A Web-based Course Delivery System for Online Teaching and Learning

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INTRODUCTION

Distance learning is commonly used as a means of providing education to learners at remote locations. In the past, this mode of education was common in continuing education and corporate training. Recent advances in Internet technology have drastically expanded the scope of distance learning. Through Internet-based online learning, individuals can now take courses from anywhere around the world at any time without traveling further than to their computers. Hence, time, distance, and limited classroom space are no longer barriers to learning.

A large number of web-based courses are now available through the Internet. For example, the "World Lecture Hall" web site (http://www.utexas.edu/world/lecture/) maintained by the University of Texas in the United States provides a large collection of web-based courses developed by instructors all over the world. As of July 2000, the web site has included over 2,500 different courses covering over 70 different subject areas. In addition, MIT has recently announced that it plans to make nearly all its courses freely available over the Internet in the next ten years.

In general, the effectiveness of education depends on three factors: the material covered, the level of mastery of the subject, and the time allocated to cover the material (Strauss H, 1988). In today's classroom, the material covered and the time allocated are more or less fixed, thus the level of mastery could vary from student to student. However, educators in the past took a rather different approach. For example, teaching in China during the time of Confucius was based on a more individualized approach, which allowed students to learn more effectively at their own pace, although this mode of education would not scale up well as the number of learners increases (http://www.san.beck.org/C%26S-Contents.html). With the help of information technology (IT), there may now be more effective ways to provide education opportunities to a large population.

An Internet-based distance-learning project

In this paper, a Web-based course-delivery system developed at HKUST will be presented. Our Internet-based distance-learning project was started in 1994 when a group of undergraduate students began their final-year projects on developing a

courseware system for an introductory programming course. The students continued to improve the courseware system over the following two years. In 1997, using this courseware system as a framework, HKUST formed a coalition with several secondary schools to develop prototype courseware modules for IT education in Hong Kong.

The main goal of this project is to provide an integrated environment conducive to teaching and learning with the aid of IT. In 1997, the Hong Kong government decided to increase significantly its investment in education. One of the decisions was to equip all secondary schools and primary schools in Hong Kong with 40 to 80 PCs with Internet access. However, it was recognized that the installation of only hardware was not enough. What is at least as important is the availability of courseware; that is, content that the students and teachers can use. The major objectives of our project are:

- to provide a courseware development environment to support teachers in course preparation when switching from the traditional mode of teaching to web-based teaching;
- to assist students in learning with the recognition that students could be from different backgrounds and that their learning requirements could be very different; and
- to make use of up-to-date technology and teaching materials for education in IT which is a rapidly changing area.

In the first part of this paper, the details of the different components of the courseware system will be described. In the second part, an online course-delivery system for offering university-level courses to secondary school students will be presented.

MAJOR COMPONENTS OF THE COURSEWARE SYSTEM

In this section, the major components of the courseware system will be described. The first component consists of some general course materials, including course outlines, lecture notes, assignments, and sample examination papers. One very important feature that we have included in our courseware system is the multilingual presentation of course materials. In Hong Kong, the mother tongue of most of the students is Chinese—in particular, Cantonese—but the medium of instruction in school could be either Chinese or English. The availability of multilingual materials would help the students in their understanding of the subject matter. There are also online discussion facilities to allow students to communicate with instructors and among students. The system also includes course administrative tools for providing instructors with student information, such as class enrollment and performances of the students, and for the students to check on their own grades.

Another important component of the courseware is an interactive online Q&A system. The display in Figure 1 shows a floor plan of a classroom setting where all students would have a computer in front of them. When a student logs on, the icon corresponding to the student's computer would light up on the display. The instructor can click on the icon to find out information about the student. At the backend, there is a database of questions available for different topics. Currently, we have implemented

three different types of questions, including fill-in-the-blanks, multiple-choice, and true-false type questions. Once the instructor selects a question, the students can answer the questions through the Internet. After an answer is submitted by a student, the color-coded answer would show up on the display next to the icon corresponding to the student. Certain statistics could also be obtained so that the instructor would be able to find out quickly how the students perform.

