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Evaluation of an Asynchronous Lecture Model based on Motivation Scales

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Abstract

In this paper, we proposed an asynchronous lecture model to encourage the self-directed learning of students, and we conducted the lecture in practice. We evaluate this asynchronous lecture model using students' motivation scales and learning activity records obtained from the learning management system (LMS). On the basis of our investigation of student activities categorized by motivation level, we observed a high assignment completion rate among highly motivated students, as well as voluntary learning activities among some students whose motivation had increased.

Keywords: e-learning, asynchronous lecture model, motivation scale, information literacy.

1 Introduction

In recent years, many educational resources, such as OCW [1] and MOOCs [2], have become available online, allowing learners to study freely without the constraints of time or place. Advances in information technology have enabled the provision of a wide variety of materials that support students' individual learning. In such an environment, we believe that students are expected to develop a self-directed and continuous learning style. If students are able to acquire such a style of learning, we believe that they will be able to grow into individuals who can independently utilize online resources to solve the various problems that they encounter.

However, in asynchronous lectures conducted in higher education (universities), not all students are able to learn as expected. While asynchronous lectures offer the flexibility for students to study at their preferred times, learning outcomes strongly depend on self-management skills. As a result, students with poor self-management skills tend to procrastinate their studies, which can ultimately lead to decreased motivation. In Japan, students who have primarily experienced face-to-face instruction through K-12 often lack familiarity with asynchronous learning formats and they may not be able to sustain independent study throughout the course even if such a format is introduced.

To promote a self-directed learning style, we propose and have continued to implement a lecture model in which learning materials and assignments are made available in advance while also providing opportunities for face-to-face Q&A sessions with instructors during the scheduled

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class time. This model is designed to support students who are unfamiliar with asynchronous learning by offering opportunities to initiate their studies through in-person interactions [3].

In this study, we aggregated students' learning activities on the basis of data obtained from the learning management system (LMS) and measured their motivation in the course using the Japanese version of the Motivated Strategies for Learning Questionnaire (MSLQ) [4]. By analyzing these data, we attempted to evaluate the proposed asynchronous lecture model.

The research questions of this study are defined as follows:

RQ1: To what extent are there students who are able to maintain their motivation and continue learning under this model?

RQ2: In order to further promote self-directed learning among students of varying levels, what improvements can be made to this model?

2 Proposed Asynchronous Lecture Model

This section outlines the structure of the asynchronous lecture model proposed in this study. Figure 1 illustrates our proposed asynchronous lecture model.

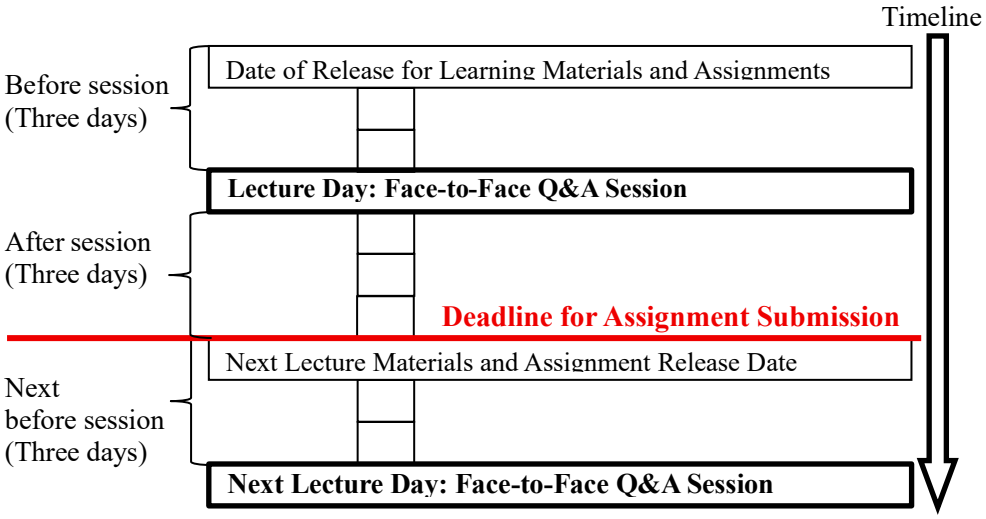

Figure 1: The asynchronous lecture model

The flow of each lecture is as follows:

Three days before the lecture: The teacher publishes the lecture materials and assignments, allowing students to begin reading and studying the content from that day onward.

