Design and Implementation of Ad Hoc Classroom and eSchoolbag Systems for Ubiquitous Learning

Chih-Yung Chang* and Jang-Ping Sheu+
*Department of Computer and Information Science, Aletheia University
+Department of Computer Science and Information Engineering, National Central University
changcy@email.au.edu.tw, sheujp@csie.ncu.edu.tw,

Abstract

This paper describes the design and implementation of a learning technology project. The purpose of this project is to develop advanced wireless technologies for building an Ad Hoc classroom in order to contrive a modern and new learning environment. A wireless platform is developed for teacher and students to establish a classroom dynamically irrespective of location and time bounds. As supported in traditional classroom, we develop information technology to provide teacher with teaching aids, such as blackboard, board rubber, colored chalk, microphone, voice recorder, video recorder, and so on, for course teaching and discussions in an ad hoc classroom. In addition, we provide student with electronic Schoolbag (or eSchoolbag) which packs electronic book, notebook, parents contact book, pencil case, writing materials, sheets, calculator, address book, and so on. Taking lesson in a lively, vivid, and new learning environment, students are expected to enhance their learning performance without any burden like attending classes physically. Moreover students get more flexible scope of learning during their convenient time.

1 Introduction

The advances of computer technology have promoted the quality of e-learning [1][2][4-5]. The trend of recent communication technology is how to make good use of wireless equipments for constructing a ubiquitous communication environment which can improve performance of traditional learning and create new learning activities or models for active learning. Wireless technologies are able to create an environment for a learner to obtain knowledge anytime and anywhere. Through wireless access, a student can access rich contents from internet, search the knowledge by keyword, interactively communicate with classmates or teacher, and participate a mobile classroom anytime and anywhere.

In this paper, we describe the design and implementation of a learning technology project. One goal of this project is to develop a wireless platform for teachers and students to build an Ad Hoc classroom and execute the learning activities in the classroom. The developed platform can be used upon an urgent matter of learning, such as knowledge linking in outdoor. Another goal of this project is to create an environment for students to self-motivated learning. We develop software systems, including Ad Hoc classroom system and eSchoolbag systems, on both PC server and mobile devices such as PDA and Notebook that are carried by students and teacher, respectively.

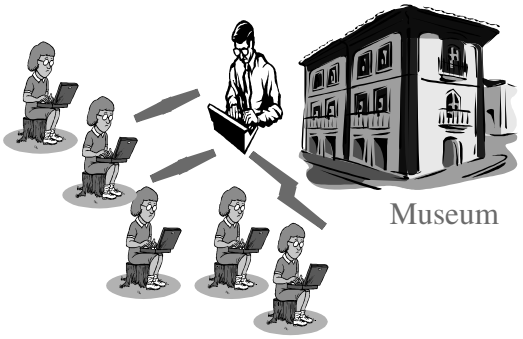

Figure 1: The scenario of Ad Hoc classroom.

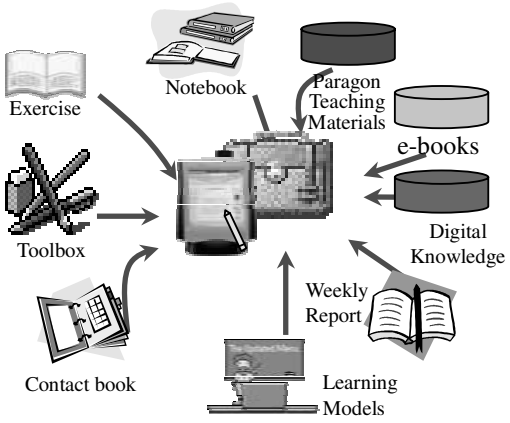

Figure 2: The components of eSchoolbag system.

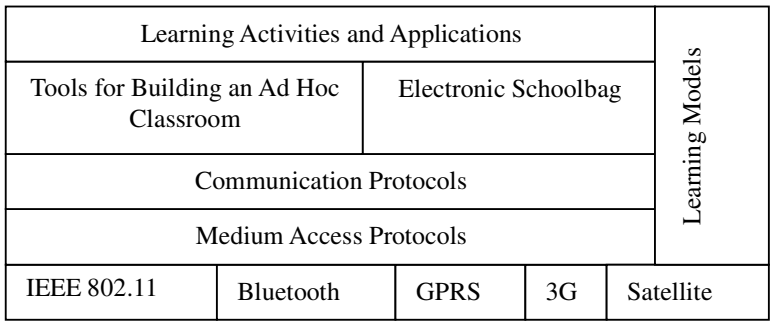

Figure 3: An overview of the developed systems.

