A Study of English Mobile Learning Applications in National Chengchi University

By

Foreign Language Center
National Chengchi University
Pei-Chun Che
Han-Yi Lin

Dept. of Computer Science
National Chengchi University
Hung-Chin Jang
Yao-Nan Lien
Tzu-Chieh Tsai

ABSTRACT

The pervasive popularity of the Internet in the past decade has largely changed the way many students live and learn. The latest technology makes it possible for learners to access Real-Time Multimedia information on the Internet. They can also receive immediate feedback from their peers and/or their teachers. Teachers of all disciplines need to modify or at least incorporate the Internet and the concept of mobile learning into classrooms today. This research studies the effectiveness and the behavior of a group of English learning students over a mobile learning platform (NCCU-MLP) developed in National Chengchi University (NCCU). The goal of NCCU-MLP is to improve students' English ability as well as to update teachers' teaching using the latest technology. The result of the study, its limitations, and future possibilities as well as detailed design will be reported in this paper. With this study, the researchers wish to prove the importance of incorporating mobile learning in current English classrooms, and how mobile learning might enhance students' learning motivation.

1. Background

The pervasive popularity of the Internet in the past decade has largely changed the way people process information around the world. It also changed the way many students live and learn [19, 30]. Learning has evolved from the traditional classroom lecture teacher-centered to collaboration student-centered, and to mobile learning that students have direct interaction with the teachers, their peers, and even the world via the Internet. Now, the latest technology has taken learning to the next level. With the installment of WiFi (Wireless Fidelity) or IEEE 802.11 WLAN (Wireless Local Area Network), it is possible for learners to access Real-Time Multimedia information on the Internet. In other words, students with a mobile device such as a PDA, or a notebook computer, can access to the information they wish to know or to learn when they are walking or moving around. They can also receive immediate feedback from their peers and/or their teachers.

Facing a group of students who grow up with the Internet, "digital natives" as researchers called them, teachers of all disciplines need to try to modify or at least incorporate the Internet and the concept of mobile learning into classrooms today [19]. Besides, as more than 70% of the information on the Internet is in English, English has become the most commonly used language for people around the world to access information and to communicate. Thus, how to improve students' English ability is another challenge teachers face today.

Being one of the campuses that celebrates a WiFi environment, National Chengchi University provides its teachers and students a very "mobile learning" context. However, how to encourage students to take advantages of this environment to improve their English has remained unanswered. After a series of discussion and evaluation, a proposal was made by the authors with the hope to combine the learning of campus historical buildings and the latest technology by English learning activities students can participate in as groups to test the feasibility of incorporating mobile learning into a college level English class. Also, as NCCU being the top internationalized university in Taiwan, both local students as well of foreign students on campus should be able to take advantage of this "mobile learning" context. Thus, all building introductions are in both English and Chinese for foreign students to access campus history and improve their Chinese in yet a different approach. However, the emphasis of this study and chapter is not Chinese learning but English learning. Thus, the effectiveness or feasibility of Chinese learning using mobile learning device will not be discussed here.

This chapter is the result of the preliminary study on the issue mentioned above. It will be roughly divided into three main parts. First is the review of the evolution of learning in the past decades, theory of mobile learning and the significance of its application in learning. In this section, the gap found in the literature review will also be discussed. In the second section, the design of the group activity and the technical support will be described in details. The last section will focus on the discussion of the result of the study, its limitations, and future possibilities. With this chapter, the authors wish to prove the importance of incorporating mobile learning in current classrooms, and how mobile learning might enhance language learning.

2. **Literature Review**

To receive an education, schools are no longer the only option for students. In fact, one can take courses at any time and any place, tailored to one's needs. Such is the nature of distance learning (d-learning), where students and the instructors are separated by time and/or distance [6]. D-learning offers numerous advantages, especially for those who need flexibility in their life, such as learners with restricted mobility, irregular work schedule or family responsibilities. In addition to having freedom in time and location, d-learning is also student-centered. Not only do learners choose their materials, they also proceed at their own speed and intensity [28]. Students are not the only beneficiary of distance learning, institutions can increase their revenue by delivering education to distance learning students; the class size increases while overhead stays the same [29].

