# Educational Significance of On-Demand Net-Class and Development of the content

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# ABSTRACT

Recently, infrastructure preparations for the Internet have rapidly developed in Japan. An educational method utilizing IT (information technology) may realize the future model of the educational environment. In this report the development of prototype content was conducted in order to examine the possibility of actualizing a networked class in a university lecture. Though this content assumes the use of a broadband line in schools such as a LAN, CATV or ADSL, the aim of the development is also on a standard level that would enable anyone anywhere in Japan to receive a message of moving images, even when using slower ISDN or PHS lines. Even if the class is not in a physical classroom, a class with bi-directional type capability can be realized through the use of tools such as E-mail and electronic bulletin boards. This networked class will help realize a lecture configuration that should satisfy both installation criteria and university scholastic evaluation methods revised in March 2001.

# **1. INTRODUCTION**

The prioritized plan of e-Japan, which was presented in January of 2001, outlined a strategy to make Japan the "foremost IT nation in the world within 5 years." Regarding the "promotion of education and learning while developing talented people," the plan set forth a set of basic criteria, including "students voluntarily and creatively learning by taking advantage of in-class Internet availability" and "producing contents in Japan with worldwide popularity and distributing them via the Internet."[1]

Some national universities issued the jointly produced "Where Universities Should Be at the Beginning of the 21st Century" (report), stating, "Each student should receive an E-mail address to enable two-way guidance through computers," and that universities should "Actively introduce two-way remote lectures as part of the school's educational plan, so that students can audit lectures at different universities around the country."[2]

By introducing Internet classes, it is felt that the current uniform classes can be

turned into ones responding to individual ability [3]. Instructors who support Internet classes can be educational assistants who belong to NPOs outside the school. Burden on instructors may be the same, but even so, he/she can hold problem solving type classes with a small group of students [4][5][6].

There is the University of the Air, which offers a curriculum comprised of video lectures, similar to net-classes. The University of the Air is a one-way lecture, distributing programs through television, therefore lessening the sender's burden, as many people can be lectured to simultaneously. There is a system to rent out video lectures, but there are only a limited amount of available videotapes.

On the other hand, through the Internet, students can repeatedly take a net-class at any time within a designated period, wherever they are. Additionally, they can send questions and reports, as well as take tests through the net. It is more advantageous, since the record of lecture deliveries and student evaluation can be managed on the Web [7][8][9].

So, the authors began this study in order to investigate what place net-classes have in future education, and if such an educational environment will be satisfactory. In this report, we've made a simple analysis of traditional lectures and net-classes. Then, we tried to create and distribute contents to see if we could conduct a higher education net-class with existing technology.

# 2. NET-CLASSES

Net-classes have many advantages, including the fact that individuals can study at their own convenience and repeatedly study certain parts if necessary (See Table 1). For example, each student can choose subjects and how much of that subject they wish to study, depending on his/her ability. By doing so, they can easily skip grades and change their courses after entering school. Gaps between different areas will disappear and students will be able to take in lectures of universities from overseas countries. By using high standard Web space (hyper space), a high standard education, based on the act of "thinking," can be offered. Additionally, these images can explain experiments that are dangerous and/or need a large-scale facility. Regarding the technology field, students can learn about actual operation conducted at corporations through images, as well as talk to people at the site in a real time manner. There are many instructive aspects, including the introduction of new workers into society, and as the country continues to gray, the support of elderly people's life-long study efforts.

Conversely, there are technical issues concerning the formation of Internet lectures. For example, how can you maintain the interactive characteristics of the original lecture, how do you keep actual attendance, how is the students' work evaluated and how do you handle questions and reports coming from students at each lecture? There are many issues to solve, in particular with a VOD (video on demand) class, with its lack of student tension in a classroom setting, possibly resulting in the absence of educational effect, and if educators can develop educationally effective, low-cost materials.

## 3. TRADITIONAL LECTURES AND NET-CLASSES

Let's call traditional lectures "live-classes." Lectures without experiments or training are generally separated into mass production classes, small group classes and seminars. The advantages and disadvantages of live and net-classes are shown in **Table 1**.

