IMPLEMENTATION OF THEMES FOR SUBJECT OF MANUFACTURING BASIC FOR FIRST-YEAR STUDENTS TO SELECT MAJOR COURSE

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Abstract

At the National Institute of Technology, Nagano College, from the fiscal year 2022, all first-year students enter the engineering department without choosing a major. The students will choose to major in one course out of Informatics and Electronics, Mechanics and Robotics, or Civil Engineering when they advance to the second grade. To provide an opportunity for students to select a major, these general subjects are provided - basic manufacturing engineering and basic manufacturing experiments. These subjects are provided based on the five original fields the school offered. We hope students will be motivated to select a major and increase their motivation for future study through these subjects. Each of these two subjects is arranged for 90 minutes, which totals 180 minutes per week. Each of the original fields will be covered for 3 weeks in the first semester and 3 weeks in the second semester, for a total of 6 weeks. The course of Informatics and Electronics (IE) consists of the former "Department of Electrical and Electronic Engineering" and "Department of Electronics and Computer Science". The course of IE consists of the information and the electronics field. We examined the themes and content for the first three weeks and the second three weeks, for six weeks. Three themes were set: machine learning, information security, and application development. In the theme of machine learning, students will study image recognition and image generation, focused on machine learning such as AI and deep learning. In addition, we hope it will lead to a new curriculum on data science that will be established for all departments. In the theme of information security, students learn about the properties of files handled by computers and the information contained in files, focusing on image files mainly. Security is an issue in the information society, and security engineers are required. We believe this will lead to security-related subjects being offered in the following year's curriculum. In the theme of application development, students will have experience programming a smartphone application. Students are familiar with smartphones and interested in programming through games, etc. In addition, our curriculum has many opportunities for programming as well. By using a tablet, we hope students can experience manufacturing through programming. In this paper, we show the results of implementing these themes, we have discussions based on the state of classes and the results of questionnaires.

Keywords: *freshman education, major select, machine learning, information security, application development*

Introduction

At the National Institute of Technology, Nagano College, all first-year students enter the engineering department without choosing a major, from the fiscal year 2022. After entering it, the students will choose to major in one course out of Informatics and Electronics, Mechanical Robotics, and Civil Engineering. at the end of the first year (Table 1). To provide an opportunity for students to consider and select a major, basic manufacturing engineering and basic manufacturing experiments are set. These subjects are provided based on the five original fields the school offered.

We belong to the course of Information and Electronics, which consists of the former Department of Electrical and Electronic Engineering and Department of Electronics and Computer Science. The IE course brings the subject separated by two fields: information and electronics (Table 2).

Basic manufacturing engineering and basic manufacturing experiments, each subject have 90 minutes per week, and these are offered consecutively throughout the year. We thought that it would not be necessary to divide the two subjects clearly, as long as these subjects could be evaluated separately.

Table 1 Department of Engineering and Course

1st Grade	2nd Grade	3rd-5th Grade
Department of Engineering	Course of Informatics and Electronics	Informatics course
		Electronics course
	Course of Mechanics and Robotics	
	Course of Civil Engineering	

Table 2 Old Department and New Course

Old Department	New Course
Electronics and Computer Science Engineering	Informatics and Electronics
Electrical and Electronic Engineering	
Mechanical Engineering	Mechanics and Robotics
Electronics and Control Engineering	
Civil Engineering	Civil Engineering

In this paper, we confirm the purpose, set themes, and examine the contents.

Purpose

In parallel with the implementation of basic manufacturing engineering and basic manufacturing experiments throughout the year, a major survey will be conducted three times (initial, intermediate, and final), and a major will be determined finally.

Therefore, basic manufacturing engineering and experiment will be opportunities to choose their major and learn the basics of engineering for first-year students.

As a theme for the information field in the course of Informatics and Electronics, we examined the content that would have the effect of increasing the motivation to study in the information courses.

The main purpose of these themes was to provide an opportunity for students to choose information electronics, and to provide an overview of information courses. Furthermore, even if students do not choose the course of Informatics and Electronics, and Information courses, since there are opportunities to utilize information technology in any field, we want students to keep the motivation to understand the knowledge of information technology.

