Cooperative Distance-Education Paradigm for a Networked Application Course

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Abstract

Internet technologies recently have developed extremely rapidly. WWW applications have also increased the accessibility of the Internet. New information and communication technologies are developing and playing a growing role in engineering education. Based on these technologies and new teaching methodologies, this work devised a cooperative distance-education paradigm for engineering education. From a team pedagogical perspective, classroom teachers collaborate on distance teaching with other teacher-librarians simultaneously in different scenes. Each teacher in this teaching team can hear/present critical information to learners and other teachers. This paradigm includes three modules, namely: web-oriented curriculum, SCORM-based e-book and Access Grid cooperative distance-education. From the trial teaching results, the average grade of the learners exceeds that of learners using traditional pedagogy and traditional Distance-Education 5% and 3%, respectively. Furthermore, the learning efficiency using the proposed approach was approximately 5% higher than for traditional methods. The author thus believes that the cooperative distance-education paradigm can enhance educational quality by sharing teacher expertise and enhanced learning.

Introduction

As defined by the ICT, Distance Education attempts to extend learning, or deliver instructional resource-sharing opportunities, to locations distant from a classroom, building or site, to another classroom, building or site via video, audio, computer, multimedia communications, or a combination of these other traditional delivery methods. For these reasons, Distance Education is becoming increasingly popular as schools are increasingly adopting it to assist teachers and students. Distance Education can be divided into synchronous and asynchronous based on time, and can be divided into video, radio and data based on teaching medium. Several kinds of Distance Education are shown in Table 1.

Table 1: Classifications of Distance Education

	Synchronous	Asynchronous
Video	Videoconferencing	Videotape, Broadcast video
Radio	Audio-conferencing	Audiotape, Radio

Data	Internet chat, Desktop Videoconferencing, web	E-mail, CD-ROM, web

Distance Education provides a method of interactive two-way communication between teachers and students without the need for face-to-face teaching. Numerous countries are examining this type of learning and teaching in the hope of finding a means of increasing student motivation to study and reducing the shortcomings of existing education systems. Since it is not face-to-face teaching, Distance Education must provide a convenient method for both teachers and students to achieve a quality education. However, the implementation of Distance Education requires the further development of future study environments with multimedia communications and systems. [Because of interactive video-conferencing technology, this work uses the Access Grid and SCORM-based e-book as the real time distance education environment. Unlike the traditional TV conferences, the proposed approach both uses an IP network to communication with other sites and can be set-up easily in existing networks. Our approach can be used in every kind of conference, seminar, and symposium.

The rest of this paper is organized as follows. Section 2 describes the components of Cooperation Distance Education Paradigm. Meanwhile, Section 3 describes the learning activity of Cooperation Distance Education. Furthermore, Section 4 discusses the Learning Achievement, and finally, conclusions are finally made in Section 5.

Cooperation Distance Education Paradigm

Three modules are designed in this paradigm (showing in Figure 1), namely: web-oriented curriculum, SCORM-based e-book and Access Grid cooperative distance-education.

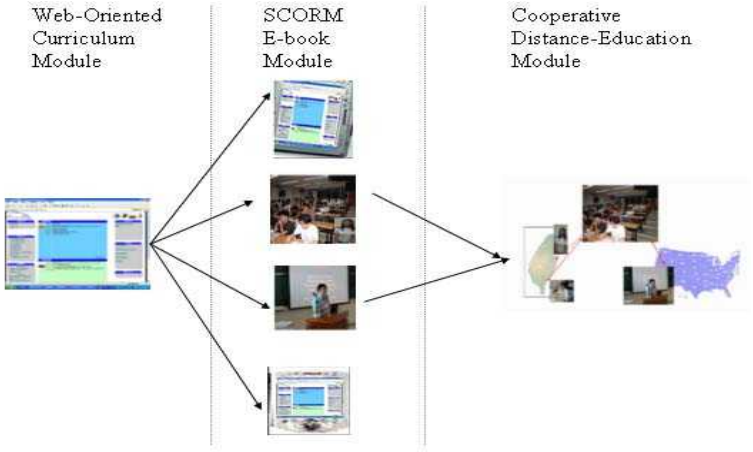


Figure 1: Three Modules of Cooperative Distance-Education Paradigm

Web-oriented curriculum module

In the web-oriented curriculum module, a curriculum website was designed and reposed on several teaching resources, including teaching materials, teaching programs, and experimental handouts (showing in Figure 2). Teachers and students can obtain the teaching/learning guidelines from the website in advance. Implementing this module will produce a web-based distance education interface that is innovative in terms of student characteristics and teaching/learning process evaluation.