Students access the lecture materials and study: If possible, they also submit the assignment. The lecture materials of documents that include all the detailed explanations traditionally provided by the instructor in face-to-face lectures. The assignments are automatically graded quizzes with predetermined passing scores, and students are allowed to attempt them as many times as needed until the deadline.

During the scheduled lecture time: The scheduled lecture time is allocated by the teacher for face-to-face question-and-answer sessions, during which the teacher responds to questions from students. Students who do not have questions engage in self-directed learning in the classroom using the lecture materials and submit their assignments accordingly. If a student achieves a passing score on the assignments before the Q&A session and has no questions, they are not required to attend the session.

By the third day after the Q&A session: The deadline for the assignment is set three days after the Q&A session. If the submitted assignment meets the passing criteria by that time, it is added toward the student's grade.

For questions outside lecture time: Students can communicate through the question database or email.

3 Evaluation Using Motivation Scales

As a method for evaluating our asynchronous lecture model, we decided to use learners' motivation.

Various methods for measuring learner motivation have been studied extensively. Pintrich et al. proposed the Motivated Strategies for Learning Questionnaire (MSLQ) [5], which is a representative scale for motivation and learning strategies. This scale consists of components related to students' motivation, cognitive strategies for self-regulated learning, and self-regulation itself. Using this scale, Itō conducted a Japanese translation and investigated the relationships among self-efficacy, attribution, and learning strategies for junior high school students [6].

The user manual for the MSLQ has already been published and defines a total of 81 questions by Pintrich et al. [6]. Miyabe et al. created a Japanese translation of 31 questions specifically related to the motivation scale and examined its reliability and validity [7]. The 31 questionnaire items that were presented to the students are listed in the appendix. Using this Japanese version of the MSLQ, Takashima et al. attempted to clarify the characteristics of self-efficacy and self-regulated learning among physical therapists [8].

In this work, we utilized the Japanese version of the MSLQ to measure students' motivation and conducted clustering on the basis of the results. Specifically, we first performed factor analysis after determining the number of factors from the questionnaire responses collected. Next, we derived subscales on the basis of the factor loadings of each question and calculated individual scores for each student according to these subscales. Finally, we classified the students into several groups on the basis of their scores. The activity status and score changes of this group are used to evaluate the asynchronous lecture model proposed in this paper.

4 Classification of Students Based on Motivation Scale

We applied the asynchronous lecture model proposed in this study to an information literacy course, which is a required subject for first-year students.

Ideally, the entire course should be conducted in an asynchronous format. However, since the

participants were first-year students who lacked prior knowledge of how to use the LMS or access the learning materials, the first through third sessions were conducted as traditional face-to-face lectures. During these three face-to-face sessions, the teacher explained to the students how to participate in the asynchronous lectures, the deadlines for assignments, and how assignment scores would be incorporated into their final grades.

We conducted a survey with these 31 questions during the 8th and 15th lectures. The students responded to each question on a 7-point scale, where a score of 7 strongly affirms the content of the question and a score of 1 strongly denies it. We received responses from 130 students for both survey periods.

We used R version 4.4.2 and RStudio [9] for data analysis. The response data were assessed via the Kaiser–Meyer–Olkin (KMO) [10] measure of sampling adequacy, which yielded a value of 0.92, confirming that factor analysis was appropriate for this dataset.