Two systems, the Ad Hoc classroom system and the eSchoolbag system, are designed and implemented for constructing a ubiquitous learning environment. Applied the Ad Hoc classroom system, teacher and students are able to create an Ad Hoc classroom in outdoor and take lesson anytime. The learning activities are thus can be executed anywhere. The eShoolbag system provides students with function of access of the electronic book, knowledge, and teaching material. Through the use of eShoolbag system, students can also download or upload their homework, teacher's notice announcement, or do exercise anytime and anywhere. Fig. 1 displays the scenario of Ad Hoc classroom whereas Fig. 2 displays the concepts of Electronic eShoolbag system.

Taking lesson in a lively, vivid, and new learning environment, students are expected to enhance their learning performance without any burden like attending classes physically.

2 Implementation of a Ubiquitous Learning Environment

The purpose of the presented work is to develop new wireless technologies [8-11] for building an Ad Hoc classroom, so that the new learning activities could be executed and new learning model could be created. We designed and implemented a wireless platform for teacher and students to establish a classroom dynamically whenever and wherever they want to take a lesson. In addition, we provide students with eShoolbag which packs electronic book, notebook, parents contact book, pencil case, writing materials, sheets, calculator, address book, and so on. Taking lesson in a lively, vivid, and new learning environment, students are expected to enhance their learning performance.

As shown in the Fig. 3, the wireless technologies include the short distance wireless technologies such as 802.11 wireless LAN [8-11] and Bluetooth radio system[12-13], the middle distance wireless technologies such as multi-hop wireless LAN[8-11] and the long distance wireless technologies such as GPRS, 3G, and Satellite systems.

The implementation of this project is divided into two phases. In the first phase, we provide teacher and students with good transmission quality. Several medium access protocols and communication protocol [8-11] are designed and implemented for different wireless technologies. Then we develop software for voice and image transmission. The wireless platform is thus established. To create an Ad Hoc classroom, we develop several subsystems such as the *E-Blackboard subsystem*, the *Voice and Image Transmission subsystem*, the *Powerpoint Broadcasting subsystem*, and the *Text Communication subsystem in* notebook computer. Equipped with notebook computer that is embedded with the developed systems, teacher and students can build an Ad Hoc classroom anywhere and execute the learning activity outdoor. Cooperated with the teacher and students of elementary school, these subsystems are designed, modified, and tested to guarantee that they are friendly for use, helpful for improving the learning performance, and easy to be applied to new learning activity.

In the second phase, we transfer the Ad Hoc classroom platform to a WinCE-based PDA so that the weight of mobile device is reduced and the device is more portable for students. Due to that a large amount of contents and teaching materials are accessible from internet, the developed system

is extended to web-based environment. Under this environment, teacher may design and share their teaching material with other teacher through internet. Before the executing of outdoor learning activity, teacher may download the teaching material to notebook computer from internet. The Ad Hoc classroom thus could be built anytime and anywhere, provided that students are equipped with PDA and the teacher is equipped with a notebook computer. By applying the designed Ad Hoc classroom system, teacher may broadcast the teaching material to students' PDA. Screen of all students' PDAs will be synchronized with the screen of teacher's notebook, in a wireless and web-based environment.

To provide an environment for self-learning and learning anytime and anywhere, we develop eShoolbag system which packs *Electronic Book*, *Electronic Notebook*, *Electronic Contact Book*, *Electronic Tool Box*, *Electronic Scheduler*, *Electronic Weekly Report*, *Electronic Address Book*, and so on. We also develop a Virtual Classroom Center 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 in a PC-based server. Teacher may announce the notices in *E-Announce Board* and all the announcements will automatically scheduled in each student's *E-Scheduler* of PDA. The *Virtual Classroom Center* provides an environment for student to store and manage their personal information, exercises, and contents of their eShoolbag. Teacher may announce and check the exercise of each student. Fig. 4 displays the functions of *Virtual Classroom Center*.

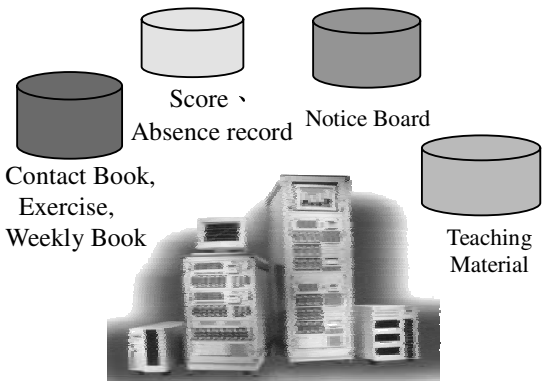

Figure 4: The Virtual Classroom Center.

