Construction and Operation Method of Remote Class Environment by "Ready-Made Computing"

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Summary
In recent years, "remote class" in the field of education has been receiving a great deal of attention as a method of delivering education. n Japan, however, remote classes are far from being common. Most of the universities in Japan are regular universities, and very few are online schools. One reason for this response is the cost. Top universities of the world may be able to use their ample funds to introduce an educational environment for remote classes to deliver to their students. Japanese educational institutions, on the other hand, cannot afford to create an environment for distance learning due to limited budget. In short, remote teaching is not yet common in Japan, no matter whether it is an emergency situation or not. Based on the above, we believe that the remote class environment most suitable for distant education in Japan is one that is highly versatile for both regular and emergency uses and that can be constructed at low cost. Here we propose a method to build, by combining mass-produced equipment and free video calling software, an environment where anyone can deliver remote classes if network is available. This method is defined as "Ready-Made Computing" in this research. "Ready-made Computing" in this research is defined as a method by which mass-produced products are combined to build services or systems with the same level of performance as existing business services or systems. In addition, this project studies adaptation of this method for the use in the field of education. In this study, we call the ready-made computing that caters to the field of education "ready-made computing for education". In this study, we call the ready-made computing that caters to the field of education "ready-made computing for education". As the first step, the purpose of this research is to construct a remote class environment using the idea of ready-made computing. In this paper, we study the construction method of a correspondence class environment with A and describe an example of its operation.

Key words:
Ready-Made Computing, Remote Class, Remote Class Environment, Video Calling Software,

1. Introduction

In recent years, 'remote class' in the field of education has been receiving a great deal of attention as a method of delivering education. It is now becoming the most popular delivery method of education around the world. In the U.S., universities provide remote classes not only on the Internet but also through a variety of media. It can be said that American schools are quite active in offering remote classes. In Japan, however, they are still far from being common. Most of the universities in Japan are regular universities, and very few are online schools. In addition, in early 2020, COVID-19 has forced the world's educational institutions to take immediate actions in response to the emergency situation. Universities around the world had to respond in many different ways. Some of the world's most prestigious universities have responded by immediately switching to "remote learning" method. Harvard University has announced its plan to move all its classes online by spring break in March. After the University went online, Massachusetts Institute of Technology has decided to follow suit. Thus, the top universities have responded to the emergency by immediately switching to online classes. On the other hand, very few Japanese universities have introduced the same method as their American counterparts. Nearly all educational institutions have only responded by extending the break with no alternative options for education. One reason for this response is the cost. Top universities of the world may be able to use their ample funds to introduce an educational environment for remote classes to deliver to their students. Japanese educational institutions, on the other hand, cannot afford to create an environment for distance learning due to limited budget. In short, remote teaching is not yet common in Japan, no matter whether it is an emergency situation or not. The huge cost and a great deal of effort required to create the environment also make it quite challenging to implement this form of education.

Based on the above, we believe that the remote class environment most suitable for distant education in Japan is one that is highly versatile for both regular and emergency uses and that can be constructed at low cost. In other words, we believe that we need a remote class environment that allows anyone to build and deliver classes anywhere. This research investigates how such a general-purpose online classroom environment can be constructed. Here we propose a method to build, by combining mass-produced equipment and free video calling software, an environment where anyone can deliver remote classes if network is available. This method is defined as "Ready-Made Computing" in this research. This research aims at constructing, based on the

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above concept, a remote class environment that anyone can build by using common mass-produced products.

2. Adaptation of "Ready-Made Computing" for Use in The Field of Education

This study investigates a method that allows anyone to build an online class environment by combining mass-produced products. We define this method as "Ready-Made Computing". The term "Ready-Made Computing" in this study comes from the technical term ready-made used in the field of clothing and art.