Net-class can be largely divided into 4 categories. Live Remote Class I offers face-to-face lectures similar to SCS form. Live Remote Class II is a person-to-person lecture with an image of the instructor shown through the individual client. WBT is automatically graded in practice style, so that the student can obtain his/her grade in short

	Type (Number of students)	Form	Advantages	Disadvantages
Live-Class	Mass class (more than 50 students)	T - IgH	More students can learn with fewer instructors.	Class tends to become standardized. Educational effect decreases. Less opportunity to ask questions.
	Small Class (less than 50 students)	T - sgH	Offering education in an ordinary manner	Lack of teachers to cover every subject and course.
	Seminar (less than 20 students)	T - seH	Educational effect is large. Education suiting each student's capability can be offered.	Cannot secure teachers to cover every subject and course.
Net-Class	Distance-Class I (SCS) (Internet) (less than 20 students per site)	T-M - M-sgH	Students can take classes of instructors at remote and overseas sites. Question and answer sessions are possible, just as in live-classes with same atmosphere.	Because it requires large-scale facilities, it is difficult to enforce. Time and place for instructors and students are limited. The more students, the less learning effect.
	Distance-Class II (Man-to-Man) (less than 10 students total)	T-C - se(C-H)	Place to take the class is not limited. Students can meet instructors in remote and overseas places. Man-to-man system allows more opportunity for Q&A in direct conversation.	Hours for taking lectures are limited. Requires CCD camera and PC with microphone. When several students take a class at one time, it is necessary to have a meeting point.
	WBT (Almost No Limit)	S - mg(C-H)	No restriction on time and place. Students can proceed with their study in a manner meeting individual ability.	Students cannot ask questions immediately. Main issue is to solve seminar questions, so students may not maintain their interest for long. Painful for those with less learning ability.
	On-Demand Type Net-Class ( Almost No Limit )	S - mg(C-H)	Since there is no limit on time and place, one can take the class anywhere. Students can learn at a speed suitable to their own learning ability. Sophisticated and easy to understand classes.	Questions are not answered immediately. No live feeling or tension for students. No feeling of closeness to instructors.

Table 1 Classification of net-class

T: Teacher (Professor), H: Human (Student), M: Machine, C: Client, S: Server Ig: large group, sg: small group, se: seminar order. The On Demand Type Net-Class provides a presentation function that displays text, figures and tables on VOD, as well as a questioning function. As net-classes are developed in the future, we think they will be totally integrated, not only differentiated for specific lectures, but co-existing with traditional live lectures, as shown in **Figure 1**.

**Figure 2** is a forecast of the effects of live-classes and net-classes. The horizontal axis shows the number of students and the vertical axis shows the degree of understanding (study effect). In the case of live-classes, as the number of students increase per instructor, the average degree of understanding falls. In the case of a live-class held from a remote place, though it depends on whether or not supporting teachers attend, we generally consider the degree of understanding to be lower compared to live-classes, while maintaining the degree of drop as the number of students increase.

However, in the case of on-demand type net-classes, there is no limit to the number of students. The average degree of understanding won't change if some third person or persons help the instructor(s) grade reports and tests. The same can be said of WBT.

The problem is how to make an ideal educational content experience in this setting, just how much of this ideal concept can be created with current technology and what kind of new technological developments are required to do so. It is crucial that one considers the content, quality, labor, time and cost of a lecture in a comprehensive manner, then construct and distribute effective, low-priced educational contents.

# 4. NET-CLASSES CONDUCTED AT OTHER UNIVERSITIES

The following shows the class forms of net-classes conducted by other universities, which are introduced on their Websites.

### (Example 1) Stanford University [10]

Class Form: Students of facilitated on-demand classes use the Internet to access their learning materials and ask questions through E-mail. These courses cannot earn



Fig. 1 Defining of net-class



Fig. 2 Type of class and understanding

Stanford University credits, but are recognized as life-long education credits by social units.

### (Example 2) Department of Economics, Doshisha University [11]

There are no classroom lectures. Questions and answers are made through E-mail and an electronic bulletin board. Students from anywhere in the world can take classes and earn credits. One lecture subject is comprised of two to four blocks in 20 to 50 minute units. (One lesson is sent out in a total 60 to 90 minutes) The maximum number of lessons is 12. Contents are replaced weekly. After the possible lecture-viewing period, the same contents are not sent out again.

### (Example 3) Waseda University [12]

Anyone, anywhere in Japan can audit classes and earn credits. One lecture is comprised of 15 to 30 sessions (20 min/session). Students can repeatedly audit their registered lecture at any time. There are no classroom lectures. Auditing lectures, questions and answers, and report submissions are all conducted via the Internet.

# 5. PRODUCTION OF EDUCATIONAL CONTENTS

To produce the contents for on-demand type net-classes, it is necessary to author the



Fig. 3 Wiring diagram for recording and distributing lecture

entire course, by organizing lecture contents, producing them, recording the lecture on DV, capturing, editing and rendering it. Additionally, it is necessary to construct and manage servers for streaming in order to distribute net-classes [13][14][15].

