Improved HyFlex Course Design Utilizing Live Online and On-demand Courses

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Abstract: HyFlex (Hybrid-Flexible) courses can provide flexibility to respond to student needs to provide both online and face-to-face courses at the same time. However, the support staff is necessary to run a HyFlex class to provide live streaming of a face-to-face lecture since the teacher has to focus on giving a lecture and responding to student questions. In this paper, we propose a new implementation of the HyFlex course so that the teacher can implement a HyFlex class without the support staff. The improved HyFlex course utilizes live online courses and on-demand courses. The teacher first records and edits the on-demand video before the class. Students watch the video in the class regardless of whether they are at home or school. The teacher launches the online conference system, such as Zoom or Webex, at the class to respond to questions and comments from the students. The students can make questions and comments using chat or audio provided by the online conference systems. They can quickly have a response from the teacher since the teacher focuses on answering the questions and comments during the class. We run the improved HyFlex course in two different types of classes at our university. Approximately 85% of the students are satisfied with the improved HyFlex course.

1 INTRODUCTION

Online education has become popular under COVID-19 (Gaudiot and Kasahara, 2020). They can be classified into the online live (synchronous) course, on-demand (asynchronous) course, and hybrid course. They all have unique educational characteristics compared to a traditional face-to-face course (Anderson, 2009; Harasim, 2017).

Many of the universities have shifted to provide online courses in face of COVID-19. Although many students are satisfied with the online courses, some students and parents strongly prefer to take face-to-face courses. The Minister of Education of Japan requested the implementation of hybrid courses at Japanese universities.

The purpose of this paper, i.e. the research question, is to develop a course mode that can satisfy these conflicting demands. The designed course should be implemented without support staff.

We propose an improved HyFlex course, which is a special type of course mode within the hybrid course, in this paper. The original HyFlex course (Beatty, 2019) needs support staff to provide live streaming of the class other than the teacher at the class, which is quite difficult at the usual university due to limitation of staff and budget. The proposed HyFlex course can be operated without support staff, while the students can freely choose face-to-face and online courses.

The improved HyFlex course utilizes both the live online course and the on-demand course so that we can take advantage of both course modes. In the improved HyFlex class, the instructor prepares the lecture video before the class and focuses on answering questions during the class. Students watch the lecture videos on demand regardless of where they are in the class or at home.

This allows for repeated viewing of the lecture video at a playback speed that matches the student's preference. Also, as in the case of online live classes, real-time responses to questions from students, and instruction using the screen-sharing function can be realized. We run the improved HyFlex course at two classes at our university and obtained strong support from the students.

Figure 1: Number of New Cases of COVID-19 Infection in Japan (as of December 31, 2020).

This paper is organized as follows. Section 2 explains the impact of COVID-19 on college education in Japan. We shall summarize the characteristics of various course modes in Section 3 including face-to-face, live online, on-demand, and hybrid courses. A survey of the related works is also discussed in this section. We shall next propose our improved HyFlex course and explain the implementation of the course without support staff. The evaluation result of the proposed course mode is demonstrated in Section 5 at two different types of classes: one is a lecture and the other is an experiment using Microsoft Access. Approximately 85% of the students are satisfied with the improved HyFlex class design at both classes. Finally, we shall conclude the paper in Section 6.

2 IMPACT OF COVID-19 TO COLLEGE EDUCATION IN JAPAN

Figure 1 represents the number of new cases of COVID-19 infection in Japan (Ministry of Health, Labour and Welfare of Japan, 2021). The number of COVID-19 infections is increasing in 2021 so that the Japanese government declared an emergency state in the Tokyo metropolitan area on January 8, 2021.

The first cases of COVID-19 were identified in March 2020, and the number of cases has increased since then. As a result, the Japanese government asked all elementary, secondary, and high schools to close that was scheduled to start the new school year in April. Many universities postponed the start of the new semester by two to four weeks. This period was used for the preparation of online education, and most of the Japanese universities started online classes in late April or May 2020.