The basic manufacturing engineering and experiment are provided by each old department field. The rotation of class and course are shown on Table 3. The IE1 means the Department of Electrical and Electronic Engineering, IE2 means the Department of Electronics and Computer Science Engineering. And MR1and MR2 means the Department of Mechanical Engineering and the Department of Electronics and Control Engineering. The CE means the Department of Civil Engineering.

Each field provide themes by 3 weeks and rotate to another class. It repeats for 15 weeks. And same pattern is provided in second term too.

Themes

The following three topics were established as the themes for Information courses in course of Informatics and Electronics.

(1) Machine learning

(2) Information security

Table 3 Class and Course Rotation Table

	Class				
Week	1-1	1-2	1-3	1-4	1-5
1	IE1 1	MR1 1	CE 1	IE2 1	MR2 1
2	IE1 2	MR1 2	CE 2	IE2 2	MR2 2
3	IE1 3	MR1 3	CE 3	IE2 3	MR2 3
4	IE2 1	MR2 1	IE1 1	MR1 1	CE 1
5	IE2 2	MR2 2	IE1 2	MR1 2	CE 2
6	IE2 3	MR2 3	IE1 3	MR1 3	CE 3
7	MR1 1	CE 1	IE2 1	MR2 1	IE1 1
8	MR1 2	CE 2	IE2 2	MR2 2	IE1 2
9	MR1 3	CE 3	IE2 3	MR2 3	IE1 3
10	MR2 1	IE1 1	MR1 1	CE 1	IE2 1
11	MR2 2	IE1 2	MR1 2	CE 2	IE2 2
12	MR2 3	IE1 3	MR1 3	CE 3	IE2 3
13	CE 1	IE2 1	MR2 1	IE1 1	MR1 1
14	CE 2	IE2 2	MR2 2	IE1 2	MR1 2
15	CE 3	IE2 3	MR2 3	IE1 3	MR1 3

(3) Application development

In the first three weeks, (1) Machine learning for two weeks, (2) Information security for one week, and (3) Application development in the latter three weeks.

In (1) Machine learning, this theme is image recognition and image generation, related to machine learning such as AI and deep learning. Interest in this field has been increasing recently, and students are interested in it. In addition, this subject will lead to a new curriculum on data science that will be established for all major departments.

In (2) Information security, the main target of the theme is images, regarding the properties of files handled by computers and the information contained in files. In the information society, information security is emphasized, and there are high demands for engineers with security technology. We believe that this will lead to security-related subjects that were added to the new curriculum.

In (3) Application development, the theme provides experiences to manufacture using programming. Students are familiar with smartphones and are interested in programming through games, etc. In the Information course curriculum, there are many opportunities to learn programming. Therefore, by creating a smartphone application that can be executed on a tablet, students can experience manufacturing through programming. This is refined content based on provided to first-year students of the Department of Electronics and Computer Science in 2019(Fujita and Nishimura, 2020).

Contents

The specific contents of the three themes are shown below.

About (1) Machine learning, students learn the basic knowledge and background related to artificial intelligence, students will experience recognition of handwritten numbers, image synthesis, and reinforcement learning, using the Python language. At

first, the theme teacher described the historical trend and current state of artificial intelligence as an introduction. As the first approach, the teacher made students recognize numbers using MNIST data as image recognition. Let each student create ten pictures of numbers from 0 to 9 with paint software. The teacher asked students to try how the numbers were recognized. After that, the ten pictures of numbers created by all the class members were collected in a shared drive and tried to see how they were clustered. As a second approach, as an attempt at the generative adversarial network, students synthesized two pictures. Each student created two pictures using paint software and combined these pictures into the generated picture. Finally, we learned the concept of reinforcement learning, applied it to an action game, and tried a game example that was reflected in the action.

About (2) Information security, the information contained in image files, students learn how to read file headers and extensions, how to read binary files, and how to edit them. As exercises, students try to analyse the given image. At first, students learn basic knowledge such as the types of digital images. Next, they confirm that the GPS and shooting information are included in the image, and check variation of the header information of the file. Next, they try reading the file using a binary editor, they can directly view and edit binary files. They learn that various information is included in the content of the image in binary data. After confirming these with the example file, they have exercises to find the implemented data contained in other files. For the first 30 minutes, they try individually, and after that, they can have discussions with nearby students. After students submit the response, the theme teacher showed the answer.

