Modifying a "Reverse Engineering" Class for the Department of Computer Engineering at KOSEN-KMITL

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Abstract

KOSEN-KMITL has been established in Thailand as the first KOSEN to develop a Japanese-style National Institute of Technology (NIT or KOSEN) abroad. KOSEN-KMITL has introduced the Model Core Curriculum (MCC) and other distinctive educational systems of KOSENs to encourage engineering education.

KOSEN-KMITL has also implemented pioneering initiatives that have not yet been implemented by Japanese KOSEN. One of the pioneering efforts is the distinctive class, 'Reverse Engineering.' This is a course where students disassemble and examine products already in circulation. By disassembling a product and examining its design, students understand the engineering characteristics of the product and learn engineering design by themselves. 'Reverse Engineering' here has a different meaning from reverse engineering in so-called software engineering which is not to recode programming from a sequence of bytes.

This subject is provided to first-year students at KOSEN as part of their introductory education. First, KOSEN-KMITL has established a Mechatronics Engineering Department. At that time, it was reported that the educational impact of this subject has been positive. In the Department of Computer Engineering, the second department established at KOSEN-KMITL, "reverse engineering," which was introduced in the Department of Mechatronics Engineering, was also introduced directly. As a result, student satisfaction was very high. However, there was the problem that some of the analyses were not directly related to computer engineering.

Therefore, this year we will implement reverse engineering related to computer engineering. In this report, we describe in detail what we have implemented and report the evaluations from students through questionnaires. Furthermore, this subject is considered suitable as an effective introduction to universal engineering education. Therefore, it is a useful reference for the introduction of all engineering education, not only KOSEN education. Since it is the result of modification from mechatronics to computers, we believe that it will be helpful in terms of its application to various fields.

Keywords: *Computer science, Reverse Engineering, primary education*

Introduction

KOSEN-KMITL is the first institution in Thailand to adopt the Japanese-style KOSEN school system. It was opened in May 2019 and is under the umbrella of King Mongkut's Institute of Technology Lat Krabang. It fully implements the education system of the Japanese National Institute of Technology (KOSEN) and fosters practical engineers in a five-year course. (e.g., KOSEN)

KOSEN-KMITL students can also participate in internships and training at companies and Japanese KOSEN. KOSEN-KMITL aims to train practical and innovative engineers who support the industries shown in Thailand's industrial policy "Thailand 4.0".

The establishment of KOSEN-KMITL was implemented as a cooperative project between the Japanese and Thai governments. Japan has provided yen loans, and Japanese KOSEN professors are guiding and training local Thai teachers.

KOSEN-KMITL is bringing new possibilities to the Thai education world. It is expected to improve Thailand's industrial technology and contribute to economic growth by adopting the Japanese KOSEN education system.

It is also worth noting that KOSEN-KMITL in Thailand offers a unique type of education that is different from the KOSENs in Japan. One of the key differences is the focus on reverse engineering courses as part of the introductory curriculum. This type of reverse engineering is different from the computer engineering definition, but it is very effective in helping students to understand technology. Komatsu et al. (2020) provide more information on the KOSEN-KMITL reverse engineering program.

In addition to the reverse engineering courses, KOSEN-KMITL also offers a computer engineering department as its second department. The computer

engineering department is unique in that it focuses not only on providing Information and Communications Technology (ICT) education to students but also on the use of ICT in education. Kobayashi et al. (2022) report on the impact of COVID-19 on online exams.

Initially, the reverse engineering courses were designed and implemented based on the contents of the mechatronics engineering department, which was the first department to be established. While some degree of success was achieved, students were not motivated to cooperate with the department. Therefore, the theme was changed to be relevant to the computer engineering department in 2020. This change resulted in a significant difference in student evaluations.

This report investigates the evolution of reverse engineering courses at KOSEN-KMITL. The results showed that reverse engineering courses are effective in the introduction of engineering education and that the introduction of more specialized courses can improve the effectiveness of the introduction of engineering education.

Reverse Engineering

Reverse engineering in information engineering is a process of analyzing binary data or executable file format to reproduce and understand the original program.

KOSEN-KMITL has introduced a reverse engineering subject as an introductory subject. The reverse engineering here is different from the general reverse engineering in information engineering. The reverse engineering at KOSEN-KMITL is to understand how a product is created by disassembling the product and to learn the methods of analysis and experiment. This subject is unique and can be very effective as an introductory education for engineering.

Previous reverse engineering at KOSEN-KMITL has been conducted in line with the curriculum of the preceding department, the Mechatronics Engineering Department. The results of the introductory education have been highly evaluated. On the other hand, these themes were not in line with the Computer Engineering Department.

