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Practice and Analysis of Asynchronous Distance Information Literacy Lectures Based on Blended Lecture Materials

Shin'nosuke Yamaguchi [*], Hideki Kondo [†],
Yoshimasa Ohnishi [*‡], Kazunori Nishino [§]

Abstract

In this paper, we report on a case study in which we converted blended information literacy lectures into asynchronous distance lectures using the basic features of a learning management system. In the implementation of asynchronous distance lectures, it is necessary to maintain the learning activity of students and to achieve the same learning effect as in blended lectures. Preparing materials for asynchronous distance lectures from scratch is a heavy burden on the teacher. Therefore, we changed the style and materials of the lectures based on the learning analytics of blended lectures that we have already practiced. We update the material, add quizzes with deadlines, and report on the results of asynchronous distance information literacy lectures. We then analyze and evaluate student learning to determine its effectiveness.

Keywords: Learning analytics, Blended lecture, Asynchronous distance lecture, e-Learning, Learning management system.

1 Introduction

In recent years, many higher education institutions have seen an increase in the practice of blended education, combining face-to-face lectures with e-learning activities. Unfortunately, the spread of the new coronavirus has led to restrictions on face-to-face teaching in educational institutions around the world. Because of this limitation, we have had to convert our traditional blended lectures into distance lectures. In this paper, we report on a case study in which we converted blended information literacy lectures into asynchronous distance lectures using the basic features of a learning management system (LMS). We discuss how to change the materials used in blended lectures, how to change the lecture style, how to deal with questions, and how to conduct examinations in the asynchronous distance lecture mode. Then, we use learning ana-

[*] Learning and Teaching Center Kyushu Institute of Technology, Fukuoka, Japan
[†] Center for Learning and Teaching Innovation, Kanda University of International Studies, Chiba, Japan
[‡] Information Science and Technology Center Kyushu Institute of Technology, Fukuoka, Japan
[§] Faculty of Business Administration Taisei Gakuin University, Osaka, Japan

lytics to evaluate whether these asynchronous distance lectures have the same learning effect on students as attending blended lectures.

Practical examples of asynchronous distance learning have already been reported by several educational institutions. For example, Shinshu University's Internet Graduate School is an example of distance e-learning in practice, and many students have already graduated from Internet Graduate School [1]. In contrast to this approach, we conducted asynchronous lectures by reusing as many of the materials created for blended lectures as possible. If this case study is valid, we expect that it will serve as a useful guide for the transition from blended lectures, which are already practiced in many educational institutions, to asynchronous distance lectures.

In asynchronous distance lectures, the most important problem is keeping students engaged in the learning activities. Unlike face-to-face lectures, there is no incentive to attend lectures, and asynchronous distance learning depends essentially on the student's motivation to learn. Various educational institutions are already researching how to keep student-learning activities in asynchronous distance lectures. For example, Yamakawa reports on a system that sends alerts to students based on LMS log data [2]. Matsuda et al. have also developed a tool that allows students to build their study schedules [3]. Fuwa et al. proposed a method to update the display range of teaching materials according to the progress of learning. The fact that some materials can no longer be viewed because of expiration dates encourages students to participate in learning activities [1]. We use the basic features of an LMS to convert a blended lecture into an asynchronous distance lecture. Therefore, we do not use special tools or alerts that are not available in the LMS; however, we try to encourage students to participate in learning activities by giving them a deadline to use the material, as in Shinshu University's Internet Graduate School [1].

Our objective is to develop a model of the asynchronous distance lecture in which students continuously engage in learning activities and obtain good learning effects. In this paper, we design an asynchronous lecture based on blended lecture materials and compare the learning activities of students and their learning effects of the blended lecture and asynchronous lecture approaches. Based on the results, we evaluate whether our distance lectures contribute to the improvement of students' learning and discuss the factors that improve students' participation in learning activities.

In the following, we describe the structure of the paper. First, in Section 2, we describe the relevant research on learning analytics and the analysis methods we used. In Section 3, we give an overview of the blended information literacy lectures we have conducted in the past and describe the students' learning activities. In Section 4, we describe the design of the asynchronous distance lecture and classify students based on their learning outcomes in Section 5. In Section 6, we analyze their learning activities. Finally, we discuss the evaluation of asynchronous distance learning and its improvement.

2 Research on Learning Analytics and Methods of Analysis

Learning analytics is research that has gained importance as ICT-based teaching mate-rials become more widespread [4]. Some researchers are already working on learning analytics using LMS log data; for example, Kubota and others proposed a method for detecting changes in a learner's activities and characteristics based on LMS log data [5]. In addition, Ishikawa and

others conducted a cluster analysis of students based on the number of times they accessed course content and the number of responses to quizzes [6]. Romero et al. suggested a method for estimating student performance using data mining in conjunction with indicators that measure the number and quality of student contributions in online discussion forums, and a module for this was developed [7]. These studies mainly utilized log data obtained from an LMS.

In addition to the discussed research, other studies have compared and analyzed LMS log data with student performance. Goda and others investigated the relationships among different learning types and ultimate learning outcomes to develop a support system for e-learning [8]. Taniguchi examined students' scores and how frequently they accessed content from multiple lectures to compare effective learning support methods [9]. LMS logs contain a large amount of data not directly related to learning; however, Lerche and Kiel reported how to use data mining to remove unnecessary logs and measure the learner's achievement activity compared with prior knowledge [10]. Christothea et al. report on a large-scale operation of a system that analyzes learning activities, predicts students' risk of failing, notifies faculty members, and discusses the challenges of promoting its use [11].