### 5.1 Distance Class Experiment

The authors carried out the following net-class experiment. To conduct a trial of contents for an on-demand net-class, 10 lectures of about 20 minutes (hereafter, "mini lectures") and an approximately 90 minute IT Education Symposium (hereafter "90 min. class") were held. Images of instructors and the site were recorded on DV tape. At the same time, 7 facilities (sites) in and out of the school were connected in a real-time manner, trying to distribute mini lectures and scenes from the IT Education Symposium through CU-See Me and Meeting Point. The slides for presentation shown by PowerPoint were linked by application software (RPT) from the lecture site. By linking the 7 sites interactively and distributing lectures, the system allowed students to ask questions from any site.

**Figure 3** shows the wiring diagram for recording and distributing the lectures. **Figure 4** shows a scene from the IT Education Symposium. The screen on the right shows the presentation of the lecture, while the one on the left shows pictures of the instructor and images sent from each site. **Figure 5** shows the screen displaying the instructor (upper right) and 4 other sites. The image on the upper left is the Power Generating Plant that generates electric power using temperature gap, located in Imari, which is the 7th lecture site. The image from Imari through the ISDN circuit was approximately 3 to 5 fps, which made it seem that the screen was changing piece by piece. However, the images created through the experimental facility were far more effective than the verbal explanations.



**Table 2** shows the speed of communication on the Internet used at the school. Although the images were somehow viewable at the other sites, the audio was not stable.

Fig. 4 DV recording and distributing of IT education symposium



Fig. 5 Screen showing an instructor and scenes from other sites at main hall

Site	Type and speed of communication circuit
1. Lecture site (main site) 4 locations in the school	Domestic LAN , 100 Mbps
2. Site No. 6	Partly wireless LAN , 10 Mbps
3. University - No. 7 (Imari)	ISDN 64 kbps

Table 2. Communication speed on Internet circuits

Even if one could hear, there was so much noise with it that it made listening difficult. Therefore, it was not capable of being used regularly.

Though the system known as Remote Television Conferencing, which distributes distance classes in real time, has been tried for more than a decade with CU-See Me and Net Meeting, its level has not reached the point where it is being regularly used for class teaching. The reasons are unstable long-term image and audio duration, picture quality so poor that students cannot read letters on the blackboard, and the difficult equipment preparations needed before class. Additionally, because television conferencing systems are two-way communication, the Internet has to deal with the issue of firewalls set for security. Therefore, usage is limited within the Intranet, which has caused development to lag. Kondo et al. conducted a distance class with highly precise images created by a high-level infrastructure, such as a giga-bit circuit and IPV6, proving that these can be used for lectures<sup>16).</sup> This method requires solving infrastructure issues, such as the need for a global circuit, so more time will be needed before it can be applied for regular lectures.

### 5.2 Producing Contents for On-Demand Net-Classes

We can expect high educational effect from on-demand type net-classes if one can distribute an image recorded on DV, because of the high-grade resolution. However, the current Internet circuit makes this almost impossible, so it has to be distributed after being compressed into MPEG1. MPEG1 is generally used when distributing moving pictures (VOD) of chemistry class experiments and equipment set-ups that involve chemical reactions. Even if we use the domestic LAN, it is too heavy to distribute 100 Mbps of moving pictures with MPEG1.

While developing class contents, the authors used broadband circuits (LAN, CATV, ADSL, etc.) as the standard, but our goal was to develop contents for creating lectures that could be audited through both 64 kbps ISDN and 32 kbps PHS circuits. To allow these lectures to be audited at any place, yet not limited to broadband circuits, it is necessary to reduce the load of instructor images. Seeing the instructor is important when listening to a lecture, but as long as the audio portion is clear, students can understand the content from presentation materials (information described by text, figures, tables, graphs, photographs, etc.), even if the picture quality is a little inferior. With this as the concept, we developed class contents. **Table 3** shows the necessary conditions for developing educational contents.

In the above-mentioned mini-lecture, we used a DV tape (A), which recorded the instructor from the front, and a DV tape (B), which recorded the audience from the front with premier equipment manufactured by Adobi Co. Then, we made a rendering from the

#### Table 3. Necessary conditions for net-class contents

- 1. Clear audio. Easy to listen to.
- 2. Information wanted delivered: text, tables, figures, graphs, pictures, etc.
- 3. Moving image of the instructor
- 4. Interaction between the instructor and students
- 5. Possible to take class without being a late-model highperformance client
- 6. Elimination of local differences. Can be audited at any place

File	24 Min. DV	90min. DV	Compression rate
Movie (AVI)	5.2 GB	18.3 GB	1
MPEG1	239 MB	880 MB	1/21
Streaming (MOV)	9.5 MB	34.5 MB	1/530

movie file (AVI) that edited the instructor and the lecture scene into MPEG1. The MPEG1 image was then rendered into a streaming file (MOV, compressed form: Sore nson Video). **Table 4** shows the size of the files at each stage and the rate of compression. The screen size of an MPEG1 file is 352 x 246 pixels, the frame rate is 30 fps, the average data rate is 170 kB, and the audio is 44 kHz-16 bit-stereo. The streaming file is 192 x 157 pixels, 7.5 fps, 6.5 kB, and 11 kHz-16 bit-monaural, respectively.

