Differences in visibility of students' proficiency by grading methods in energy electronics-related lectures based on DX format

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Differences in Visibility of Students' Proficiency by Grading Methods in Energy Electronics-related Lectures Based on DX Format

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***Abstract*— In Japan, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) decided in March 2021 to select institutions to implement the "Plan for Upgrading Education at Universities and Colleges of Technology Using Digital Technology" project. Universities implementing the plan will use the Internet, computers, artificial intelligence (AI), and other technologies to promote learning tailored to each student's needs. However, the method of grading, as well as the method of converting lectures to DX, is left to the lecture educators, and it is difficult to say that sufficient know-how has been accumulated. This paper discusses how the incorporation of DX into lectures and examinations to increase students' proficiency in lecture content has been reflected in grading results.**

Keywords—Digital Transformation, online and real-time lecture, examination method

I. Introduction

DX (Digital Transformation), the use of digital technology to reform and streamline operations, is being promoted by companies DX is broadly defined as the use of IT and digital technology to improve human lives. This trend is not only in the business world but also in the world of school education, where the development of IT is driving innovations. Bolder and more innovative DX are being developed, including the use of data and AI.

Japanese universities are gradually beginning to transform their educational methods by utilizing DX. The Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) supports this transformation through its "Plan for the Advancement of Education at Universities and Colleges of Technology Utilizing Digital Technology." MEXT defines the Plan as follows; "This plan is implemented to actively incorporate digital technology in universities and colleges of technology, developing an environment for initiatives that contribute to the "realization of learner-oriented education" and "improvement of the quality of learning," materializing educational methods in higher education in the with covid-19 era, and disseminating the results of these initiatives."

While it used to be the norm for university students to attend classes in classrooms with faculty and fellow students, the global spread of covid-19 crisis since the beginning of 2020 has made it difficult for students to commute to campus and attend regular classes, resulting in an increase in remote courses, such as on-line and real-time style, on-demand style, and so on.

Although there are some issues with remote lectures, such as difficulty in maintaining concentration, there are also some advantages: it is easier to ask questions since it is not face-to-face, and in the on-demand format, the lecture content is recorded in advance so that students can repeat the lecture according to their proficiency level. Remote class is a new form of teaching, in which students and teaching staff work together at a distance. It is one form of DX for universities to solve problems, increase benefits, and make good use of this technology.

However, it is difficult to say that sufficient know-how has been accumulated on the methods for quantitatively evaluating the effectiveness of lectures. This paper reports on the results of a study of a course related to electronics, in which we found that the degree of proficiency of students may be seen differently by changing the style of grading examination when incorporating an online remote class, which is positioned as the initial stage of DX.

II. Lecture Format and Examination Methods

A. Two Subjects in Energy Electronics

This paper focuses on "Circuit Theory B" and "Electrical Machinery A, " of which the author is in charge. Both lectures are given to approximately a hundred students in the department of electrical and communication engineering. 60 of whom are in the energy-electronics course. For the students in the energy electronics course, these two subjects are indispensable. On the other hand, for the 40 students in the telecommunications course, these are elective subjects. "Circuit Theory B" is offered in the second semester, and "Electrical Machinery A" in the fourth semester of the second year. Incidentally, "Circuit Theory A," a more basic class offered in the second semester of the first year, is a compulsory subject for students in both courses.

Most of the students who have obtained credits for "Circuit Theory B" will take "Electrical Machinery A." On the other hand, most of the students who did not receive credits for "Circuit Theory B" do not take "Electrical Machinery A." In a sense, it can be said that "Circuit Theory B" has the function of screening students in the energy-

TABLE I. LECTURE FORMAT AND EXAMINATION METHOD DEPENDING ON THE YEAR

～2019	Circuit theory B	Lecture	F2F
		Exam	F2F
	Electrical Machinery A	Lecture	F2F
		Exam	F2F
2020	Circuit theory B	Lecture	Online
		Exam	Online
	Electrical Machinery A	Lecture	Online
		Exam	Online
2021	Circuit theory B	Lecture	Online
		Exam	Online
	Electrical Machinery A	Lecture	Online
		Exam	F2F

electronics course who are interested in electronics and electronics.

