, the investigation with a program of the same contents has been carried out for three years.

Necessity of enhancement of student's learning motivtion in an engineering education program

Outreach activities: Recently, the number of students who enter a higher education school in science and technology is decreasing in Japan. We have also practiced the following outreach activities positively in order to obtain excellent new students.

- Science experiment and basic technology lessons were provided to elementary schools and junior high schools as off-campus class lessons.
- We have set up "Science Land" in Nago city to provide scientific education for local community.
- Off-campus education programs with demonstration related to some research and development outputs were provided at local industry festivals for local community.

An early stage program in our college: However, it is hard to say that all of the youngest students are familiar with the engineering and have a strong will to learn and master engineering skills and knowledge. It is necessary and important to enhance their learning motivation. In our college, a mixed class system is introduced for the first and second grade students. As for the specialized subject related to each department, they have a lecture with students in the same department. On the other hand, about the common subject, they take lectures in a mixed class that consists of students in various departments such as mechanical systems engineering, information and communication systems engineering media information engineering and bio-resources engineering. Therefore, we have developed an initial introduction program for engineering education as a common subject by paying attention not to make it the one that is biased to the specialty of the specific subject. So, it should be related to the basic common skill such as IT-literacy. In addition, in consideration of communication skill development, we designed a program as an engineering education practice through PBL by 4 or 5 students a group by focusing on a technical specification investigation and discussion with team members, writing reports, making an image processing product in cooperation with team members, preparing presentation materials, making presentations. Specifically, a digital still camera was chosen as a target product for a technical specification investigation. There were approximately 40 students in one class and they were divided into 9 groups. Three different types of digital cameras made by different manufacturers were provided to each group. And the following contents were practiced.

- Investigation of the function and specification of digital camera by referring to the on-line manual via internet.
- Image capturing of processing materials by using many functions of a digital camera.
- Investigation of how to use image processing PC software such as Paint.NET and GIMP, and editing captured image by using them.
- Writing reports about the above.
- Making a presentation mainly about the edited image products as a result (both by group and by individual).

Table 1 shows an example of a part of a report about comparison among three cameras by a group. Their functions and specifications have to be compared by referring to their manuals. Image contents can be captured by using various functions under the different capturing modes. The decision was made through discussion by the group unit, such as the concept of the group work, its materials selection, division of roles, the group work production, presentation form and so on.

Table 1: Comparison of functions and specifications

Manu factur er	**Model type**	***Size of the image sensor***	***Image size***	***Image type***	***Zoom, Focus***	:
Canon	IXY 210F	12.3M	4608x3440 2816x2112 : 640x480	JPEG	x4, AF	:
Panaso nic	DMC-FH5	16.6M	4608x3456 [4:3] 4608x3072 [16:9] : 640x480	JPEG	x4, AF	:
Nikon	COOLPIX S3300	16M	4608x3456 [4:3] : 640x480	JPEG	x6, AF	:

And Figure 1 shows an example of a student's work result for image processing and editing.

Figure 1: An example of a student's work

Evaluation of the education effect

In order to evaluate education effects of our approach, we took student's attitude, situation of action and reaction into account. In addition, in order to prevent an evaluation from becoming a subjective one of teacher's side, we also prepared a questionnaire based on a student's direct impression and comments with self-evaluation.

Questionnaire: A questionnaire by a free format with choosing-one style was taken from all students (approximately 160 in total) every year for inspection of effectiveness, mainly about the following items.

1) Self-evaluation of the understanding level
2) Situations for preparations and reviews of lessons including submission status of weekly reports
3) What were you able to improve?
4) Level of the lecture (easy to understand, challenging?)
5) Necessity of the improvement of this program

From questionnaires 1) to 3), they were mainly for self-evaluation. And the answers for questionnaires 4) and 5) could be used for the faculty development of teachers and improvement of this program.

Answers from Students: In order to check presence of the difference between generations, the investigation with a program of the same contents has been carried out for three years. Table 2. shows the answer rates to each item mentioned above in each year. As for the questionnaire 1), according to the student's answers, self-evaluation levels for understanding by students were between 60% and 90%, and 80% on the average in every year. 80% level of understanding seems to be highly evaluated one. As for the questionnaire 3), there were many affirmative opinions for the communication among team members, acquisition of basic skill and knowledge, and effectiveness to widen the field of vision. In addition, there are many opinions that acquired knowledge and skill will be very important and helpful for their future work.

Table 2: Answer rates (Just answered)

Rate/Year	*2011*	*2012*	*2013*
Questionnaire 1)	70%	100%	42.5%
Questionnaire 2)	92.5%	100%	47.5%
Questionnaire 3)	45%	100%	67.5%
Questionnaire 4)	87.5%	100%	40%
Questionnaire 5)	85.2%	100%	45.3%

Since many of the tasks are the first time for students, this program seems to be a little bit challenging and a tough work in limited time, 9 hours in total. The following shows some of the typical impressions and comments from students. They could be obtained almost every year.

- We could learn many things such as digital camera specification, image characteristic change by editing
- Through PBL works, we could discuss many things related to our tasks with group members and knew well about each other
- Presentation by other students and their work (output results) were very impressive and we were strongly stimulated
- Writing reports was a very tough work but we could learn and master many basic techniques

Conclusions

We designed a common initial introduction program of engineering education for 15 or 16-year-old students who have just begun to take lectures for a specific specialized field of engineering in order to enhance their learning motivation for various fields of engineering. And in consideration of a mixed class system, the basic skills such as the communication skill, report writing skill and presentation skill had been picked up. In addition, the program was carried out as a PBL by 4 or 5 students a group. And in order to evaluate the effectiveness of our approach in consideration of not only the evaluation of the teacher side but also student's direct impressions and comments with self-evaluation, we prepared a questionnaire by choosing-one style with a free format that was taken from all students. According to the questionnaires results and impression from students, we conclude that our PBL based approach is effective not only for the enhancement of student's learning motivation in the engineering education program but also their recognition for importance of the skill acquirement was confirmed. However, it should be improved and investigated with continuous inspection. Since our PBL approach is not limited to 15 or 16-year-old students, we hope that our approach can be applied to the younger age in many countries where 15 or 16-year-old students are well past the age of motivation.

Acknowledgements

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REPORT ON THE SUBJECT OF AQUA-MECHATRONICS TRAINING PROGRAM IN YUGE NATIONAL COLLEGE OF MARITIME TECHNOLOGY

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Abstract

Yuge National College of Maritime Technology, (YNCMT) is one of the characteristic colleges which has maritime technology departments in KOSEN. This college is located in the Seto Inland Sea and has been an important educational institution which is responsible for higher education in this region. YNCMT has also set up departments that specialize in Engineering and Technology. They are the Electronic Mechanical Engineering Department and Information Science and Technology Department.

Electronic Mechanical Engineering Department focuses mainly on electronics and mechanics modules. The students will be required to attend lectures and practicals.. The traditional techniques, such as welding and lathe, will be mainly taught during their practicals. Some techniques related to advanced engineering or technologies dealing with underwater robotics will also be included in the sessions.

The "Aqua-mechatronics training program" was launched in 2013. This unique program aims to educate engineers who have knowledge of technology related to the characteristics of water and the basic skills for developing underwater robot. The target group for this program is third and fourth grade students. In the third-grade workshop practice, students can learn the characteristic of water and its skills through experience, such as water pressure, buoyancy, hydrodynamics and waterproof techniques. In the fourth-grade engineering experiment, students can learn the structure of the underwater robot and its control techniques using existing robots. This paper describes the ideas and approaches used in the Aqua-mechatronics training program designed for the third-grade workshop practice, and the findings obtained.

Keywords: *mechatronics, underwater robotics, hydrodynamics, training program, engineering education*

Introduction

YNCMT has three courses: Maritime Engineering, Electronic Mechanical Engineering and Information Engineering. Each course has been conducting original education involving the oceanographic technology.
In Electronic Mechanical Engineering, the elemental technology of mechatronics has been conducted[1,2). Although Electronic Mechanical Engineering is in a good educational environment, the robotics engineering concerned about the underwater technologies has not been conducted.

Accordingly, this course has set up the original subject named "Aqua-mechatronics training program" since 2013 school year. This unique program aims to educate engineers who have the knowledge of technology related to characteristic of water and basic skill for developing the underwater robot.

This training program was adopted as one theme of the student experiment conducted in the omnibus form. One group has 7 or 8 students, so it is possible to teach each student effectively. This Aqua-mechatronics training program is set up in the third and fourth grade student experiment.

In the third-grade workshop practice, the students can learn the characteristic of water and its skill through experience such as the water pressure, buoyancy, hydrodynamics and waterproof techniques. In the fourth-grade engineering experiment, the students can learn the structure of the underwater robot and its control techniques using the existing robot.

This paper describes the ideas and approach for the Aqua-mechatronics training program in the third-grade workshop practice and considers some findings obtained.

Outline of the subject (Syllabus)

The form of third-grade workshop practice is shown in Table 1. This practice is intended for the third grade students. This workshop practice deals with traditional engineering skill such as lathe, casting, CAD, sequential control. In addition to this traditional skill training program, we establish the subject named "Aqua-mechatronics training program I".