As of May 2020, some of the online classes at Japanese universities were live online classes using Zoom or on-demand classes. However, many classes were conducted only by uploading pdf documents to websites containing education contents and homework instructions.

The latter class format was introduced mainly to reduce internet traffic and to allow university faculty members who were not familiar to teach online classes. However, student evaluations were quite low, and as faculty members became accustomed to online classes, they were replaced by live online classes or on-demand classes.

Many faculty members were confused by the first-experienced online classes, and there was much confusion due to the lack of guidance and support from the university.

To address these issues, the National Institute of Informatics (NII) launched the Cyber symposium to share the status of initiatives for distance learning at universities starting in April 2020. The symposium series has been held every two weeks, and the author also made a presentation at the symposium (Kakeshita, 2020). This paper is an extended version of the approaches proposed in this symposium.

At the end of March 2020, a Facebook group was established to share knowledge and information on what college faculty should and willing to do in response to the impact of COVID-19. The group is run on a volunteer basis by 17 faculty members belonging to different universities and has about 20,000 members, mostly university faculty members. The group has received more than 5,000 postings and 40,000 comments since its beginning. Recently, the group has been actively exchanging knowledge and opinions through postings and comments on online education at a frequency of 8.9 postings/day.

Although universities and faculty members were confused in May 2020, they understood that all

universities were in a similar situation in June 2020. This led to the exchange of knowledge for improving online classes and the exchange of opinions on the prospects for university education after COVID-19.

In Japan, some students and their parents are strongly requesting the resumption of face-to-face classes at universities as well as at elementary and secondary schools, as is happening at universities in the US, the UK, and other countries. Some of them lobbied the Prime Minister and the Minister of Education. As a result, the Minister of Education requested Japanese universities to resume face-to-face classes and to implement hybrid classes despite the increasing number of COVID-19 infections.

Some advanced Japanese universities are making effort to implement hybrid classes in response to this situation. These efforts also envision university education after the convergence of COVID-19. This research is motivated to contribute to society in this context.

3 CHARACTERISTICS OF VARIOUS TYPES OF COURSE MODE

In this section, we summarize the characteristics of conventional face-to-face classes and various online class formats (Anderson, 2009; Harasim, 2017). The characteristics described in this section are also based on the experiences not only of the author but also of the university faculty members who participated in the Facebook group introduced in Section 2. We shall also discuss the related works in this section.

3.1 Face-to-Face Course

The primary advantage of a face-to-face class is the ease of communication between teachers and students, as well as between students. These communications include not only in-class communications but also out-of-class informal communications, which play an important role in building human relationships, especially for freshmen.

In addition to this, there are some types of education, such as art and medicine, that require special facilities and equipment that are difficult for students to prepare by themselves, and for which effective instruction may be difficult to achieve without face-to-face interaction depending on the educational content.

Furthermore, considering the possibility of cheating and ensuring fairness, regular and entrance examinations should be administered in a face-to-face mode. Unless special facilities and examiners are prepared to take these points into account, online examinations are considered to be inappropriate.

There are many works to compare the educational outcome of online courses and face-to-face courses. Recent work indicates that no significant difference was observed between these two course modes, while there is a difference in terms of the engagement of the students between the two modes (Basu, 2021).

3.2 Live Online Course

In a Live online course, the teacher delivers live streaming of the class using an online conference system such as Zoom or Webex. Students can attend the class from anywhere as long as they have a PC connected to the Internet. By reducing the restrictions on the location of the class, it becomes possible to reduce the risk of COVID-19 infection, as well as reduce transportation time and cost to and from school. Online classes also make it possible to provide education to a larger number of students than face-to-face classes.

Teachers can give a lecture even if they are not physically at school. It is also possible for multiple professors from multiple universities to collaborate on a single class. It will also be possible to invite external teachers within the country and from abroad to give online lectures without travel costs. In this sense, it can be expected to improve the quality of education by introducing online education.