Table 1 shows the topics of reverse engineering in 2021 and 2022. The number of topics in 2021 is small because online classes and other parallel classes were held due to the influence of COVID-19.

Table 1. The theme of Reverse Engineering

AY2021	AY2022
DC Motor	Motor and Coil
Camera	Software and Data
Digital Camera	LAN cable
Display	IR sensor
	Keyboard
	Computer
	AC/DC box (inside a computer)

Student Survey Results and Discussion for Themes

This study surveyed student satisfaction with the reverse engineering course at KOSEN-KMITL in Thailand. The survey was conducted over two years, in 2021 and 2022, with 48 students each year.

The survey asked students "Which projects were interesting to you?" Multiple answers were allowed.

Figure 1 shows the results for 2021.

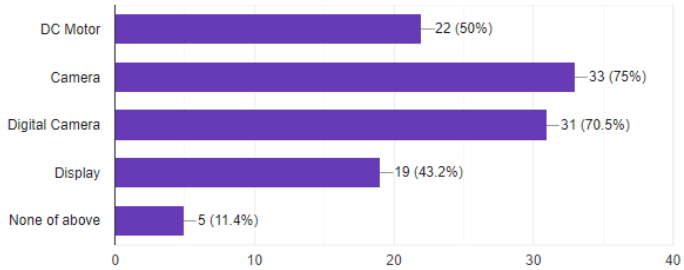

Figure 1 Interest for topics (AY2021)

DC Motor and other topics were found to be interesting to about half of the students, while Camera and Digital Camera were found to be interesting to more than 70% of the students. Display, which is relatively close to computers, was only found to be interesting to 43% of the students.

In the case of Camera and Digital Camera, the actual products were disassembled, and the students were able to see the circuit boards, lenses, and image-processing processors. On the other hand, Display was limited to the analysis of the images on the screen, and the students were not able to touch the circuit boards. It can be inferred that the act of actually opening the product is related to interest. On the other hand, in the case of a DC Motor, even though the magnets and coils that make up the motor were disassembled, only half of the students were interested. We believe that this result is due to the psychological distance between the students' interests in computer engineering and their motivation.

The results for the year 2022 are shown in Figure 2.

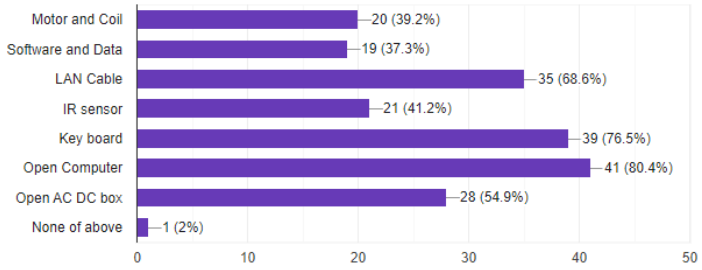

Figure 2 Interest for topics (AY2021)

The interest in LAN cables, computers, and keyboards, all of which are directly related to the Department of Computer Engineering, was very high. This year was characterized by a lower interest in DC motors and other topics compared to the previous year. Whether this indicates the nature of the student population's low interest in subjects other than computer

engineering in the first place, or whether the relatively low interest is since the survey was conducted on subjects that are highly related to computer engineering, requires further analysis. In any case, the results confirm the effect that subjects that are highly directly related to computers for computer engineering students can increase student interest.

On the other hand, the evaluation of software that analyzed IR sensors and jpeg files did not interest the students. These may not have attracted the students' interest because the focus was on the analysis using computers and devices, rather than on the actual products themselves.

Student Survey Results and Discussion for Subject

The reverse engineering course itself was also evaluated based on a student questionnaire. The target students are the same as the students in the previous section.

Figures 3 and 4 show the responses of students in the academic years 2021 and 2022, respectively, to the question "On a scale of 1 to 4, do you think this subject relates to computer engineering? The answer shows 1 is Mostly irrelevant, 2 is less relevant, 3 is relevant, and 4 is very relevant.