Though distance learning is often thought to be a new form of education, it actually has a history of over one hundred years. As early as the nineteenth century, efforts were made to promote adult education beyond university campuses using correspondences. With technological improvements, more and more mediums have become available to serve as educational tools. During the World Wars, the concept of serving education through radio was developed when broadcasting licenses were granted to many higher educational institutions by the U.S. government. Though the concept never took off, it prompted research in other possible mediums, such as educational television in the mid 20th century. A few decades later, in the 1970s and 1980s, cable and satellite television and videotapes were used as delivery tool for distance learning courses [17, 29].

With the advancements of technology in the 1980s, the electronic learning (e-learning) era was in rein. It compensated for a major defect in distance learning, the lack of face-to-face learning. It became possible for teachers to instruct a class in another country, and have real-time discussions with their students. By using the three major didactic uses of technology, satellites, videoconferencing, and the World Wide Web, learners were able to interact with their instructors and other learners. However, in the e-learning environment, the equipments decided where learning would take place. The cables and wires restrict learners to move around, as seen in Figure 1 [11].

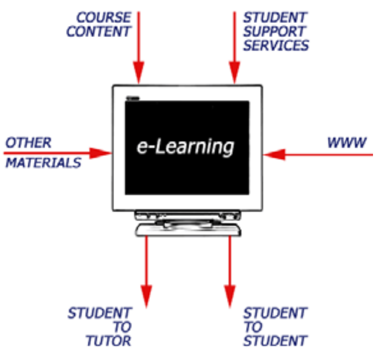


Figure 1: The e-learning environment [11]

As technology advanced to its wireless phase at the end of the 20th century, devices as cell phones, and laptop computers incorporated with wireless communications (e.g. Wi-Fi) and technologies (e.g., 3G) allow learning to become interactive, taking place at anytime and anywhere [6]. Nevertheless, the term “mobile learning” (m-learning) has different definitions depending on the viewpoint one takes. From a more technological perspective, Quinn [20] views m-learning as learning made possible through mobile devices. In line with that definition is O'Malley, C. et al [18], where m-learning is seen as“[a]ny sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies.” Sharples [21], on the other hand, takes on a more constructivist view on m-learning; he believes that mobile technology increases the amount of communication and interaction in learning. This research project will adopt the m-learning definition by Sharples, Taylor, and Vavoula [22], which is “the processes of coming to know through conversations across multiple contexts amongst people and personal interactive technologies.”

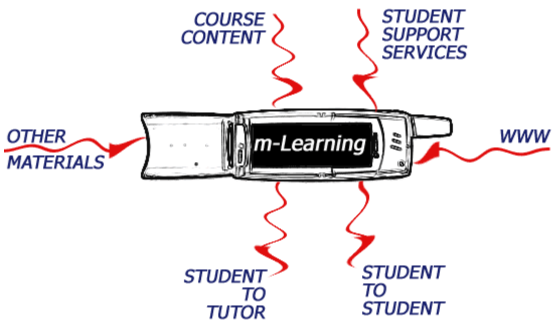


Figure 2: The m-learning environment [11]

M-learning significantly improves the education environment in e-learning, as seen in Table 1 [14]. From the pedagogical perspective, m-learning allows more types of instruction and gives student flexibility in their environment. When learners communicate with the teacher and other fellow students, m-learning is instantaneous, spontaneous, not restricted by time or geographical locations.

Table 1: Differences between e- and m-learning (Modified from Laouris & Eteokleous [14]**)**

	e-learning	m-learning
Pedagogical differences	Lecture in classrooms, home, or in Internet labs	Learning occurring in the field or while mobile (Anywhere)
	Lecture at restricted time	Learning occurring at non-restricted time (Anytime)

Communication differences	**Teacher vs. Student**	
	Time-shifted (delayed checking of e-mails or web)	Instant delivery and check of e-mail or Instant Messages
	Scheduled	Spontaneous
	Student vs. Student	
	Restricted location	No geographic boundaries
	Travel time to reach to Internet site	No travel time to access WLAN
	Poor voice communication due to public courtesy	Rich voice communication due to reduced inhibitions in open field

Today's students are different from their predecessors; these students are the first generation growing up in a ubiquitous computer environment. Prensky [19] labels them as "digital natives", who are born in the digital era, fluent with the use of technology. Digital natives carry out many daily activities online, such as chatting with their friends via instant messaging, meeting new people on virtual communities, and doing their shopping online. With wireless technology combined with portable gadgets, students can conduct these activities anytime, anywhere. Students nowadays are characterized as those who are accustomed to on-demand information, multi-tasking, preferring visuals to texts, and constantly networking [19, 30]. As most instructors are born before the digital era, they never experienced what their students went through. The instructors will encounter problems applying conventional methods that worked for them in the past to this new breed of students. Presnsky [19] urges instructors to communicate in the style of the students to bridge the gap between them.