One very important feature of this system is the multimedia learning aids for helping students in understanding difficult concepts. These learning aids are presented in the forms of text, audio, video, and animation using Java applets. As an example, Figure 2 illustrates a learning aid for the loop concept in the C++ programming language. Loop is a programming concept that is quite difficult to understand for some learner programmers. With this Java applet, the user can enter a C++ code segment in the edit window. The user can then transform the program code into a flow chart representation by hitting the convert button. In Figure 2, the flow chart representing the program segment is displayed in the left window. The user can modify the source code in the edit window and then convert the code into a different flow chart structure. In providing interactivities between the user and the system, the user can also go through the execution of the program step-by-step by using its VCR-type control buttons. In the example given in Figure 2, the first statement to be executed is a conditional statement. The user would be asked to select whether the condition is true or false. If the true branch is selected, the action inside the loop would be executed or the action would be skipped if the false branch were selected. Such learning aids would allow the user to go through these interactive activities at their own pace.

Another example is illustrated in Figure 3. In this example, another learning aid is used in demonstrating the programming concept of sorting in arrays, that is, to arrange the items stored in an array in ascending (or descending) order. There are different sorting algorithms available in computer programming. One of the sorting algorithms is called the “selection sort”. If a student has a problem understanding the selection sort during a lecture, the learning aid in the courseware would provide a step-by-step illustration of the algorithm. In addition, there is an option to turn on the sound. While the program is executing, the student can also listen to the step-by-step instructions. The system would also allow the students to go through the algorithm at a different pace. While some students may like to follow the step-by-step execution of the program, other students may want go at a faster pace. When the student hits the fast-forward button, the execution of the entire algorithm would be carried out automatically through the use of animation. A large number of students have found these learning aids useful in helping them to better understand certain difficult concepts.

This prototype system was first tested in a class of 115 students in the Spring semester of 1997. A survey was conducted at the end of the semester to collect feedback from the students. Results show that, in general, the students reacted quite positively to the system (Yu P Y, 1988). As illustrated in Figure 4, the students were asked about their opinions on how easy it is to learn the system, its usefulness, effectiveness, etc. Overall, most students picked the choices in the ranges from 3 up to 5 where a “1” means it is “a lot less desirable,” and a “5” means it is “very good.” We also asked the students to provide us with feedback on what they found to be the most useful features and one of

the features that they have selected is the bilingual presentation. This prototype courseware system has later been improved on in the Fall of 1997, based on feedback from the students, to include presentations in two different Chinese dialects, Mandarin and Cantonese, in addition to English. The current system can be accessed at the URL: http://www.courseware.ust.hk/.

AN ONLINE COURSE DELIVERY SYSTEM

In general, online learning is considered as an inferior alternative to traditional classroom teaching. It was arguable whether online teaching could offer much advantage over the traditional mode of teaching. In Fall 2000, we started a project that could not have been carried out without the use of online distance learning. In Hong Kong, the secondary school curricula are relatively rigid compared to most Western countries, including the United States and Europe. In the United States, it is quite common for the more capable high school students to attend university class in getting a head start in their university studies. In Hong Kong, because of the rigid class schedule, secondary school students are normally not allowed to skip classes. In order to provide the opportunity for the more capable students to excel themselves, we have developed a Web-based online multimedia course-delivery system to allow students to take university-level courses in cyber-classrooms located at secondary schools distributed around different districts in Hong Kong. These cyber-classrooms serve as regional centers for students from nearby schools. Through this system, lectures given at HKUST can be delivered to the cyber-classrooms through a video-on-demand system over the Internet. In Fall 2001, we are offering three courses to over 150 secondary school students at eight Cyber-classrooms through the Cyber University program funded by the Quality Education Fund. The advantages in allowing students to attend courses through the Cyber University program include:

- providing a stimulating environment for academically gifted and talented students to excel and to develop to their full potential;
- offering a more challenging educational setting, including access to university facilities, to stimulate student interest and motivation in learning;
- allowing more capable students to get a head start in their university education and to explore their interest in different disciplines;
- providing students with opportunities to adjust their pace of learning according to their abilities and individual circumstances; and
- enriching students' learning experiences through a wide variety of high-quality online courses which are accredited by the university.