Table 1 Outline of the subject

Third-grade Workshop Practice	
Year・Semester・Division	Third Year・1year semester・Required
Major	Electronic Mechanical Engineering
Form / Credit	workshop practice / 2 credit
Time for Study & No. of Study	[1 Class (100min.)]×30
Items of Class	**Period**
1. Orientation	1
2. Test-hammer manufacturing - lathe, casting	5
3. Cup-coaster manufacturing - CAD, NC wire-cutter	5
4. Sequential control training - sequential control	5
5. Electronic experiment - transistor, logic circuit	5
6. Aqua-mechatronics training program I - Understanding the wave - Buoyancy and Lift - Resistance of water - Water pressure - Sealing technics	5
7. Shipping workshop - Board a YUGEMARU	4
[Evaluation]	Perfection of work (50%) + Report evaluation (50%)

This workshop practice has been conducted in the omnibus form. One period is 100 minutes and each workshop has five periods. The number of group members is 7 or 8. In Aqua-mechatronics training program I, each week has a different theme.

The theme of the first week is "Understanding the wave". It includes not only the physical wave but also the radioactive wave under water.

The theme of the second week is "Buoyancy and Lift". The students make simple midget submarines and learn the basic theory of buoyancy and lift under water from their real experience.

The third week is "Resistance of water". In this training, the high transparent water tank is used. The students make original-shaped floating objects and make them float from the bottom of the tank. Thus, they can understand what shape is better for moving under water from their real experience.

The fourth week is "Water pressure". The transparent water pressure pipe and water pressure pump are used. In this training, they can understand the fear of water pressure and the importance of the waterproof techniques in the deep sea.

The last week is "Sealing technics" The simple piping work is carried out in this training. They learn about the piping material and how to use the necessary tools.

The questionnaire on this training program was conducted after the whole training was finished.

Development of class

1) Characteristics of waves and foundation of underwater communication

In this training, the students learn about the characteristics of waves such as frequency, paragraph, amplitude and resonance.

The large water tank (W:100cm, D:200cm, H:100cm) was used in this training. This water tank made of transparent acrylic boards and put on the iron frame with a height of 100cm. They can easily see the object which is located under water.

At the first step, they make the waves using the cylinder pipe by themselves as shown in Fig.1. At this time, the teacher tells them about the characteristics of waves and explains that other waves, such as sound wave, light wave and electric wave, have the same characteristics of waves. At the next step, they make the up-and-down motion of the cylinder pipe and that of water waves synchronize. And then, they can make a big wave caused by resonance. They can observe the waves actually, so they have a good understandings for the characteristics of waves.

At the next step, they measure the acoustic velocity in air and under water with the transceiver. This equipment consists of the ultrasonic wave transmitter and receiver sensor and the oscilloscope. The acoustic velocity can be estimated by observing the delay time between the transmitter wave and receiver wave. They can understand the difference in the acoustic velocity through a medium.

In addition, the teacher explains the kind of device in which underwater communication is possible by using the infrared sensor and radio frequency sensor.

Figure 1 Snapshot of the wave making.

2) Buoyancy and Lift

At first, the teacher explains the relation between the volume and buoyancy of an object under water. Next, he or she also explains the lift which works for the flat plate by using the vector diagram. After that, each student makes the simple midget submarine which continually cruises at the same depth under water.

The main part of this submarine is made up of iron plates which have several sizes and materials. The drive source is a commercial underwater motor. This motor can change its attachment position using the sucker. They cut the styrene foam in arbitrary sizes and glue it on the iron plate to adjust its buoyancy. And then they drive the underwater motor and put the submarine into water in the arbitrary depth.

In the case of the submarine surfacing or submerging, they adjust the volume of the styrene foam or change the attachment position of the underwater motor. Repeating this work, they complete the simple midget submarine which continually cruises in the same depth under water.

Thus, they can understand the buoyancy and lift and realize the difficulty of maintaining the balances under water.

3) Resistance of water

In this training, the students learn about the differences in the resistance of water according to the object shape. The high transparent water tank is used. It is a cylindrical acrylic tank which is 40cm in inside diameter and 200cm in height as shown in Fig.2.

At first, in this training they make the original-shaped floating object. This object is made of plastic which can be deformed with hot water. Each floating object has the same volume, and so is its buoyancy. The light-weight iron base is attached to the bottom of that object. The waterproofed magnetic coil is used for the launch pad, and the floating object is set on this launch pad by the electromagnetic force. This electromagnetic force can be switched on and off by the infrared remote controller placed outside the water tank.

Figure 2 The high transparent water tank.

The floating object and launch pad are set at the bottom of the water tank. After that, the electromagnetic force is switched off and the floating object surfaces due to its buoyancy. By measuring the time the object takes until it begins to lift and reaches the water surface, the students are able to know the relation between the object shapes and its traveling time under water. At this time, the teacher explains the resistance of water and the swing of the object due to the swirl caused behind it. At the next step, they make new-shaped floating objects which travel fast under water.

Through this training, they can understand the required elements for the shapes of the object moving under water, such as a hull and a robot arm.

4) Water pressure

At first, the teacher explains the outline of pressure and relations between the water pressure and water depth. And next, he or she demonstrates the objective appearances under the water pressure by using the water-pressure pipe. This pipe is a transparent acrylic cylinder which is 10cm of in inside diameter and 60cm in height. The water pump can apply the pressure up to 1.5MPa to the pipe. The arbitrary shaped styrene foam is set into the pipe. When the water pressure applied inside the pipe, the styrene foam reduces only its volume keeping its shape. The students observe this process and can understand how the pressure is applied to the object under water.

At the next step, they make a capsule by putting an aluminum lid on the small transparent acrylic cylinder of 1cm in inside diameter. This capsule is set into the pipe and then the water pressure applied to it. They observe how much of the water pressure the capsule withstands.

By this training, they feel actually the fear of the water pressure in the deep sea and the importance of the waterproof techniques for the object which is used under water.

5) Sealing technics

In this training, the students work on assembling the simple water-pressure vessel. This vessel consist of the steel flange, chlorination vinyl pipe, ball valve and copper tube. And this works needs several technics such as piping, sealing and flared processing.

After this vessel is assembled, the water pressure (~5 MPa) is applied to this vessel by using the water pump. They check a leak in the vessel and continue doing the work until it has no water leakage.

Through this training, they can understand the names of the sealing parts, their handlings and the difficulty of the sealing.

Findings of questionnaire to students

In order to grasp the purpose attainment of the subject, a questionnaire was conducted to the students. The questions and the findings are as follows:

Questions:

(1) Did you gets interested in underwater mechatronics (Aqua-mechatronics)?
(2) Did you demonstrate the originality when you made your object?
(3) Did you tackle your work independently?
(4) Did you discuss with your group members well?
(5) Did you ask a question positively to the teacher?
(6) Whenever you repeated work, did your skill improve?
(7) Were you able to acquire a sense of accomplishment through each training?
(8) Do you think that the knowledge acquired in this training is useful to your future?

Evaluation:
5: Very much so
4: Generally so
3: So-so
2: Generally not so
1: Not at all

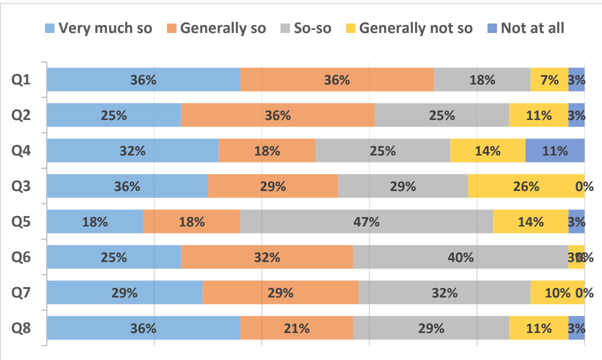

Figure 3 The result of questionnaire.

Results and Discussion

The result of questionnaire are shown in Fig. 3. The students worked on this training positively. Through the training, about 70 percent of students got interested in underwater mechatronics. It is considered that this training specialized in the contents that the students make things by themselves. This can also be imagined from the result in Question 3 that 64 percent of students tackled their work independently.

The results of Questions 4 and 5 show that there was inadequate communication between students or students and teachers. It is considered that they spent too much time tackling the work and little time discussing with each other. We must reconsider the contents of each theme and reduce the number of themes if need be.

On the whole, a lot of students were very satisfied with the training.

Conclusions

Establishing the new workshop practice “Aqua-mechatronics training program I “, we conducted the several training program to make student understand the basic skill of robotics engineering in underwater. Now we conducting the next step of this practice named “Aqua-mechatronics training program II “. We intend to achieve these workshop practice by making deeper analysis of the result.

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HUMAN RESOURCE DEVELOPMENT ASSOCIATED WITH CONSTRUCTION OF A SECURITY SYSTEM WITH INDEPENDENT POWER SOURCES DISPERSED TO LIMIT RISK

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Abstract

After the Great East Japan Earthquake, a reconstruction project promoted by technical colleges of the Tohoku district was launched in 2011, to construct a human resource development system to foster human resources. It is able to resolve problems corresponding to short-term and long-term needs of the affected areas. That project is expected to take root in the local community through collaborations between industry, educational institutions and public administrators. We considered construction of a security system with independent power sources dispersed to limit risk.

This is a concept incorporating small power generation systems using green energy – wind and solar power generation – with an electricity storage system using lead, and an electric power measurement and control system. Even when infrastructure such as electrical grids and networks are disabled by an earthquake or other natural disasters, and transmission and sharing of information become impossible, the system establishes a network using satellite communication and constructs a base station for wireless local area networks (LAN). We can access the Internet by a free spot connected wirelessly via satellite communications and data communication terminals.

During a power failure, this system functions as the power source for LAN driving to keep a LAN circuit available without interruption. During normal operations, this system provides security measures because of its monitoring effects using camera and LED illumination. The power generation status of small power generation systems, acquisition of sensor data of environment monitoring systems and the display of those data might be useful as materials for science education, thereby contributing to science and engineering education.