The analysis method we used is similar to the latter method that uses activities and some kind of grades. We attempt to measure learning activities from the basic log data of the LMS and the electronic textbooks (e-textbook) used for teaching materials. The LMS records when, who, and which materials are accessed. The e-textbook records the user who opened the textbook, the page, and the time it was opened. However, the LMS does not have such a function. This resulted in a larger number of records compared to the LMS, although the e-textbooks had been used in only a portion of the lectures. Because of the difficulty of evenly tallying the number of open e-textbooks, page-by-page records are not kept for e-textbooks. Therefore, we count the following records as learning activities.

- ✧ Students access resource files.
- ✧ Students open the e-textbook.
- ✧ Students send in their quiz answers.
- ✧ Students submit their report files.
- ✧ Students post to the forum and view forum posts.

Next, we describe the data on grades used in our analysis. In related studies, researchers have analyzed students' learning effectiveness based on their assignment scores, submission status, and exam scores. We use a pretest to measure students' prior knowledge and attempt to measure the learning effect by comparing the results of the pretest with the results of the final exam. However, when comparing simple differences in scores, there is a problem that students who scored high in the pretest do not easily increase their scores and end up in a group with poor learning effectiveness. Therefore, in this paper, we do not focus on the score but on the content of each question and measure learning effectiveness based on whether the student answered the question correctly or not.

Based on the learning activity and learning effect records we collect, we will analyze whether the students have performed the learning activities we expect them to perform and whether they

have achieved the learning effects we expect. We will then reflect on the problems identified in the analysis in our teaching materials and use them in the following year's lectures.

3 Overview and Learning Activities for Blended Information Literacy Lectures

We gave a blended information literacy lecture and conducted a learning analysis [12][13]. This information literacy lecture is a compulsory subject for first-year students at our university. A total of seven classes were offered the previous term. The lecture content of all classes is unified based on the course syllabus. A total of 162 students in two classes attended the blended lectures in 2019. There are 16 blended lectures in total, and the last one is a final exam. Table 1 shows the schedule for each lecture. The number of pages of slides is the number of pages of material the teacher shows the students during the lecture.

Table 1: Content and Schedule of Information Literacy Lectures (2019)

Times	**Content of each lecture**	**Number of pages of slides**
1	Initial computer setup. Notes on creating a password. Procedure to connect to a wireless local area network (LAN). Usage of LMS.	72p
2	Usage of e-mail. Notes on using e-mail.	78p
3	Setting up the Unix environment.	97p
4	Operating a computer in the Unix environment.	
5	Search for information on the Internet. Search for books through the library system.	40p
6	Media literacy. Critical thinking. Approaching the media.	48p
7	Creating electronic documents using word processing software.	37p
8	Linux file system. The path of files and directories. Basic Linux commands.	63p
9	Linux commands. Usage of the text editor on the command user interface (CUI).	38p
10	Network Literacy, remote access by ssh command. File transfer by scp command.	30p
11	HTML5 language. Creating a Web Page.	32p
12	Designing Web Pages with Cascading Style Sheets.	36p
13	Representation of information in a computer.	63p
14	Logic circuits, sequential circuits, flip-flops.	105p
15	Types of programming languages. Fundamentals of programming.	50p

All lecture materials, e.g., assignments, tests, and quizzes, are provided by the LMS. Our university uses Moodle [14] as its LMS, which is a free, open-source LMS that allows teachers to create course spaces in which to deliver their teaching materials. Some materials and quizzes are

provided in the information literacy lectures. All students use their computers to access the material. Therefore, in the first four lectures, students learn how to set up and use their computers. In addition, we adopted an electronic e-textbook. Students can read these textbooks on their devices (information terminals and personal computers). Students' textbook operations and browsing history are recorded separately, and faculty can check these records. We also used the e-textbook history for analysis.

The flow of a blended lecture in this paper is described as follows.

1. By the time of the lecture, the teacher makes available the materials to be used in the lecture.
2. During lecture time, the teacher shows the lecture materials and explains them to the students.
3. Depending on the content of the lecture, students may be required to use a PC to complete the exercises.
4. After the lecture, the teacher prepares for the next lecture, and the students review using the published materials.