To determine the number of factors, we subsequently generated a scree plot and, on the basis of its results, set the number of factors to four. We specified the number of factors as four and estimated the factor loadings. The estimation method employed was the minimum residual method, while the factor rotation method chosen was oblimin rotation. Through this estimation, we found that among the 31 questions, 14 questions were associated with Factor 1, 3 questions were associated with Factor 2, 4 questions were associated with Factor 3, and 9 questions were associated with Factor 4.

Table 1: The Selected Questions for the Subscales and The Factor Loadings (The Values in Parentheses Indicate Factor Loadings.)

MR1	**MR2**	**MR3**	**MR4**
Q10 (0.65)	Q7 (0.67)	Q3 (0.59)	Q5 (0.72)
Q18 (0.71)	Q11 (0.73)	Q14 (0.56)	Q6 (0.81)
Q23 (0.83)	Q13 (0.70)	Q19 (0.74)	Q15 (0.77)
Q26 (0.70)		Q28 (0.71)	Q20 (0.81)
Q27 (0.69)			

Furthermore, we selected 3 to 5 questions with strong correlations from each factor and defined them as subscales. Table 1 presents the question numbers selected as subscales for each factor, with the values in parentheses indicating the factor loadings for each question. The question numbers in the table correspond to those listed in the appendix. We calculated the Cronbach's alpha coefficients for these subscales and confirmed that the reliability of the selected questions was 0.7 or higher for all factors.

On the basis of these results, we defined the meaning of each factor by analyzing the wording of the questions with high factor loadings. The names of each factor are as follows.

- ✧ MR1: Awareness of lecture contents
- ✧ MR2. Awareness of lecture performance
- ✧ MR3. Anxiety toward examinations
- ✧ MR4. Confidence in understanding lecture content

Next, we calculated the scores for all students for each factor by these subscales. On the basis of these scores, we performed hierarchical clustering of all students using Ward's method and

generated a dendrogram. Finally, we classified the students into five groups. Figure 2 presents box plots illustrating the score distributions for each factor across the groups.

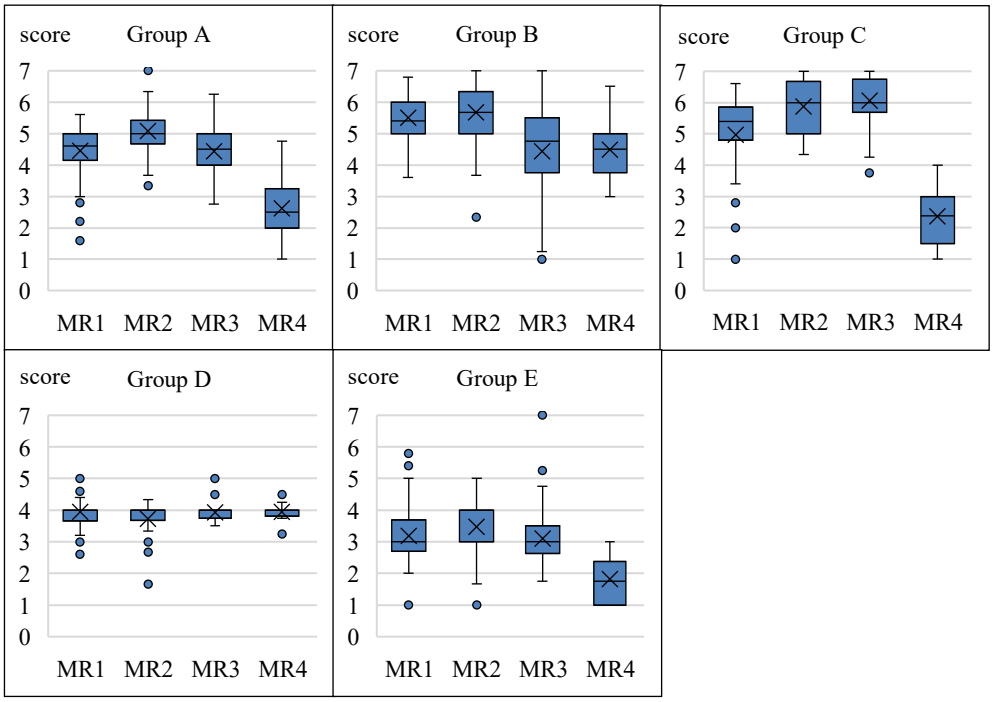

Figure 2: Boxplots of the score distribution for each group.