Ready-made is a technical term introduced by a French artist Marcel Duchamp. Basically, it means mass-market products but now has a different meaning. Among Marcel Duchamp's works, there is a work of art called "Bicycle Wheel". He created the piece in 1913 by simply mounting a bicycle wheel onto the seat of a kitchen stool. Duchamp considered this as a form of art, and since then has created many pieces, which either modify ready-made objects or are unmodified objects which he regarded as artworks. In this way, a work completed by using or combining existing objects has come to be called an Readymade work. In light of this example, we consider the word "ready-made" means a concept that gives a new meaning or role to a combination of mass-market products. Thus, "Ready-made Computing" in this research is defined as a method by which mass-produced products are combined to build services or systems with the same level of performance as existing business services or systems.

In addition, this project studies adaptation of this method for the use in the field of education. As one of such applications, the study aims to construct a remote class environment using ready-made computing. In this study, we call the ready-made computing that caters to the field of education "ready-made computing for education". Ready-made computing for education is a method that is designed to build a service or system that supports education by combining off-the-shelf products. A prime example of this is remote class discussed in this paper.

In the past, commercial remote class system and teleconference system were essential in building a remote class environment. This is because stable communication needs to be ensured. Without securing required equipment performance and adequate communication environment, there is a risk that the online classes will result in a total failure. However, with the dramatic advancement in computer performance in recent years and the faster network speed, it has become easier to secure an adequate communication environment even with personal computers. High performance computing equipment and high-speed networks are available for anyone to purchase and use today. Therefore, we consider individuals could build an environment that achieves performance equivalent to commercial remote class systems by combining existing products and seek to create such an environment. Another benefit of the proposed system is that it can be built and operated at a very low cost compared to existing remote class systems. Commercially marketed remote class environments often use dedicated hardware and software for operation. This requires a certain amount of cost for implementation. In fact, Toyo University uses the remote class system provided by Sony Corporation to deliver online classes between campuses. This resulted in a huge cost of installing dedicated hardware for each campus. On the other hand, the remote class environment based on "ready-made computing" proposed in this research can be built with only mass-produced products available on the market. This makes its low-cost implementation possible.

3. Achievements of Ready-made Computing for Education in a Remote Class Environment

The purpose of this research is to construct a remote class environment using the idea of ready-made computing. Our attempt at building this environment has actually turned out a success. This chapter describes the equipment used in this research and operation examples of the remote class environment.

3.1 About Equipment and Software

In this research, which is based on the idea of "ready-made computing", we construct an environment that can withstand the delivery of remote classes by using only equipment available on the market. This section describes the equipment required for this environment.

3.1.1 Main Computer

The most essential component is the main computer that the teacher will use to run the class. This computer will be connected to the computer on the other campus to deliver the class. Basically, the device controls all the functions as the main computer when it shares teaching materials, connects itself to the projector or to the sound system. As of March 2020, this study uses an OS X laptop. MacBook Air or any other computers with equivalent specifications of about 100,000 yen could operate this remote class system. However, since the computer needs to be connected to all the computers on the network via video calling software, there is a risk that it might not handle the processing workload if its performance is too low.

3.1.2 Sub Computer

Another required device is a secondary computer that assists the main computer. The main computer controls the operation of remote class. Due to the restraints of the video call software, the main computer is used exclusively for sharing teaching materials. This keeps the instructor from viewing the classroom on the other campus. The lack of visibility into the responses of remote class students makes it difficult to deliver an interactive class. This is why a secondary computer is needed to capture the remote classroom. A secondary computer is used to capture the classroom so that the instructor on the other side of the system can see the students. With this device, a simultaneous and interactive remote class environment equivalent to existing systems can be built. Any device can be used as a secondary computer as long as it is capable of capturing the classroom. In this study, we use MacBook Air but sometimes use a tablet such as iPad as well. The environment is sufficiently equipped for us to provide the classroom view to the other campus without any problems. However, this is only suitable for medium- to large-sized classrooms. In small-sized rooms, the class can be captured by connecting the main computer for class operation to a webcam or a similar device for recording.