We constructed an independent dispersed power source and performed field study. Many students from all courses in the college participated in the problem-solving of elements in this study as their graduation research, in cooperation with engineers of firms in this area, who contributed to human resource development. This field study has greatly benefited the students from the mechanical course and the electric electronic course as they have learnt the techniques of systems construction, data collection, analysis and maintenance. In addition, by field study, many students have acquired problem solving skills.

Keywords: *Independent dispersed power source, Environment monitoring, Satellite communications, Human resource development*

Introduction

After the Great East Japan Earthquake, a reconstruction project promoted by technical colleges of the Tohoku district was launched in 2011 to construct a human resource development system to foster human resources able to resolve problems corresponding to short-term and long-term needs of the affected areas. That project is expected to take root in the local community through collaboration between industry, educational institutions, and public administrators. Technical colleges have been promoted six projects. Tsuruoka Technical College is responsible for "Human resource development associated with construction of a security system with independent power sources dispersed to limit risk."

Independent power sources dispersed to limit risk is a concept incorporating small power generation systems using green energy—wind and solar power generation––with an electricity storage system using lead and lithium ion storage cells, and an electric power measurement and control system. Even when infrastructure such as electrical grids and networks are disabled by an earthquake or other disaster and transmission and sharing of information become impossible, the system establishes a network using a satellite communication network and constructs a base station for wireless local area networks (LAN). Regarding internet access, a free spot is provided such that wireless LAN equipment is distributed, and notebook computers, portable terminals, smartphones, WiFi equipment, etc. are connected wirelessly via satellite communications and data communication terminals. During a power failure, this system functions as the power source for LAN driving to keep a LAN circuit available without interruption.

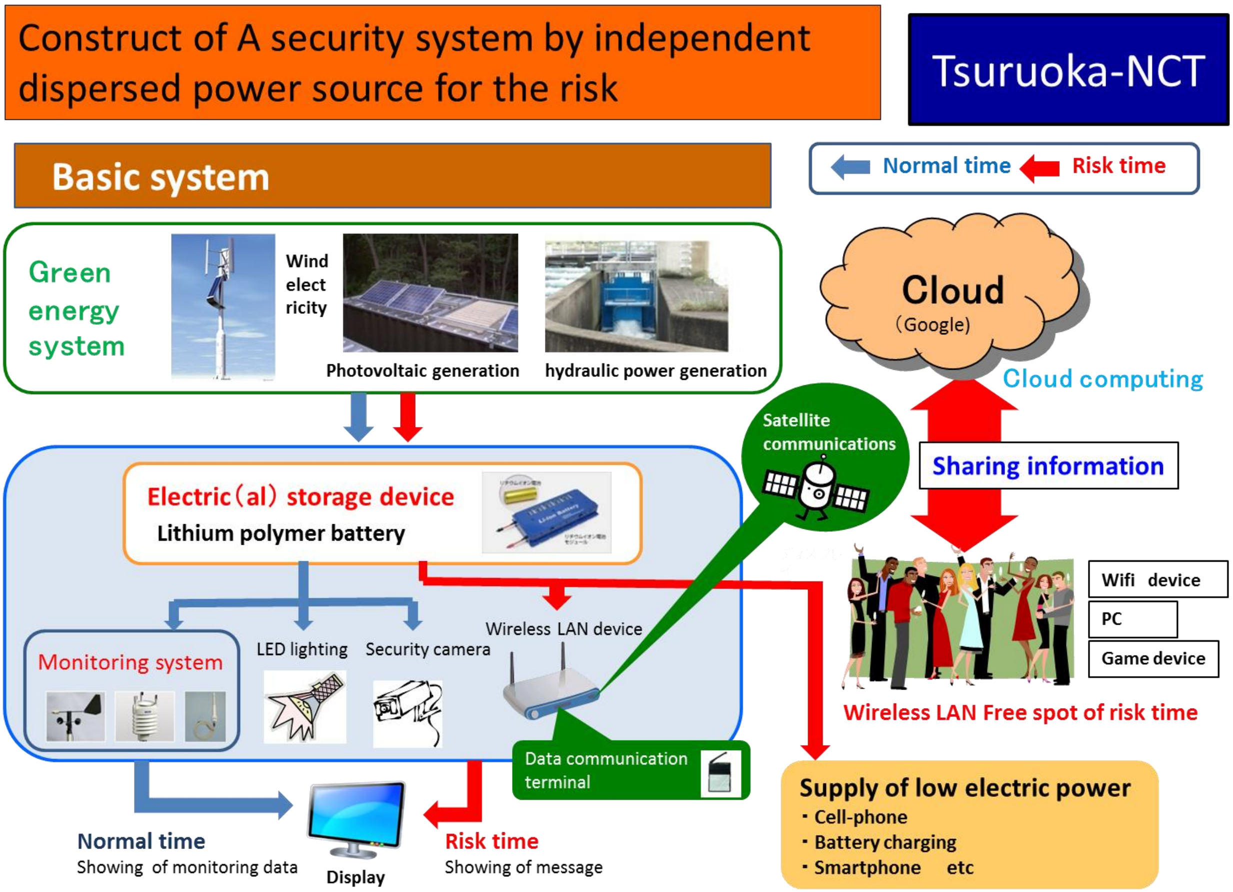

Figure 1 System concept.

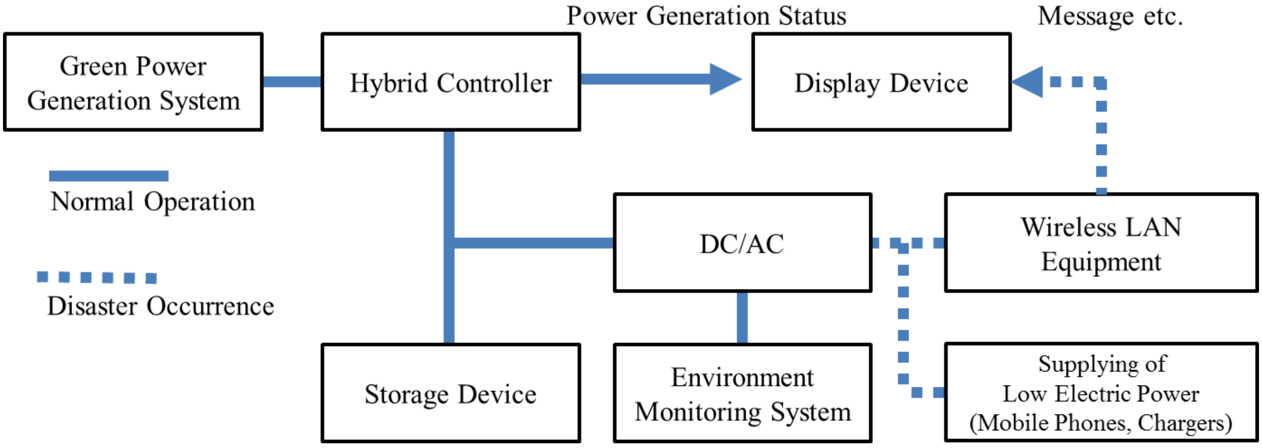

Figure 2 Block diagram of the electric system

During normal operation, this system provides security measures because of its monitoring effects using camera and LED illumination. The power generation status of small power generation systems, acquisition of sensor data of environment monitoring systems and the display of those data might be useful as materials for science education, thereby contributing to science and engineering education.

We intend to foster students and engineers at firms through the activities described above.

In this presentation, human resource development in the process of constructing independent dispersed power source by green energy, monitoring meteorological data and the like during ordinary times and construction of a dispersed security system under risky conditions will be introduced.

System Configuration

Figure 1 presents a concept of this system, which primarily comprises an electrical system, a network section, and an environment monitoring section.

2-1 Electrical system

Specifications of the green power generation system used in this system are shown in Tables 1 and 2. With a wind power generator, the cut-in wind velocity is 2.5 m/s and the output is 1 kW. The solar array has an installation angle of 30°, facing south, with total output of 1 kW from four panels, each providing 250 W. Table 1 gives wind power generator specifications (Z-1000-48; Zephyr Corp.).

Table 2 shows solar battery specifications (PV-MGJ250ACF; Mitsubishi Electric Corp.).

Figure 2 shows a block diagram of the electric system. A hybrid controller connected to the green power generation system performs efficiency improvement of green power generation system and measurement of power generation status. Over-discharge and overcharge prevention circuits of the electric storage device are also incorporated.

Electrical power generated by the green power generation system charges the electric storage device via a hybrid controller. The charged electric power is transmitted to each device via an inverter.

During normal operation, the generated electric power is sent to the environment monitoring system.

The display device provided at the college shows the power generation status of the green power generation system.

At disaster occurrence, the generated electric power is used for supplying low levels of electric power to cellular phones, chargers and the like, and to wireless LAN equipment, whereas display devices show messages and other information using communication functions of wireless LAN equipment.

Table 1 Specifications of wind power generation

Rotor Diameter	1.8 m
Mass	18 kg
Type	Permanent Magnet Three-Phase Synchronous
Output Voltage	50 V
Rating Output	1 kW (12.5 m/s)
Rating Rotational Frequency	1000 rpm
Cut-in Wind Speed	2.5 m/s

Table 2 Specifications of solar power generation

Maximum Output	250 W
Maximum Output Operating Voltage	31.1 A
Maximum Output Operating Electric Current	8.08 A
Size	1.625 m*1.019 m
Mass	20 kg
Number	4

The measurement section measures the power generation status from a hybrid controller connected to the green power generation system.