3 The Application of Ad Hoc Classroom and eSchoolbag Systems

In the following, we give an example to apply the developed Ad Hoc classroom and eShoolbag systems to student's learning. In the morning, student, say John, can read the *E-Book* while he takes the bus from home to school. John may check the *E-Scheduler* to make sure that all exercises have been completed. As John arrive school, he uploads exercises, *E-Contact Book*, *E-Weekly Report* from his PDA to PC-based *Virtual Classroom Center* server. Also, John downloads the teacher's announcement from *Virtual Classroom Center* (PC) to the *E-Scheduler* (PDA) at the same time. During a class, John takes notes in his *E-Notebook*. The alarm clock designed in *E-Scheduler* may remind John to download the teaching material from *Virtual Classroom Center* to his PDA so that the outdoor learning activity can be executed. During executing the outdoor learning activity, teacher may create an Ad Hoc classroom and execute the teaching process. Screen of John's PDA will be synchronized with teacher's screen. After executing the teaching process, teacher may take a *Real-Time Examination* to evaluate the learning performance of each student. After going back to school, teacher may leave some messages for John's parents in *E-Contact Book* of *Virtual Classroom Center*. Also, teacher may announce today's exercises and put John's learning status on *Virtual Classroom Center*. Before going home, John will download today's exercise, the message of *E-Contact Book*, *E-Book*, and learning status from *Virtual Classroom Center* to PDA. John can do the exercise or read *E-Book* as he takes the bus from school to home. John's parents thus can check the *E-Contact Book* and communicate with teacher by replying messages in *E-Contact Book*. John's learning status could be checked on PDA by his parents.

Provided with the Ad Hoc classroom system and eShoolbag system, we believe that new learning models are easy to be built for outdoor learning. We integrate our system with systems developed by other wireless projects so that all subsystems of "Future Learning Classroom" system could work together. We cooperated with other content-based projects and involve their designs in contents, learning models, and learning activities into our system.

In addition to develop the Ad Hoc classroom and eShoolbag systems, we cooperated with some elementary schools and held learning activities. For example, students of elementary school apply the developed systems when they visit the zoo. We organized ten groups each containing about three

students. Each group was provided with a PDA (Personal Digital Assistant) embedded with the developed Ad Hoc classroom and eShoolbag systems. The teacher was equipped with a notebook that was embedded with the Ad Hoc classroom and a real-time examining system. The notebook and PDA could be communicated via 802.11b wireless card or GPRS radio network. Students were well trained in the operating of the PDA functions before executing the learning activity. Students were asked for answering a list of questions before and after the learning activity so that we can measure the learning performance of learning activity of a specific learning model.

During the visiting of the animals, teacher created an Ad Hoc classroom nearby the animals and instructed the knowledge of visited animals. Fig. 5(a) displays the snapshot of notebook used by teacher. In Fig. 5(a), many hypertexts of various animals, such as elephant, penguin, tiger, and so on, link to different web sites containing animal knowledge. Fig. 5(b) displays the snapshot of student's PDA, which is synchronized with teacher's notebook. Fig. 5(c) displays the scenario of learning activity. After the visiting process of zoo, teacher could execute a real-time examination around the zoo so that the learning performance of each student could be evaluated immediately. In general, teacher and most students approve the positive contribution of the Ad Hoc classroom system in outdoor learning.

4 Functionalities of the Developed Systems

This section proposes the main functions of the project. A number of tools are developed in Ad Hoc classroom and eShoolbag systems. Due to that the notebook user and PDA user have different requirements, some common functions are designed for both notebook and PDA users, whereas the other functions are designed only for notebook user.

- **Functions designed for Notebook**

(1) Development of new communication protocols for wireless card.

The development of communication protocols guarantees that the multimedia material in complex format can be transmitted when a learning activity is executed in an Ad Hoc classroom [8-11].

(2) The *Electronic Blackboard Subsystem* for Ad Hoc classroom.
The developed *Electronic Blackboard Subsystem* provides functions such as board rubber, colored chalk, drawing, coloring, symbol toolbar, zooming, capturing the contents of blackboard and so on. Factors that affect the transmission quality such as the size of blackboard, the transmission quality, the speed of operation in writing drawing, and the number of students are designed as parameters setting by user so that the learning environment could be set in a best mode.

(a) Snapshot of teacher's screen.

(b) Snapshot of student's screen.

(c) Snapshot of learning activity.

Figure 5: Snapshot of the held learning activity.