Figure 5 gives a general overview of the set up of the online course-delivery system. Several remote classrooms are set up in secondary schools in different locations, and students from nearby districts can go to these schools to attend classes. One important factor that we have considered in developing this system is that, unlike in continuing education where the target audience is the more mature students, the students in secondary schools are less mature and may need more guidance. Instead of simply playing recorded lectures during class, we want to set up an environment that would facilitate interaction between the instructor and the students. In this system, the

pre-recorded video lectures—these are actual lectures given to university students within the university—are delivered to the secondary schools through the Internet. The students, while watching these pre-recorded video lectures in the remote classrooms, can pose questions through the chat room and the shared whiteboard over the Internet. In addition, the instructor can answer students' questions through question-and-answer sessions using live video link.

In the actual implementation, the lecture given by the instructor in the university, would first be recorded. A video lecture would then be produced by synchronizing the recorded lecture with the PowerPoint presentation. The video lecture would then be transmitted through the Internet to the different remote sites. In the remote sites, students would be watching the lecture projected onto the screen while participating in the online discussions through the use of the chat room and shared whiteboard. In order to promote interaction between the instructor and students, the video lecture would be divided into smaller modules. For example, a one-hour lecture would be divided into three segments of 15 to 20 minutes modules. After viewing each module, the students would be allowed to ask the instructor questions and the instructor could answer the students' questions through a live video link.

In Hong Kong, students are quite passive. In general, students would seldom raise any questions during the traditional classroom setting. Moreover, most students would not respond to questions raised by the instructor. One surprising outcome was that students taking the online course were a lot more active in participating in class discussions. While there were usually no more than a couple of questions raised when the lectures were conducted in a traditional classroom setting, there were on average over ten questions raised through the Q&A system when the same lecture was offered online. This is a clear indication that the students of this Internet generation feel more comfortable interacting in an "ICQ-style" environment.

CONCLUSION

What lessons have we learned so far through the development of this system? We found that good instructional design is needed in integrating web-based instruction with face-to-face instruction; this is especially the case when exploring ways to take advantage of the interactivity and multimedia features that are possible using IT. However, effective uses of multimedia capabilities need careful consideration For example, simply including video with a talking head would not be a very cost-effective way of using multimedia. There is a steep initial learning curve in developing courseware systems. Everyone who has participated in online learning systems knows that there is an extra workload imposed on the instructors. As for the learners, they themselves have to be motivated and willing to take on active responsibility because, no matter how much effort one has spent in developing the system, it will not be useful unless the students actually spend time using it. Lastly, student involvements in the development of courseware are also very important because students in this information age are more familiar with this kind of web-based learning environment. Their input is important in the development of multimedia learning aids as they know best what can help them most in understanding difficult concepts.

REFERENCES

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Yu, P Y (1988). "Internet-based Virtual Classroom – A Study of its Critical Success Factors in Hong Kong's Tertiary Institute", Master Thesis, City University of Hong Kong, June 1998.

Appendixes:

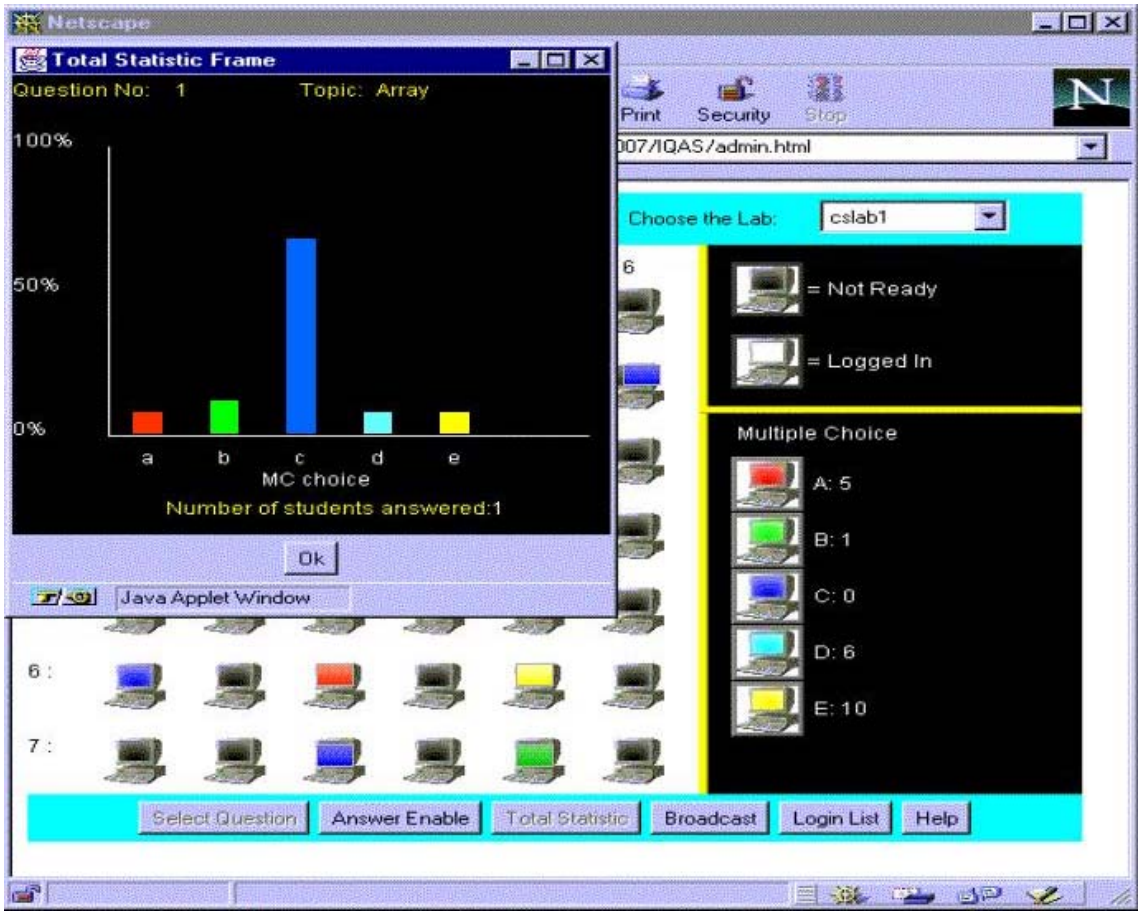

Figure 1: A display showing the setup of the interactive Q&A system.