By using a live online course, it is easy to interact with the teacher by asking questions and asking for advice in real-time, rather than a one-way class like at a traditional online university. This is important for activating communication between students and teachers and increasing the effectiveness of education. With the implementation of live online classes, the number of questions from students using private chats has significantly increased during classes.

Although it is necessary to overcome the problem of the time difference, it will be possible for Japanese students to study online at foreign universities and for foreigners to study online at Japanese universities.

There are a certain number of students who are in the hospital or who are withdrawn or not attending school. Online classes can be utilized for these students to provide opportunities to receive an education.

In exercises using PC (e.g., programming education), students can present their PC screens to the teacher for consultation using the screen sharing

function. This allows the teacher to guide while accurately understanding the student's situation. Furthermore, by providing the teaching situation to other students, it is possible to answer similar questions at the same time.

In an exercise class, breakout sessions can also be utilized to facilitate communication and learning among students and to make group work more effective.

3.3 On-demand Course

In an on-demand course, the teacher creates a lecture video of the class and the students watch the video to learn. Unlike the live online course, students cannot ask and answer questions in real-time, but they can communicate with other students and teachers through chat rooms, forums, and e-mail.

One of the advantages of an on-demand course is that students can freely choose not only where to watch the video but also when to watch it. This will make it possible to provide education to a large number of students, although it is necessary to establish a (human and/or IT) system for responding to questions and answers from students and grading reports. On the other hand, a certain number of students tend to accumulate lecture videos without watching them because of these characteristics.

When students watch a lecture video, they can repeat it as many times as necessary to deepen their understanding. Besides, if PC operations are demonstrated and recorded on a video, students can operate their PCs while watching the video, so that detailed operations can be effectively conveyed. Furthermore, students can choose the playback speed of the video according to their understanding speed. This makes it easier for them to concentrate on the explanation of the teacher.

It is sometimes difficult for students to have a high-speed internet connection at home. In such a case, the students can download the on-demand video to their PC and watch it in an offline mode. In this way, students can watch the class videos smoothly even with a low-speed internet connection.

From the teacher's viewpoint, the advantage of an on-demand course is that the lecture video can be recorded at a convenient time for the teacher and can be edited as needed. Through editing the video, it becomes possible to add narration, background music, subtitles, etc. Unnecessary parts can also be removed to create high-quality educational content.

There is a case that part-time teachers are giving lectures at universities. Some of them even have the same lecture at different universities. An on-demand education is suitable for this case since they can create lecture videos to use at different universities. Then they do not even need to go to universities.

By utilizing on-demand education, it is possible to create opportunities for people to return to the university to study advanced technology and liberal arts even after they have graduated from university and entered the workforce. This is desirable from the viewpoint of lifelong learning and recurrent education for technical personnel.

3.4 Hybrid Course

The definition of a hybrid course is not necessarily fixed, but there are three major types: HyFlex course, blended course, and distributed course.

The HyFlex course (Beatty, 2019) is typically implemented by live streaming of a regular face-to-face course. Students can freely choose to take the course either in face-to-face or online modes. On the other hand, the teacher needs to be aware of both face-to-face and online students at the same time during the class and needs to answer questions from both types of students. Since this places a heavy burden on the teacher, the support staff is necessary to operate the live streaming operation.

A blended course is a method that uses both face-to-face and online course modes for each class in consideration of educational effectiveness. Students are not allowed to choose between face-to-face and online classes.

In the Distributed course, the same class is conducted in both face-to-face and online modes. Half of the students are divided into groups, and when one group is taking the face-to-face course, the other group takes the online course. Such assignments can be flipped to maintain fairness. The main purpose of this method is to reduce the number of students taking the face-to-face class, thus this is meant to secure the social distance associated with COVID-19. However, it is not a method considering educational effectiveness.