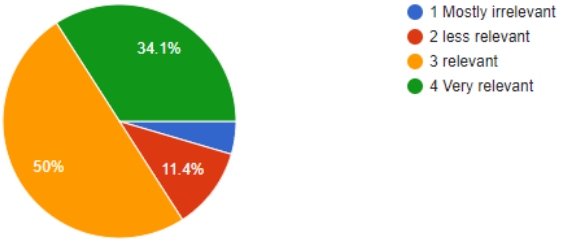

Figure 3 relevant (AY2021)

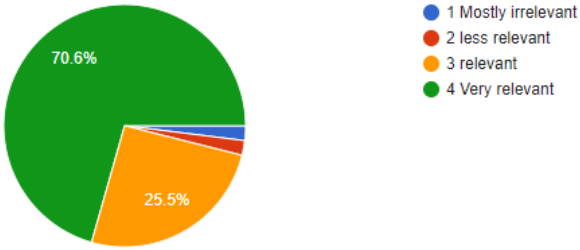

Figure 4 relevant (AY2022)

In 2021, the largest number of students chose 3, while in 2022, more than 70% of the total number of students chose 4. This result is because our course change content made students more aware of the relationship to computer engineering. The Welch's t-test also showed that this mean was significantly different at a significance level of $p<.05$. Thus, the change in subject matter means that students were made more aware of the relevance of the subject to computer engineering.

Figures 5 and 6 show the results of the questionnaire asking about students' interest in the subject itself. Figures 5 and 6 show the results for the years 2021 and 2022, respectively.

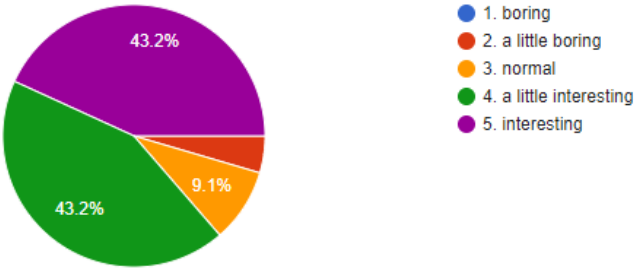

Figure 5 Interest in this subject (AY2021)

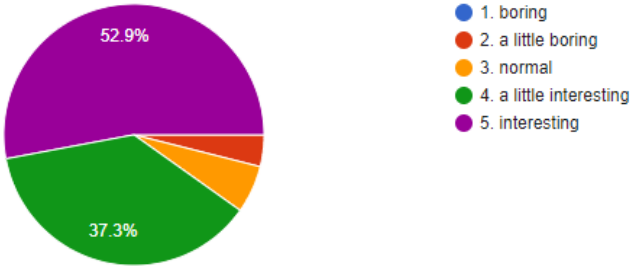

Figure 6 Interest in this subject (AY2022)

From the results, a significance test on the mean did not yield a significant difference. However, the percentage of students who responded "interesting" increased from 43% in AY2021 to nearly 53% in AY2022.

These results indicate that the change to content more closely related to the department's content was effective in attracting student interest.

Thirty AY2021 students responded to the open-ended question of what they would like to learn in such a reverse engineering class.

In the free-text responses, 15 students indicated that they would like to do computer assembly, and 2 students indicated that they would like to copy websites and analyze source code. One student indicated that he did not want to analyze motors.

On the other hand, 36 responses were received from students in AY 2022. Three students indicated that they were satisfied with disassembling the PC. In addition, some opinions showed interest in more detailed computer engineering, such as wanting to disassemble a CPU, disassemble a hardware keyboard, and disassemble a smartphone. There were also opinions such as wanting to know what is inside various software.

Although not simply comparable, we believe that these results confirm that our aims have been realized in the following respects. First, the students are interested in education that is appropriate to their department, as more than half of the active students who responded in

AY2021 wanted to learn more about subjects closer to their majors in this course. For students in AY2022, the results indicate that the introductory education has been successful in creating a desire to learn more about the subject.

Of course, we cannot ignore the influence of the difference in learning opportunities and learning together with friends due to changes in the social environment, such as COVID-19. However, we believe that the fact that many students developed a desire to reverse engineer computers and were motivated to actively learn about their majors was very effective as an introductory education.

Conclusions

Reverse engineering is one of the unique introductory courses at KOSEN-KMITL. In this report, we describe the results of the modification of the curriculum of reverse engineering, which was not designed for the Department of Computer Engineering, to a curriculum.

The questionnaire survey showed that students understood the relevance of the subject to computer engineering and that they were more aware of the relevance of the subject than in the previous year, with a significant difference at the $p<.05$ level of significance. Regarding interest in the subject, about 53% of the students were also able to develop the most interest in the subject.

These results suggest that when students are made aware of the relationship between their department and a subject, their interest in that subject increases. This result has positive implications not only for computer engineering but also for engineering education in general. Particularly concerning introductory education, attracting interest is very important for the long years leading up to graduation. Therefore, we expect that our approach will be very effective for engineering in general.

In the future, we would like to explore introductory education for each department, and design and plan classes that will generate interest in the subject among students.

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