At the end of the course, the number of students in each group was as follows: Group A had 35 students, Group B had 34, Group C had 19, Group D had 23, and Group E had 19. More than half of the students belonged to Groups A through C, which represent relatively high levels of motivation. At the very least, in this asynchronous lecture, the motivation of a large proportion of students did not decline.

On the basis of the responses from the survey conducted during the 15th lecture, we classified the students into the five groups presented in the previous section. The characteristics of each group are as follows.

Group A shows low confidence in understanding lecture content while maintaining moderate levels of awareness of lectures and academic performance.

Group B demonstrates a high level of awareness of lectures and performance, along with a moderate degree of confidence in understanding, although group members' anxiety toward exams is more varied.

Group C exhibits low confidence in understanding lecture content but shows strong awareness of lectures and academic performance, as well as a high level of exam-related anxiety.

Group D presents average to slightly below-average scores across all factors: awareness of lectures, academic performance, exam anxiety, and confidence in understanding.

Group E shows low scores across all factors, including awareness of lectures and academic performance, exam-related anxiety, and confidence in understanding lecture content.

5 Analysis of Learning Activities

In this section, we analyze the learning activities of the student groups identified in the previous section by using the learning records obtained from the LMS. The LMS records all student activities, including logins, course and file access, and quiz attempts and completions, among others. From these records, we aggregated the following as learning activities: access to instructional materials, assignment submissions, execution and evaluation of programming tasks, and the posting of questions to the teacher.

5.1 Learning Activities of Students by Group

Figure 3 presents a graph of the average number of activities per student in each group. This graph illustrates when and how frequently each group engaged in learning activities during the asynchronous lecture period. “Before session” refers to the three-day period starting from the release of lecture materials and assignments up to three days before the in-person Q&A session. “Q&A session” represents the day on which the in-person Q&A session takes place. “After session” covers the period from the day after the session to three to six days later. If the next in-person Q&A session is scheduled two weeks later, the “after session” period is extended accordingly.

The lower part of the bar graph represents the number of times students accessed the learning materials, whereas the upper part indicates the number of submissions for quizzes, programming tasks, and other assignments.