There is a work on the evaluation of the HyFlex course from the viewpoint of students (Lakhal, et al., 2014; Abdelmalak, and Parra, 2016). However, to the best of the author's knowledge, there has been no evaluation from the perspective of the class administrators or improvements considering the operational costs. Although the HyFlex course has many advantages, it is not expected to be widely used in many educational institutions unless the problem of operating cost is resolved.

4 IMPROVED HyFlex COURSE: A PROPOSAL

As explained in Section 3, face-to-face courses and online courses have different characteristics. HyFlex course is the most suitable model for flexibly changing the class format according to the COVID-19 infection status and flexibly responding to the requests of students and parents. The major problem to widely implement the HyFlex course is that support staff are required at each class. However, it is quite difficult for many universities to ensure a required number of such support staff.

Typical HyFlex course is based on face-to-face courses and has been implemented as an online extension of face-to-face teaching. On the other hand, the improved HyFlex course proposed in this paper is based on online courses and is designed to be used for face-to-face classes as well.

This is implemented as follows.

Teachers record the lecture video before the class. During a class, students watch the lecture video on demand, whether they are in the classroom or at home. Students can raise their hands and ask questions verbally if they are in the classroom, but they can also ask questions at any time by using chat. The teacher focuses on the question and answer session during the class, and broadcasts the questions and corresponding answers to every student via chat. In this way, both face-to-face and online education can be provided with minimum equipment and teachers.

One issue may arise how to deal with a large number of students who wish to attend a face-to-face class. Considering the situation of COVID-19, if a large number of students wish to attend a face-to-face class, a single classroom may not provide sufficient social distance. In such a case, we assign multiple rooms for the class and distribute students among the rooms. Each student brings his or her PC to attend the class. Teachers visit each of the classrooms, in turn, to answer students' questions during the class.
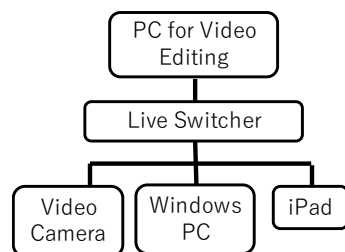
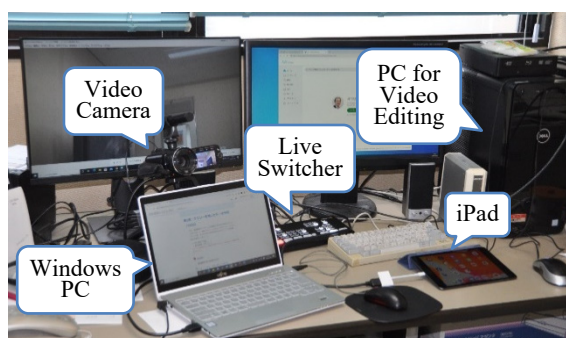Figure 2: System Configuration for Lecture Video Recording and Editing.

Figure 3: Lecture Video Recording and Editing System.

Figure 2 illustrates a system configuration for video recording and editing in the improved HyFlex course. Figure 3 shows an example of the implementation.

A video camera is used to capture the teacher's face, and a gun microphone is used to record the teacher's voice. The Windows PC is used to display lecture materials and the teacher can give a lecture presentation. In the author's case, the PC is used to present PowerPoint slideshows, materials created using Word, Excel, Access, Visual Studio, Astah Professional, etc., as well as to display Moodle course pages. The iPad is used in conjunction with an Apple pen and a note application to provide handwritten explanations. The note application also provides functions to add handwritten explanations to images, screenshots, pdf documents, etc. so that we do not need a blackboard at class anymore.

These devices can be switched using a live switcher to send video and audio to the PC for video recording. By using a live switcher, it is easy to realize picture in picture as well as transition effects when switching screens. In addition to these functions, the live switcher also provides functions such as mixing of microphones and video audio, chroma key composition, the addition of logos and onscreen text, etc.

By using video editing software to edit the output and source video, the teacher can freely cut off extra scenes, add transition effects, and add background music and narration, making it possible to create high-quality lecture videos if the teacher takes the time to do so.