About (3) Application development, students create applications that run on a tablet in Java language from scratch using Android Studio. At first, students try to create an application “do nothing” with the wizard. Then create an app that calculates Body Mass Index (BMI). After that, students create an original application from the below list: ingenuity application of BMI calculates, form format application, and completely original application. At first, the theme teacher explained the environment required to create an Android application.

Students learn the procedure for creating an application in Android Studio to create a "do nothing application" and check how the application is created on the tablet. Next, students create an application that calculates and displays BMI by inputting height and weight and pressing a button. At last, they create an original application. A theme teacher shows three categories. Ingenuity application case, it adds any information to the result display of the BMI application. Form application case like a BMI app, to enter data and press a button to display the results. Completely different application case, it needs high skills.

Results

Here are the results of a theme devised for first-year students in 2022. We show preparation for implementation, the state of classes, questionnaire taken at the end of each class. The target students are first-year students, and they have their own Windows laptops. It is possible to practice on their own PC that they have brought with them. In addition, they have a Microsoft account and a Google account, so it is possible to use these services.

About preparation for three themes for each. In the theme of machine learning, we confirmed that the exercise can be implemented in Google Colaboratory. Since the students have Google accounts at school, we confirmed that they can be used using that account. In the theme of information security, since we work on exercises and assignments to explore the information contained in images, we prepared images for students to explore related information, as well as a binary editor that can edit binary files. In the theme of application development, we prepared PCs with Android Studio as an application development environment. This is because we thought that installing the development environment on students’ own PC would be a high hurdle for first-year students. And we also prepared a tablet that can run the application.

Regarding class structure, for the three themes, two weeks of machine learning and one week of information security were implemented in the three weeks of the first semester. Three weeks of application development were implemented in the latter three weeks of the second semester. This pattern is applied to 5 classes.

Regarding the state of implementation, in the theme of (1) Machine earning, own drawing pictures by students had become input data for AI. As for recognizing numbers, students tried to write numbers in a way like other numbers, or they write is so that they would be difficult to read. By increasing the number of times of learning and increasing the number of layers, students confirmed the recognition rate increased. As unsupervised learning, the numbers of pictures created by everyone were classified into ten types, and the results of clustering were shown by themselves. Figure 1 shows the ideal of clustering by handwriting number.

In the practice of generative adversarial network, students who were interested in drawing tried to draw elaborate pictures or anime character pictures, as input

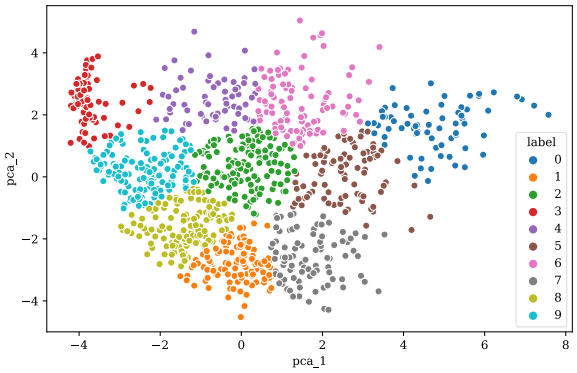

Figure 1 Ideal of Handwriting Number Clustering

Figure 2 Hidden Data Implemented in Image

pictures. When creating the pictures, it was observed that problems were occurring at the time of implementation, as they worked on conditions such as resolution and color restrictions without listening to the teacher's explanations and instructions.

About states of implementation in the theme of (2) Information security, students confirmed that contained data (Figure 2) in the image using a web service (TETRA, 2021).

Some students were surprised that the location can be specified by latitude and longitude included in the picture file. In the step of using a binary editor for the file header, many students had puzzled by the difference in usage between opening a file with a binary editor and with a normal editor. At the step of exercises, some students tried other methods than learned earlier methods. Some had used web services, and image search engines. As time passed, some tried to use a binary editor.

About the state of implementation in the theme of (3) Application development, when students created a "do nothing application" in the first step, some are surprised that could make a smartphone application easily. Next, students create the interface of the application that calculates BMI and display it on the tablet (Figure 3). After they wrote programs by reference to the textbook, completed that can calculate BMI by inputting height and weight and pressing buttons.

