Development of an e-Learning environment across all departments and a model class

DEVELOPMENT OF AN E-LEARNING ENVIRONMENT ACROSS ALL DEPARTMENTS AND A MODEL CLASS

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ABSTRACT

In 2006, Kanazawa University (KU) adopted a policy that made it mandatory for all freshmen to have a laptop PC, and started a new class called *Introduction to Information Technology* as a compulsory first-year subject. We designed this class as a model for developing an e-Learning environment across all departments. We realized that educational systems and support environments are important for the success of e-Learning, so we added portal functions with the cooperation of the company which developed the LMS for us. In addition, we set up a wireless LAN infrastructure, and upgraded some lecture rooms for the *Introduction to Information Processing* courses. We started up a support room to assist teachers in developing their teaching materials, and opened a PC support room for students in the university hall, near the hub of student activity. In this paper, we will show the outline of the educational system, and report the largely positive student evaluations of the *Introduction to Information Technology* course and the educational system during its first two years. The number of classes that use the educational system tripled in 2007.

KEY WORDS
educational system, e-Learning environment, LMS, MODEL CLASS

1. Introduction

In recent years, both foreign and domestic institutions of higher education have started to reorganize their educational systems by introducing ICT technology[1]. Some trials using various aspects of e-Learning have been started in Japanese universities, but there have been very few of these trials that involved the entire school. At Kanazawa University (KU), we adopted a policy that made it mandatory for students to have their own laptop PC's beginning in 2006. We also introduced the *Introduction to Information Technology* class as a required subject in which the students use their PC's as part of the coursework[2]. We saw this class as a model class from which the development of an e-Learning environment across all departments would proceed.

In a previous survey we found ten conditions that are necessary for the introduction of an e-Learning environment to succeed[3]: these conditions include significant experience in education before the introduction of e-Learning, a user friendly interface, an appropriate learning form, innovativeness and appropriate infrastructures. We considered each of these conditions carefully before we began developing an educational system centered around e-Learning.

J. M. Rosenberg described 11 benefits of e-Learning in his book, *E learning Strategies for Delivering Knowledge in the Digital Age*[4]. Blended e-Learning is the most suitable strategy for developing an e-Learning environment across all departments, so we decided to use it as the basis for the development of our program.

We realized that educational systems and support environments are important for the success of e-Learning, so we added portal functions with the cooperation of the company which developed the LMS for us, set up a wireless LAN infrastructure, and opened some lecture rooms for the *Introduction to Information Technology* courses. In addition, we started up a support room to assist teachers in developing their teaching materials, and opened a PC support room in the university hall which is near the hub of student activity.

In one of our questionnaires in 2007, more than 80% of the students who responded a good evaluation of the *Introduction to Information Technology* class which used the new educational system. In 2007 the number of classes that use the educational system increased three times as compared with the previous year.

2. Construction of the educational system

Educational systems and support environments are important for the success of e-Learning.

At our university, almost 12,460 students and 2,190 staff are registered and almost 7,000 subjects are offered every year. We constructed the educational system to be able to support these conditions. We used WebClass (http://www.webclass.jp/) as the common LMS, which is simple to use and has an excellent cost performance. We implemented a policy of making PC's mandatory as a tool to make IT for education possible for all students. For safe and easy network use, we set up Wireless LAN access points in the main lecture rooms of the university and rebuilt the firewalls for the educational network. We started up a curriculum development support room for teachers, and a PC support room in the university hall. In addition, we started up the ICT education promotion room as a support organization for the entire university.

2.1 Mandatory PC Policy
At our university, we began to require our students to have a laptop PC in fiscal year 2006, and to use it for classes. Before the mandatory PC policy was

implemented, students used the PC's in the Information Media Center for doing work related to information processing classes. The computers in the Information Media Center were acquired from a rental company with a rental term of five years. Therefore, by the fifth year the computers were technologically far behind. Therefore we decided which PC's to recommend the students to buy for use in future classes that involved e-Learning.

There are now a total of 2,640 first and second year students who have their own PC. Table 1 shows the ratios according to the types of PCs in 2006 and 2007. The increase in the B5 type, which is very light, can be attributed to the fact that our campus is very hilly.