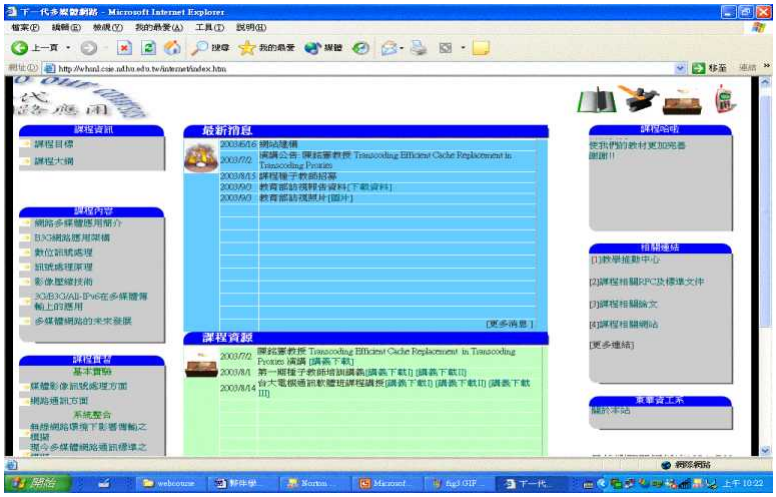


Figure 2: Web-Oriented Curriculum

SCORM-based e-book

To provide ubiquitous learning environments, this paradigm included an e-book module based on the learning technology standard, SCORM (Sharable Content Object Reference Model), which provides a standardized communication interface between the LMS (Learning Management System) and learning content for tracking learner profile and enabling the learning object reusability. Using wireless communication and Bluetooth technology, this work also makes teaching materials and resources accessible to mobile learners at anytime, anywhere.

SCORM-based e-book develops new wireless technologies for building an Ad Hoc classroom, to enable new learning activity execution and new learning model creation. This work designs and implements a wireless platform that teachers and students can use to dynamically establish a classroom whenever and wherever they wish. Additionally, this work provides students with an electronic schoolbag, including electronic books, notebooks, parents contact book, a pencil case, writing materials, sheets, a calculator, and an address book. Taking lessons in a lively, vivid and new learning environment is expected to help students to enhance their learning performance].

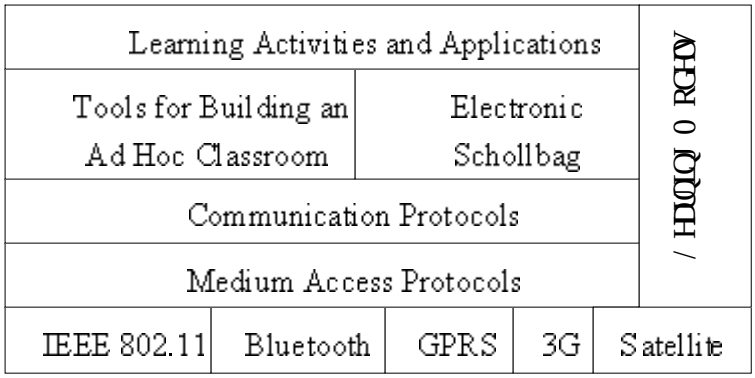


Figure 3: An overview of SCORM-based e-book

Wireless technologies include the short distance wireless technologies such as 802.11 wireless LAN and Bluetooth radio system, middle distance wireless technologies such as multi-hop wireless LAN and long distance wireless technologies such as GPRS, 3G, and Satellite systems (showing in Figure 3). To provide teachers and students with sound transmission quality, several medium access protocols and communication protocol are designed and implemented for different wireless technologies. This work first examined the various wireless technologies and design communication protocols based on different wireless mediums. Software for voice and image transmission was then developed. A wireless platform was thus established.