3.1.3 Video Calling Software

In this research, video calling software is used in the remote class environment to deliver a low-cost online class using existing mass-produced equipment. The two requirements for video calling software to be used for remote classes are: 1. screen sharing; and 2. no need to use any special equipment. Regarding screen sharing, the remote class environment of this research assumes the teaching materials will come in data formats like PowerPoint. Therefore, it would be difficult to deliver the class if we could not display the teaching materials in data format via a screen-sharing projector. As to the ‘no special equipment’ requirement, commercially available remote class systems used to require installation of dedicated hardware, which made construction of such environments quite costly. This study intends to create an environment that does not require any special equipment as we are aiming to build a remote class system only with equipment commonly available on the market. We currently use Google Hangouts and can deliver remote classes without any problems.

3.1.4 Voice Input and Output Device

The system requires a voice input device. Whether it is a regular class or a correspondence course, a teacher's commentary is an essential factor. Even if there are perfect class materials, they cannot work in full performance in a class without a teacher's explanation. An input device is needed to deliver the teacher’s commentary. For the remote class environment of this research, a "unidirectional" condenser microphone is used. In the past, during the pilot operation of the remote class environment, "omnidirectional" microphones for meetings were used. The reason is that teachers do not necessarily talk in front of the teacher’s desk, and we assumed that they would move around. However, the "omnidirectional" microphones picked up all the ambient noises, which lowered the sound quality of teacher’s voice as a result. To solve this problem, we introduced a new "unidirectional" condenser microphone, and the quality of voice was dramatically improved to receive students’ high evaluation. Thus, the correspondence classroom environment of this study adopts a unidirectional microphone. Regarding audio output, we used either a phone connector or HDMI connection.

3.1.5 Connection to the Projector

A connection to the projector is required to connect a classroom to another classroom in a remote location. If a correspondence class type is online class, it will not be necessary. For example, this is necessary when a single lecture is given as a remote class in classrooms located in multiple remote locations. Regarding interclassroom-type remote classes, students are present not only in the remote classrooms, but also in the class delivering side classroom. Students needs to see teaching materials projected onto a projector, as it would be difficult for them to understand class content smoothly without them. In the example of this research, the connection to the projector is made by either of VGA or HDMI. Recently, more and more laptops are equipped with USB-Type C as the standard connection format, and when using such a computer, people need a connector that conforms to the standard.
By connecting and combining such equipment, we have been able to construct a low-cost remote class environment. The environment built in the course of this research is actually being used to deliver remote classes at Toyo University.

3.2 Operation example of the remote class ″Sports and Nutrition″ at Toyo University

In this research, a remote class environment based on "ready-made computing" was constructed. We have successfully delivered a full series of remote classes for a class offered at Toyo University. This section describes an example for the construction and operation of a remote class proposed in this study.
Currently, this research project is collaborating with Toyo University to carry out the remote classes using the

proposed remote class environment. There is a class, ‘Sports and Nutrition’ in the Faculty of Food and Nutritional Sciences at Toyo University. This class is one of the classes in the program for the qualification of certified sports dietitian offered by Toyo University. Originally, this class was offered only at Itakura campusb(Gumma Prefecture) of Toyo University. However, Toyo University's program for the qualification of certified sports dietitian is also offered at the Kawagoe Campus (Saitama Prefecture). It is considerably difficult for students on the Kawagoe campus to attend the classes of ‘Sports and Nutrition’ every week on the distant Itakura campus. Therefore, using the remote class environment of this study, we conducted a remote class between two campuses of Toyo University, which was originally difficult to implement. Fig. 1 shows an example of construction of the main computer on the delivery side in the operation. Throughout this research, this construction example is the basic form of the remote class environment. Anyone can build a remote class environment by adjusting the video and audio of the video calling software.

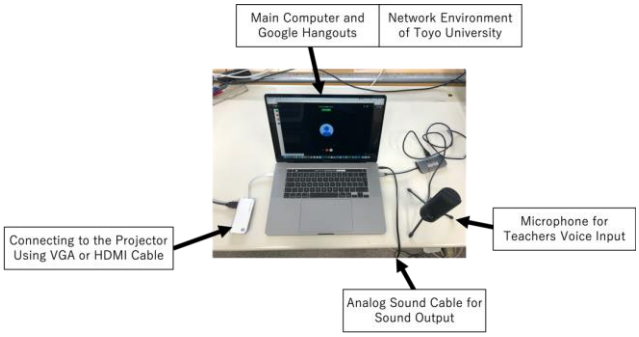

Fig. 1 Example of the construction of the main computer for ‘Sports and Nutrition’ at Toyo University

We have been running correspondence classes for two years from FY 2018 to FY 2019. We could deliver classes successfully without any major problems. At present, we believe that a remote class environment that can be called as almost completed form, has been built. The remote class environment was constructed using "Google Hangouts." It is a concern that the system depends on Google Hangouts.
As the next development, ‘to manualize’ is necessary to implement remote classes with other video calling software packages.