The electric storage unit comprises 12 sets of a lead battery (Life Line G PL-31105 Ah, 12 V; Concorde Battery Corp.) and a lithium ion battery for low electric power supply (2 kVA; CorePro R&D ,INC).

2-2 Network section

The network section uses a satellite broadband service IPSTAR. The satellite communication antenna (120 cm) is provided on the rooftop. High-speed internet access is possible via a satellite modem. Construction of a network is still possible under disaster conditions where cellular communications and ground networks are interrupted.

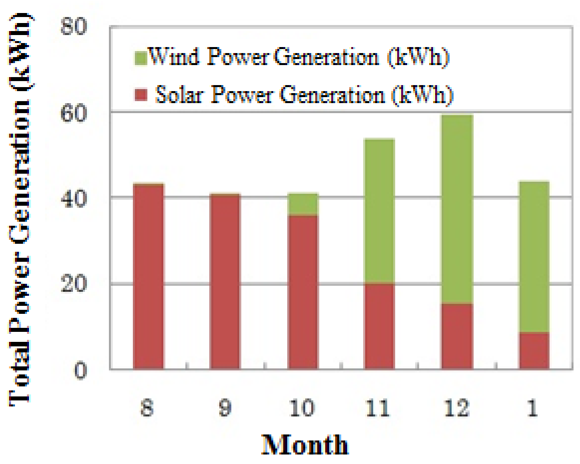

Figure 3 State of Total Power Generations

2-3 Environment monitoring section

Measurements of wind direction and wind velocity, precipitation, amount of solar radiation, temperature, humidity and the like are performed using sensors mounted on an environment monitoring measurement device installed on the rooftop. Measured data are transmitted to the server every 15 min. They can be browsed with a web browser after access. Measured data are accumulated.

Results and discussion

Figure 3 shows the total electricity produced and measured by this system. Figure 3 shows that during August–October, wind power generation is nearly zero. Almost all power generation is covered by solar power generation. During November–January, electricity generated by wind power exceeds that by solar power. At least 40 kW of power generation was confirmed in every month during August–January. It might be said that these data are useful for confirmation of a tendency and the effectiveness of wind power generation and solar power generation, although total power generation is not represented here because the power generation side is turned ON/OFF by judging conditions. The experimental data are regarded as a field study for this system.

Conclusions

We constructed an independent dispersed power source and performed field study. Operational availability of the environment monitoring measurement device in this system was demonstrated.

Results show that 24 hour continuous operation of electricity, including communication equipment and others, is difficult. This objective should be examined in future studies. Various problems including summer heat, wind power generator noise, induced lightning, and snow accumulation on solar panels were identified. These problems are expected to be resolved before this system is applied and developed in other areas.

Many students from all courses of this college participated in problem-solving of elements in this study as their graduation research, in cooperation with engineers of firms in this area, who contributed to human resource development.

Especially the students of the mechanical course and the electric electronic course were able to learn about techniques such as systems construction, data collection, analysis, the maintenance. In addition, by field study, many students were able to acquire ability for solution to the problem.

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ACHIEVEMENTS AND PROBLEMS OF THE NEW ENGINEERING EDUCATION WITH A LOCAL COMMUNITY －EFFORTS FORTEN YEARS IN THE ARCHITECTURAL DESIGN AT KUMAMOTO NATIONAL COLLEGE OF TECHNOLOGY－

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Abstract

Since 2001, a new engineering education program with a local community as a classroom has been implemented in our Department. It is designed by students' active learning. Students worked with real life complex problems are required to solve and to propose an innovative solution by collaboration with a local community in our Architectural Design class. From the assessment of these programs by EQ scores, it is confirmed that development is large as the year become higher. Through inspection of the Aalborg Model of project based learning at Aalborg University, it has been found that our approach has much in common with the Aalborg Model. But, there is significant point of difference: the curriculum. To enhance the quality of our new engineering education program it is necessary to improve our traditional curriculum to as the Aalborg Model.

Keywords: *Engineering education, Active learning, Architecture, Collaboration, Local Community, PBL, Emotional Intelligence Quotient (EQ)*

Introduction

A new engineering education program with a local community as a classroom has been implemented in our department for over ten years. It is designed by students' active learning to develop them as engineers who understand not only scientific technology, but also local history and culture, and who can see problems from the local residents' point of view. Students worked with real life complex problems are required to solve and to propose an innovative solution with collaboration of a local community in an Architectural Design class. Therefore, the local community is an ideal place to develop students' abilities in problem solving.

The purpose of this paper is to clarify that contribute to developing student's abilities and problems to be solved through working our program for over ten years.

Contents of our "New Engineer Education

1. Goals and objectives, Theme of the issue

As shown in Figure 1 in this work the goals set for each school year approximately, it is basically arranged with cooperation with social activities in accordance with the contents of each goal. Students will acquire, while spiral up the force corresponding to the school year by this. For example, in the "drafting and design" of 3rd year it will develop basic skills to mainly, such as learning basic skills, technology basic skills, and ability to gather information. And they have a deep relationship with the local community, such as in the information collection. In the architectural design of 4th year is focus on applied skills such as proposals and design. And it is a strong relationship with the local community in problem seeking.

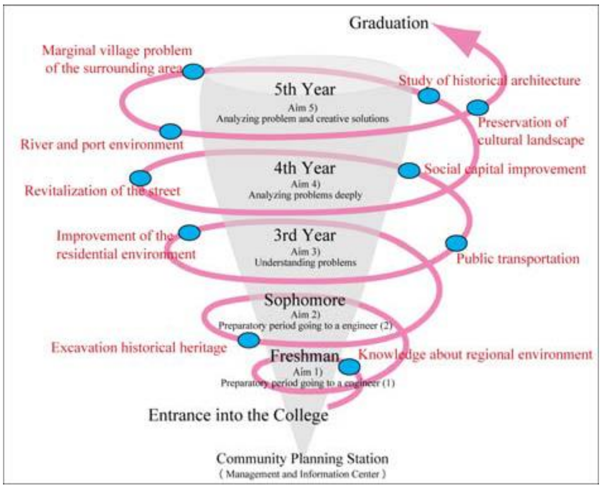

Figure 1, Relationship between the Curriculum of Department of Architecture and Civil Engineering and New Engineering Education in Collaboration with the Community

2. A meaning of "the learning with the local community

As mentioned before, students meet real life complex problems in the process of learning with the local community and they are required to solve them. The local community is an ideal place to develop student's abilities of solving problems. In the local community, students do not learn from teachers, they learn various things from the community. From our experience of with the local community, the relation between teachers and students become horizontal position from the general relation between upper-lower (Figure 2) i.e. teachers and students challenge to solve the difficult real life problem together. This is very important to develop "students activate learning".

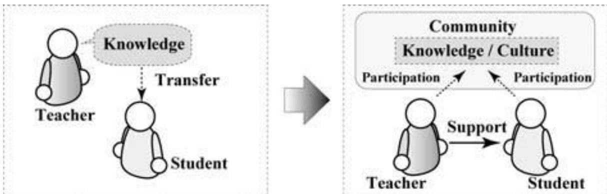

Figure 2, Relationship between Teachers and Students

3. The characteristics of our learning methods

The learning style of our Architectural Design Class has been developing to as followings. However, it is important to develop contentiously upward.

(1) The collaboration with a local community, craftsmen, companies, governments, specialists, our graduates

The reason that we can work these multiple collaboration without any difficulty is mainly that our city is medium scale. And there are the historical area and down town area near by our college. They are true supporters for our education. In the students' presentation, it is very important to have opinions by various kinds of persons from viewpoint of real life. To keep our collaboration with local community, it is necessary to keep with strong supplementing relationship on a daily basis.

(2) Group work

It has been considered generally that architectural design is individual work. But in our Architectural Design Classes without the lower year, all students' works are by group. Methods of a group formation are as follows; in the 3rd year, teachers decide group members, in the 4th year, teachers decide or students decide by talking together, in the 5th year, students decide by talking together.

(3) The real life problems in the local community

As mentioned before, students are required to solve real life problems. In the theme setting, there is large room for option in the higher year. In the 5th year, students are required to discover problems and to decide the planning are. In the 4th year, students are given the planning area and the problems to be solved, and they are required architectural solutions. They make an on-site inspection frequently and deep relationship among the local residents as the year goes up. The planning should be in response to the wishes of the community residents.

(4) Supervision by multiple teachers

We have taken supervision in the Architectural Design Classes by multiple teachers. From last year, we have introduced "Supervisor's Studio System". We have realized to enhance more deeply learning by 4 supervisors' supporting.

(5) The learning together and beyond the year

In this year, we have tried opening the 5th year's and the 4th year's Architectural Design at the same time. The studio composed 5th and 4th students have been tried to carry out. About from last year, there are some 5th year students who join in the lower Architectural Design Class presentation and advice to the lower year students. It is going to be natural that some students start up a study session independently and lower-class students help upper-class students to make models in their graduate design.

Figure 3, Explanation from a local resident

Figure 4, Hearing research to a paper

Figure 5, Mixed group with local residents and our students

Figure 6, Collaboration with purple of a elementary school

Figure 7, Moriyama Studio

Figure 8, Presentation to the specialist and our graduates

Figure 9, Workshop of the Hospital Gallery

Figure 10, the 5th year students are advising to the 3th year students'

The Educational effects

1. EQ

The Department of AC requires much general knowledge for students, because projects are closely related to a society. In addition, the engineering work environment requires extensive collaboration with other specialized fields, and ability to exchange opinions and work together is necessary. As such abilities are related to personal attitudes towards society and others, EQ (Emotional Intelligence Quotient) as advanced by Daniel Goleman (1996) was fund to be useful. Goleman states that sense of values and ability to respect consideration, self-control, cooperation, and harmony are important. They are considered to form the background of the desire to learn and willingness to contribute to social activities. Therefore, we considered EQ to be a fair assessment of attitudes towards work.