Mobile learning is the answer to the students' needs because of its numerous advantages. First, learning for students is no longer restricted in terms of physical space or time; rather, they are able to engage in nomadic learning. At any time or place, students can easily access learning materials of their choice. Teachers are able to conduct lessons outside of the classroom, into students' surroundings. The learning then becomes more contextual, and personal, rather than hierarchical and lecture-recited [16]. Furthermore, students make better use of their time because of mobile learning. They receive formal learning experience (e.g., taking a class, attending a workshop) with informal learning experience (e.g., on a school bus). Students could be using their time more efficiently.

Secondly, ubiquity of wireless devices and services allows mobile learning to be easily integrated into peoples' lives. By the end of first quarter of 2006 in Taiwan, there are 22.51 million cell phone numbers in use, and about 1.91 million people, subscribe to mobile Internet service, allowing them to be connected to the web using their cell phones. Moreover, the popularity of WiFi in Taiwan has increased annually (see Figure 3). Lastly, the prices of personal digital gadgets continue to decrease as time goes by, making them more affordable to the public. Hence, they provide more opportunity for people to access to mobile learning [30].

Taiwan has high population of Internet users. The nation's population totaled 22.75 million as of October 2005, and more than 65% uses Internet services as seen in Figure 3. The number of Internet users has steadily grown over the last four years, as shown in July 2006 Taiwan Network Information Center (TWNIC) summary report of Internet broadband usage. In just a few years, a sixty percent of growth, or six million users, used Internet service. More impressively, approximately one out of five Internet users use wireless Internet services as of 2006, and the number of wireless customers continues to climb annually (see Figure 4). The number of wireless Internet users has doubled, from one and half million to three million in just two years, from July 2003 to July 2005. An additional half a million used the service in the next one year duration, from July 2005 to July 2006. We can expect the number of wireless Internet users continue to increase, as the government is actively promoting the wireless services.