The main contents of “Circuit Theory B” are as follows;

- ✓ Thevenin's theorem and superposition theorem etc. in AC circuits
- ✓ Four-terminal circuit
- ✓ Mutual induction circuit
- ✓ Three-phase circuit
- ✓ Non-sinusoidal AC etc.

On the contrary, those of “Electrical Machinery A” are

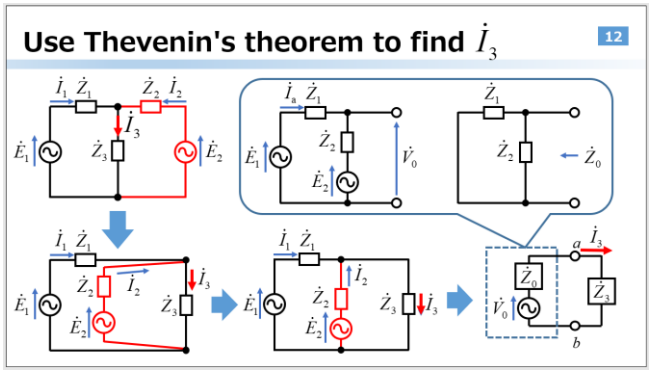
- ✓ Ideal Transformer
- ✓ Actual Transformer
- ✓ Induction Machines etc.

The transformer treated in “Electrical Machinery A” can be considered theoretically identical to the mutually inductive circuit in “Circuit Theory B”. In addition to the theory, practical contents are added in “Electrical Machinery A”. Induction machines, another item in “Electrical Machinery A” can be treated as equivalent to transformers in terms of electric circuit theory. Furthermore, an induction machine is one of the typical three-phase circuits. Therefore, the two courses are virtually seamlessly connected.

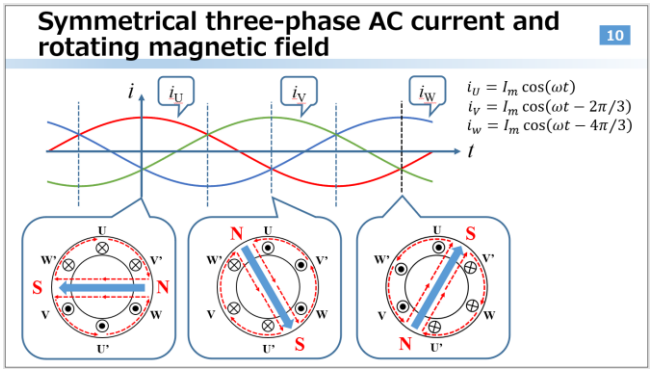
B. Differences in Lecture Format and Examination Method depending on the year

Table 1 summarizes the differences between the lecture format and the examination method for grade evaluation for the above two lectures depending on the year in which the lecture was given.

In 2019, which was not affected by the covid-19, both lectures were given face-to-face, and the grade evaluation test was conducted face-to-face. Lectures from the beginning of 2020 to the first half of 2021 when the covid-19 crisis spread worldwide included online lectures using MS-Teams and Moodle as tools, and online regular examinations.



(a) Lecture slide example of "Circuit Theory B"



(b) Lecture slide example of "Electrical Machinery A”

Fig.1 Online Materials shared with students using Moodle.

As for the On-line lectures, the author tried to reproduce the face-to-face lectures on MS-Teams in real-time, so that the contents and exercises in each lecture are basically the same whether they are given in F2F or real-time online. 10-16 pages of slides based on the lecture notes and 2 or 3 exercises were uploaded to Moodle. Fig.1 shows the online materials shared with students using Moodle. After real-time and on-line lecture with MS-Teams, the students uploaded their homework to Moodle till next lecture (3-4 days apart). This

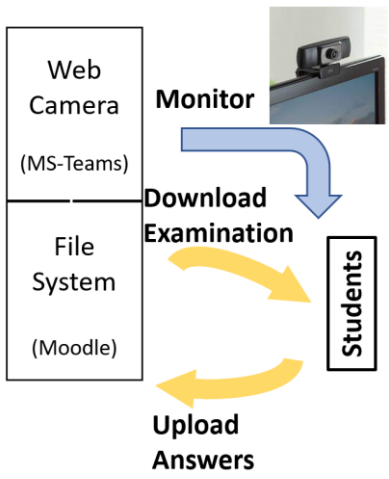


Fig.2 Online and real-time examination using MS-Teams and Moodle.