For the education of engineers in our department, EQ is related to the following. They can be learned through group activities and involvement with the community and enhance their learning motivation, so students aim to produce good work in cooperation. Trough EQ tests on a regular basis, we can continue to observe whether the students have mastered basic abilities and attitudes of engineering education.

We did an EQ test of 40 questions in total on the basis of Kikuo UCHIYAMA (1997): four questions corresponding to 10 items. Each question was graded on a Likert scale of 1 to 5 corresponding to "completely disagree" "somewhat disagree" "cannot say" "somewhat agree" "completely agree". The questionnaire was conducted four times between 2010 and 2013. Figure 11-13 show the results.

The change in the EQ value from 3rd to current 5th year in the same class is shown in Figure 11. Figure 13 and 12 show the change in the value of EQ in the current 4th and 5th years. As shown in Figure 11 and 12, the outermost spread occurs at 4th and 5th years. We believe this shows that students have been able to master basic abilities and attitudes toward learning through our engineering education. The EQ in Figure 13 is almost unchanged. It is thought that this school year students have experienced our education from our college entrance by steps.

2. The Design Competition

Students have been acquire professional skills on the work competency surely. In the Design Competition of National College of Technology, Number of qualifier in our department has been increasing.

Table 1, Number of qualifier in our department and applicants in the Design Competition

year	category	Qualifier's number of our department	Number of qualifier	Number applicants
2004	Interregional interchange symposium	1	12	19
	Manufacturing workshop	1	7	146
	Wooden house design	1	12	239
2007	Spatial design	1	20	153
2011	Spatial design	1	12	131
2012	Spatial design	1	13	133
	Environmental design	1	10	41
2013	Spatial design	3	20	115

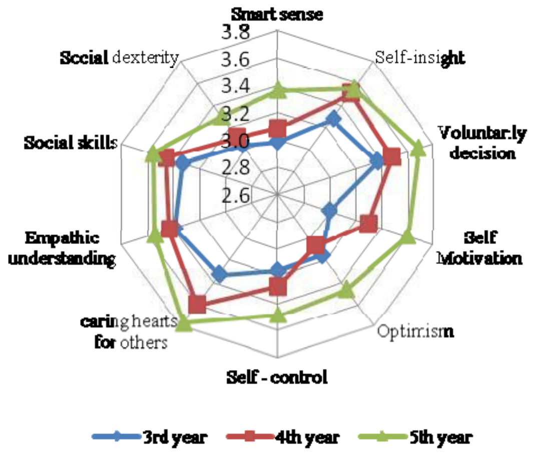

Figure 11, 2012 Academic year 5th year students

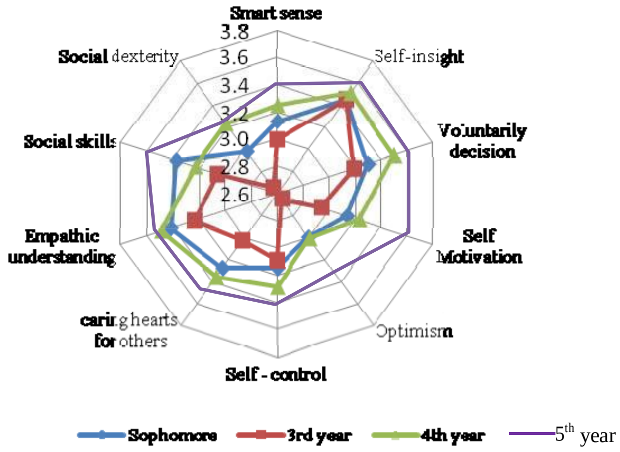

Figure 12, 2013 Academic year 5th year students

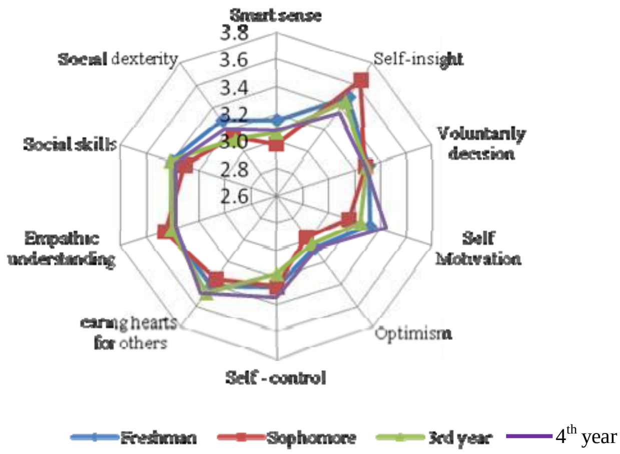

Figure 13, Current 5th year students

Figure 14, the presentation of students, 2013

Problems

1. The curriculum

Diagrams of The Aalborg PBL Model and the KNCT AC curriculum are shown in Figures 15 and 16. The KNCT AC curriculum is a traditional one that is common to almost all Japanese Universities and National Colleges of Technology. There are many special subjects and they have almost no relevance to each other. Teaching is generally left to the professors. Our approach to teaching with PBL methods is only used in a few courses, under the traditional curriculum (Figure 16). Most so-called PBL approaches in Japan are in almost the same situation.

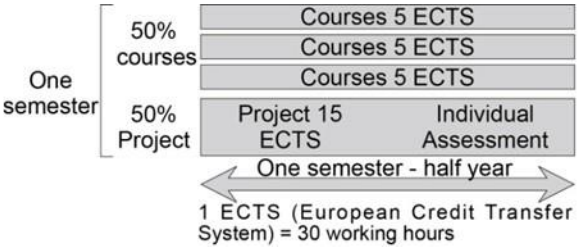

Figure 15, the diagram of the curriculum of The Aalborg PBL

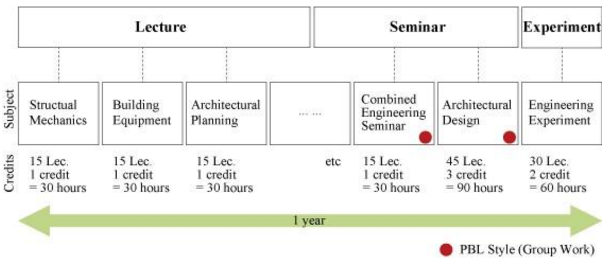

Figure 16, the diagram of the curriculum of KNCT

2. Improvement of the existing traditional curriculum

It is necessary to improve the traditional existing curriculum to Student-Centered PBL as the Aalborg Model so that our approaches can be more easily to practice. However, it is impossible to disregard in discussing "National Architect Qualification License Examination". So it is difficult to be a curriculum as same as the Aalborg model. But, it is important point the relation between projects and courses (lectures). So we should challenge to reorganize of our traditional curriculum. The followings can be proposed from the above view.

(1) Special subjects are integrated to ten subjects based on the subjects of "National Architect Qualification License Examination".

(2) "Projects" are The Architectural Design and the Engineering Experiments.

(3) Eight Courses except (2) are set in the first half of the semester.

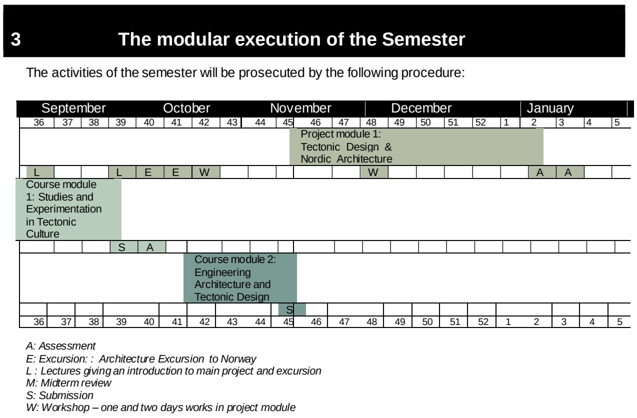

Figure 17, the modular execution of the Semester in Aalborg University

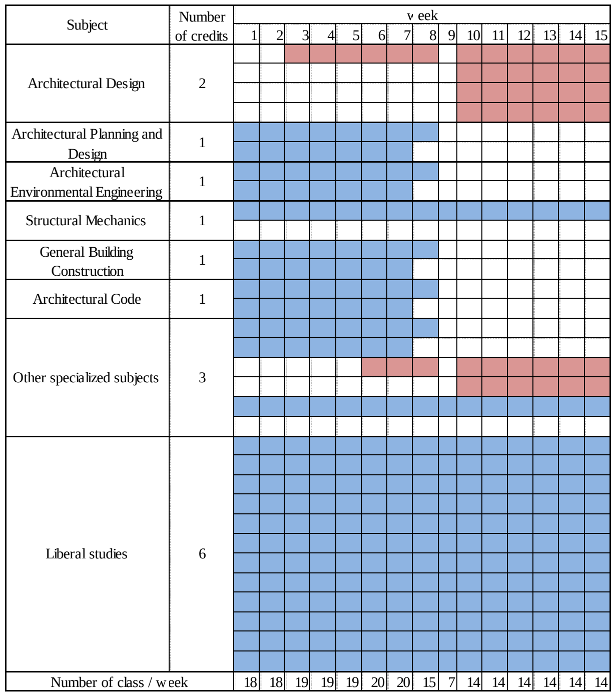

Figure 18, the simulation of placement subjects in the first semester of 4th year

Conclusions

We have shown the characteristic learning methods, achievements and problems of our New Engineering Education; mainly the Architectural Design Subject in the Department of Architecture and Civil Engineering on the basis of our approaches for over 10 years. We understand that the educational effects are students' internally development, so we have tried to take EQ as the measuring methods of it. As the result, it became clear the educational effects of our approaches. And to effectively address our New Engineering Education, we have examined to improve our traditional curriculum to the students-centered one as the Aalborg model. Further practically investigation is necessary.