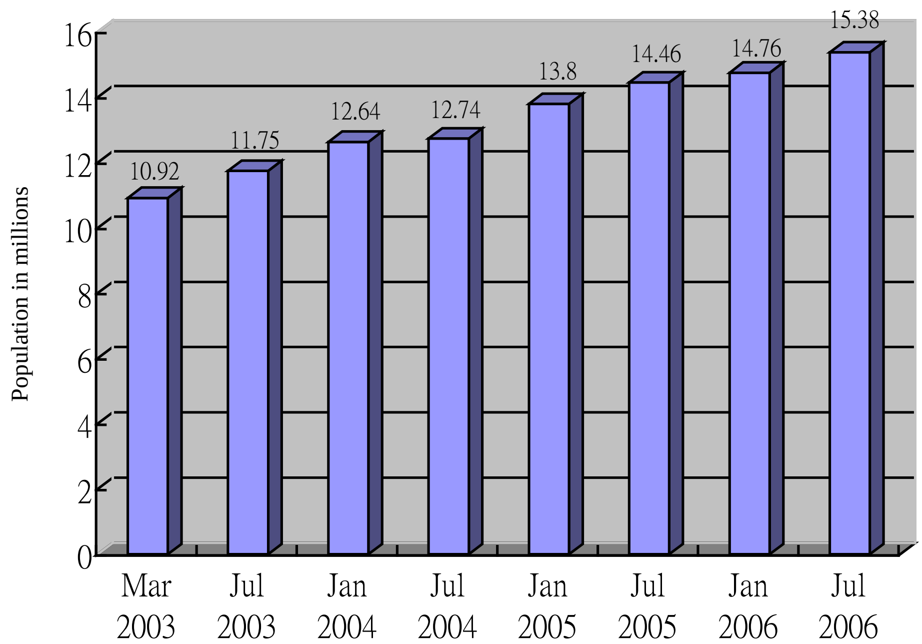


Figure 3 : Growth of Internet users in Taiwan from 2003-2006

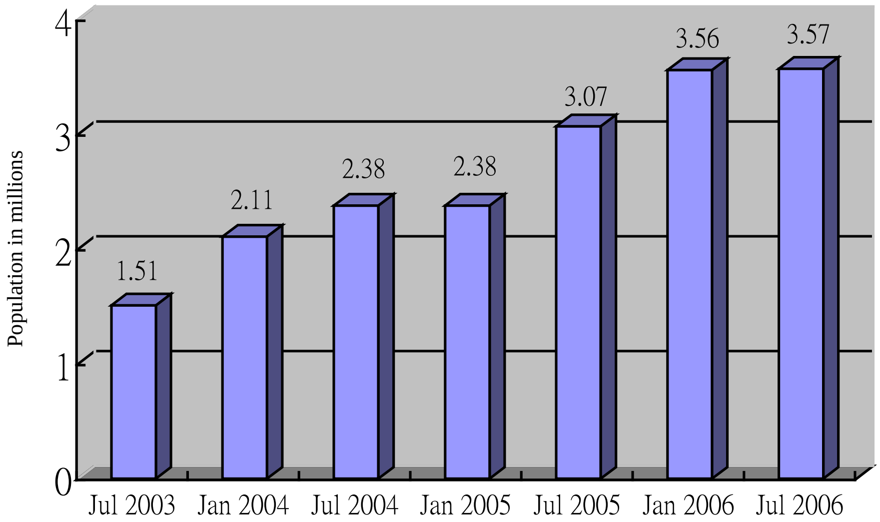


Figure 4 : Growth of wireless Internet users in Taiwan from 2003-2006

3. **Theoretical Underpinnings**

Learning with mobile technology can be examined using an adapted version of Engeström's [4] expansive activity model, which originated from activity theory. The theory was developed from Sociocultural theory, founded by Vygotsky, Leont'ev, and Lauria in the 1920s and 1930s, but was only internationalized half a century later, in the 1980s and 1990s [5]. The basic tenet of Sociocultural theory is that the human mind is mediated and relies on tools and labor activity, to establish indirect relationship among themselves and the world [13]. The tools may be symbolic, such as language, or physical, like computers. Activity theory is an extended theory developed from Sociocultural theory, focusing on Vygotsky's claim [13, p. 8] that "human behaviors results from the integration of socially and culturally constructed forms of mediation into human activity."

Engeström illustrates how activity theory applies to education in his expansive activity model (see Figure 5). To achieve the final outcome of learning, may it be one's well being, or success, the premise is to produce objects, in this case, knowledge. The subject, or the learner, engages in activity in order to obtain the object (knowledge). During the process, the learner uses artifacts, or mediating instruments, which includes both tools and signs (e.g., language, learning resources), to conduct the activity. Another element that mediates activity is the community, which composes of individuals or group involved. The subjects may share responsibility of achieving the objective with the community, realized through division of labor. Finally, the community may establish rules, referring to the regulations and norms that restrict actions and interactions of the subjects [4].

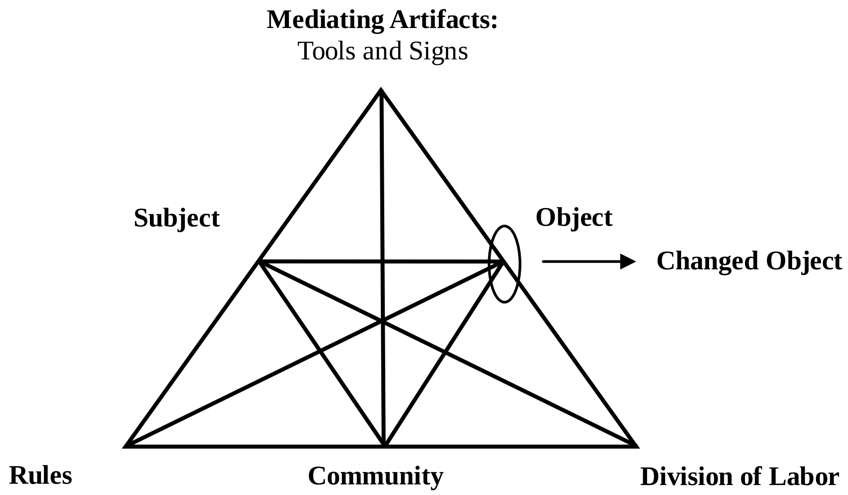


Figure 5: Engeström's expansive activity model [4]