As a minimum configuration, the video recording and editing system can be implemented only with a PC connected to the Internet. The teacher connects to an online conference system such as Zoom or Webex. The teacher's presentation on the PC is sent to the conference system for recording using the screen sharing function. Simple cut editing can be done by temporarily pausing the recording.

The teacher workload for the proposed method may be an important issue when it is introduced in actual classes. In the case of the improved HyFlex method, the teacher needs to record the lecture video in advance and edit it if necessary. The teacher's workload may change drastically depending on the amount of time and effort spent editing the video.

In our experience in the process of video recording using Webex at the author's office, the recording was temporarily interrupted by a phone call from outside, and the recording was resumed after the call ended. Other than that, the author gives a normal lecture to produce the recording so that the class time and the video production time were almost the same.

Although such lecture videos may be redundant, the students fast-forward through the redundant parts when playing back the video. Thus, it is not mandatory to edit the video even if there were some redundancies in the explanation. Of course, we recommend creating a higher-quality lecture video by editing the original recording with video editing software if time permits.

Figure 4 shows a system configuration during a class. The video camera for the teacher is used to distribute the teacher's video and voice. The video camera for the students is used to distribute the video and sound in the classroom. Also, by connecting two microphones to the live switcher, questions from the students can be delivered by voice. An iPad (or any PC) can be connected to the live switcher to send handwritten messages from the instructor.
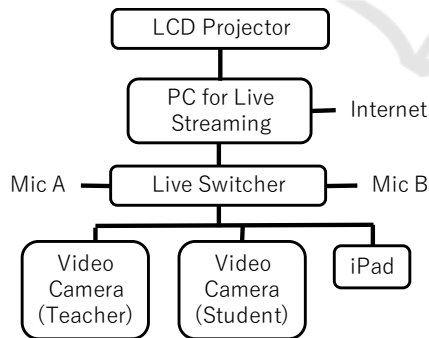

Figure 4: System Configuration at Class.

Currently, there is also a 360-degree camera with a microphone and a speaker for conference rooms that automatically determine the focus target based on a comprehensive evaluation of the amount of speech, volume, and other factors using AI, as well as a web camera with automatic tracking and focusing of the target. Thus, the variety of devices that can be connected to this system continues to increase.

The teacher connects the live switcher to the PC for live streaming and presents the video to the classroom using an LCD projector. Figure 5 shows an example scene in a face-to-face class. The streaming PC is also connected to the Internet so that the videos and sounds of the teacher and the classroom are broadcasted to the online students.

The teacher connects to an online conference system with the streaming PC and checks questions from the students via chat. Students can ask questions to the teacher via private chat, and the teacher can broadcast the questions and answers back to all students to promote communication between students and teacher. We can expect to make it easier for students to ask questions by broadcasting the questions in anonymized form.

If the teacher runs an LMS such as Moodle, the teacher can post the chat log after the class for the convenience of the students.
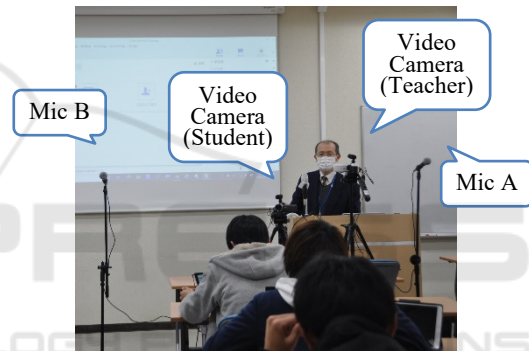

Figure 5: Face-to-face Class of Improved HyFlex Course.

Figure 6: Teacher's PC View at Improved HyFlex Course.