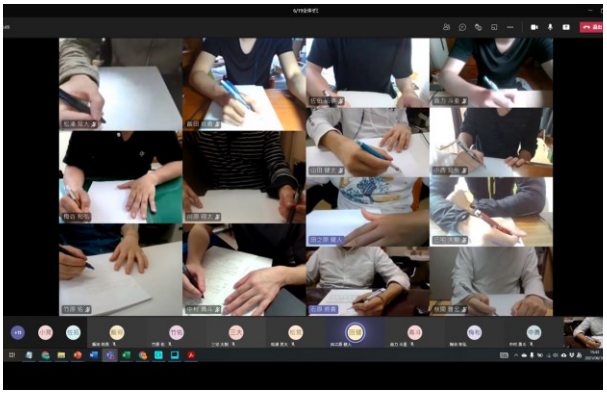


Fig.3 Monitoring online final examination.

lecture was repeated 12 times. Questions related the content of the lectures were dealt with on one-to-one basis between the educator and the students using the Moodle communication system or e-mail.

Two examinations to calculate the grade were given, one at the exact midpoint of each of the 12 lectures and another at the end of all lectures. Under the covid-19 crisis, it was necessary to conduct the examinations online, and in this case, as shown in Fig. 2, MS-Teams and Moodle were utilized.

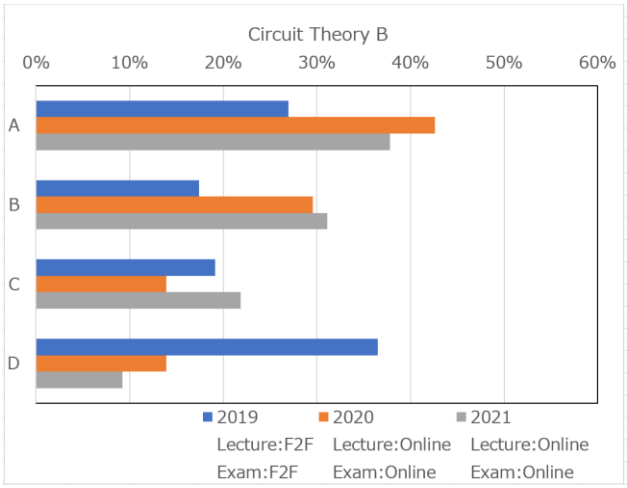
At the start of the examination, students will download the examination questions sheet from Moodle as soon as they become available. As shown in Fig. 3, web camera using MS-Teams will monitor all students during the examination period. At the end of the examination, students will digitize their answer sheets by using digital scanner or handy phone and upload them to Moodle within 5 minutes.

It is important to note that although a web camera monitors students during the exam, it is impossible to monitor whether they are referring to their textbooks, notebooks, websites, or consulting on their handy phones. Therefore, online examinations must be conducted under the condition that students are allowed to refer to all items such as textbooks, websites, etc., in order to eliminate inequality among students as much as possible.

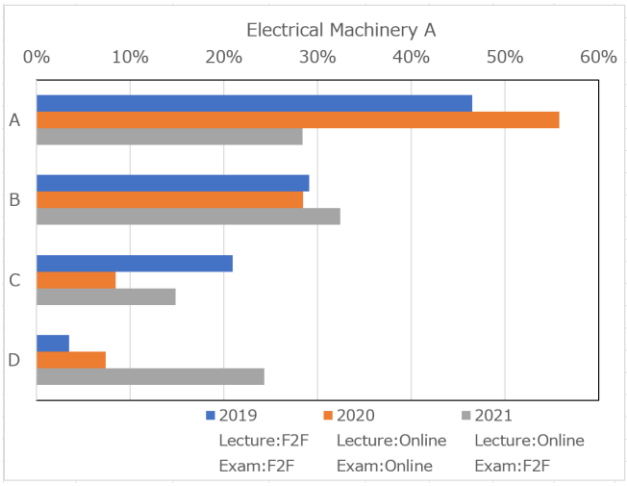
The examination is 100 minutes long and consists of five questions. Four are slightly modified versions of the exercises and homework assignments explained during the lecture. The remaining one will be new to the students, but all the questions will be fundamental rather than a novel. Therefore, students who have made adequate preparation for the exam can score at least 80%. Needless to say, every effort has been made to ensure that there is quite little difference in the level of the exam questions between online style and face-to-face style.