A modified Sharples et al. [21] model of mobile learning explained using the activity theory will serve as the framework for this study. The mediating artifacts refer to the mobile learning technology, which the subjects, in this case the students, mediate in their learning activity. Control refers to issues regarding human-computer interaction, such as rules indicating acceptable behaviors (e.g., network etiquette) in operating mobile devices students must adhere to during learning. The students will conduct the activities in various buildings on campus, the context they will be exploring. During the activity, students will communicate with their peers, and also interact with their laptops to gather information. Finally, students' knowledge and skills should be improved and revised upon completion of these activities. By integrating mobile technology with learning, an optimal learning environment that caters to needs of today's students is provided. Figure 6 below is an illustration of this modified model.

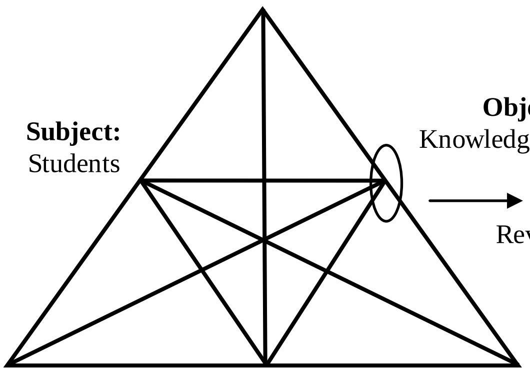


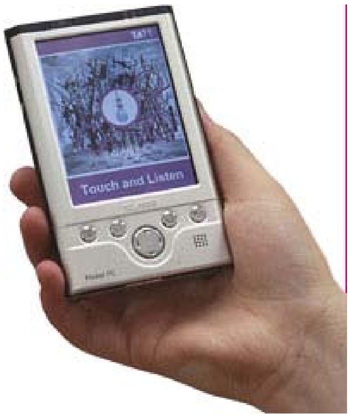
Figure 6: Modified Sharples et al.' activity theory model of mobile learning [21]

4. Relevant Mobile Learning Studies

4.1 Tate Modern Multimedia Tour

In 2002, Tate Modern Museum in the UK launched a multimedia guide for visitors to learn more about the art of its galleries [24]. A three-month pilot project studied how visitors evaluated the guide. Visitors used PDAs that provided them with more contextual information of the artwork on display via different medias, such as still images, audio clips, and videos. Visitors could use the interactive screen to select the media desired, and play games and quizzes about the work. The wireless network in the project is location sensitive, meaning correct information is sent to the visitors at the right time and place. As a central server stores all the information, the content sent to the PDA is limitless in continent and easily updated. 825 visitors participated in the pilot study, and questionnaires and focus groups were used to gather feedback.

The results showed that the visitors enjoyed the tour, spending an average of fifty-five minutes, and seventy percent commented they had spent longer in the museum than expected, and a similar percentage said the tour had improved the quality of their visit. Multi-tasking and multi-tracking of different media (e.g. looking between screen and artwork) was not a problem for the users. However, they did not tolerate long messages and blank screens. Using PDAs to enhance learning is thoroughly proven in Tate Modern Museum's media guide. The following photos are taken from Tate Modern, 2002.

		
The interface of the PDA	Visitor taking the tour	Visitor taking the tour

4.2 Butterfly- Watching System

A mobile butterfly-watching learning system [3] was developed for fourth grade Taiwanese elementary students to learn about local butterfly species. The experimental group was divided into teams of two, and each team received a PDA with a LAN card and a digital camera. The teacher used a notebook with a wireless LAN card system that acts as the server, containing a database of the butterflies in Taiwan. The students visited a butterfly farm six times. The first step of the procedure is self-selection, where students take pictures of butterflies. Second, in self-determination, students transfer the photo to the database to find possible matches. Next, in self-modification, students modify their previous search to arrive at the final decision. The last step is for students to record their findings and their learning process on their journals, and then the teacher sends her comments to the students on their PDAs. The experimental group was compared with control group, who used a butterfly textbook instead of mobile system. To evaluate the learning effects of mobile system implemented, multiple-choice questions on butterflies' key features were administered before and after the trial. Results showed that the experimental group did better than the control group in identifying key features. The following photos are taken from [3].