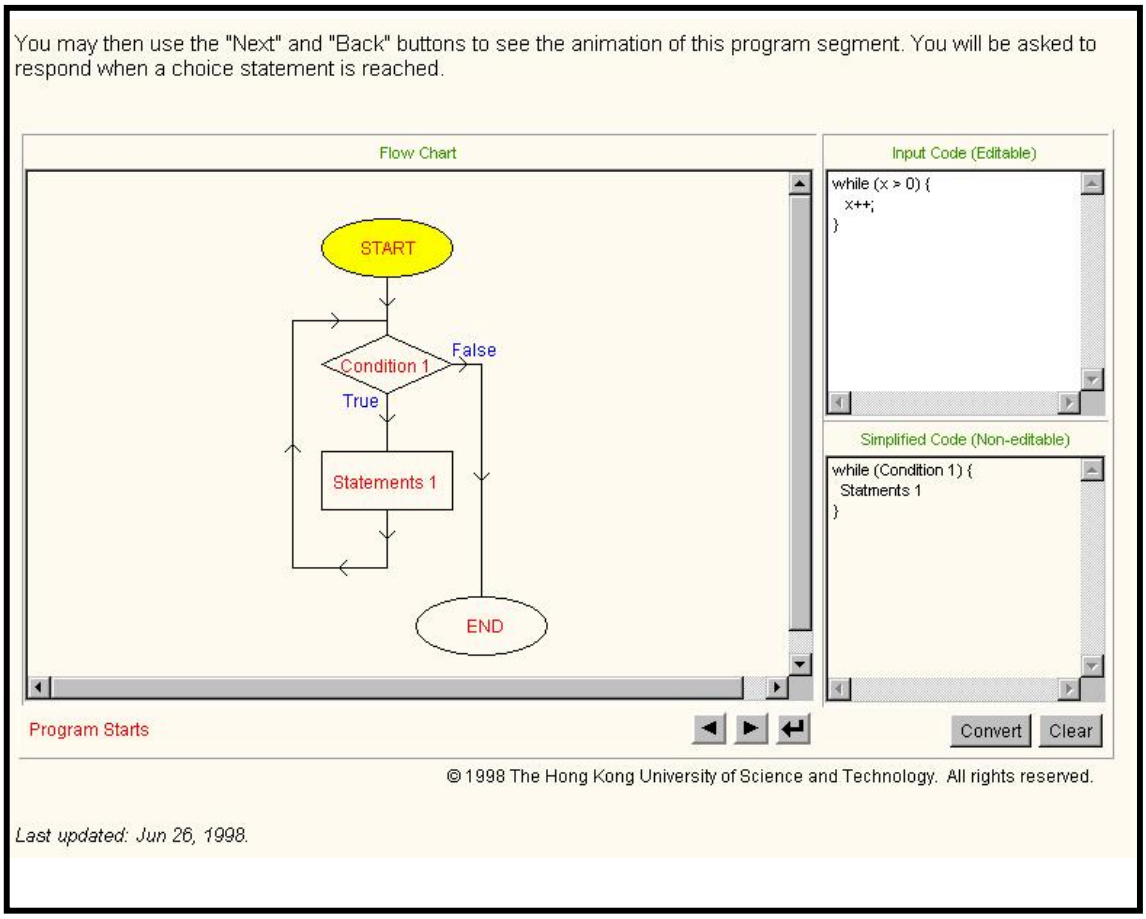

Figure 2: A screenshot showing the learning aid for the loop concept.