Table 1: Changes in the numbers of each type of PC

	2006		2007	
	number	rate	number	rate
B5 type	1,384	75.2%	1,496	83.4%
A4 type	23	1.3%	20	1.1%
Other PC	433	23.5%	277	15.4%

2.2 Maintenance of a firewall for the educational network

In order to prevent our students from becoming victims of Internet trouble or assailants, we began education on information ethics and network security. We also rebuilt the firewall so that students and faculty could use e-Learning environments safely.
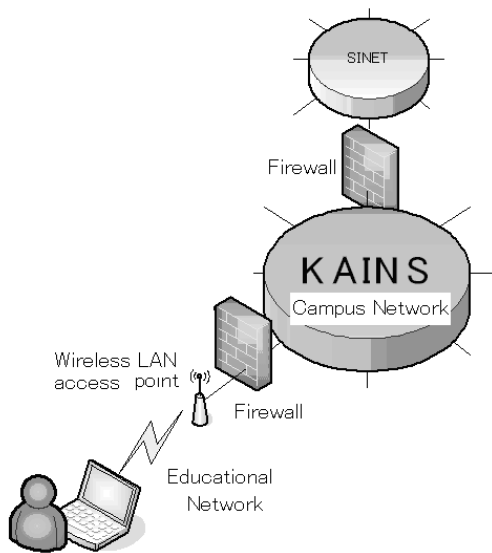

Fig.1:   Firewall for the educational network.

2.3 Construction of wireless LAN access points

To construct an environment in which students can review educational materials as many times as they wish by using LMS, wireless LAN access points were set up in 59 main lecture rooms and 66 other places, such as libraries and lobbies, in 2007.
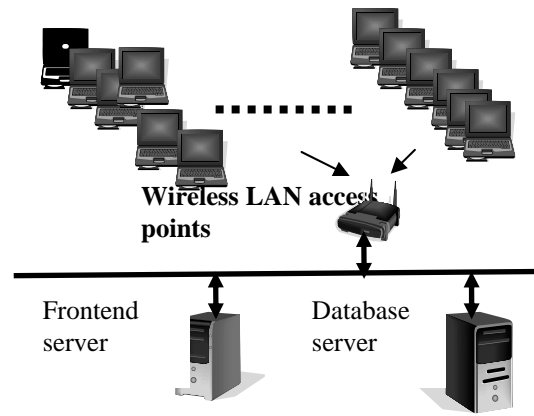

Fig.2: LMS and the wireless LAN system.

We predicted that all students would use the wireless LAN, so the easiest possible user authentication method was preferable. Therefore, we adopted IEEE 802.1x EAP-PEAP [5].

A performance test was conducted by 100 users in 2005, and the results showed a transmission speed of about 3.5Mbps[5]. However, in a questionnaire during the first year, the students indicated that the speed of the wireless LAN was slow. Then we checked the network, and found a problem with the HUBs in two lecture rooms in April, 2007. We replaced poorly performing HUBs, and examined the system again in a similar way. We measured the effective transmission speed between lecture rooms and an LMS while we lectured simultaneously in two lecture rooms. As a result of the examination, we obtained a performance of 10Mbps on average while teaching, and we confirmed the effect of the network check.   Table 2 shows the mean values of five tests.

Table2:   Performance test results of the wireless LAN(in class)

	Lecture room	Average speed (Mbps)
Cable LAN	C10	86.1
	F10	85.3
Wireless LAN	C10	10.5
	F10	10.7

2.4 Rebuilding of lecture rooms for *Introduction to Information Technology*

We set up two lecture rooms: C10 (which accommodates 154 students) and F10 (which accommodates 105 students). We introduced power supplies for PCs, LAN and wireless LAN in each lecture room, and connected the two lecture rooms with a TV conferencing system. As a result, we can educate all of the students of one department at once with one teacher plus TAs (with a ratio of one TA/25 students).

Fig.3: Class scene in a rebuilt lecture room.

2.5 Construction of an LMS server system

The server system consists of a front end server and a database server, as shown in Figure 2, and each server has a backup server that takes over in case of trouble. Table 3 shows the server specifications as evidence of the cost performance. The price for one of the servers that suited the basic specifications shown in Table 3 is about US$8,500 (The price includes the cost of the uninterruptible power supply). RAID5 is composed of three hard disk drives for the protection of information.