To create an Ad Hoc classroom, this study developed several subsystems such as the *E-Blackboard subsystem*, the *Voice and Image Transmission subsystem*, the *PowerPoint Broadcasting subsystem*, and the *Text Communication subsystem* for notebook computers. Equipped with notebook computers that are embedded with the developed systems, teachers and students can build Ad Hoc classrooms anywhere and can thus execute learning activities (showing in Figure 4). In cooperation with the teacher and students, these subsystems are designed, modified and tested to ensure they are user friendly, effectively improve learning performance, and easy to apply to a new learning activity.

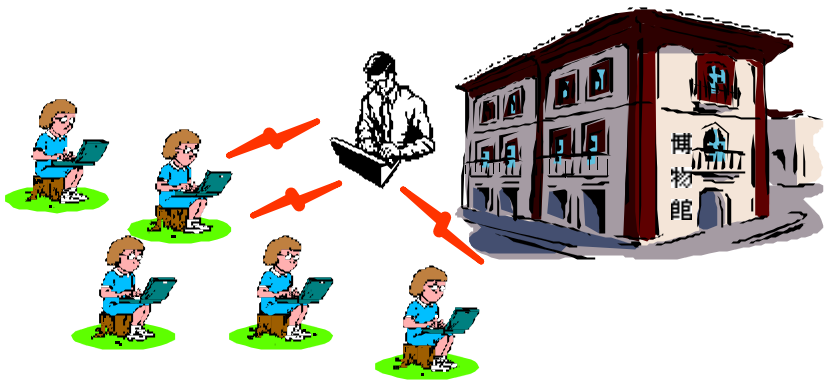


Figure 4: the scenario of Ad Hoc classroom

To provide an environment for self-learning and learning anytime and anywhere, this study develops the E-Schoolbag system, which contains *Electronic Book*, *Electronic Notebook*, *Electronic Contact Book*, *Electronic Tool Box*, *Electronic*

Scheduler , *Electronic Weekly Report* , and *Electronic Address Book* . This study also designs a *Virtual Classroom Center* (showing in Figure 5)so that the teaching materials, score database, examination questions database, class information, and contents of *E-Book*, *E-Contact Book* , and *E-Announce Board* can be stored and managed using a PC-based server. Teachers can announce the notices in *E-Announce Board* and all the announcements will automatically be scheduled in the PDA *E-scheduler* of each student. The *Virtual Classroom Center* provides an environment in which students can store and manage their personal information, exercises, and the contents of their *E-Schoolbags* . Teachers can announce and check the exercises of each student. Figure 5 illustrates the functions of *Virtual Classroom Center* .

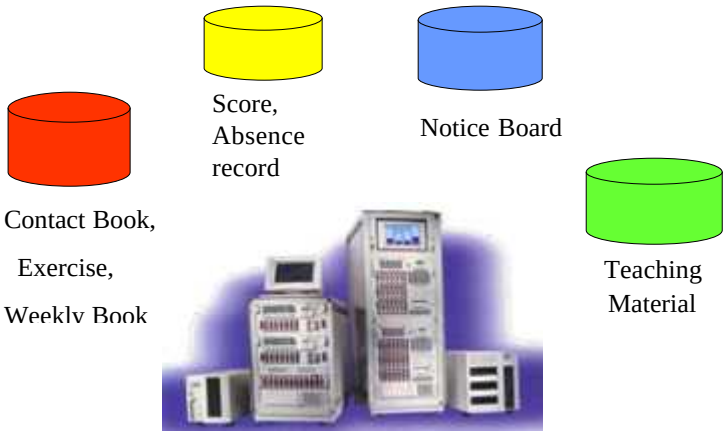


Figure 5: Functions of *Virtual Classroom Center*

Access Grid

The Cooperative Distance-Education module integrates distributed resources from different networks/sites on a shared platform that learners can use to easily fulfill cooperative learning. Moreover, Access Grid technology provides interactive network services and supports multimedia applications through a high-speed backbone network. Because it involves communication systems linking individual clients with servers, Access Grid technology overcomes the limitations of traditional Distance-Education operations. Constructing a cooperative learning network using the Access Grid system is more flexible, scalable and economical than doing so via the existing system. Every Access Grid node can select which of the videos of the other nodes it wishes to view and then project them onto the wall. Access Grid Systems communicate with one another on IP-based networks, thus reducing the expenses associated with least-line connection and equipment. The Access Grid environment comprises three components: Hardware Architecture, Software Architecture, and Network. The detailed functions and requirement *of the environment* are as follows.