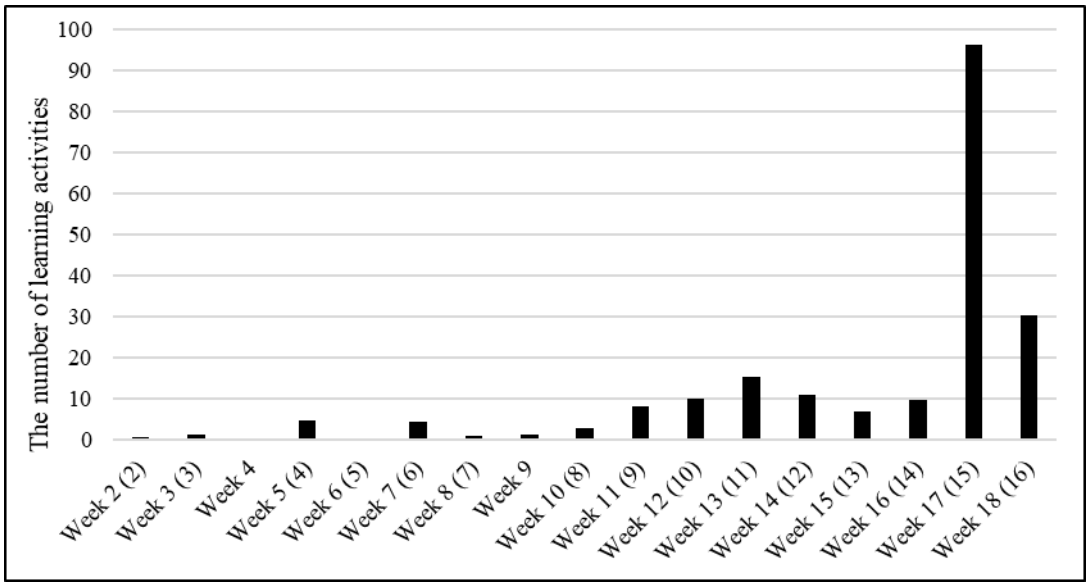

Figure 1: Average number of learning activities per week (2019).

These teaching materials include slides to be presented by the instructor during the lecture and materials and quizzes for students to read for self-study. The self-study materials are different from the slides shown during lectures in that they contain more detailed explanations and solutions to the exercises. The self-study materials are ex-tensive and may be more than 100 pages each. These have been prepared by the teachers so that students can access them if they need further assistance. These self-study materials do not cover all the lecture content, but they provide explanations of Linux commands, file and directory paths, text editors on the CUI, and solutions to exercises that students consider difficult. Quizzes for independent study can be answered by students only outside of lecture hours. The teacher instructs the students that these quizzes do not affect their grades but that they should work on them for the sake of learning.

During the lecture period, students will be required to submit two assignments. One is an electronic file using a word processor. The web page files must be uploaded to a web server created by the teacher and not Moodle.

Next, we describe the learning activities of the students in our 15 blended lectures. This is shown in Figure 1 and averaged over the students weekly. The numbers in parentheses on the horizontal axis indicate the lecture number in Table 1. Students started using Moodle from the second lecture, so there is no record for the first lecture. The two reports are due in weeks 12 and 17. These data show that students became more active in their learning activities one week before the final exam. Furthermore, most of the learning activities in all but week 17 were on lecture days, with very few learning activities taking place on the other days.

In blended lectures, there are weekly face-to-face lectures, at which time the teacher can give students access to the material. However, relying on student independence outside of the lectures, we can be sure that the time when students begin to work independently is immediately before exams and assignments are due. The same thing can happen in asynchronous distance lectures if we rely on the same student autonomy. We need to prevent students' learning activities from being skewed toward the end of the course.

4 Design and Materials for Asynchronous Distance Lectures

In this section, we discuss the design of the asynchronous distance lecture and the changes we made from the blended lecture material. To keep students' learning activities and the same learning effect as in blended lectures, we design lectures as follows.

1. Teachers provide materials for independent study.
2. Teachers provide some quizzes with due dates for each lecture.
3. Teachers add due assignment scores to student grades.
4. Teachers change the order of lecture content.
5. Teachers use video conferencing systems, forums, and e-mail to communicate with students.

First, in this lecture, the students learn not by video but by file materials. We chose this format to reduce the burden on the students because their Internet environment is diverse. File materials need to be detailed in content so that students can read and learn. Therefore, we changed all the slide materials that we created for the blended lectures into a format for self-study. Some of the materials were adapted from the self-study materials provided in the blended lectures to reduce the burden on teachers. The file materials provided in the asynchronous lectures contain all the content explained by the teacher in the blended lectures using text and diagrams. This led to more detailed material, but in return, the number of pages of material increased significantly to over 100 pages per lecture.

Second, we decided to provide some quizzes with due dates and add their scores to the grades to encourage student participation in learning activities. However, in weeks when report assignments were made, no quizzes were given. These quizzes have a deadline of 3–5 days from the

date of the lecture, and after the deadline has passed, students will be unable to answer the quiz. Therefore, students must answer the quizzes within that period.

Table 2: Schedule and Content of Distance Lectures (2020)

Times	**Content of each lecture**	**Number of pages of material**
1	Initial computer setup. Notes on creating a password. Procedure to connect to a wireless LAN. Usage of LMS.	91p
2	Usage of e-mail. Notes on using e-mail.	84p
3	Setting up the Unix environment. Operating a computer in the Unix environment.	84p
4	Linux file system. The path of files and directories. Basic Linux commands. Search for books through the library system.	278p
5	Linux commands. Usage of the text editor on the CUI.	205p
6	Network literacy, remote access by ssh command. File transfer by scp command.	271p
7	HTML5 language. Creating a Web Page. Designing Web Pages with Cascading Style Sheets.	190p
8	Internet literacy, search for information on the Internet.	e-textbook only
9	Media literacy. Critical thinking. Approaching the media.	76p
10	Creating electronic documents using word processing software.	116p
11	Representation of information in a computer.	177p
12	Logic circuits, sequential circuits, flip-flops.	131p
13	Types of programming languages. Fundamentals of programming.	120p

These quizzes consist of a few multiple-choice questions and pose other questions about the content to be studied in the lecture materials. To prevent students from not reading the material and just answering the quiz, all quizzes have a set passing score. If a passing mark is not achieved, the quiz score is added to the grade. However, students can answer a quiz as many times as they want within the time limit. These quizzes have a low level of difficulty and are new quizzes created by teachers, unlike the independent study quizzes used in the blended lectures. By giving these quizzes to the students, we tried to increase the number of learning activities. In addition to these quizzes, starting in week 12, we also published quizzes for independent study. These quizzes are the same as those used in the blended lectures.