Table 3: Basic server specifications

Fujitsu Computer Systems Corporation PRIMERGY RX300 S3	Chip Set	Intel 5000P
	Processors	Intel Dual Care Xeon Processor 5160
	Frequency	3GHz
	Front-Side-Bus	1333MHz
	Second-Level-Cache	4MB
	Main Memory	2GB
	Hard Disk Ultra 320 SCSI	300GBx3(RAID5)
	LAN	2x10/100/1000 Mbit/s Ethernet
	Graphics Expansion Module	1xVGA

In the *Introduction to Information Technology* class in 2006, 250 students were able to use the LMS without any serious trouble. Figure 4 shows, over time, the number of computers accessing the teaching materials during a 90 minute class period on April 11, 2006. We confirmed that the system is able to support 250 or more students accessing the teaching materials during a two minute time period.
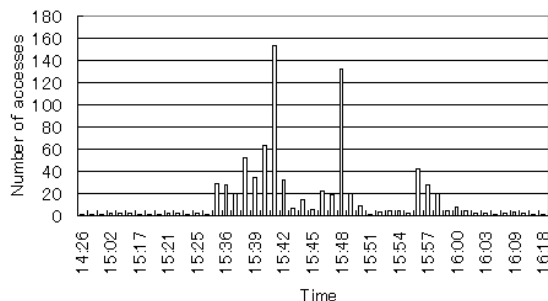

Fig. 4: Change in the number of computers accessing the teaching materials.

With the expansion of the e-Learning program we rebuilt the LMS system with three frontend servers, a database server and a backup server, and began to use it in August, 2007. The system does simple load balancing by using the DNS round-robin function. Based on previous experience with constructing servers, the company which developed the LMS for us estimated that the load of the database server should not exceed 0.6 times the load of the front end server. We expect to begin using the LMS simultaneously in three lecture rooms (with a total capacity of 400 students) in April, 2008 will test the performance at that time.

In general, the license cost of a marketed LMS (eg: WebCT, Blackboard, etc.) is not made public, so the cost of the server operation in 2007 is shown (including license and maintenance cost) for judging the cost performance. In the case of our university, the estimated cost(total of the license and the maintenance cost) for Blackbord Learning System were estimated to be much higher than the following amounts of money.

[Server License fee(Unrestricted)]	US$8340
[Support fee(Four servers)]	US$6250
[VeriSign certificate (Three)]	US$2025
[Backup server license fee (One)]	US$1670
[Backup server support fee (One)]	US$340
Total	US$18625

2.6 Establishment of teacher and student support environments

We opened a PC support room in the university hall, near the hub of student activity. We offer support for questions that relate to the use of the LMS with laptop PC's. The PC support room was used by about 25% of the second year students (403 people) according to a questionnaire (of 1,679 people) in 2007. Moreover, we constructed the ICT teaching material development support room as an organization that supported the teachers. Therefore, teachers are able to make ICT teaching materials from lecture memos.

Because many teachers do not have the time and technology to produce ICT materials on their own, we employed four engineers who have the knowledge of ICT technology necessary for making the teaching materials, and they support the teachers. Moreover, we created a system in which a team of graduate students make teaching materials by the teacher's instructions as a part time job.

3. Design of a model class: *Introduction to Information Technology*

The *Introduction to Information Technology* course will be worth 2 units of credit and will meet 15 times. There will be three main areas of content: 1) information ethics and network security, 2) information retrieval and 3) Internet Technology (IT) literacy. This will be a required class taught during the first semester.
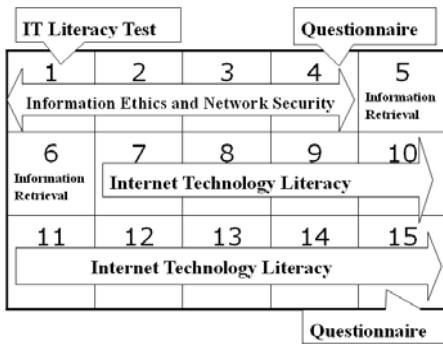
Fig.5:   Contents of the class.