Figure 6 represents the screen of a teacher's PC that displays the lecture video and the chat at the same time. The notepad application is used to edit questions and answers so that the teacher copy and paste them to the chat. By displaying a similar screen on the PC as that of the teacher, students can easily ask questions to the teacher while watching the lecture video, and at the same time, they can read the
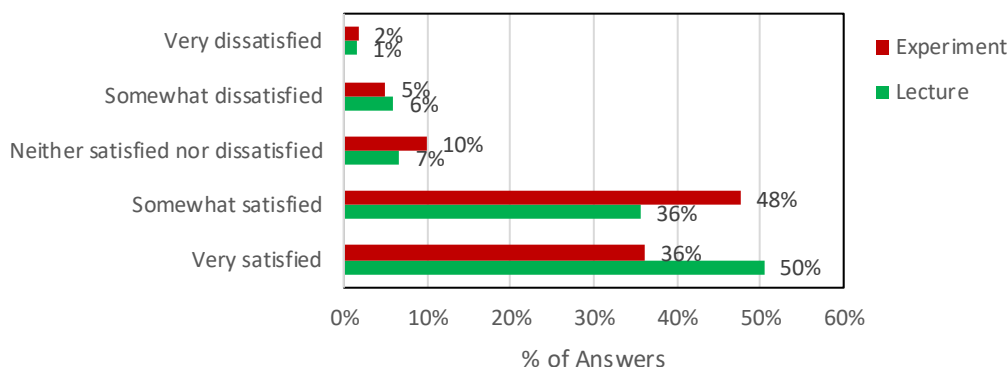
Figure 7: Student Satisfaction of the Improved HyFlex Class.

questions of other students and the teacher's answers to them in real-time.

5 EVALUATION OF THE IMPROVED HYFLEX COURSE

We conducted a questionnaire survey to determine the level of satisfaction of the students who took the improved HyFlex course for two types of classes: One is a lecture for freshmen and the other is an experiment using Microsoft Access. We also collected students' comments on the reasons for their responses. With six months of experience in the various online classes (live and on-demand), the students have enough experience to evaluate the improved HyFlex classes.

One of the advantages of the improved HyFlex course is that the students can choose the replay speed of the on-demand video. Thus we also collected preferred replay speed from the students of the two types of classes.

5.1 Student Evaluation at a Lecture

The target lecture is "Introduction to Information Network Engineering," which is a class for 177 first-year students of the Faculty of Science and Engineering of our university to introduce them to one of the 12 courses to which they will be assigned in their second academic year.

Only three students choose to take the face-to-face class while the remaining students choose to take an online class. This is mainly because most of the other lectures are held online and because of the COVID-19 infection risk. On the day of the survey, 147 students attended the class, and the number of responses was 135 (response rate: 91.8%).

Figure 7 shows a summary of the results. 85.9% of the students gave a positive evaluation of very satisfied or somewhat satisfied. On the other hand, only 7.4% of the students answered that they were somewhat or very dissatisfied.

Some of the comments from the students who gave positive evaluations are listed below. The readers can confirm that our intention of the improved HyFlex course is correctly understood and strongly supported by many of the students.

- I can watch the videos at my own pace and ask questions to the teacher, so I can understand the course well.
- I appreciate the real-time question and answer system.
- I think this class format is very good because it can meet the various needs of the students.
- I appreciate that there is no need to worry about the lecture video stopping during live streaming.
- Some teachers are so absorbed in the class that they don't notice the questions in the chatbox, so I think this is a great way to avoid missing questions.
- The on-demand course has the advantage of repeated viewing of the video, but I often end up working on it just before the submission deadline. The improved HyFlex course requires students to take the course at a scheduled time frame, which helps them maintain their motivation, and I am so satisfied with the system that I hope it will be adopted for other lectures as well.
- I can read questions and answers in real-time. Since the lecture videos are provided in an on-demand manner so that I can stop and adjust the playback speed, and Webex allows me to check attendance information.

On the other hand, when we reviewed the opinions of the students who negatively evaluated the course, many of them told that they would like the course to be available at any time as an on-demand class. This implies that there are a certain number of students who do not recognize the value of communication including question and answer within the class.