- **Hardware Architecture**

  An Access Grid system can include any number of machines, since each machine merely provides distinct services such as video, audio, and MUD. All of these services can either be provided on a single notebook or shared among numbers of machines built in the same way. The distributed framework increases the usage and reduces the harm of systems crashes. Every computer manages different resources: One computer, which includes four capture cards, is responsible for video capture; another computer, containing three audio cards, is responsible for voice

capture, receive and transfer; one comprising two display cards is responsible for receiving video from the Access Grid server and projecting it on the wall; and the other is responsible for controlling the Access Grid system. The collocation of the multimedia equipment provides a high-resolution visualization environment and a high-quality Distance Education system. Figure 6 illustrates the architecture of Access Grid.

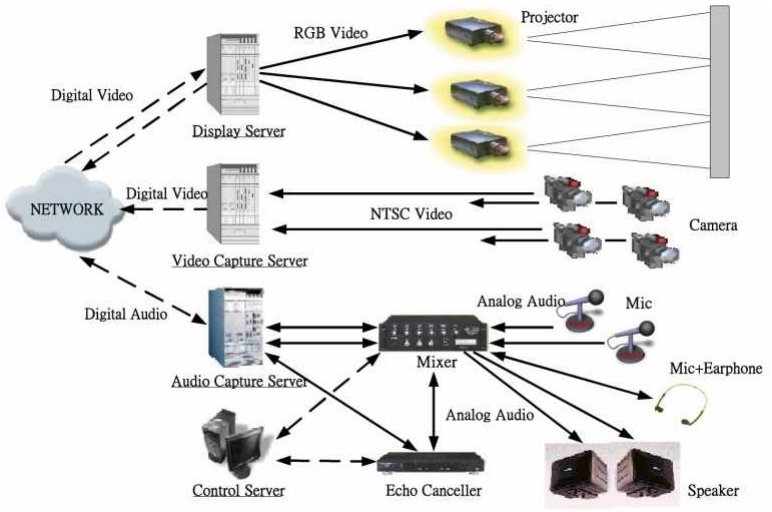


Figure 6: Access Grid Cooperative Distance-Education Module

- **Network Requirement**

Access Grid can be serviced over unicast and/or multicast IP, using quality but affordable high-performance IP-Based networks, such as TANet2, TWAREN (The Taiwan Advanced Research & Education Network http://www.twaren.net/english/), to improve the user experience beyond traditional teleconferencing.

- **Software Architecture**

Access Grid Toolkit

Access Grid Toolkit The Access Grid Toolkit implemented with Python includes VIC RAT Virtual Venue tkMOO-Light Multicast beacon; It provides users with the software components required to explore the next generation collaborative environments showing in Figure 7. Users of the Access Grid can share audio, video and text with the toolkit in different locations.

Python

Python is an interpreted, object-oriented programming language, much like Perl or Java. It has modules, classes, exceptions, very high level dynamic data types, and dynamic typing. The Python implementation is portable: it can be run on many brands of UNIX, on Windows, OS/2, Mac, and many other platforms. There are

interfaces to many system calls and libraries. With wxWindows, wxPython, a writing friendly GUI program is available.

wxPython

wxPython is a Python extension module that encapsulates the wxWindows GUI classes. It is available for the Win32 and GTK ports of wxWindows and provides a common API (Application Programming Interface) for GUI functionality to access some commonly-used operating system facilities.

Globus ToolKit

Every user and service in the Access Grid must have a valid identity certificate issued by a trusted certificate authority. The Globus Toolkit uses the Grid Security Infrastructure (GSI) for enabling secure authentication and communication over an open network.