In the first class meeting, the students are taught how to connect the wireless LAN to their PC's and how to use the LMS. In this way they become acclimated to the e-Learning environment. They also take an IT literacy test that allows us to determine their level. They fill out some questionnaires for practice as well. In the next three lectures, the students are taught about the basics of information ethics and network security so they will be better equipped to protect themselves against fraud, identity theft and other online schemes. Classes 5 & 6 are taught by library staff members, who teach information retrieval. This involves the technology that's used to collect information through different networks (the LAN and the internet.)

For the remaining nine classes IT literacy is taught using original teaching materials that have been developed by the faculty. When there are no original teaching materials, the faculty uses a standard text made by the Editing committee. Classes at KU last 90 minutes. For the first 20 minutes a lecture is given using animated teaching materials. The students then study the materials on the LMS for the next 50 minutes or so. This is to reinforce and deepen their understanding of the material. The students are then given an exam to check their understanding in the remaining 20 minutes. Other e-Learning materials have been designed using this same pattern. Since *Introduction to Information Technology* is a required subject for all freshmen, there will be a lot of variance in the IT literacy levels of the students. Therefore many figures and pictures were used in the e-Learning teaching materials in consideration of these students' different levels.
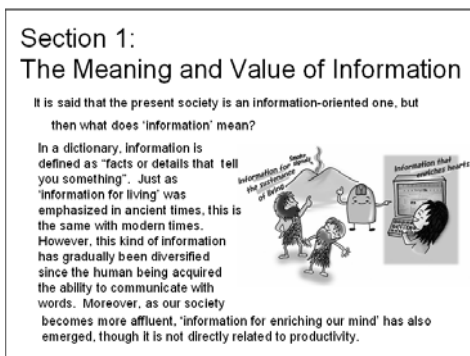

Fig. 6:   Sample of the educational material.

Offering these learning materials through the LMS enables the students to review a class over and over again. The reason for using animation software to create teaching materials is uniformity – to make the content of the lecture the same for every class. This also reduces the teachers' load. Students from the Broadcasting Club dub narration into the animated teaching materials. We designed it this way as a kind of 'multi media presentation' offering not only visual learning but also auditory learning. We found that students had a hard time maintaining concentration when the animated teaching materials are simply played at length. Therefore, we chose a more interactive type of animated teaching material where the teacher could stop not only within a chapter, but within a paragraph as well. We felt that this would best hold the students' concentration and the teacher could provide supplemental information when necessary. Moreover, we made multilingual teaching materials (English, Chinese, and Korean) for international students.

4. Evaluation from questionnaire responses

We performed an evaluation of the educational system and the *Introduction to Information Technology* class by using LMS questionnaires, which were completed during the fourth and 15th sessions of the *Introduction of Information Technology* class in 2006 and 2007. In 2006, 1,679 people responded in the fourth class, and 745 responded in the 15th class. In 2007, the number of people responding was 1,779 and 1,584 respectively.

Figure 7 shows the changes in responses to the question, "Were the explanations with the video teaching materials easy to understand?". Our students gave high evaluations of the video teaching materials, and the results improved over time. In 2007, the sum of "very comprehensible" and "comprehensible" was 84.5%, while the sum of "not easy" and "difficult" was only 7.4%. We think that this is an effect of the improvement of the teaching materials.
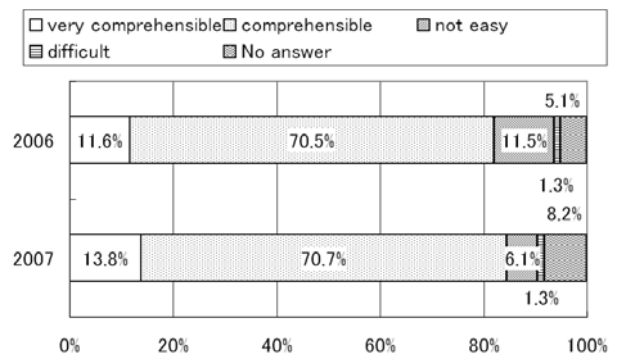

Fig.7: Comprehensibility of the video teaching materials.