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CAN AUTOSUGGESTION IMPROVE ENGLISH PROFICIENCY OF JAPANESE COLLEGE STUDENTS?

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Abstract

The English proficiency of Japanese college students is not strong as compared to other students from Asian nations. The reason is not due to the linguistic distance between Japanese and English. This is because some nationalities, whose first language has greater linguistic distance than Japanese, score higher in TOEFL. The Japanese, in general, do not need to use English on a daily basis, therefore there is very little motivation for them to learn the language. . This corresponds to raising "Affective Filter (AF)", one of the Input Hypothesis suggested by Krashen claiming that acquisition will occur in environments where anxiety is low and defensiveness absent. However, what if AF is softened or diminished or even removed?

The paper deals with this issue and proposes an experiment to clarify whether modifying AF could improve students' proficiency or facilitate their learning of English. Modifying AF is to change the attitude towards English. A person's openness to learning determines the amount of knowledge which he can gain in class, This is known as autosuggestion. Autogenic training (AT) among others is known to be a simple but effective method to bring about autosuggestion. This is done by facilitating relaxation of trainees and subjects.

In the proposal, therefore, I adopt AT to enable college students to experience autosuggestion in learning English. Students need to have this mindset that "we are very good at learning English" or "we can speak, listen, and write English on whatever topic we have in mind." Students' mental state is examined either by a change in brain activity, measured with electroencephalography (EEG), or by the time required to reach an induced state of warmth and heaviness in both arms and both legs. The following teaching is designed to adopt script-memorization and shadowing, which were previously shown to improve reading and listening proficiency, respectively. When the results are positive, AT is then proven to facilitate the English learning of Japanese college students. The conclusion goes that the learning method should always accompany AT or others that could attain autosuggestion. The results will also pave the way for their extension to other spectrum of teaching.

Keywords: *linguistic distance, affective filter, hypnosis, autogenic training (AT), autosuggestion*

Introduction

In general, Japanese college students are not good at using English and their proficiency of English is quite low compared with other Asian students (*TOEFL iBT* Test and Score Data Summary, 2013). The linguistic distance between Japanese and English is one of the possible reasons (Shirai, 2008), but it does not give us full explanation because Japanese students score lower than the other nations with a linguistic distance in a similar range (Odlin, 1987). In addition to a lack of decisive method of teaching English exclusively for Japanese, that Japanese tend to feel difficulties in using and learning English or high Affective Filter (AF) (Krashen & Terrell, 1983) toward English should be taken into account. Without addressing AF issue, an argument on proper English teaching method best suited for Japanese must swing between a communicative approach and a grammar-translation approach as our predecessors have experienced so far. To address the issue, here I propose an experimental design that could suggest how modified or lowered AF, achieved by autogenic training (AT) (Weiz, 1991) known to be a an effective method for achieving autosuggestion (Kubo & Tomioka, 2006; Goldbeck, L. & Schmid, K. 2003; Vitasari et al., 2011) improves the process of English learning by enhancing motivation toward English learning. Once modifying AF is proved effective for English learning, the same approach could be applicable to whatever the subject students are engaging, including the primary concern of the symposium: technology education.

Methods

Subjects: Forty participants/students are recruited by considering the easiness to perform autogenic training (AT) although a larger number of the participants are statistically preferable. Subjects are assigned to one of four categories (hypotizability: high/low x sex: male/female), each of which is controlled to have 10 subjects. Hypotizability has been reported to be assessed by electroencephalography or EEG (e. g., Dierks, et al., 1989; Ray 1997; Stinson & Arthur, 2013) in many literatures. However, no consistent criterion has been suggested so far (Kihlstrom, 2013; Halligan & Oakley, 2013), and hence I alternatively use "warmness and heaviness" of both arms and legs of subjects and assess hypotizability with the time required for subjects to reach that condition. Heaviness is assessed by a questionnaire and warmth by a thermography as well as questionnaire.

Autosuggestion and autogenic training: All participants take AT throughout the experiment (Figure 1). In the training session, AT is designed to be thoroughly performed, namely from a background formula through to the seventh formula (Table 1). Participants proceed to the autosuggestion stage after 6 months from the beginning (Figure 1) and reaching a state where they can feel warmth and heaviness in both arms and legs (2^{nd} and 3^{rd} formula). Examples of sentence for autosuggestion to be mentally repeated are also shown in Table 1.

English learning: All participants learn English with a method performed by Ikematsu (2013) throughout the experiment (Figure 1). The method consists of three factors such as script-memorization, shadowing, and writing-instruction, details of which are shown below.

Script-memorization: All participants will be instructed to memorize a script, which is selected from materials on the internet and some scientific papers with about 150-200 words and explained in the class, and put it down in the following class. Each memorization session is completed in 20 minutes. The results are assessed in between 0 and 100 points.

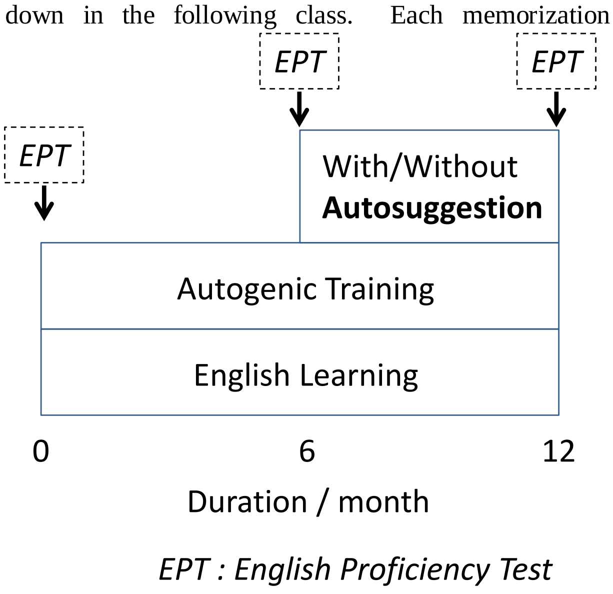

Figure 1. Timeline for English learning and autogenic training.

Table 1. Formula of autogenic training and sentences for autosuggestion.

Formula / function	What subjects repeat mentally/orally
Background formula	I am completely calm.
First formula	My both arms and legs are heavy.
Second formula	My both arms and legs are warm.
Third formula	My heart beats calmly and regularly.
Fourth formula	My breathing is very calm.
Fifth formula	My abdomen is flowingly warm. My solar plexus is flowingly warm.
Sixth formula	My forehead is pleasantly cool.
Autosuggestion	➢ **I like English.** ➢ **I am good at English.** ➢ **I enjoy learning English.**
Canceling	Say: "Arms firm, breath deeply, open eyes." (Do: Bending your arms vigorously, then breathe deeply and open your eyes.)

Shadowing: All participants will be instructed to do shadowing or parallel-reading whenever they listen to listening materials for reading, grammar (role-play type), and rapid-reading in class. No formal shadowing instruction will be performed.

Writing Instruction: All participants will be instructed to follow a writing strategy, suggesting focusing on a structure (opinion – reasons – conclusion) and using simple expressions.

Assessment of English proficiency: English proficiency tests such as TOEFL or TOEIC will be used to evaluate English proficiency of the participating students. Participants are to take three times in one year of study, namely "just before the study (0-month)," "just before entering an autosuggestion session (6-month)," and "after finishing the study (12-month) (see Figure 1).

What to be confirmed

The present experiment is set up to confirm the following three points.

1. Individual difference in the process to reach autosuggestive stage

In this study, I postulate *a stage where autosuggestion is possible (autosuggestive stage: ASS)* to be a condition where formula 3 through to 7 are attained. What is confirmed is the time required to reach ASS for each participating student. ASS will possibly be an important guidline concerning class-organization in general.

2. Effect of AT-canceling during autosuggestion on the course of improvement of English proficiency

AT is one of hipnosis and hence it requires a canceling or an awakening process. However, there is a possibility that the canceling process literary diminishes or erases the effect of autosuggestion. Once this study confirms the difference in English proficiency among students with or without AT, there is no further need to take account of the negative effect of canceling process on the outcome of AT.

3. Variation in the effect of autosuggestion

What kind of sentence is used for ASS is important because it is natural to think that even the same sentence arouse different anlysis and understanding of the sentence depending of indivisual student, and hence the possible effect of the sentence. It sure is crucially important to set sentences for autosuggestion to minimize such indivisual differences, and more to it, knowing about the difference existing even after a strict sentence setting plays a certain role in calss-organization as suggested above.

Conclusion

Here I hypothesized that autosuggestion is effective in enhancing students' motivation toward English learning even in a situation, like Japan, where there is nearly no need to use foreign languages. I suggested to use autogenic training as a method to achieve autosuggestion in place of hipnosis because of easiness to apply. By combining autogenic training with a hitherto developed English learning method, I proposed an experiment to check the effect of autosuggetion on the improvement of English proficiency of Japanese college students. Apart from ordinary high-school students who are highly motivated to pass university entrance examinations, not a few students at national college of technology seek only credits to get promoted and have a weak motivation toward being *better and better*, and so "active-learning." Therefore, when the present study confirms that autogenic training or autosuggestion has potential to strengthen students' motivation toward English learning, it also holds for whatever the subjects students are learning (Figrue 2). The results should never only be confined to Japanese college students, but be for any student with relatively lower motivation. In other words, when autosuggestion is proved effective, any field of study including technology education will have to take account of such a training that enables students to enhance their preference toward those subjects.