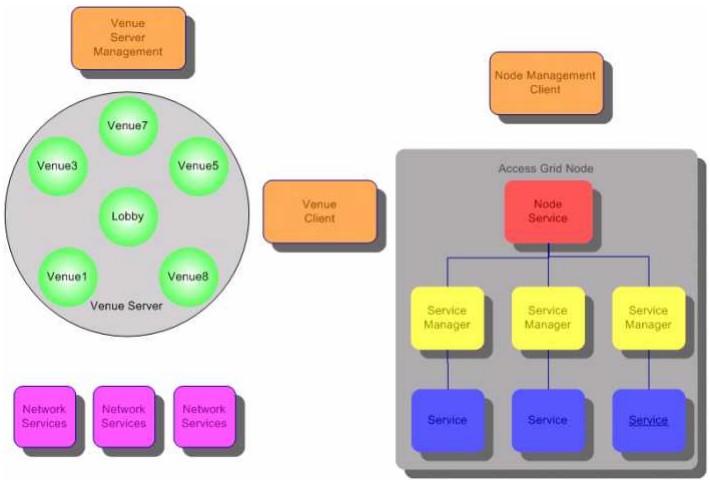


Figure 7: Access Grid Software Architecture

Learning Activity

Access Grid Approach for Cooperative Distance-Education

The Distance-Education Project results the joint efforts of the following five Taiwanese universities: National Dong Hwa University, National SunYat-sen University, National Chen Kung University, National Pingtung University of Science and Technology, and National Taitung University. The project goals are to: 1) Import the Access Grid in Distance Education environment, 2) Use the Access Grid to combine courses at each participating university, and 3) Test the Access Grid environments in the TANet, TANet2, and TWAREN networks. To achieve those objectives, each of the participating universities broadcasts one or two classes to other schools via Access Grid technology. The Project also compares the advantages and disadvantages of traditional teleconferencing and the Access Grid system.

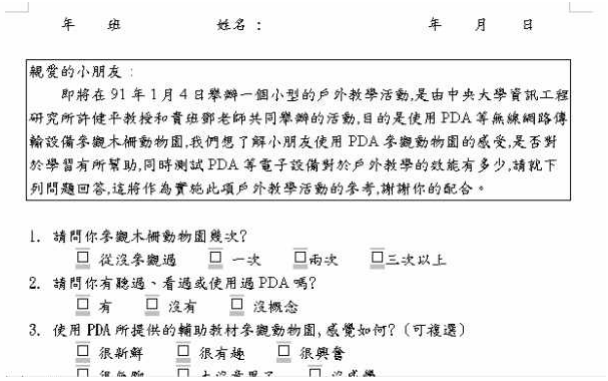
Figure 8: Poster of Distance Education Project

The initial step of the Project is to construct the Access Grid node in every participating university by installing it via a room node, desktop computer, or notebook. The center node, housed in the National Center for High-performance Computing, contains the network requirements and the Access Grid authorized server. Every university in the system can enter the venues built into the Access Grid server node in NCHC and test the video, audio, shared text, etc. Because this is a sharing environment, each node can cause an echo in the Access Grid system. When the Access Grid system is ready, five classes are publicized to other schools. All of the seminars were successful], including the Network Security Seminar, IPv6 Technology Seminar, and Traditional Workmanship Education Seminar.

Figure 9: Commentary of Access Grid E-learning Project

SCORM-based e-book Approach for Cooperative Distance-Education

Besides developing the SCORM-based e-book system, this study cooperated with Ming-Dow Elementary School and held a learning activity in the Taipei Zoo. This work organized ten groups, each containing approximately three students. Each group was provided with a PDA in which the developed Ad Hoc classroom was installed]. The teacher was provided with a notebook on which the Ad Hoc classroom and a real-time examining system were installed]. The notebook and PDA could communicate via an 802.11b wireless card. Students were well trained in the operation of the PDA functions before commencing the learning activity. Moreover, students were asked to answer a list of questions before and following the learning activity to measure the learning activity learning performance using the Ad Hoc classroom system]. During the animal visits, the teacher created an Ad Hoc classroom near the animals and taught the knowledge of the visited animals. Following the visit to the zoo, the teacher performed a real-time examination near the zoo to enable the evaluation of the learning performance of each student. Generally, teachers and most students approve the positive contribution of the Ad Hoc classroom system in outdoor learning.