(3) The *PowerPoint Broadcasting Subsystem* for an Ad Hoc classroom

A lot of teaching materials are made in PowerPoint format. We develop the *Powerpoint Broadcasting Subsystem* which provides teacher with functions of opening a Powerpoint file, broadcasting of the teaching materials in Microsoft Powerpoint format, changing to previous or next page, stopping broadcasting, and so on, under wireless environment. As far as teacher initiates the PowerPoint Broadcasting subsystem, the screen of all students, as shown in Fig. 6, are locked and synchronized with the teacher's screen. This tool helps teacher to broadcast the teaching material that is made in PowerPoint format in outdoor.

(4) The *Voice and Image Transmission Subsystem*

In an Ad Hoc classroom, distance between students and teacher may be long and the number of students may be large. It is difficult for a teacher to transmit the voice to every student and difficult for student to clearly observe the material displayed by the teacher. Therefore, we design and implement the *Voice and Image Transmission Subsystem* so that the teacher's voice and image could be transmitted to each student's mobile device clearly. The teacher is equipped with a digital camera and microphone so that the image and voice of teacher can be captured by our system and transmitted to student's mobile device via wireless technology.

(5) The *Text Transmission Subsystem*

During the teaching process in an Ad Hoc classroom, teacher may transmit texts to students by using the developed *Text Transmission Subsystem* so that the transmitted Powerpoint material, content of Electronic Blackboard, and the image could be further illustrated by texts. Students can also ask question by applying the developed Text Transmission Subsystem. Teacher can reply the student's question by using the *Electronic Blackboard Subsystem* or *Text Transmission Subsystem*. Fig. 6 displays a snapshot of *E-Blackboard*, *Powerpoint Broadcasting*, *Voice and Image Transmission*, and *Text Transmission* subsystems.

■ **Functions designed for both Notebook and PDA**

(1) The web-based teaching environment.

This environment will help teacher and students to download the ready-made teaching material from internet to notebook or PDA and perform the teaching activities in a wireless internet environment.

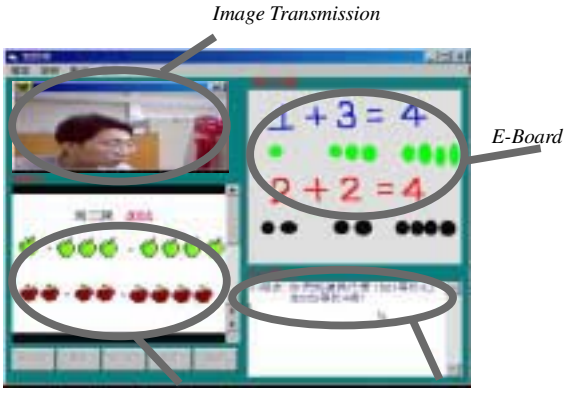

Figure 6: A snapshot of *E-Blackboard*, *Powerpoint Broadcasting*, *Voice and Image Transmission*, and *Text Transmission* subsystems.

(2) The real-time examination subsystem in the web-based environment.

Teacher can execute a real-time examination after a teaching activity so that the learning performance of each student could be evaluated immediately.

(3) The *Electronic Book* (*E-Book*) subsystem.

A FTP (File Transfer Protocol) driver in WinCE based PDA is developed by subproject designers[14] so that student may download the E-Book contents from a PC-based machine. Contents of the health education of grade five of elementary school are designed as an E-Book. The E-Book subsystem also provides students with functions such as viewing of the E-Book, changing the current page, searching the keyword, and so on.

(4) The *E-Notebook* subsystem.

The *E-Notebook* subsystem designed in PDA provides an interface for students to take notes during learning in Ad Hoc classroom.

(5) The *E-Contact Book* subsystem

The *E-Contact Book* subsystem designed in PDA provides a communication channel for teacher and the parents. The user interface of *E-Contact Book* is designed according to the Contact Book currently used in elementary school.

Teacher may put record of specific student's learning status and examination results in the designed *E-Contact Book*. Parents of each student are required to input the password and then communicate with teacher by writing down some message in PDA. Students can also download the exercises and notice announced by teacher from *Virtual Classroom Center* into *E-Contact Book* that is embedded in the student's PDA so that they can do exercises in a mobile environment.

(6) The *E-Tool Box* subsystem

The *E-Tool Box* subsystem designed in PDA provides some tools such as calculator, pencil case, and so on. Students can open the *E-Tool Box* and select some tool whenever they want. More tools will be designed in the *E-Tool Box* next year.