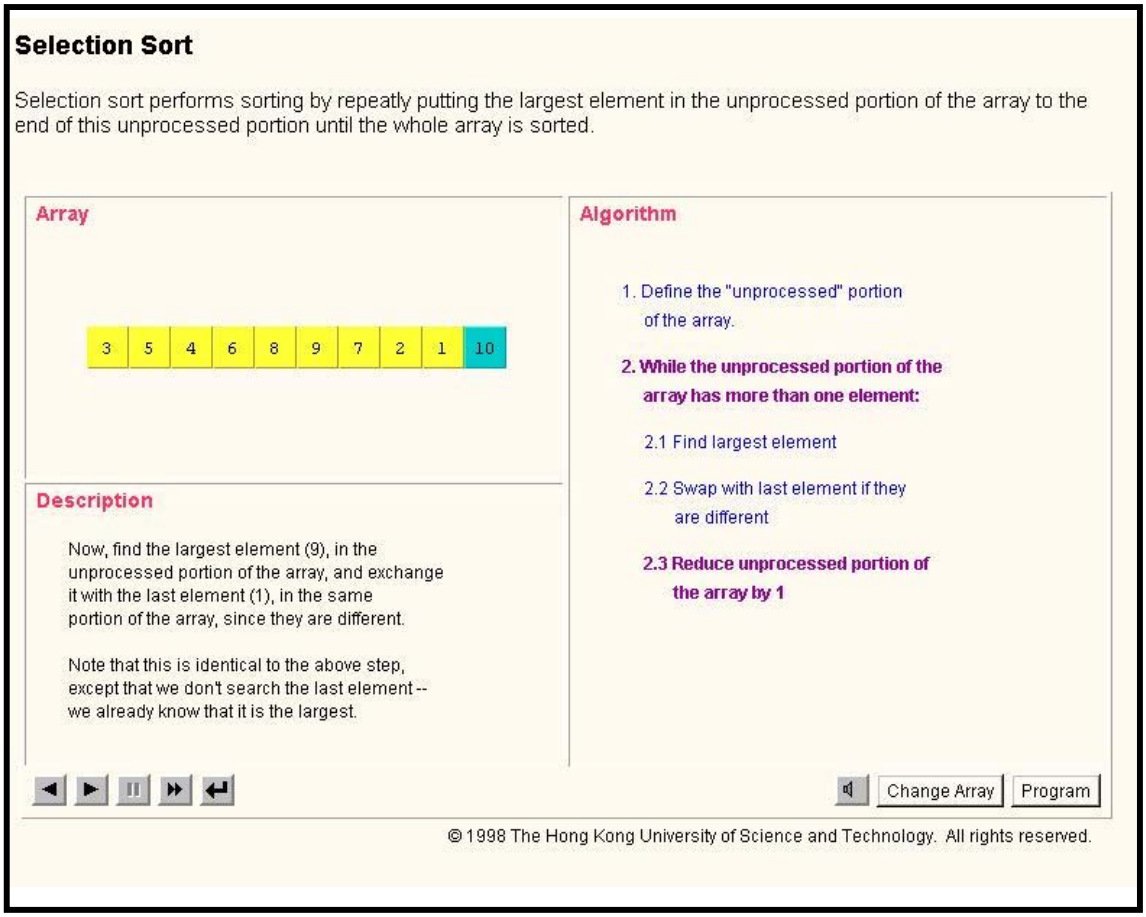

Figure 3: A screenshot showing the learning aid for the selection sort algorithm.