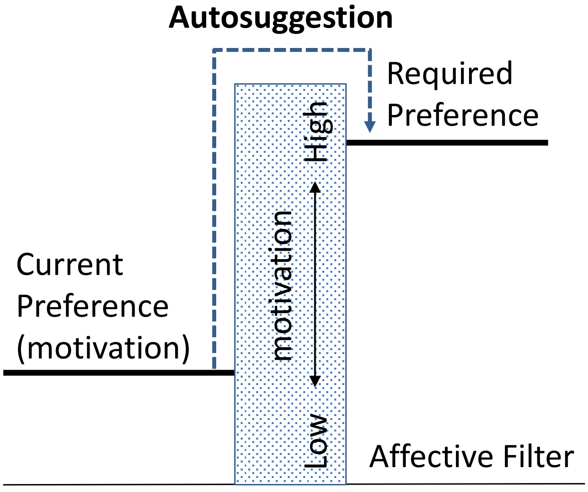

Figure 2. Schematic illustration of Affective Filter and how autosuggestion helps preference/motivation enhance.

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preference toward those subjects.

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DEVELOPMENT OF A LEGO MINDSTORMS NXT PLATFORM BASED PRACTICAL C PROGRAMMING COURSE AT NIT, KAGAWA COLLEGE -COLLABORATION BETWEEN CLASSROOM LECTURE AND PRACTICE-

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Abstract

Programming languages are a crucial element of the information technology program. Student lack of motivation to learn programming languages has been a serious hurdle for the program. The authors consider that motivating students to study programming is the foundation for the beginning of learning the subject. To address this, the authors implemented a discovery learning based LEGO Mindstorms NXT development activity in the programming curriculum. Development on the NXT platform provided students with feedback by means of the ability to check the results of their programs visually and within a timely manner. This activity also gave students the opportunity to link classroom lecture content with practical implementation. The positive affect this curriculum had on the students' motivation for learning programming was confirmed via the results of student questionnaires.

Keywords: *software, LEGO, robot, discovery learning, classroom lecture*

Introduction

Programming languages are a crucial element of the information technology program for KOSEN students. Most of department in KOSEN have programming language class and conduct their class in their own way such as Shinkai (2009) and Kosaka (2012). In the Department of Electrical Systems Engineering at National Institute of Technology, Kagawa College, normal classroom lecture had been provided for students as a C programming class until 2009. In this lecture, non-specialized students for programming practiced through a CUI. Therefore, many students couldn't get themselves interested in C language and the lack of motivation to learn programming languages has been a serious hurdle for the program. As conventional approaches to this problem such as Okamura (2010) and Oiguchi (2013), the department has increased the number of staff to provide more aggressive teaching regiment. However, this solution may be causing increased burden on the faculty involved.

The authors consider that motivating students to study programming is the foundation for the beginning of learning the subject. To address this, the authors implemented a discovery learning based LEGO Mindstorms NXT development activity in the programming curriculum. Fujii (2013) reported that the motivation for learning C language of student was encouraged. However, some problems were remained which motivation of students for preparing and reviewing of the class and contents of the learning.

The contents the authors focused on include variables, input/output and control statements as baseline knowledge. In addition, the authors added array as base line knowledge from 2013. Robot specification and error reporting were required as a basic development procedure for engineers while developing their robots and programs. In addition, classroom lectures were iteratively carried out alternating with hands-on laboratory time using the LEGO Mindstorms NXT.

Development on the NXT platform provided students with feedback by means of the ability to check the results of their programs visually and within a timely manner. This activity also gave students the opportunity to link classroom lecture content with practical implementation. In addition, this review helped the students to acquire the baseline knowledge that they need.

As the result of the implementation, the students achieved and completed all of the desired learning outcomes and activities while enjoying the class. Via the result of student questionnaires, acquisition of baseline knowledge, basic software development skills and improvement of motivation for preparation and review were confirmed. The positive affect that this curriculum had on the students' motivation for learning programming was also confirmed.

Problems of Conventional Programming Language Class

Many students feel confused about the learning content and stumble at the beginning of the class, because most of students have never used programming languages before. These students who get off to shaky start are more likely to become programming-phobic and less likely to learn programming. In addition, some other students may lose interest in programming over the course of learning for the following reasons (P1-4). These problems are accentuated in the Department of Electrical Systems Engineering especially because programming is not one of the specializations of the department.

P1. Lack of interest in programming

P2. Lack of fulfilment in practices

P3. Lack of opportunities to think by themselves

P4. Lack collaboration between practice and lecture class

P1 is caused by lack of educational material and time to induce interest in programming. P2 is caused by practices through CUI that has been used in the usual C programming class. CUI can bring a much more less sense of achievement than learning materials that students can see and touch. P3 is caused by practice that can be achieved with the same code. That means students can copy and paste from other student's code. P4 is caused by a curriculum plan that has no practices of programming using the concepts promptly after the classroom lecture. It means that students have little opportunity to immediately check and apply the knowledge obtained in classroom lecture in practice.

Countermeasure to the Problems

In this section, countermeasures to implement in the lecture to solve four problems (P1-4) are described.

C1. Motivating students to learn programming.

C2. Introducing educational material and practice that builds on their feelings of accomplishment

C3. Introducing educational materials that provide the students opportunities to develop their own ideas into practice

C4. Keeping a pace of progress between classroom lecture and practice

The authors consider that the beginning of the curriculum is very important to motivate the students for programming. To attract their interest, teachers need to explain for what reason students need to learn the C language for and use their knowledge for. Also, teachers need to introduce to the students educational material that can make learning fun. In addition, it is more effective if students have the experience of using the educational materials.

To build on student feeling of accomplishment, the educational material is expected to provide an environment in which learners can check their code immediately after programming in a way that is appealing to the eyes.

To provide opportunities to develop their ideas into practice, "copy and paste", needs to be prohibited. Therefore, the educational material must not be developed using the same code.

To grasp learning content, using knowledge frequently or immediately after classroom lecture is important. To review learning contents when students need to is also important.

Introduction Education of Engineering for 1st Graders Using Lego Mindstorms NXT

In this course, the authors employed the Lego Mindstorms NXT as an introduction to the C programming language for 2nd grade students in the Department of Electrical Systems Engineering. The students can build robots as they like using the Mindstorms NXT.

In the author's department, a course to introduce basic robotics engineering using Mindstorms NXT for 1st graders is offered as shown in Figure 1. In the course for 1st graders, the students use the icon based LEGO NXT software IDE that enables students to program the robots easily. Therefore, 2nd grade students in this department experienced programming basics to control their own robots during the previous year. This is a key element that the authors employed Mindstorms NXT for this course. Figure 1 (left) is a picture that shows some aspects of the course that students were making the robots and participating in a robot contest.

In addition, it is a great advantage that the students cannot use the same code as other students because the each student builds their own unique robot that has an original design and function and needs its own unique programming code. Therefore, they cannot copy-and-paste from other students to achieve tasks.

In this course, the authors used "STAR series embedded system developing course by Afrel (2009)" as C language developing environment for the Mindstorms NXT.

Figure 1 Pictures of introductory education to engineering for 1st grade students

One Year Learning Contents of C language Course

The contents of the course for the 2013 school year are shown in Table 1. As shown in this table, the students learn some contents from lecture, see it in practice and receive detailed explanation taking way to control the NXT as an example. Also, to review the learning contents after 1-2 months again, the authors designed practice tasks and a robot contest. Additionally, the authors added "arrays" as learning content to cover more completely the basics of programming.

Table 1 Learning contents in 2013

	Information Processing Ⅰ (Class room lecture)	Elementary Engineering Experiment (Experiment)
April	Sketchy explanation of C language Format, printf function, variable Command line prompt	Review of robot building and programming using NXT software
May	Operator **Control statement (if statement)** Function	Practice to use **control statement** • Program NXT using C language • Practice to use sensors
June	**Control statement** (for and while statement) NXT control practice (Level 1 and 2)	Practice to use **control statement** • Practice to use sensors • NXT control practice (Level 1 and 2)
July	NXT control practice (Maze task)	NXT control practice (Maze task)
September	Review of control statement Robot building for curling task	Robot building for curling task
October	Curling task	Curling task
November	Array	Curling task
December	Curling task	Curling task
January	Review of control statement, array • Game programing (tic-tac-toe)	Curling task Presentation of curling robot
February	Presentation of curling robot	Presentation competition

Table 2 A plan for classroom lecture and practice about control statement

	Information Processing Ⅰ (Class room lecture)	Elementary Engineering Experiment (Experiment)
	Learning contents of control statement	Programming practice to handle motors and sensors
1st week	if statement • Explanation • Programming with CUI • Practice exercise	Programming practice to handle motors and sensors • Excursion of sample programs of touch sensor (if statement) • Explanation of if statement using NXT programming • Debug and coordination
2nd week	while statement • Explanation • Programming with CUI • Practice exercise if statement • Explanation using sample programs of NXT	Programming practice to handle motors and sensors • Excursion of sample programs of ultrasonic sensor (while statement) • Explanation of if statement using NXT programming • Debug and coordination
3rd week	for statement • Explanation • Programming with CUI • Practice exercise while statement • Explanation using sample programs of NXT	Programming practice to handle motors and sensors • Excursion of sample programs of light sensor (while statement) • Explanation of if statement using NXT programming • Debug and coordination

In

Table **2**, lesson plans for classroom lecture and practice about control statements shown. During the 1st week a lecture on "if" statements was given. The students used conventional educational material a compiled programs from a CUI in the class. In the design laboratory period during the same week, the students ran some sample programs that included "if" statements. After that, the students changed the condition of the "if" statements and the settings of the motors and checked for the change in behaviour of the robot.