(7) The *E-Scheduler* subsystem

The *E-Scheduler* subsystem designed in PDA provides functions for daily scheduling in a calendar. Student may input their daily schedule in *E-Scheduler* subsystem and set up an alarm clock to remind himself. It is notable that the announcement made by teacher will automatically insert into the E-Scheduler of all student's PDA. In the next year, we will extend the *E-Scheduler* subsystem with some self-learning functions. Snapshot of the *E-Scheduler* is shown in Fig. 7.

Figure 7: Snapshot of *E-Scheduler* subsystem of *E-Schoolbag* system.

(8) The *E-Weekly Report* subsystem

The *E-Weekly Report* subsystem designed in PDA provides functions for students to record the weekly report. The user interface of *E-Weekly Report* subsystem is designed according to the Weekly Report Book currently used in elementary school. This system provides students with function of recording the weekly report in a mobile environment. Students then upload their reports to the *Virtual Classroom Center*. Teacher may check all students' weekly reports from the server of *Virtual Classroom Center*.

(9) Develop the *E-Address Book* subsystem.

The *E-Address Book* subsystem designed in PDA provides functions for students to record the information of their friends. The information includes telephone number, address, photo, interests, birthday, and so on.

(10) Develop the *Game Shop* for learning while playing

In PDA, we design some interested games that can help students learning while playing the games.

In addition to develop tools for Ad Hoc classroom and eSchoolbag systems, we coordinate and involve with the teachers of elementary school to get their feedbacks and comments in the design of the mobile classroom system. The experimental study of student's learning performance is still under going. We expect that the developed learning environment could improve their learning performance and help to create new learning models for ubiquitous learning.

5 Conclusions

This paper presents the work of learning technology project. Development and functions of Ad Hoc classroom and eShoolbag systems have been illustrated. The Ad Hoc Classroom system helps teacher to create a classroom and take lesson anytime and anywhere, whereas the eShoolbag system establishes a self-motivated learning environment for students. Applying the developed systems, several learning activities and learning models can be executed outdoor. Experimental studies are currently proceeding. Students are expected to get more flexible scope of learning during their convenient time.

Acknowledgement

The authors would like to thank the Ministry of Education, ROC, for partially supporting this research under contract no: 90A-H-FA07-1-4 (Learning Technology).

References

1. N. Davis, "Do Electronic Communications Offer a New Learning Opportunity in Education?" in *Using Information Technology*

Effectively in Teaching and Learning, pp. 167-180, 1997.

2. P. Navarro and J. Shoemaker, "The Power of Cyberlearning: An Impirical Test," *Journal of Computing in Higher Education*, Vol. 11, No. 1, pp. 29-54, 1999.
3. Z. Moore, "Technology and Teaching Culture in The L2 Classroom: An Introduction," *Journal of Educational Computing Research*, Vol. 20, No. 1, pp. 1-9, 1999.
4. L. Cuban, Teachers and Machines: the Classroom Use of Technology Since 1920. Teacher College Press, New York,, 1986.
5. W. Reader and N. Hammond, "Computer-Based Tools to Support Learning from Hypertext: Concept Mapping Tools and Beyond," *Computer and Education*, Vol. 12, pp. 99-106, 1994.
6. S. M. Alessi, and S. R. Trollip, Computer-based instruction. Prentice Hall. Englewood Cliffs, N.J., 1991.
7. J. Bourdeau and A. Bates, "Instructional Design for Distance Learning," *Journal of Science and Technology*, Vol. 5, No. 4, pp. 267-283, 1996.
8. S.-L. Wu, Y.-C. Tseng, C.-Y. Lin, and J.-P. Sheu, "A Multi-Channel MAC Protocol with Power Control for Multi-Hop Mobile Ad Hoc Networks", *The Computer Journal* (accepted).
9. W.-H. Liao, Y.-C. Tseng, S.-L. Wang, and J.-P. Sheu, ″A Multi-path QoS Routing Protocol in a Wireless Mobile Ad Hoc Network,″ in *Proceedings of the First International Conference on Networking* (ICN), Part II, pp. 158- 167, France, July 2001.
10. C.-F. Hunag, Y.-C. Tseng, S.-L. Wu, and J.-P. Sheu, "Increasing the Throughput of Multihop Packet Radio Networks with Power Adjustment", *International Conference on Computer Communication and Networks (ICCCN)*, pp. 220-225, Nov. 2001.
11. The Bluetooth Specification, http://www.bluetooth.org 1.0b & 1.1
12. Pravin Bhagwat, "Bluetooth: Technology for Short-Range Wireless Apps," *IEEE Internet Computing 5*(3), (2001).
13. R. S. Chang and J. L. Chen, Technical Report of Learning Technology, National Donh Hwa University.