In the questionnaire that asked about the experience of e-Learning, only 6% (2006) and 10% (2007) of the students had any previous experience.

Figure 8 shows the results of a questionnaire given in the 15th class. This shows the responses to the question, "The class *Introduction to Information Technology* used the LMS, but how were the teaching methods?". Figure 8 shows that while the sum of "very good" and "good" was 73%, the sum of "not good" and "bad" was only 16.7% in 2006, and it was improved to 86.8% and 10.5% in 2007. The students gave an overwhelmingly good evaluation of this course. Although most students hadn't had any experience with e-Learning, they gave a good evaluation of this class because of its format.
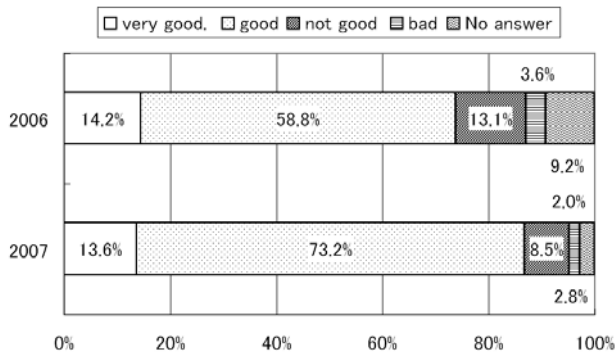

Fig.8: Evaluation of the educational format.

Figure 9 shows the answers to the question, "Was the LMS easy to use?". The sum of "very easy" and "easy" did not change significantly, but the sum of "not easy" and "bad" was decreased by 3% compared with the previous year. In an evaluation of the ease of use of the system, over 70% of the students gave a positive response.
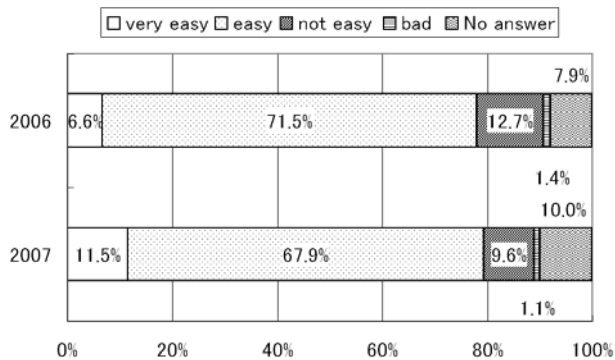

Fig.9: Ease of use of the LMS.

Figure 10 shows the answers to the question, "What are the most convenient aspects of the LMS?".
Many students answered "possible to submit reports, etc. directly from a PC". The students indicated an increase in convenience in student life. The teachers' positive evaluations for the LMS were "possible to receive reports online", "possible to see the result lists and the study history" and "possible to prevent students from dropping".
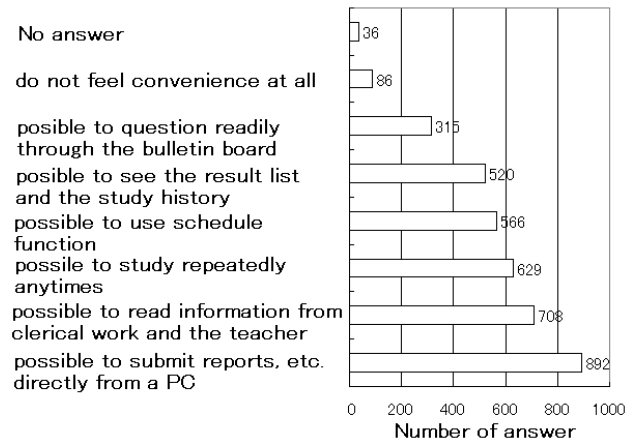

Fig.10: Convenient functions of the LMS.