On the 2nd week, a lecture on the "while" statement was given. A review of "if" statements with an example of the sample programs of NXT was carried out later during the classroom lecture. In the design lab during the same week, the students ran some sample programs using an ultrasonic sensor that included "while" statements.

On the 3rd week, a lecture on "for" statements was given. A review of the "while" statement with an example of the sample NXT programs was carried out later in the classroom lecture. In the design lab during the same week, the students ran some exercises using loops with counters that also included "for" statements.

In this course, some practices tasks and two robot contests were carried out from June to January. The first programming practice tasks that were carried out in May consist of 5 steps.

Step1. From the start point, move 1m forward.

Step2. After contacting the wall, move back 30 cm. (Touch sensor)

Step3. Clap your hands to stop your robot. (Sound sensor)

Step4. Stop 5cm in front of the wall. (Ultrasonic sensor)

Step5. Stop within the black area. (Light sensor)

Students learned how to use control statement to control robot by seeing behaviour through this practice.

The second programming practice tasks that were carried out in June consist of 3 steps.

Step1. Push the touch sensor to move 1m forward and stop. Repeat this procedure using endless loop.

Step2. Clap your hands to start and wave your hand to stop the robot. Repeat this procedure 3 times.

Step3. Start by pressing the touch sensor and clap your hands 5 times to slow to a step.

To achieve Step1, Step2 and Step3, more complex combination of control statements are required. Students acquired the ability to combine various statements to control the robots precisely.

After the programming practice, a robot contest using maze field as shown in Figure 2 was held. The students need to program the robot to go through the zigzag street and go out into the plastic bottle zone. The robot can get points that vary based on the mass of the bottles by knocking the bottles down. The students can also try to knock a ball down or capture it to get extra points. To achieve the task, a complex combination of control statements, building an appropriate robot and robot motion coordination are required.

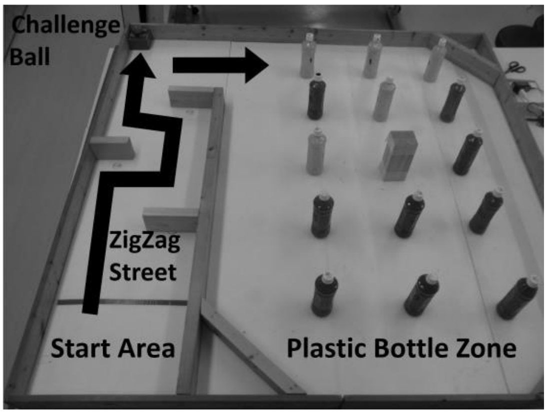
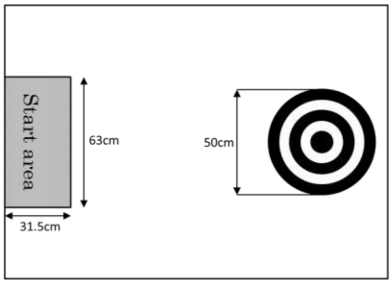


Figure 2 Overhead view of the field of Maze task



Rule

- Concentric circle is scoring area.
  The outermost ring (black) is 5 points.
  The second-outermost ring (white) is 10 points
  third one is 20 points, fourth one is 30 points.
  The center of the circle is 50 points

- 3-4 students per team
- Players from either team alternate in taking shots from the start area.
- Play 2 ends
- A plastic bottle is placed point where a robot stopped
- When robot fall opposing team's bottle down, deduct points
- After finishing taking all shots, calculate points

Figure 3 Rules of curling task

Figure 4 Picture of practice for curling task

After the maze task, another robot contest was held. The rules and the field is shown in Figure 3. The students need to develop a strategy against robots of opposing teams. The students are also required to control their robot precisely to get higher points. To bring victory, a complex combination of control statements, building robot to meet the team requirements, and robot motion coordination to get higher points and not to get a deduction of points are required. Figure 4 shows that the students enjoyed playing the curling task. In this figure, one student is trying to push an opponent's bottle away and put his robot to the center of the circle.

During the "Curling" task in January a lecture on "arrays" was given. This lecture used a CUI, however the authors imposed practice tasks as a game to motivate students to learn about "arrays". The authors provided the students a sample code of a tic-tac-toe program that has some errors to be found and fixed.

Results of Questionnaires and Discussion

In this section, the student's motivation for learning is compared before and after implementing.

Table **3** shows results of a questionnair of the students evaluation of Information Processing I. The students evaluated this class on a 5-point scale. Here, several questions were chosen from 16 questions to evaluate this course. Before implementing, from 2007 to 2010, only conventional classroom lecture taught for students. From 2011, a collaboration between classroom lecture and practice tasks in the design laboratory has been implemented. From

Table **3**, in comparison between the result of 2007 to 2010 and the result of 2011 to 2012, almost all values have improved except motivation to preparation and review in the second line. Therefore, improving student's motivation to learn C language was confirmed from the results. However, the problem of motivation to preparation and review still remains. "Arrays" were also introduced in the class as new learning content and some practices for classroom lecture such as the tic-tac-toe program as a countermeasure for motivation to preparation and review for the class was taken in 2013. In comparison between 2011 to 2012 and 2013, the result was improved. Therefore, motivation to learn C language was improved.

The results of a questionnair that was carried out in isolation with the student evaluation is shown in Table 4. The answer for Q1 indicates that almost all of the students enjoyed the course. The answers for Q2, Q3 and Q7 indicates that about 70-90 percent of the students understood "if", "while" and "for" statements. From the answers for Q4, it was confirmed that about 70-80 percent of the students understood how to use sensors and apply the knowledge of control statements to control the robot. The answers for Q5 and Q6 indicates that 70-90 percent of the students understood functions very well. The answer for Q8 shows that 58 percent of students understood "arrays". This result indicates that improving the explanation and practice tasks are required.

Table 3 Result of student evaluation for the class

Question	2007	2009	2010	2011	2012	2013
Did you pay attention to the teacher and concentrate on learning?	3.800	3.833	3.675	4.366	4.475	4.644
Did you prepare for next lesson and review a previous lesson?	2.857	2.972	3.075	2.951	3.050	4.689
Did you understand the learning contents?	3.171	3.194	3.150	4.073	4.325	4.711
Did you find it easy to ask question in this class?	3.343	3.694	3.425	4.390	4.450	4.600
Did the teacher give you clear explanations?	2.944	3.278	3.225	4.220	4.450	4.778
Do you think this class is good in a comprehensive way?	3.500	3.686	3.564	4.436	4.550	4.553

Table 4 Result of student questionnaire

Q1. Did you enjoy this experiment using NXT?	2011	2012	2013
1. Definitely	21	20	21
2 Can't complain	15	18	24
3. Not so much	2	2	0
4. Definitely not	0	0	1
Percentage of answer in the affirmative (1 and 2)	95%	95%	98%

Q2. Did you understand how to use if-statement?	2011	2012	2013
1. Definitely	14	12	17
2. Moderately	16	21	25
3. Maybe not	5	7	3
4. Definitely not	3	0	1
Percentage of answer in the affirmative (1 and 2)	79%	83%	91%

Q3. Did you understand how to use while-statement?	2011	2012	2013
1. Definitely	13	8	15
2. Moderately	14	24	27
3. Maybe not	9	8	4
4. Definitely not	2	0	0
Percentage of answer in the affirmative (1 and 2)	71%	80%	91%

Q4. Did you understand how to use sensors by C-language?	2011	2012	2013
1. Definitely	11	9	9
2. Moderately	19	18	27
3. Maybe not	6	13	10
4. Definitely not	2	0	0
Percentage of answer in the affirmative (1 and 2)	79%	68%	78%

Q5. Did you understand how to use functions?	2011	2012	2013
1. Definitely	15	9	12
2. Moderately	13	19	25
3. Maybe not	9	11	8
4. Definitely not	1	1	1
Percentage of answer in the affirmative (1 and 2)	74%	70%	80%

Q6. Did you understand effectivity of functions?	2011	2012	2013
1. Definitely	19	21	19
2. Moderately	11	15	21
3. Maybe not	7	3	5
4. Definitely not	1	1	1
Percentage of answer in the affirmative (1 and 2)	0.789	0.9	0.87

Q7. Did you understand how to use for-statement?	2011	2012	2013
1. Definitely			16
2. Moderately			26
3. Maybe not			4
4. Definitely not			0
Percentage of answer in the affirmative (1 and 2)			91%

Q8. Did you understand how to use arrays?	2011	2012	2013
1. Definitely			8
2. Moderately			18
3. Maybe not			18
4. Definitely not			2
Percentage of answer in the affirmative (1 and 2)			57%

Conclusions

In this paper, the authors consider that motivating students to study programming is the foundation for the beginning of learning of the subject. To address this, the authors implemented a discovery learning based LEGO Mindstorms NXT development activity in the programming curriculum. As the result of student questionnairs, authors confirmed that the students enjoyed the class and experiments and they were boosted and keep their motivation. In addition, the authors also confirmed that most of the students understood the foundations of the C programming language and how to organize their ideas and solve problems.

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