	
Interface of the PDA	Test sheet for evaluation

4.3 Short Message Service (SMS)

A study in Japan was conducted to see how university students' acquired English vocabulary using SMS [25]. Forty-four students received 100-word text messages three times a day, for a period of two weeks. For each week, students study five vocabularies used in context and constantly reviewed. The medium of learning vocabulary through cell phone is then compared with Internet and paper-based materials. In the first experiment, a within-in subject, counter-balance design was used. One group of students received a set of ten word vocabulary from their cell phones while the second group logs on the instructor's website to retrieve the same material. After two weeks, the groups switch the media and the experiment ran for another two weeks. The results from pretests and posttests showed that mobile text messaging showed an improvement over using Internet method. In the second experiment, one group of students learned vocabulary via SMS while the other received vocabulary on paper. The same tests were run, and the results show that students who studied by mobile text messaging does significantly better than the other groups.

5. Gap Found in the Literature Review

In the domain of mobile learning, most studies are conducted in science education, with little studies in language learning and teaching. In Taiwan, the studies focused mainly on elementary education. Numerous studies implement mobile gadgets such as tablet PCs and PDAs in elementary schools to see how effective these devices are for students' motivation and learning. Content of the studies included aquatic life [10, 26, 31], botany[15] and bird-watching [23]. The results from these studies indicate positive results for motivation, though in some cases, the effectiveness is not more significant than conventional methods. There is lack of studies in the area of integrating foreign language education and mobile learning, especially in higher education. Hence, the purpose of this study is to address the blind spot with the hope to explore future possibilities in incorporating mobile learning in university classrooms.

6. Technical Support and Activity Design

Before designing an English learning activity that can be used by NCCU students on campus, the first question needs to be answered is “What should or can students learn on campus using mobile devices?” The answer, after discussion, is the history and the stories of some old buildings on campus. By adopting the activity model proposed by Sharples et al. [21], students learn the knowledge in a context with a group of peers using English and a mobile device as the tool when participating in this activity. Unlike the Japanese study discussed above, English in this activity is not just the goal of learning, but also a tool to learn new knowledge, and a tool for communication with the peers. Also unlike the Japanese study, students do not passively receive information but actively participate in a group activity sharing and exchanging the information they receive with their peers in order to learn new knowledge.

However, before such a group mobile learning activity can be designed, the establishment of the audio, video and text files of these buildings, and the confirmation of technical support are vital. As a result, a field investigation of the buildings and the study of their histories were conducted by the authors. Photos were taken and the content of the introduction were recorded in digital files. On the other hand, a series of experiments were conducted as well to ensure the “friendliness” of the campus. In the following sections, the experiments conducted and the decisions made on the technology side, and the detailed design of the group activity will be discussed.

6.1 Technical Support

6.1.1 NCCU-Mobile Learning Platform (NCCU-MLP)

In order to investigate the feasibility of mobile learning on campus, the activity designed needs to be able to foster group work, peer communication and Internet access while subjects walk or move around. Thus, a NCCU-mobile learning platform (NCCU-MLP) is implemented to meet these needs. This platform consists of three main subsystems which are Instant Communication subsystem, Positioning subsystem, and WiFi Multimedia subsystem as shown in Figure 7.

Instant Communication subsystem has Instant Message and Push-to-Talk to exchange text messages and voices among a group of parties. Positioning subsystem is used to determine the locations of the users through surrounding WiFi access points (APs). NCCU-MLP has to dynamically detect the user location first then access the right learning materials. WiFi Mutimedia subsystem has WiFi TV to play IPTV programs, WiFi Radio to listen to radio stations, WiFi Theater to support movies on demand, WiFi Music Station to play local music, and WiFi Monitor to support on site real-time video monitoring. WiFi Multimedia subsystem is programmed by Microsoft Embedded Visual C++ 4.0 and Java JMF (Java Media Framework API). Both the Instant Communication subsystem and Positioning subsystem are integrated under Java programming environment.