Next, we discuss the changes in how the lecture content is ordered. In the blended lecture, the schedule shown in Chapter 2 had deadlines for the submission of reports in the second half of the lectures in weeks 12 and 17. The second of these reports, the creation of a web page, was difficult for the students, so there was a lot of access to the materials for the exercise. Therefore, we predict that if the lecture sequence is changed so that students work on this report earlier, learning activities will increase in the first half. Specifically, the lecture on the Linux file system and commands started in the fourth week, and the web page assignment was given in the seventh week. This report was due in week 10. In contrast, the word processing lecture was given in week 10, and this report was due in week 13. Table 2 shows the schedule of distance lectures.

The number of pages of material indicates the total number of pages of the material provided in that session, and students are required to read and study all the pages. By changing the lecture sequence, we hope to increase the number of learning activities of the students in the middle of the lecture period. Note that the lecture period is shorter this time because the university was temporarily closed due to the coronavirus. Teachers will give 13 lectures, and the 14th will be the final exam.

Finally, we describe our communication with students. A teacher uses a forum on Moodle or e-mail to reply to students' questions and to contact students simultaneously. However, we felt that some information could not be conveyed through forums and discussion boards, so we used a video conferencing system to allow a teacher to answer questions in real time during lecture periods only. In asynchronous lectures, it is important to send alert e-mails to students who are not very active to promote student participation in learning activities. Unfortunately, Moodle, which is used in this lecture, does not have a function to send alert e-mails to students according to their access status. However, there is a function that allows instructors to send the same message to all students as an e-mail. In this asynchronous lecture, faculty members will use this function to send periodic e-mails. The content of the message will be the due date of the assignment and the progress of the assignment for all students. Although this is not an individual communication, it is an attempt to encourage students' learning activities in the same way as alerts.

We describe the flow of the asynchronous telelecture designed in this paper as follows.

1. The teacher provides learning materials and quizzes with deadlines available before the lecture time.
2. Students can access and study the published materials and answer quizzes by their deadline.
3. During class time, students can access the video conference system and ask questions of the teacher.
4. Outside of class time, students can ask questions of the teacher via the forum or e-mail.
5. The teacher checks the progress of the quiz and contacts the student via e-mail or forum if there are any problems.

We give these 13 lectures and analyze the students' learning activities and their effects.

5 Classifying Students by Learning Effectiveness

This section discusses the classification of students according to learning effectiveness. First, the learning effect of the lecture is determined by the results of the pretest and the final examination. The pretest has 15 multiple-choice questions all derived from lecture content. In the pretest answer options, "I don't know" is added to facilitate a more accurate measurement of the students' level of understanding. The teacher gave the pretest to the students, telling them that the pretest had nothing to do with their grades and that they should choose "I don't know" if they did not understand the question. The total number of students who attended the asynchronous distance lectures was 145 in two classes. The average score on the pretest for students was 15.8. Out

of a total of 2,175 responses, approximately 70% were "I don't know." Based on these results, we judged that before the lecture, students had little knowledge about the lecture's content.

Next, we focus on the term examination. In the asynchronous distance lectures in this paper, the final examination was also conducted asynchronously. However, students were only allowed to take the exam on the day of the exam, and students had to take the exam between 13:00 and 17:00, as specified by the teacher. Students must start taking the examinations by 16:00 because they have only one hour to respond. Unlike the pretest and quizzes with a deadline, most of the questions in the final exam are fill-in-the-blank-type questions, requiring the student to enter a string of characters to give the correct answer. The final exam is, therefore, more difficult than the pretest and quizzes with a deadline. In addition, to prevent cheating, we have reworked the final exam questions for the distance lectures into random questions so that each student is given a different question. The average score for this final exam was 45.4.

Next, the results of these two tests are used to measure the learning effectiveness of the students. We chose questions from the final exam that are similar to the questions in the pretest to create pairs of questions. Although some of the questions were random and therefore did not correspond to the pretest questions, we created a total of nine pairs of questions. Next, we compared the results of all student responses to these nine pairs of questions and gave them four different grades as the learning effect for each question.