5.2 Student Evaluation at an Experiment

We also implemented an improved HyFlex class in the course "Experiment in Information Systems" for second-year undergraduate students specialized in computer science.

The course is composed of extensive assignments of information system design and implementation using Microsoft Access. 82 students take the course and 5 students are regularly taking face-to-face courses since questions to the teacher are easier for them than online mode. On the day of the survey, 69 students attended the class, and the number of responses was 61 (response rate: 88.4%).

Figure 7 shows a summary of the student survey. 83.9% of the students are satisfied with the improved HyFlex course. The following is a list of comments from the students.

- I was able to understand the details of Access operations by following along with the lecture videos. I also appreciate that the videos can be played as many times as necessary.
- When I had trouble understanding something, I went back and watched the lecture videos. Since I can watch the videos at any time, I will actively use them.
- By using the screen sharing function to show my PC screen to the teacher, I was able to receive precise guidance. Therefore, I was able to solve my questions immediately.
- The screen sharing function is very helpful for me because I can see the teacher advising other students.
- It is very nice to have the chat questions and answers posted on the lecture Moodle after the class.
- It is very helpful that the lecture videos become available earlier at the lecture Moodle since I can work on the assignment ahead of schedule.
- I appreciate that the teacher tried to incorporate our opinions.

In contrast to a regular lecture, in the video of the experiment, the instructor demonstrates the operation of a PC using Microsoft Access, etc., and the students operate the PC themselves while watching the demonstration. Thus, many students commented that they made effective use of the on-demand video.

Furthermore, by using the screen-sharing function to guide while viewing the student's PC screen, the student can accurately communicate the specific situation to the teacher. In addition to this, by showing the instruction to other students, it becomes possible to provide an opportunity for students to solve the same questions themselves.

As mentioned in the comments from the students, the fact that we try to improve the course by listening to students' opinions is also considered to be a reason for the high evaluation. This kind of room for improvement is one of the advantages of the improved HyFlex class.

We also have some students having negative evaluations. Their reason is essentially the same as the comments from the students taking the lecture explained in Section 5.1.

5.3 Preferred Replay Speed of the On-demand Video

The improved HyFlex class is also characterized by the fact that students can freely select the playback speed when watching the on-demand video. We conducted a questionnaire survey on the speed at which the students could most easily understand the content of the video.

The results are shown in Figure 8 for two types of class. The preferred replay speed is generally faster for a lecture than an experiment.

This difference may be due to the nature of the class. In a normal lecture, it is enough for the students to understand the teacher's explanation. In the case of an experiment, however, students need to be able to practice based on the teacher's explanation. Besides, students need to be able to operate the PC by themselves while watching the PC operation by the teacher. Therefore, students need to listen to the explanation more carefully in the latter case.

Although special training is required for speed listening at more than twice the original speed, increasing the speed to some extent will not only reduce the watching time but also meet students' needs and improve their concentration (Allen, 1994).
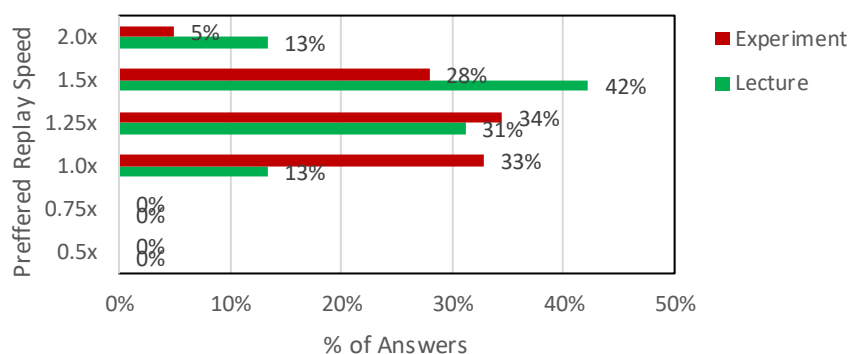
Figure 8: Preferred Replay Speed of the On-Demand Video.