4. Combination and Implementation Method with Video Calling Software

The basic hardware of the proposed remote class environment is indicated in the construction example as shown in Fig. 1. On the basis of this environment construction, remote classes can be made possible through coordination with video calling software. Regarding video calling software, any package can be combined if it is free of charge and has a screen sharing function for class progress. In this chapter, we briefly describe how the alternative systems can be constructed with the representative video calling software that is available for free of charge.

4.1 Case of ‘Google Hangouts’

The first is the case of using Google Hangouts, which is actually used for the proposed system in this research. Google Hangouts is a video calling software provided by Google LLC. In the case of computers, we can use it through the Internet browser, and in the case of smartphones and tablet PCs, we can mainly use it as the application. As an Internet browser for the use of the software, Google Chrome is recommended.

4.1.1 How to share teaching materials : case of Google Hangouts

To share class materials, you can open the various settings windows in the upper right of the call screen and you will find the ‘Share Screen’ tab. When you select the ‘Share Screen’ tab, there are two choices, ‘Full Screen’ and "Application Window". If you have already started a slideshow of class materials by Powerpoint, ‘Powerpoint Slideshow’ is added to theose choices in the ‘Application Window.’ If you select ‘Powerpoint Slideshow’ and ‘share,’ you can switch your video call screen to a slideshow screen. Other class participants can switch the screen display to the class material by keeping the shared video call selected. This flow is indicated in Figure 2.

Fig. 2 Sharing teaching materials: Google Hangouts case

To adjust the voice input and output in Google Hangouts, you can operate ‘gear icon’, which means settings, in the upper right of the call screen. If you press this icon, you will be able to select a video or audio device. In the settings screen, there are ‘Video’ for output, ‘Microphone’ for audio input, and ‘Speaker’ for audio output. If the

external cameras and microphones are properly connected, the output and input devices can be selectable. Regarding Google Hangouts, it is not possible to adjust the volume from the application or browser. If you want to adjust the volume with the system proposed in this study, it is necessary to adjust the volume from the system preferences of the MacBook Pro.

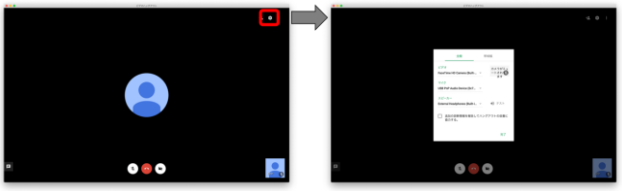

Fig. 3 How to adjust the audio input and output: Google Hangouts case

4.2 Case of 'Skype'

Skype is one of the world's most famous video calling software from Microsoft. Skype can be used by anyone with any device for free by downloading the application. In recent years, 'Skype online', which allows users to use Skype through a web browser, has also appeared, and it is widely used around the world. Although there is a paid version of this application, it is basically free of charge and is compatible with the "Read-Made Computing" proposed in this study, and it can also be used for delivering remote classes.

4.2.1 How to share teaching materials: case of Skype

Regarding Skype, as a method of sharing teaching materials in a remote class, the screen sharing function of video calls is also used in the same way as other video calling software. To share your screen in Skype, there is a Share Screen button at the bottom right of the screen during a video call. When you select this button, a window select screen to share will appear. If you select "Share Screen" in the upper center of the screen, you will see the choice: 'Share Application Window'. When 'Share Application Window' is selected, you'll see a slideshow window, you can select this and start sharing. This flow diagram is shown in Figure 4.