III. Visibility of Students' Proficiency by Final Grade

Figure 4 shows the distribution of grades for the two subjects over the past three years, including the two years when the DX lecture was introduced due to the covid-19 crisis. The lecture format and examination style for each year are shown in Table 1.



(a) Circuit Theory B at 2nd semester of 2nd year



(b) Electrical Machinery A at 4th semester of 2nd year

Fig.4 Final grades comparison.

Final grades are calculated overall based on homework and two exams; “A” indicates a score of 80 or higher; “B” indicates a score of 70 to 79; “C” indicates a score of 60 to 69; “D” shows a score of 59 or lower or have not joined to the examinations; a grade of “C” or higher is sufficient to receive credit.

Figure 4 shows the following;

- In both subjects, more than 90% of the students received credits when lectures and examinations were online and real-time.
- The percentage of “A” or “B” earned through DX lectures is 10-20% higher than in 2019 when they were conducted face-to-face. In other words, grades are inflated.
- When either or both of the two lectures have a face-to-face examination, 20-35% of students fail to get the credit for the first class in which administered the face-

to-face examination (Circuit Theory in 2019, Electrical Machinery in 2021).

It should be noted, however, that the students who took the course in 2021 have not been able to come to campus for covid-19 crisis since they entered the university. Thus, they have been taking most of their classes online and have spent the last two years without experiencing an exam of any kind. Nevertheless, the author believes that what can be read from Fig.4 suggests the following.

- It does not seem to mean that students' understanding is deepened by the DX-lectures.
- Face-to-face examinations have, in a sense, a screening function for students (DX-lectures allow students to get good grades even if they are not interested in the lecture content).
- It is not a good idea to try to reproduce face-to-face lectures and examinations in their original form in DX lectures. It will be necessary to find a method that is unique to DX.

Figure 5 shows the results of the questionnaire in which all students who took the course evaluated the class. The percentage of students who answered "Yes" to each question is shown. The data shown are the results of the questionnaire for the lecture given in 2021, which is available for reference at this time. Interestingly, the percentage of "Yes" answers to all questions is higher for " Electrical Machinery A," in which 25% of the students failed to receive the credit due to the face-to-face exam, than for "Circuit Theory B."

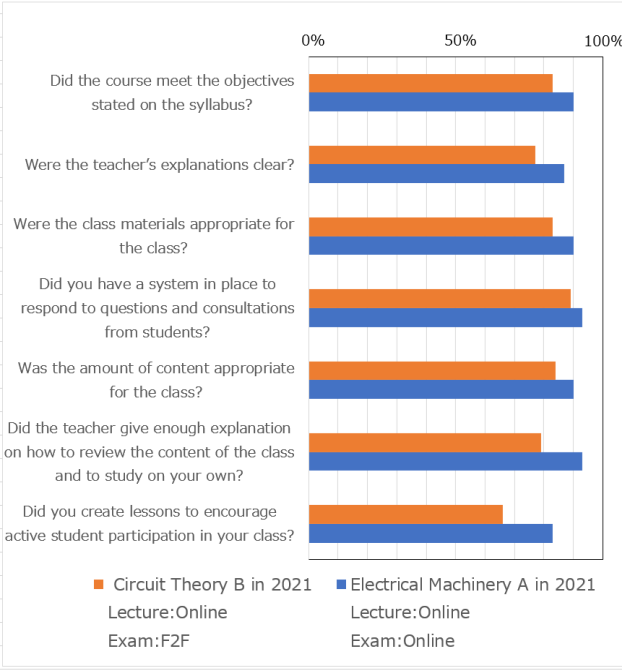


Fig.5 Results of the questionnaire.

IV. SUMMARY

The number of remote lectures based on DX (Digital Transformation) has exploded globally to maintain university lecturers under the influence of covid-19. However, it is difficult to say that sufficient know-how has been accumulated in this field since the way lectures are conducted and grades are graded is left to the lecturers. In this paper, we investigate how the results of grading are reflected in the results of the DXs incorporated into lectures and examinations in order to increase students' proficiency in the lecture content. As a result, it does not seem to mean that DX lectures deepen students' understanding. It is not a good idea to try to reproduce face-to-face lectures and examinations as they are in DX, and it may be necessary to find a unique method.

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