**Figure 6** shows the screen composition for the net-class created by this study. The system sets the upper right picture of the instructor as the time axis, and switches the presentation in the left frame (text, figures, graphs, pictures, etc.) in order.

When students have questions during the lecture, they write them in the lower frame, so they can be automatically transferred to the contents manager (instructor). All auditors on BBS can view questions, answers, and advice. Subjects for reports on each lecture are posted on a separate page after the lecture is finished. With this, the simple Q&A session, report submission and correction, and perfect interactive character can be retained. (Since this on-demand type of net-class realizes an interactive character, it apparently has a different function and education environment than WBT, which allows students to study by themselves with exercise questions, and VOD, the purpose of which is to deliver pictures of experiments, etc. Therefore, we suggest calling it WBL, Web Based Lecture)

#### **5.3 Distribution Server**

Even if an exclusive use server for streaming is installed, only a limited amount of people can access at one time. When we put a 90-minute lecture in one folder, the size of the





folder is approximately 35 MB. Therefore, if we transfer it to the server of another university and/or a local server, students can easily audit the net-class at any university. Additionally, if the text is changed into English, and the instructor's voice is dubbed over in that language, it can be used at English speaking universities in other countries.

# 6. TRIAL RESULTS

# 6.1 Activity of Website Contents

To confirm the activity of the developed contents, the writers established a server for an experimental net-class site (ordinary PC with 1 GHz, 256 MB, 40 G, OS: LINUX) in our seminar room at the university. We then investigated the time until the image appeared, as well as the image and sound quality, using various Internet circuits (domestic LAN, wireless LAN, CATV, ISDN, PHS circuits) and clients. **Table 5** shows the results of this checking activity on the longest lecture of 90 minutes.

The time between pushing the Start Button and the appearance of the image differed, more or less, depending on the condition of current Internet circuit usage. On a domestic line, it took approximately 10 seconds. The local CATV circuit started the lecture within 30 seconds. Streaming finished in about 20 minutes. When cache memory was used, after downloading on the first visit, lectures started within several seconds afterwards. When a PHS circuit was used, the lecture started after about 3 minutes.

# 6.2 Usage Probabilities for the Developed Contents

To investigate the possibilities of using the on-demand type contents developed for this study for future net-classes, we conducted a survey of 20 instructors and students. **Figure 7** shows the survey results. We asked them to rate 7 items: (a) the operatability of the lecture image, (b) the image itself, (c) the audio, (d) presentation, (e) the rate of understanding, (f) satisfaction rate, and (g) the general possibilities of use as a net-class. There were 5 possible answers. (1: very bad, 2: bad, 3: normal, 4: good, 5: very good) All items received an evaluation of either "normal" or "good", which leads us to expect that the trial we developed at this time is generally hopeful as a net-class. Even if the client each person used was a one generation old system (CPU: 200 MHz, RAM: 64 MB), and/or

Type of Internet circuit	Time until start	Streaming time
Domestic LAN	5-10 sec.	Approx. 20 sec.
Domestic wireless LAN	5-20 sec.	Approx. 2 min.
Local CATV	Approx. 25 sec.	Approx. 20 min.
ISDN (Arita)	Approx. 2 min.	-
PHS	Approx. 3 min.	-

Table 5. Type of the Internet circuits and activity condition (for 90 minute lecture)

whether or not the communication circuit was ISDN or a normal telephone line, the survey confirmed that the lecture was audible. However, there were opinions that in some areas, audio had problems to the point that the lecture was hard to listen to.



Fig. 7 Survey results

# 7. CONCLUSIONS

This study analyzed traditional live-classes and various net-classes while developing an on-demand type net-class. Not only limited to broadband, we could develop contents for a 90-minute class that could be listened to even through ISDN and PHS circuits.

At the beginning of this trial, we did not have any prior arrangements with content creators or instructors, and the lectures were freely conducted. We conducted authoring of the class contents to adapt them for an on-demand net-class. Regarding image creation, we had several matters to reevaluate, including the fact that when an instructor moves a lot, the image often distorts, that it is difficult to edit when a speaker does not pause, and the importance of shooting angles.

We think editing will be less troublesome and quality more satisfactory if instructors and content creators sufficiently discuss the contents of their lectures and preplan the class before recording it on DV so it is easier for students to understand.

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