年　班　　姓名：　　年　月　日

親愛的小朋友：

即將在 91 年 1 月 4 日舉辦一個小型的戶外教學活動，是由中央大學資訊工程研究所許健平教授和貴班鄧老師共同舉辦的活動，目的是使用 PDA 等無線網路傳輸設備參觀木柵動物園，我們想了解小朋友使用 PDA 參觀動物園的感受，是否對於學習有所幫助，同時測試 PDA 等電子設備對於戶外教學的效能有多少，請就下列問題回答，這將作為實施此項戶外教學活動的參考，謝謝你的配合。

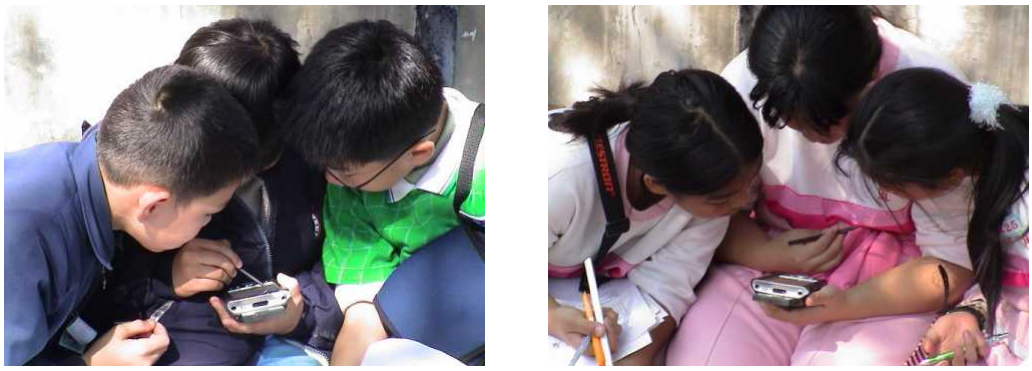
1. 請問你參觀木柵動物園幾次？
   □ 從沒參觀過　□ 一次　□兩次　□三次以上
2. 請問你有聽過、看過或使用過 PDA 嗎？
   □ 有　□ 沒有　□ 沒概念
3. 使用 PDA 所提供的輔助教材參觀動物園，感覺如何？（可複選）
   □ 很新鮮　□ 很有趣　□ 很興奮

(a) Question list asked before learning activity.

(b) Snapshot of teacher's screen.

(c) Snapshot of student's screen.

(d) Snapshot of Real-time Examination.



(e) Snapshot of learning activity.

Figure 10: Snapshot of the held learning activity.

Learning Achievement

To investigate the feasibility of the cooperative distance-education paradigm, a novel course, next-generation networked multimedia application (the curriculum website: http://134.208.27.212/internet), is being taught at three Taiwanese universities (See Table 2). Each teacher in the teaching team is responsible for teaching particular technologies and specific skills from one of the courseware topics/chapters, which were collaboratively designed last year (2003).

Figure11: Trial Teaching

Table 2: Teachers of Cooperative Distance-Education

Professor	School	Technologies and Skills
Jiann-Liang Chen	Dept. of C.S.I.E. National Dong Hwa University	Next Generation Internet
Mei-Juan Chen	Dept. of E.E. National Dong Hwa University	Image Processing
Guan-ling Lee	Dept. of C.S.I.E. National Dong Hwa University	Multimedia Database
Cheng-Chang Jeng	Dept. of E.E. Nation Taitung University	Multimedia Education Technology
Kuo-Liang Ou	Dept. of I.E. Nation Taitung University	Information Education
Show-Jane Yen	Dept. of C.S.I.E. Fu Jen Catholic University	Database System

Constructing the Distance Education environment using the Access Grid system is more flexible, scalable and economical than constructing it using the H.320 MCU system. Previously, performing video conferencing using the H.320 MCU system over ISDN entailed using a Quad card to combine multiple videos from all of the distributed participants. The number of videos displayed on the monitor was limited by the expensive Quad card; participants were unable to determine which videos they wished to view because the H.320 terminals could only view the videos of all of the H.320 MCU systems combined. Figure 12 shows the snapshot of Cooperative Distance-Education.