Finally, I instructed the creation of an original application. At first, some seemed confused about what to do, they refer to textbook that explained how to use checkboxes and radio buttons and control architecture. Some create simple fortune-telling applications and diagnosis applications were created. As a device of the BMI application, some add health advice that is displayed using conditional judgment from the diagnosis result. During the last class time of creating the application, some students showed their applications to each other.

It shows questionnaire results. In the last frame of the last week of the application development theme, we conducted a questionnaire on the three themes. However, due to preparation reasons, questionaries applied to only four of the five classes.

One question is "Please rank 1, 2, 3 (1 is the highest) in order of interest in the content of the information course". The results of the question are as Figure 4.

Figure 3 BMI Calculator Application

From this result, there is a high interest in the theme of application development. In the question, it has a column to write the reason for adding 1-3. The following descriptions are written. The reasons for his high interest in machine learning are: "I was surprised that a machine could distinguish numbers", "I had learned a lot about AI", and "Because I like to think of my own goals and how to achieve them." The reasons for his high interest in information security are: "I could learn things that are not visible in normal use, such as file formats and structures.", "It's interesting that a single image contains many data.", "I could see the other side of what I usually use." The reasons for showing high score for application development are: "I felt a sense of accomplishment after completing the application development." "I could create a practical application by myself.", "I could program like I had imagined, not just copy and paste."

However, according to the reason for ranking, we could evaluate some answers are inappropriate choices or not accurately reflect opinions for the question. For example, there are descriptions such as "I am interested in machine learning because I entered this school with an interest in machines.". Some students couldn't understand the connection between the theme and the course. In addition, there are descriptions such as "I don't remember what I did" about machine learning and information security. It seemed that some students

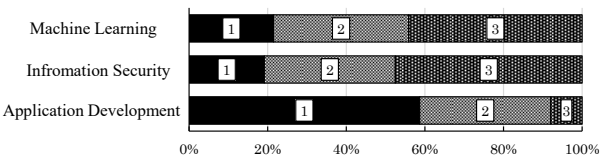

Figure 4 Ratio of 1-3 ranking for themes

couldn't be connected between the listed theme and the contents of the previous term.

Discussion

It shows the status of implementation. Each theme was able to be implemented as planned.

In the theme of machine learning, students could experience AI by creating an image as an input for learning by myself. The experiences are automatic discrimination by clustering in unsupervised learning, recognition rate improvement by increasing the stage and number of times of learning, etc. It seems that interest in the processing and performance of AI has increased. It is thought that students could comprehensively learn about general techniques related to machine learning. On the other hand, we provided a part to input the prepared Python program, they execute the program process, but it seems that it was not enough to give a real feeling of manufacturing.

In the theme of information security, students were surprised to find that the file contained an unexpected of information. In addition, as for file operations, it seems difficult to use because of the peculiarities of a binary editor. However, some students are trying to find out the contents of the file by using it somehow, and some students have a growing desire to hack. It seems that the impressions depended on students according to their aptitude as an information security engineers.

In the theme of application development, the class has a style that students proceed along to demonstration by the teacher, but some students felt it was early. One reason for this is thought the difference in familiarity with computer operation. Some were surprised at how easy it was to develop applications. We think that the reason is the interface was created using a GUI. In the original application, the students seemed to enjoy being able to create their own applications. During class time, students ask teachers how to use images and sounds and set colors. We taught them how to do it and explored it with them, and they seemed happy with the result. It can be considered that they enjoy the application development to turn their own ideas into the smartphone applications.

On the other hand, some students ended up feeling that it was difficult. For students who like a learning style that builds up step by step, the experience style maybe imposes a burden on students.

It shows discussion about interest in each theme through questionaries results.

From the results of the questionnaire, they were most interested in application development. I think that the reason for this is that students did the developing applications by myself. In the BMI application, they copied and pasted the text for the program part, but they created the interface and set the association between the interface and the program by themselves. In the original application development part, we provide time to do it on their own. Students could try the creation by their voluntarily, we thought it increases their interest in this theme. However, students who have little interest in IT, might think programs harder than they had to do or they may be annoyed by programming little mistakes. It might lead to feelings of inadequacy. Some responded that they enjoyed application creation and that they wanted to devise more. In the next year, they will learn programming from the beginning. So, we want to provide that they can learn it while keeping in mind that it is the knowledge that can be used in programming learning.