Figure 11 shows the answers to the question, "Where do you use the LMS outside of class?". "Used it at home" increased from 27% to 53% between 2006 and 2007. It is apparent that the LMS is being used for learning and self-study. The proportion of students with internet at home was 61% in 2006 and 75% in 2007.
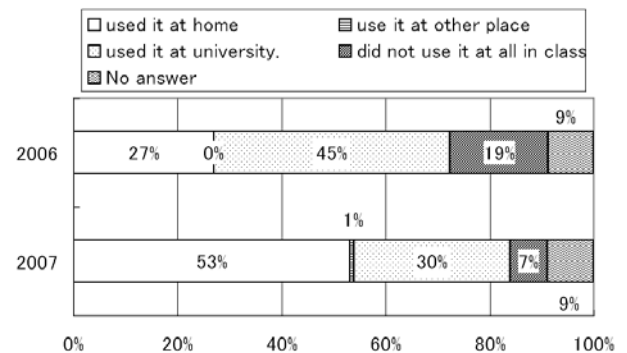

Fig. 11: The places where the LMS was used outside of class.

Figure 12 shows the answers to the question, "How about the total evaluation of *Introduction to Information Technology* class?". Positive evaluations increased by 8.3% to 81.2% as compared with the previous year.
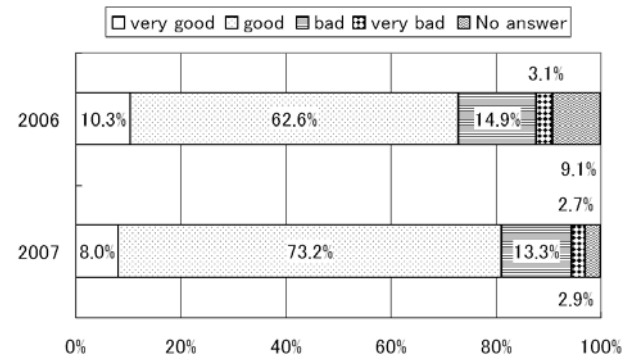

Fig.12: Total evaluation of the *Introduction to Information Technology* class.

The answers to the question, "Do you think that the number of classes that use e-Learning should increase?" went up by 11.3% from 53.3% in 2006 to 64.6% in 2007. Clearly, our students are giving positive evaluations to the approach of e-Learning.

5. Changes in the number of classes which use e-Learning

Table4 shows the change over time in the number of e-Learning classes offered at our university from 2005 to 2007. In 2005, the number of e-Learning classes was only 29. In 2007, the number of e-Learning classes increased drastically to 941. In the third year, almost 13,650 user ID's for students and teachers were registered to the LMS. Thus, it is apparent that the development of e-Learning is advancing well.

Table 4: The number of classes which used e-Learning

	2005	2006	2007
The first semester	15	224	548
The second semester	14	93	393

Figure 13 is a representation of data from the Apache access log that is used in the LMS. We found from the figure that the number of accesses (until October 19, 2007) was an average of 2.6 times higher compared with the previous year.
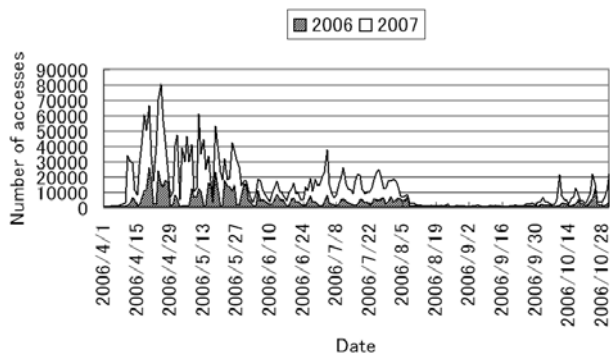

Fig.13. Change in the number of accesses.

6.   Conclusion

We established a method of creating an E-Learning environment across all departments, and provided the construction cost of the LMS as a reference for other researchers who aim at more effective system construction. We confirmed that the LMS system can be used by 250 students simultaneously through these teaching practices. Over 70% of the students gave a positive evaluation throughout the entire class (including their evaluations of the system) for two consecutive years. Regarding the results of teachers' evaluations for this educational system, in 2007 the number of classes that use the educational system increased three times compared with the previous year. We also confirmed that the model class form was used successfully in classes of students with a variety of IT literacy levels. Experience from the development of *Introduction to Information Technology* will be reflected in other classes such as *Lecture on Life in Campus and Society* which is scheduled to be offered via e-Learning. In the future we hope to establish a method of evaluating the educational effects of this system.

Acknowledgements

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