Fig. 4 Sharing teaching materials: Skype case

4.2.2 Adjusting Audio Input and Audio Output: case of Skype

To set up voice input and output, select the "..." next to your own name on the standby screen of Skype, and when you choose the 'Settings' tab, the screen will change to the Settings screen. By selecting the 'Audio/Video' tab in the settings, you can set the input video, microphone, and speakers. Out of them, microphones and speakers are initially set as the default devices. By clicking on microphones and speakers, the list of currently connected devices will pop up. Each device of the proposed system can be determined by selecting the microphone to be connected and the audio output for classroom delivery. At the same time, you can also adjust the microphone input volume and speaker volume on the application. This flow diagram is shown in Figure 5.

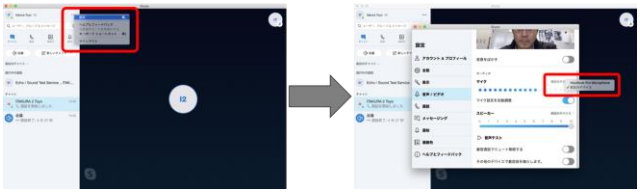

Fig. 5 How to adjust the audio input and output: Skype case

4.3 Discord

One free video calling software that has been rapidly gaining market share in recent years is "Discord". Discord is a voice chat tool that was originally developed for the combination use with computer games. Regarding the features of this software, it is very lightweight and has various functions such as an overlay function for distributing computer games reflecting the original purpose. Due to its high functionality, it is now widely

used not only just for a computer game but also as a communication tool among users. People can use Discord through web browsers, or as of application version. It also has a video call function. Besides, it has a screen sharing function, which is one of the conditions to be available for the proposed remote class environment. It also does not require any extra equipment. Therefore, the software can be adapted to the “Ready-Made Computing” remote class environment.

4.3.1 How to share teaching materials: case of Discord

A video call’s ‘screen sharing’ should be turned on as a way to share teaching materials. In advance, you can create a group with an account in charge of the campus that you're connecting to, in Discord for smoother connection. When you start a video call with the account, there appears a ‘Share’ button in the pop-up window at the bottom of the screen. When you select this, you have the choice of ‘Your Entire Screen’ and ‘Application Window’, just like Google Hangouts. If you have already started a slide show of your teaching materials, the ‘PowerPoint Slide Show’ will appear upon the "Application Window". When you select this to start screen sharing, the sharing of the slideshow will start and the class material will be delivered to the receiver side classrooms. This flow diagram is shown in Figure 6.

Fig. 6 Sharing teaching materials: Discord case

4.3.2 Adjusting Audio Input and Audio Output: case of Discord

The audio input and audio output can be set on the application. You can see your name and ID in the bottom left of the Discord screen, and there are three buttons of ‘Mute’, ‘Speaker Mute’, and ‘User Settings.’ If you select ‘User Settings’, you will move to the screen where you can set various functions. Upon the app settings, select the ‘Audio and Video’ settings. Under this settings screen, you can set ‘Input device’ and ‘Output device’ as audio settings. The "input audio" and "output audio" can be also freely set here. This setting method is shown in Figure 7.

Fig. 5 How to adjust the audio input and output: Discord case

5. Conclusion and Future Work

In this research, we are studying a new concept called “Ready-Made Computing”. As the first step of "Ready-Made Computing for Education", which can be developed in the field of education, we are researching a system that allows anyone to build a remote class environment by using only mass-produced products that is generally available to everyone, specifically, by combining free video calling software and university network environments. The current status of our research is that we have succeeded in constructing a remote class system with which anyone can operate remote classes anywhere in a network environment. Our study adopts Google Hangouts to provide remote classes, but it is undeniable that some parts of the system depend on Google Hangouts. As a further development, it is necessary to establish a construction method that supports not only the video calling software described in this paper but also other various video calling software that is available for remote classes。 Creating ‘Manual’ of the method is also the future task. In addition to the sharing of class materials and the input/output volume control described in this paper, we plan to create a complete manual that includes detailed settings and content that can solve anticipated problems and troubles.

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