From the result of the questionaries, interest in machine learning was not very high, but it is possible that it was not remembered because it was the first time. It is also possible that the name" machine" gave students a different impression. Even just emphasizing "AI" seems to make the result different from the questionary. Of course, some topics make interest high, such as improving automatic number recognition and clustering. It is thought that it can be based on actual utilization and application in data science subjects that will be held in the future.

From the result of the questionaries, interest in information security is the lowest. It is considered an intriguing topic for students who are highly interested in information processing. For example, hacking with a binary editor is an unusual experience that couldn't do in the common usage of computers, and deep knowledge is required. For information security engineers, it requires a wide knowledge of the whole and deep knowledge of each part. For such students who are interest in this theme, it is better not only to have subjects on information security in the school curriculum but also to encourage them to participate in security camps and event of CTF (Capture The Flag).

Improvements

Next year, it is decided that subject week times will be five weeks for each field. In the final five weeks, 3 weeks for common learning for all classes, and two weeks for each course learning for major course classes (Table 4). The number of times of implementation in 5 fields will be reduced from 6 weeks to 5 weeks. In the information course, we planned to reduce application development from 3 weeks to 2 weeks. As a result, we reduce one week to creating an original application. It is necessary to verify how this affects students' interests.

About the theme of machine learning, we name the theme Artificial Intelligence. It makes students the image to information processing and data science instead of the mechanical engineering field.

About the theme of information security, we plan to update the content. It will be changed to contents so that students can learn color processing and image files deeply.

Conclusions

At the National Institute of Technology, Nagano College, the subjects Basic manufacturing engineering and basic manufacturing experiments have been established for new students in the 2022 fiscal year. The main purpose of these subjects is to introduce fields of the course that they belong to in their second year.

Table 4 Class and Course Rotation Table in 2023

	Class				
Week	1-1	1-2	1-3	1-4	1-5
1	IE1_1	MR1_1	CE_1	IE2_1	MR2_1
2	IE1_2	MR1_2	CE_2	IE2_2	MR2_2
3	IE2_1	MR2_1	IE1_1	MR1_1	CE_1
4	IE2_2	MR2_2	IE1_2	MR1_2	CE_2
5	MR1_1	CE_1	IE2_1	MR2_1	IE1_1
6	MR1_2	CE_2	IE2_2	MR2_2	IE1_2
7	MR2_1	IE1_1	MR1_1	CE_1	IE2_1
8	MR2_2	IE1_2	MR1_2	CE_2	IE2_2
9	CE_1	IE2_1	MR2_1	IE1_1	MR1_1
10	CE_2	IE2_2	MR2_2	IE1_2	MR1_2
11	IE1_1	MR1_1	CE_1	IE2_1	MR2_1
12	IE1_2	MR1_2	CE_2	IE2_2	MR2_2
13	IE1_3	MR1_3	CE_3	IE2_3	MR2_3
14	IE2_1	MR2_1	IE1_1	MR1_1	CE_1
15	IE2_2	MR2_2	IE1_2	MR1_2	CE_2
16	IE2_3	MR2_3	IE1_3	MR1_3	CE_3
17	MR1_1	CE_1	IE2_1	MR2_1	IE1_1
18	MR1_2	CE_2	IE2_2	MR2_2	IE1_2
19	MR1_3	CE_3	IE2_3	MR2_3	IE1_3
20	MR2_1	IE1_1	MR1_1	CE_1	IE2_1
21	MR2_2	IE1_2	MR1_2	CE_2	IE2_2
22	MR2_3	IE1_3	MR1_3	CE_3	IE2_3
23	CE_1	IE2_1	MR2_1	IE1_1	MR1_1
24	CE_2	IE2_2	MR2_2	IE1_2	MR1_2
25	CE_3	IE2_3	MR2_3	IE1_3	MR1_3
26	Common Learning				
27					
28					
29	Course Learning				
30					

In the informatics field of the Course of Informatics and Electronics, machine learning, information security, and application development were set and implemented as the contents of the subjects.

Students had been interested in application development, machine learning, and information security, in this order. But all of the themes had been interesting in students for each specialized knowledge for succeeding subject.

In the next fiscal year, the time for themes will be reduced by one week. And the other themes also fix contents based on the result of implementations and environments. We have to confirm the impacts of the change. Including this change, we would like to raise the interest of students and consider the effect of the following curriculum.

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