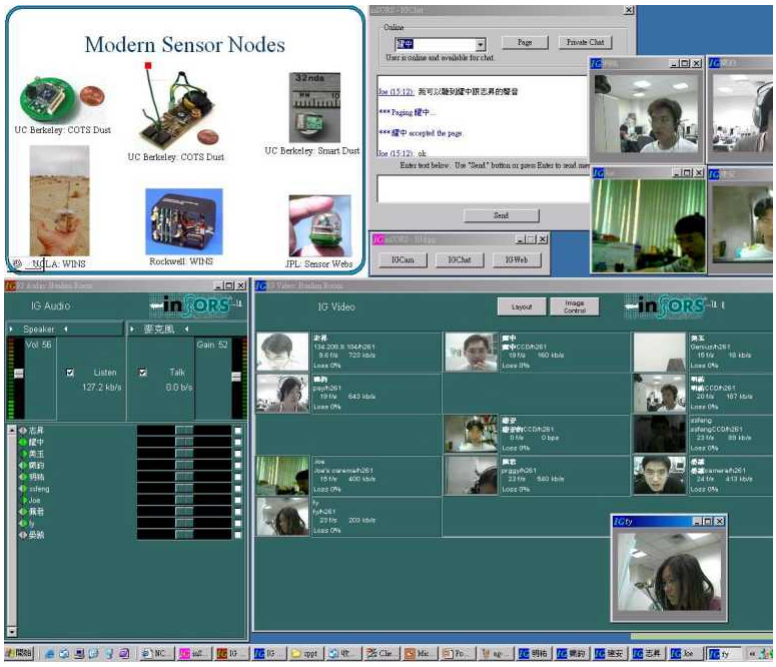


Figure 12: Snapshot of Cooperative Distance-Education

In the SCORM-based e-book system, each group of students and teachers are provided with a PDA that is embedded with the developed Ad Hoc classroom. Meanwhile, the teacher is given a notebook that is embedded with the Ad Hoc classroom and a real-time examination system. Teachers create an Ad Hoc classroom nearby the student group and teach Sensor Network related knowledge. Generally, teachers and students approve the positive contribution of the Ad Hoc classroom system to both indoor and outdoor learning.

Figure 13: Trial Teaching Results

Based on the trial teaching results (showing in Figure 13), the average grade of the learners exceeds that of learners in traditional pedagogy and traditional Distance-Education by 5% and 3%, respectively. Furthermore, the learning

efficiency using the proposed approach is approximately 5% higher than for traditional methods.

Conclusion

This cooperative distance-education paradigm establishes the Access Grid node at every participating university by installing the Access Grid using a room node, desktop computer, or notebook. The Access Grid requires IP-based multicast support and an authorized server. Every university in the system can enter the venues incorporated in the Access Grid server node and share the video, audio and text. To investigate the feasibility of the cooperative distance-education paradigm, a novel course, next-generation networked multimedia application, is taught at three Taiwanese universities. Each teacher in the teaching team is responsible for teaching specific technologies and skills from one of the courseware topics/chapters, which were collaboratively designed last year.

This paradigm also provides a wireless platform for teachers and students to dynamically establish a classroom whenever and wherever they wish to take a lesson. As supported in traditional classrooms, this study develops information technology for providing teachers with teaching aids, for example blackboards, board rubbers, colored chalk, microphone, voice recorders, video recorders, and so on, for course teaching and discussions in an ad hoc classroom. Taking lessons in a lively, vivid and new learning environment is expected to enhance student learning performance. The trial teaching results indicate that] the average grade of the learners exceeds that of learners in traditional pedagogy and traditional Distance-Education by 5% and 3%, respectively. Furthermore, the learning efficiency using the proposed approach is approximately 5% higher than for conventional methods. We believe that the cooperative distance-education paradigm can improve educational quality by sharing teacher expertise and promoting better learning.

Provided with cooperative distance-education paradigm, this study believes that new learning models for future learning are easy to build. The next step in this study is to develop a self-learning system and apply the developed systems to learning models. We will cooperate with the teacher and students and executing learning activity to evaluate the improvement of learning performance. Additionally, this study integrates the proposed system with systems developed by other projects to enable all subsystems of the “Future Learning Classroom” system to work together. This study cooperates with other content-based projects and involves their content, learning model and learning activity designs] into the proposed system.

Acknowledgment

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