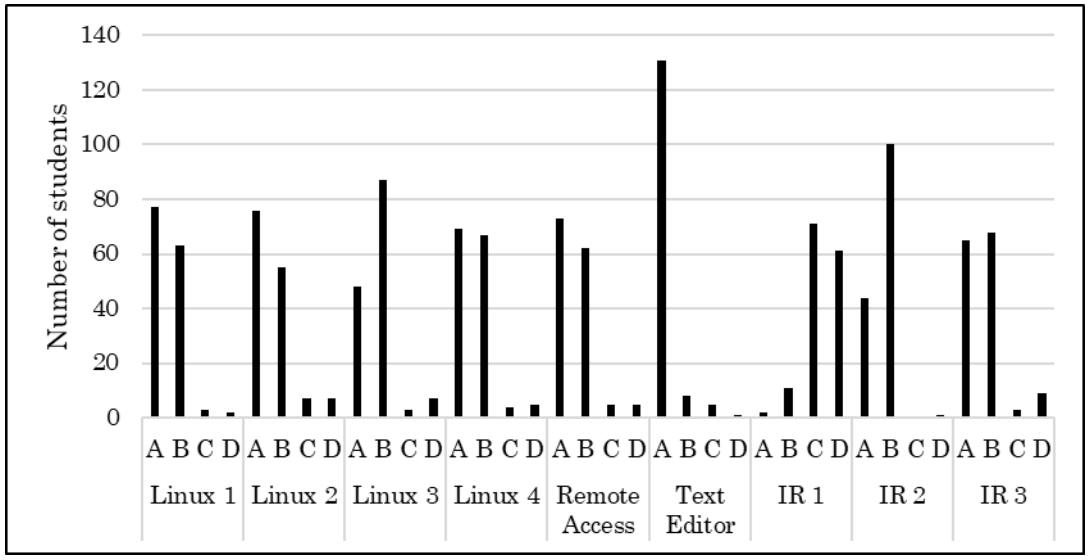

Figure 2: Number of students who received a grade for each combination of questions.

- ✧ A: The student could not answer the question on the pretest but answered it correctly on the final exam.
- ✧ B: The student could not answer the question correctly on the pretest or the final exam.
- ✧ C: The student answered the question correctly on both the pretest and the final exam.
- ✧ D: The student answered the question correctly on the pretest but not on the final exam.

Figure 2 shows the distribution of students' grades for each question. The Linux 1–4 shown in this figure are questions about Linux commands and file paths. Remote Access is a question about ssh commands, Text Editor is a question about Emacs operations, and IR 1–3 are multiple

questions about information representation and asking about binary and hexadecimal. These questions are what we want students to learn in this lecture.

Most of the pretest responses were "I don't know," so most students received a grade of A or B. The exception to this is the Information Representation question 1 (IR 1), which has a high percentage of correct answers. This question entails converting a positive binary number to a decimal number, and many students answered correctly on the pretest. Unfortunately, students were not able to solve similar problems on the final exam. The reason for this, we believe, is that when we created the random problem, it included the problem of solving negative binary numbers, which made it slightly more difficult.

Then, based on the numbers of A, B, and D, the students were classified into three groups.

- ✧ Group H: Students with 5 or more A grades
- ✧ Group L: Students with 5 or more B or D grades
- ✧ Group N: Students who do not belong to either Group H or L

Using this classification method, we can evaluate whether the students have acquired the correct knowledge from this lecture without depending on their prerequisite knowledge. The students who attended this lecture were divided into these three groups: Group H had 61 students (42%), Group L had 58 students (40%), and Group N had 26 students (18%). As data for comparison, the same combination of questions was chosen for the blended lectures and grouped.

Although the data are not exactly the same because the questions on the final exam are not the same as those on the asynchronous distance lectures, 83 students were in Group H (53%), 52 students were in Group L (32%), and 27 students were in Group N (17%). Unfortunately, the results show that a smaller proportion of students learn better in asynchronous distance lectures.

6 Learning Activities of Students in the Asynchronous Distance Lecture

In this section, we analyze the learning activities of distance learning students. Figure 3 shows a graph of the average number of learning activities per week. As in Figure 1, the numbers in parentheses on the horizontal axis indicate the number of lectures in Table 2. First, we compare the number of student activities to FY2019. In FY2020, an average of more than 7 learning activities per student were recorded in a week with lectures. Compared with the 2019 level of study activity, student activities in 2020 were greater except for week 12. Second, one of the major differences between the blended students and the nonblended students is that the number of learning activities peaked in week 6.

In this graph, there are small differences between the groups, with Group N being higher in week 6 and Group L being lower in the week before the test. To analyze the learning activities in greater detail, we check some lecture days and other learning activities. Figure 4 shows a graph of weeks 4, 5, 6, and 11 broken down by day. These weeks are lecture weeks where students learn the content about the questions that we have chosen from the pretest and final exam to measure the learning effect.

A lecture day is a day when this lecture is present in the timetable, and on this day, the teacher releases new material. As new materials are released, the learning activities for the day are greatly increased. Afterward, the activity drops significantly but then slightly increases. Excluding week 6, the days with the most learning activities after lectures were June 5, June 12, and July 26.