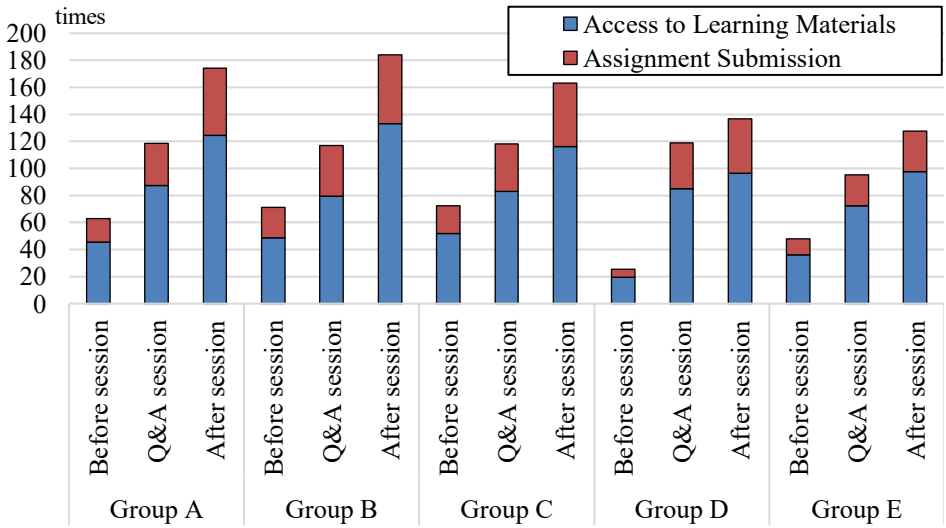

Figure 3: Average number of learning activities per student in each group

As shown in Figure 3, as expected, there is a difference in the frequency of learning activities based on motivation levels. However, despite the differences between groups, all groups exhibited some learning activity before the Q&A session, followed by a significant increase in activity on the day of the session. In a conventional asynchronous lecture, we would anticipate minimal differences between the "before session" and "Q&A session" periods, with a substantial increase in learning activity occurring during the "after session" period, just before the assignment deadline. However, by incorporating the Q&A session, we provided students with additional oppor-

tunities to engage in learning, leading to the stepwise pattern observed in Figure 3.

Next, we compare the assignment completion rates for each group on the basis of the assignments presented to students from the 4th to the 15th lectures, with a maximum score of 16 points. We measured how many students in each group achieved a passing score. Table 2 shows the assignment completion rates and average scores for each group. Groups B and C have high average scores, above 15 points, with completion rates exceeding 95%. Groups A and D have similar levels of both completion rates and average scores. Group E is the lowest group, with an average score of 14.11 and an achievement rate of 88%.

In the graph of activity counts in Figure 3, it is evident that Group D had a low number of learning activities, but over 90% of the assignments were completed. This finding suggests that the students in Group D may have been learning more efficiently in Q and A sessions, than those in Group A, who had a similar assignment completion rate but engaged in more learning activities.

Table 2: The Completion Rate of Assignments for Each Group and The Average Score for Assignments

	Assignment Completion Rate	**Average score**
Group A	91.73%	14.68
Group B	95.22%	15.24
Group C	95.72%	15.32
Group D	91.30%	14.61
Group E	88.16%	14.11

We believe that the high levels of motivation in Groups B and C positively influenced their learning behaviors, ultimately leading to a higher completion rate of assignments. Unfortunately, students in Group E, possibly due to their lower motivation, tended to give up on completing the assignments before finishing them compared with students in the other groups.

In this study, we confirmed that student motivation, as measured, had an impact on the students' actual activities. Next, we examine the changes in motivation during the lecture period and their subsequent influence on learning activities.

5.2 Learning Activities of Students Who Changed Groups

In this section, we focus on students whose group changed on the basis of the clustering results from the surveys conducted in the 8th and 15th sessions.

Table 3 shows the number of students whose group moved between the first and second surveys. The left column indicates the groups from the initial survey, and the numbers represent how many students moved to each group. For example, the "to A" column in the row for Group A shows 21 students, indicating that these 21 students remained in Group A without any change.

A total of 14 students transitioned from the higher-motivation groups, B and C to the lower-motivation groups, E and D. In contrast, only five students moved from the lower-motivation groups to the higher-motivation groups, which was, unfortunately, a small number. Unfortunately, more students moved to lower-motivation groups by the end of the course.

Next, we turn our attention to the learning activities of students whose motivation levels changed. Figure 4 shows the average number of learning activities per lecture session for students whose group classification changed.

Table 3: The Number of Students whose Group Changed After the Lecture

	to A	to B	to C	to D	to E
Group A	21	9	8	8	5
Group B	2	16	3	**6**	**2**
Group C	5	5	7	**1**	**5**
Group D	2	**1**	**1**	7	2
Group E	5	**3**	**0**	1	5