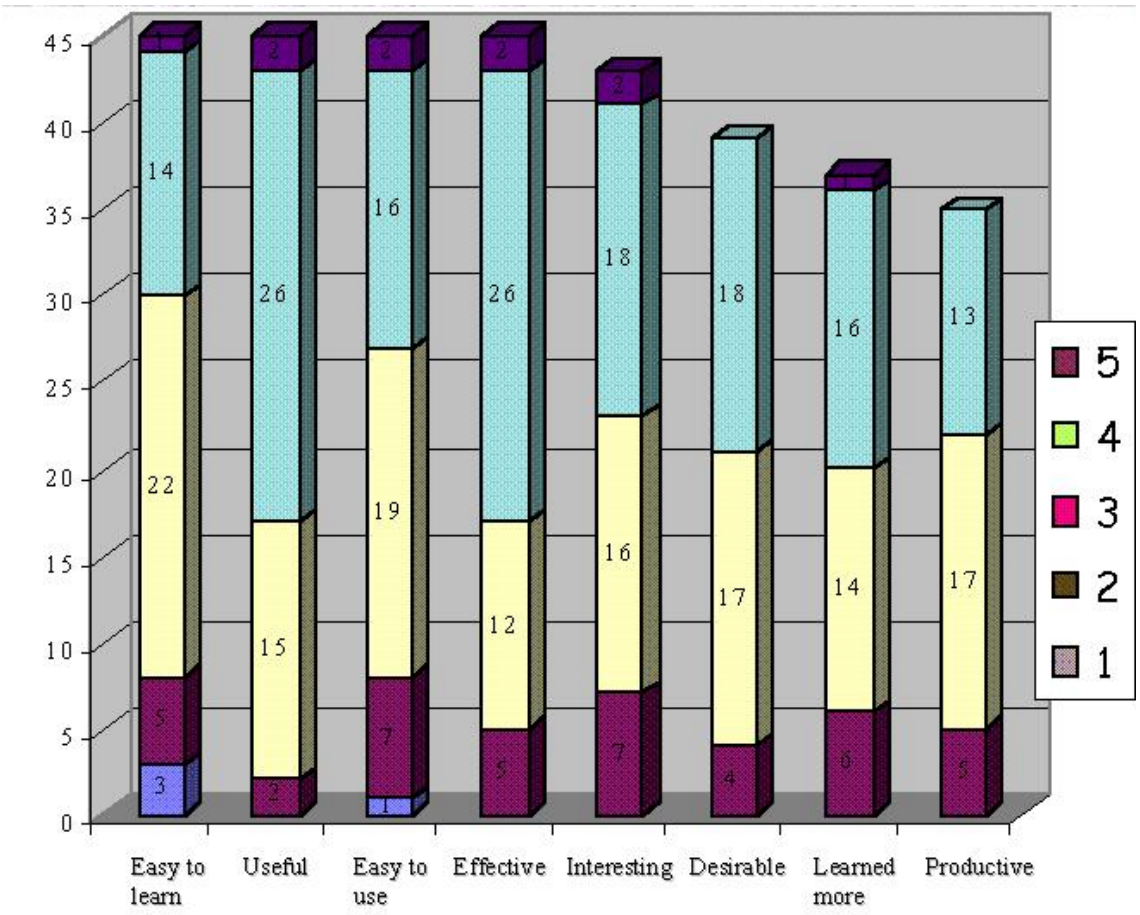

Figure 4: Results of a survey conducted on the offering of COMP102.

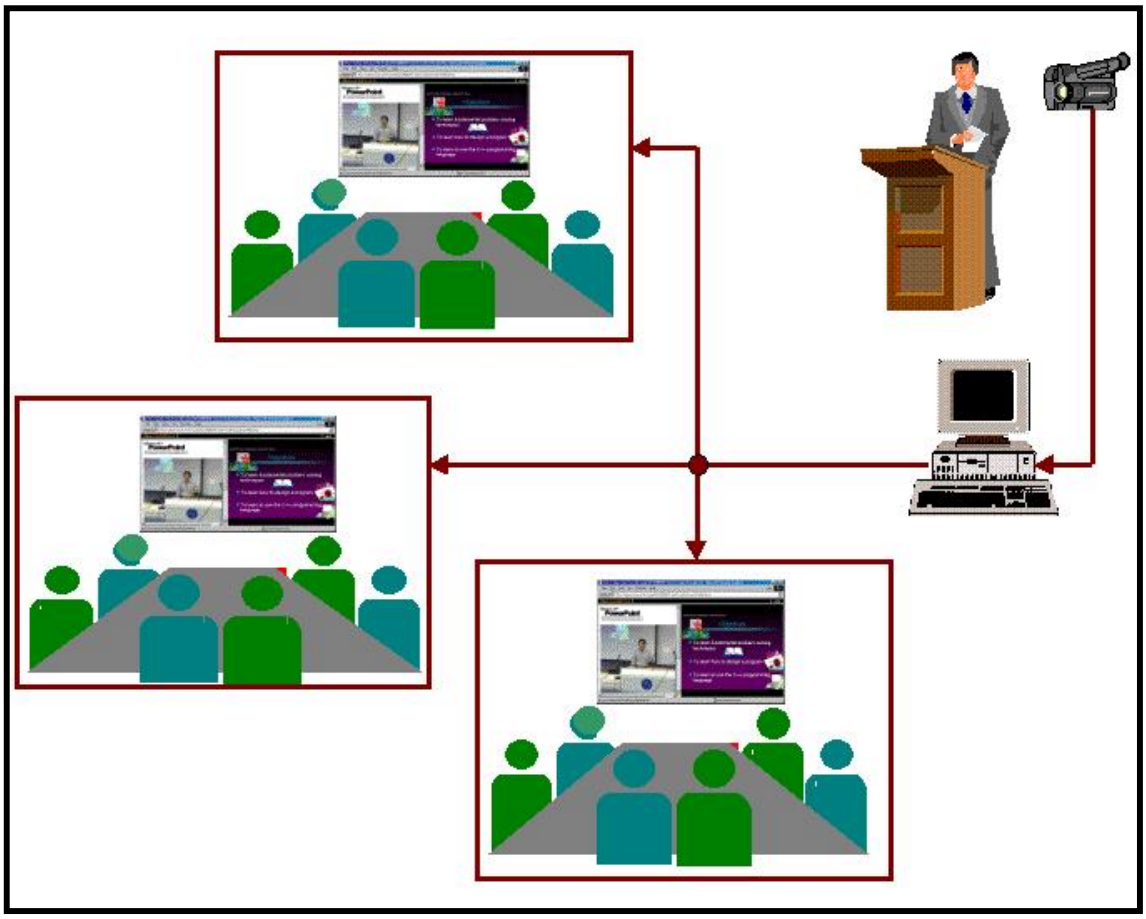

Figure 5: The figure illustrates the setup on the online course delivery system.