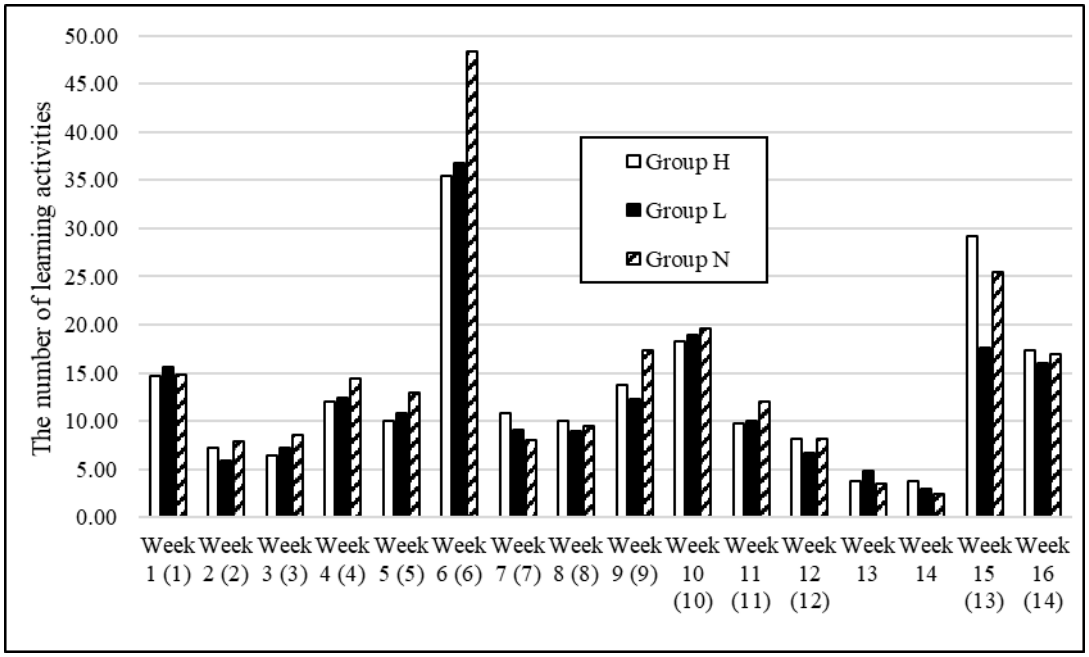

Figure 3: Average number of learning activities per week

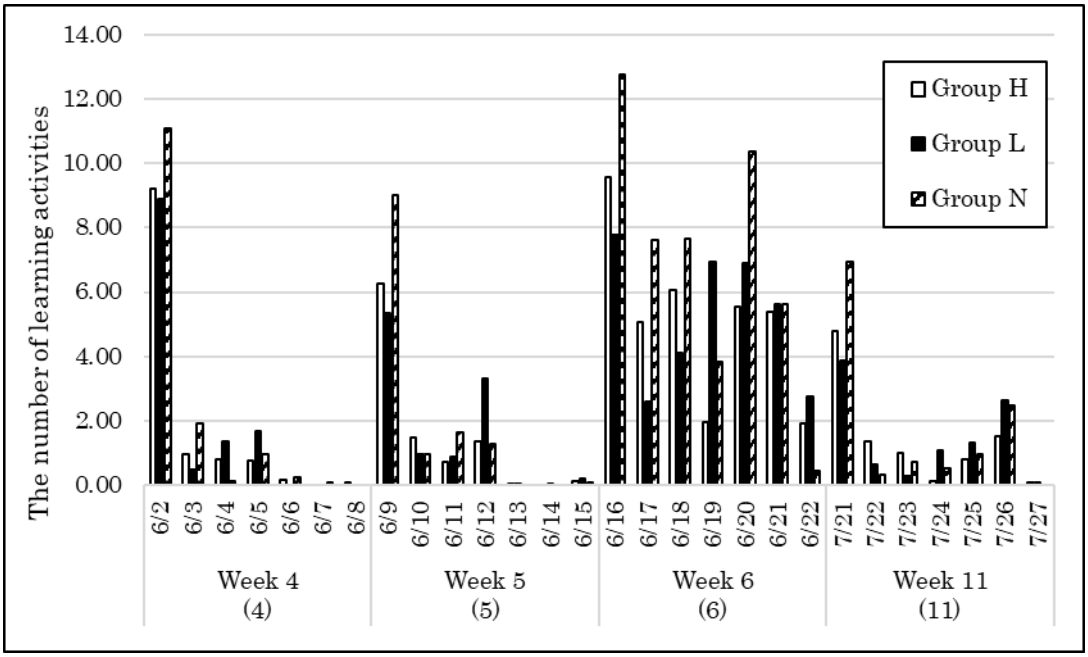

Figure 4: Average number of learning activities per date.

In fact, this was the deadline for the quizzes. We consider that this is the reason why learning activities cease after that day. Comparing the groups in this graph, we can see that except for the difficult assignment due in week 6, the students in Group L tend to be more active on the deadline day. Only in week 6 do we provide exercises with due dates instead of quizzes. This exercise was very difficult for the students, as they had to create a specified file using a text editor and upload it to a web server prepared by the teacher using Linux commands. Therefore, we postponed the deadline and set it for the following week's lecture day. As a result, week 6 has more learning activities throughout the week.