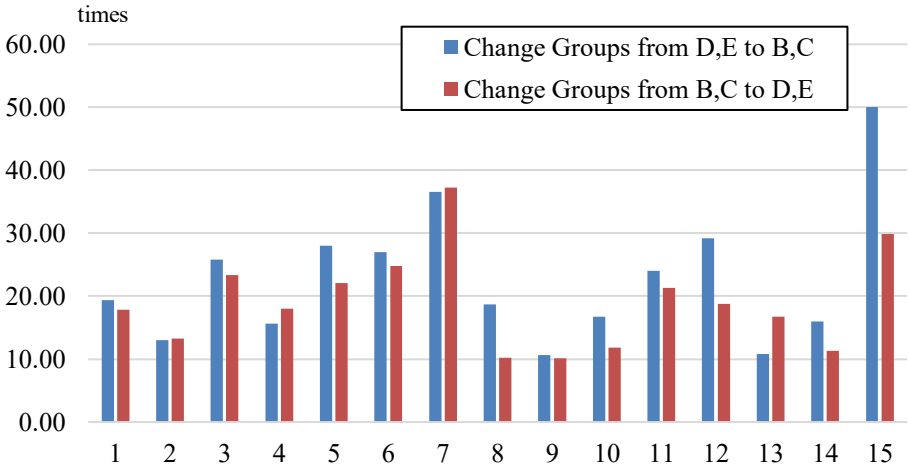

Figure 4: Average number of learning activities per lecture for students who changed groups.

During the first half of the course (Lectures 1–8), there were no notable differences in the number of learning activities; even students in the lower-motivation groups during this period exhibited a comparable level of activity frequency. However, in the latter half of the course, students who transitioned to Groups D and E demonstrated a decline in activity, consistently showing fewer learning activities than their counterparts—except in Lecture 13. Conversely, students who moved from Groups D and E to Groups B and C exhibited a slight increase in activity, with a marked rise in learning behavior observed in Lecture 15 just before the final examination.

Among these, two students had engaged with the practice assignments more than ten times. Since these practice assignments had no deadlines and did not contribute to the final grade, we consider that engagement with them was driven almost entirely by the students' own volition.

However, when the assignment achievement rate was examined, the percentage of students who belonged to Groups B and C in the latter half of the course decreased—from 93% in the first half to 82% in the second half. Although their awareness of the course increased and they engaged in more learning activities, students were ultimately unable to complete the assignments. Similarly, the percentage of students who belonged to Groups D and E during the second half decreased from 95% to 82% in the second half, indicating a general decline.

On the basis of these findings, we consider that changes in students' awareness had a certain degree of influence on their learning activities. However, although some students demonstrated increased awareness and more active engagement in learning during the lecture period, it is regrettable that this did not lead to the successful completion of assignments. We interpret this finding as an indication that the changes in students' awareness occurred late.

6 Analysis of Learning Activities

On the basis of the results above, I evaluate the proposed asynchronous lecture model.

First, the implementation of in-person Q&A sessions provided students with earlier opportunities to engage in learning and helped prevent the concentration of learning activities solely near assignment deadlines. We evaluate this aspect as an advantage of our model.

Next, we turn our attention to students' motivation, as measured by the MSLQ. According to our survey, 53 out of 130 students maintained high motivation and exhibited frequent learning activities. These students are those who align with the proposed asynchronous lecture model, as outlined in the research question (RQ1) of the introduction.

On the other hand, 42 students exhibited low motivation and a low frequency of learning activities. Furthermore, there were more students whose motivation was high during the course but decreased by the end compared to those whose motivation increased. However, the number of students whose motivation changed significantly was approximately 20 in total. On this basis, the proposed lecture model does not substantially decrease the motivation of students who are well suited to it.

Next, we discuss the improvements that should be made to accommodate students with low motivation (RQ2).

One factor contributing to the greater number of students whose motivation declined than those whose motivation increased is the inclusion of programming sessions in the latter half of the course. We believe that understanding programming content through asynchronous instruction poses a considerable challenge for first-year students. To contribute to the motivation of all groups, it is necessary to revise the programming materials to make them more accessible and conducive to learning. We also propose enhancing student engagement by incorporating elements of enjoyment and a sense of achievement into the programming exercises, thus encouraging participation through intrinsic motivation rather than external enforcement by the teacher.

Furthermore, to prevent a decline in motivation caused by difficulties in learning, we propose a method that automatically presents supplementary exercises or instructional materials as hints to students whose assignments do not meet the passing criteria. This allows them to unintentionally follow different learning paths within their own motivation levels. We aim for all students to reach the learning objectives, regardless of variations in learning time related to differences in their motivation levels.