6 CONCLUSIONS

We propose the improved HyFlex course design to provide both face-to-face and online classes operated without support staff. Since there are many cases where educational institutions cannot afford to have enough support staff, the proposed method will be useful at many institutions to widely provide HyFlex courses.

We also implemented the proposed HyFlex course at a regular lecture and an experiment. 85% of the students positively evaluate the improved HyFlex course design as explained in Section 5. This implies that the improved HyFlex course design can be widely applied to various types of courses.

There are some issues we should consider when introducing the improved HyFlex course design in experiments. Students operate their PCs while watching on-demand videos and chatting. However, it is difficult to display all the information at once if the PC has only one screen like a typical notebook PC. Therefore, we recommend that the students utilize multi-display systems to increase the effectiveness of the improved HyFlex course design. An alternative solution is to utilize a smartphone or a tablet PC in addition to the student's PC.

Even if pandemics caused by infectious diseases such as COVID-19 come, online education will not stop education anymore. Although only 15% of the Japanese elementary and junior high schools provide online classes (Cabinet Office, 2020), it is expected that online education will be promoted in elementary and junior high schools as well. We can expect that there are many ways in which universities can support those schools to introduce online education.

As explained in Section 3, online education has various educational advantages that cannot be found in traditional face-to-face education. On the other hand, certain educational activities are difficult to realize through online activity only. Therefore, it is important to utilize both face-to-face and online methods appropriately.

A certain level of IT skills is required for both students and teachers to smoothly implement online education. Schools are also required to have adequate network infrastructure and PCs. The Japanese government is promoting the development of hardware and internet connection at elementary and secondary schools through the GIGA School Program (Ministry of Education, 2020). The author believes that improving the IT skills of teachers will be an important issue to improve many aspects of contemporary education in the near future.

REFERENCES

Abdelmalak, M., Parra, J. L., 2016, "Expanding learning opportunities for graduate students with HyFlex course design", Int. Journal of Online Pedagogy and Course Design, Vol. 6, Issue 4, pp. 19-37.

Allen, B., 1994, "Perceptual speed, learning and information retrieval performance", in Proc. 17th ACM SIGIR Conf. on Research and Development of Information Retrieval, pp. 71-80.

Anderson, T., 2008, The Theory and Practice of Online Learning, 2nd Edition, Athabasca University Press.

Beatty, B. J. Ed., 2019, Hybrid-Flexible Course Design: Implementing student-directed hybrid classes, EdTech Books. Available at https://edtechbooks.org/hyflex

Basu, D., Heckman, S., Maher, M. L., 2021, "Online vs face-to-face web-development course: Course strategies, learning, and engagement", in Proc. 52-nd ACM Technical Symp. On Computer Science Education (SIGCSE'21), pp. 1191-1197.

Cabinet Office, 2020, "Survey on Changes in Attitudes and Behaviour under the Influence of New Coronavirus Infection", Japanese Government Report.

Gaudiot, J.-L., Kasahara, H., 2020, "Computer education in the age of COVID-19", *IEEE Computer*, pp. 114-118.

Harasim, L., 2017, Learning Theory and Online Technologies, 2nd Edition, Routledge.

Kakeshita, T., 2020, "Improving online classes using Facebook communities and a proposal for an improved HyFlex class", *Cyber symposium to share the status of initiatives for distance learning at universities starting in April*, National Institute of Informatics. (in Japanese)

Lakhal, S., Khechine, H., Pascot, D., 2014, "Academic students' satisfaction and learning outcomes in a HyFlex course: Do delivery modes matter?", Proc. World Conference on E-Learning, pp. 1075-1083.

Ministry of Education, Culture, Sports, Science and Technology of Japan, 2020, "About GIGA School Program". Available at https://www.mext.go.jp/en/content/20200716-mxt_kokusai-000005414_04.pdf

Ministry of Health, Labour and Welfare of Japan, 2021, Number of positive cases of COVID-19 PCR test, Available at https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/0000164708_00079.html