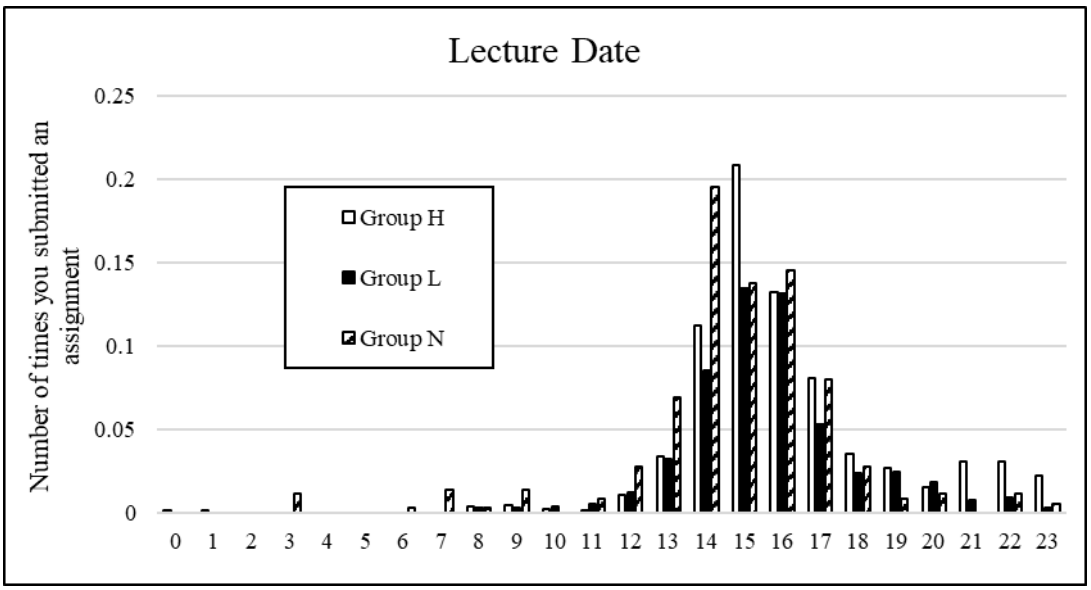

Figure 5: Average number of assignments submitted on the day of the lecture.

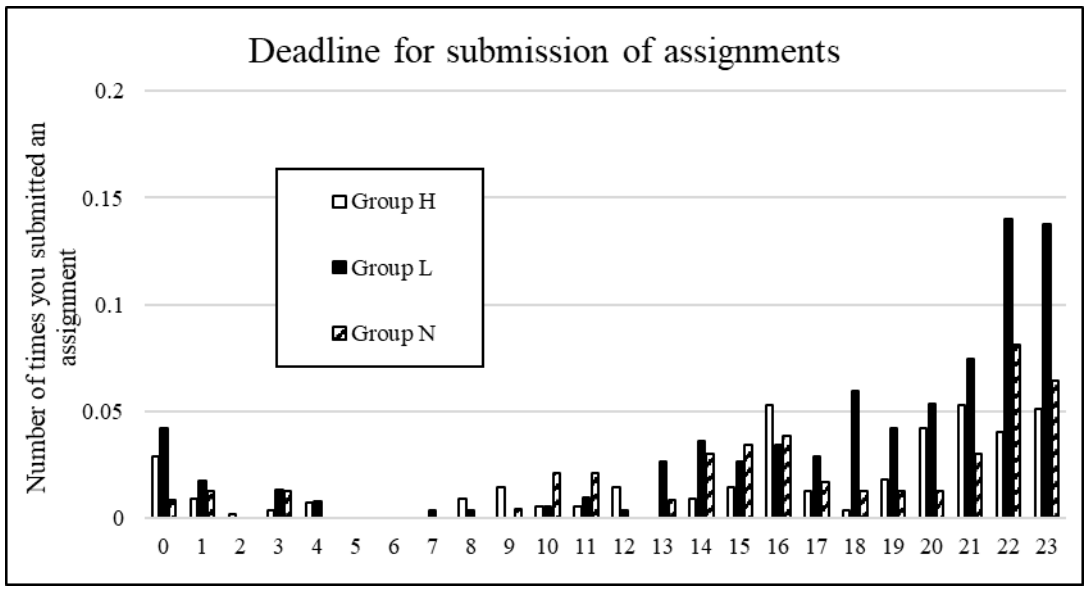

Figure 6: Average number of assignments submitted on the deadline day.

Therefore, we focused on the students' activities on lecture days and quizzes or report due dates. Figure 5 shows the average number of times reports or quiz answers are submitted per lecture

day. Figure 6 shows the average number of submissions per the due date. The horizontal axis of the graph represents the time of the day. Figure 5 shows that on lecture days, students are more likely to submit their reports or quiz answers between 1:00 and 4:00 p.m. during lecture hours. In contrast, in the case of deadlines, there is a tendency for more of them to be submitted in the evening and at night, with the highest number of submissions occurring at 10:00 and 11:00 p.m. just before the deadline. On the other days, the average number of submissions was much lower, less than 0.35. In terms of the tendency of students in each group, Group H and Group N submitted slightly more on the lecture day. In contrast, Group L students submit the most assignments at night just before the deadline.

Group L students also access materials and submit reports or quiz answers on the day of the lecture, although to a lesser extent than the other groups. However, the quiz scores were lower than those of the other groups. The total score for the quizzes was 75 points, and the average score for each group was 45.3 for Group L, 50.3 for Group H, and 51.4 for Group N. Except for week 6 exercises, most of the questions of quizzes were multiple choice and not difficult. In our opinion, if this score is low, it means that the students in Group L could not learn enough by the deadline to submit the quiz answers.

7 Evaluation and Improvement of Distance Lectures

In this section, we present our evaluation of the asynchronous distance lectures we have conducted and the improvements we have made. We implemented the five changes proposed in Section 4 to the blended lecture format and teaching materials to encourage students' learning activities in the asynchronous distance lectures. We discuss whether the five changes had an impact on learning activity. However, the first change, the change from lecture materials to independent study materials, is omitted because it is difficult to measure the influence.

First, the effects of the second and third changes are discussed. During the lecture period, students learned more regularly than in the blended lectures. As shown in the graph in Figure 3, we were able to measure the same level of learning activity in all groups. We conclude that the provision of quizzes with a deadline and having the scores added to the grades affected learning activities, especially because the number of learning activities increased on the days when there was no lecture but assignments were due. Another reason could be the influence of other lectures that the students are taking, which were given synchronously. When students follow the lecture schedule, it is predictable that they will also learn information literacy lectures on time.