7 Conclusion

We proposed an asynchronous lecture model to encourage students' self-directed learning. To assess the impact of the lecture model on students' self-directed learning activities, we measured their motivation toward learning using the Japanese version of the MSLQ and compared it with their learning activities.

The inclusion of face-to-face Q&A sessions within the asynchronous lecture model led to increased student learning activity. The two groups of students with high motivation demonstrated learning activities and task completion rates that aligned with the ideal learning activities that we envisioned for this asynchronous lecture model. On the other hand, the groups with low motivation exhibited fewer learning activities and lower task completion rates than did the other groups.

Students whose motivation changed from the first half to the second half of the lecture period showed corresponding changes in the frequency of their learning activities. Among the students whose motivation increased, we observed voluntary engagement with the practice assignments. However, this engagement did not lead to an increase in assignment completion rates, indicating an area for improvement in future iterations.

In this paper, we applied this asynchronous lecture format to a course on information literacy. This lecture consists of explanations from a teacher and student exercises. We believe that, as long as a course does not require students to synchronize their learning pace with others, as is the case in project-based learning (PBL) or collaborative learning, this format can be adapted to other lectures as well. Moreover, Japan is currently implementing the nationwide GIGA School Initiative [11], which aims to establish an educational environment in compulsory education where each student is equipped with an individual personal computer for learning. Accordingly, we anticipate that the number of students capable of adapting to the asynchronous lecture format we propose will increase in the future.

In the future, we aim to implement improved instructional materials in subsequent lectures, with the goals of fostering more effective student learning activities and achieving a better asynchronous lecture model.

Acknowledgement

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APPENDIX.A: LIST OF QUESTIONS IN THE JAPANESE VERSION OF THE MSLQ

Q1. In a class like this, I prefer course material that really challenges me so I can learn new things.

Q2. If I study in appropriate ways, then I will be able to learn the material in this course.

Q3. When I take a test I think about how poorly I am doing compared with other students.

Q4. I think I will be able to use what I learn in this course in other courses.

Q5. I believe I will receive an excellent grade in this class.

Q6. I'm certain I can understand the most difficult material presented in the readings for this course.

Q7. Getting a good grade in this class is the most satisfying thing for me right now.

Q8. When I take a test I think about items on other parts of the test I can't answer.

Q9. It is my own fault if I don't learn the material in this course.

Q10. It is important for me to learn the course material in this class.

Q11. The most important thing for me right now is improving my overall grade point average, so my main concern in this class is getting a good grade.

Q12. I'm confident I can learn the basic concepts taught in this course.

Q13. If I can, I want to get better grades in this class than most of the other students.

Q14. When I take tests I think of the consequences of failing.

Q15. I'm confident I can understand the most complex material presented by the instructor in this course.

Q16. In a class like this, I prefer course material that arouses my curiosity, even if it is difficult to learn.

Q17. I am very interested in the content area of this course.

Q18. If I try hard enough, then I will understand the course material.

Q19. I have an uneasy, upset feeling when I take an exam.

Q20. I'm confident I can do an excellent job on the assignments and tests in this course.

Q21. I expect to do well in this class.

Q22. The most satisfying thing for me in this course is trying to understand the content as thoroughly as possible.

Q23. I think the course material in this class is useful for me to learn.

Q24. When I have the opportunity in this class, I choose course assignments that I can learn from even if they don't guarantee a good grade.

Q25. If I don't understand the course material, it is because I didn't try hard enough.

Q26. I like the subject matter of this course.

Q27. Understanding the subject matter of this course is very important to me.

Q28. I feel my heart beating fast when I take an exam.

Q29. I'm certain I can master the skills being taught in this class.

Q30. I want to do well in this class because it is important to show my ability to my family, friends, employer, or others.

Q31. Considering the difficulty of this course, the teacher, and my skills, I think I will do well in this class.