Second, we believe that the fourth change, the change in the order of lecture content, also affected learning activities. Unlike the graph for the blended lecture in Figure 1, the asynchronous distance lecture had the most learning activities in the sixth week. By changing the order of the lectures and moving difficult content to the first half of the lecture, we consider that the students' participation in learning activities increased. However, from week 7 onward, students' learning activities returned to normal. The exercise of week 6 had the greatest impact, and we judge that the report to create a web page did not have that much impact based on the number of activities in week 10 when it was due.

Third, we note the five changes that were implemented by communicating with students. During the lecture period, a total of 22 e-mails were sent by the faculty. We counted the number of ac-

tivities in the 24 hours before and after each e-mail. However, we excluded days when there was a lecture before or after. The results showed an average increase of 1.4 activities for all students. When the students were divided into groups, we found that Group L students increased their activity by an average of 6 activities in the 24 hours before and 24 hours after the e-mail was sent. In contrast, the average number of activities of students in Groups H and N fell two to three times before and after mail. There is no alert function on Moodle, which was used in this lecture, to automatically send e-mails to specific students. Instead, teachers sent periodic e-mails to all students. Alert e-mails are originally sent to students who are not active or lagging in their studies to encourage them to become active. The increase in activity among Group L students whose assignments were close to the due date was consistent with the purpose of this periodic e-mailing by teachers. While it is possible that the activity of Group L students increased because it was closer to the assignment due date, it is our judgment that the communication from the teachers affected the activity of the students in Group L in a positive way.

Finally, we discuss the learning effects of asynchronous distance lectures. Unfortunately, compared to students in blended lectures, students in asynchronous distance lectures had an 8% increase in the number of Group L students, which lowered the learning effect. However, students in asynchronous distance lectures had the disadvantage of short lecture periods. In this result, we judged that some students cannot complete the assignment during the deadline. Their activities manifested as high learning activities on the due date. Considering the short duration of the lecture, it was fair standard for an asynchronous distance learning course.

These results indicate that four of the five changes we have provided in this paper for asynchronous distance lectures work well and keep students engaged in sustained learning activities. However, given the learning activities of some students and the strain on teachers and students, we need to improve these materials. We propose the following actions to improve asynchronous distance learning.

- ✧ Dividing the material into sections and reducing the number of pages per section.
- ✧ Allowing students to answer quizzes after the deadline.
- ✧ Adding a new, slightly more difficult, applied assignment.
- ✧ Providing a questionnaire for students to ask questions of the teacher.

The first recommended improvement is to reduce the amount of learning materials. As a result of describing all the teachers' detailed explanations, some of the documents are at least 100 pages long, and many are more than 200 pages. Some students commented on the carefulness of the material, but many said that there were too many pages of material, which makes it difficult for students to find the right place when they want to review an unclear section.

The next recommended improvement is to allow students to answer the quiz even after the submission deadline has passed. In our design, after the quiz deadline has passed, students will not be able to answer. This triggers students to engage in learning activities, but if they fail to solve them on time, it deprives them of further learning opportunities. Consequently, those quizzes should be ready for students to answer, even if they do not get any points after the deadline.

The third recommendation is to add a slightly more challenging applied assignment that is not required to be submitted. Students will receive extra points for submitting the applied assignment, but no points will be deducted for not submitting it. Difficult assignments stimulated students' learning activity. From this, we believe that motivated students will increase their learning activity by working on applied tasks.

The final step is to improve the question-and-answer session. We attempted to respond to questions from students using the video conferencing system during lectures. However, the number of students who accessed the video conference system was very small, approximately one or two per week. We also provided a forum for questions, but there were only 16 postings. However, there were 513 e-mail inquiries from students. In asynchronous distance lectures, the lack of information in the e-mail inquiries resulted in extra correspondence, which was burdensome for students and teachers. In addition, e-mails are handled individually, meaning that information cannot be shared, and this has an impact on the number of students posing similar questions. We assume that the reason for the high volume of e-mails and low usage of the forum is the display of usernames. Therefore, to reduce the burden of answering questions by e-mail, we propose an anonymous questionnaire that allows students to request the information needed to answer the question. We will also attempt to make the questions more relevant by providing examples of good questions and material on how to ask them. We aim to improve these points to make asynchronous distance learning more effective.

8 Conclusion

In this paper, we modified blended lecture materials to deliver asynchronous and distance information literacy lectures. The part designed for asynchronous distance lectures allowed students to continue their learning activities during the lecture period. In addition, students learned slightly less from the redesigned self-learning materials than from the blended lectures; however, the learning effect did not drop significantly. As a result, we were able to effectively reuse the materials of blended lectures to achieve asynchronous distance lectures.

In addition, we divided the students into three groups based on their learning effectiveness and analyzed their learning activities. As a result, some students were found to have not learned enough by the assignment deadline. Based on these analyses, we proposed three ways to improve the teaching materials and question-and-answer sessions.

In the future, we intend to implement asynchronous distance lectures with improved teaching materials and analyze the subsequent learning effects and activities. The learning analysis in this paper shows that students who have not fully learned the material are more likely to submit it just before the due date and are more likely to have a low score. Therefore, we expect to be able to follow them as well. Our ultimate goal is to establish a more effective distance lecture course.

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