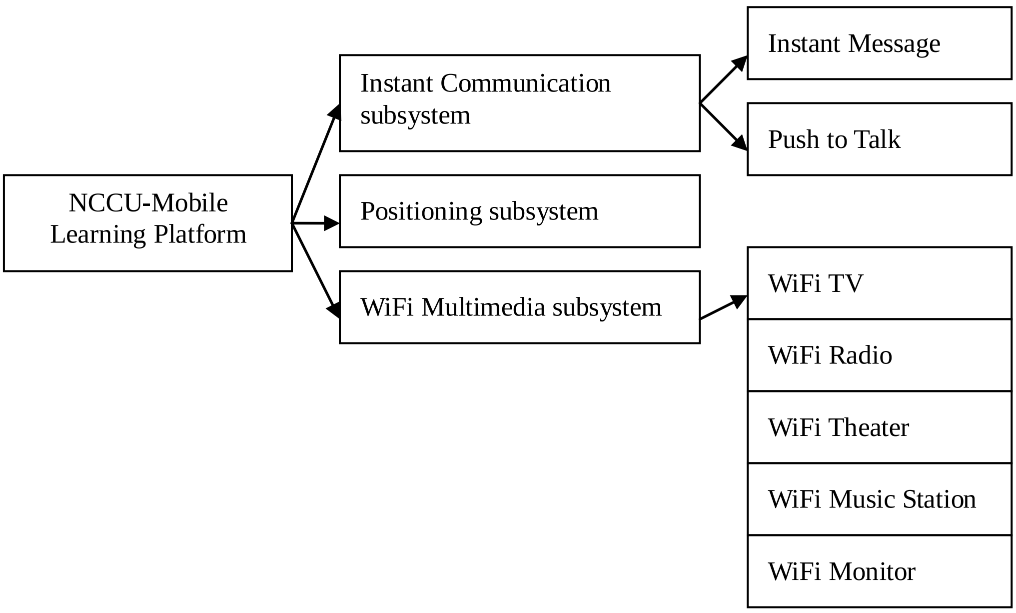


Figure 7：NCCU-mobile learning platform

In the following sections, a brief description of the three subsystems will be presented.

6.1.2 Instant Communication Subsystem

6.1.2.1 Characteristics of Group Communication

As stated earlier, in order to test the feasibility of mobile learning on campus, the activity designed must be able to foster group work and peer communication on the move. In other words, a wireless instant group communication system becomes a very important part of a mobile learning environment. Generally speaking, a mobile group communication system must be inexpensive in cost, convenient in use, and comprehensible in quality.

Before discussing what might be the most appropriate system to be adopted for this study, it is important to understand the demands of an instant group communication. The demands are as follows:

- the system must be able to manage the group membership, including adding, removing, and authorizing group members;
- a user must be able to initiate a "talk" to all members in one touch (it is not desirable to have callers to call all members one by one);
- a user must be able to broadcast his/her "talk" to all other members;
- the communications must be able to proceed in full or half duplex conversation mode. (In full duplex mode, any user can talk to all others at any time, while in half duplex mode, only one user can talk to all others at a time);
- the communication delay time MED (the time latency from talker's mouth to listeners' ears) must be controlled within a reasonable limit. (The maximum allowable MED is yet to be determined);
- the consumed network bandwidth must be kept as low as possible;
- users must be able to communicate with others in writing or drawing.

Though the last characteristic is essential in a mobile learning system, as the subjects in this study may need to communicate to each other by writing or drawing to assist voice communications, it is not the priority of this section to discuss the use of “White Board” in this study. Voice communication will be the main focus here.

6.1.2.2 Selection of Communication Technology

With inexpensive in cost, convenient in use, and comprehensible in quality in mind, researchers in this study evaluated several possible means to be used in this subsystem. The evaluation consists of two steps. The first step is to choose to use either public cellular phone system or Internet-Based VoIP (Voice over IP network) system. With its high quality and stability, public cellular phone system is an ideal communication system to meet this study’s need. However, it is simply too expensive to use. Thus, VoIP over WLAN is chosen for this study, although it has a lower reliability and quality (long MED delay, large jitter, and high packet loss rate).

The second step is to choose to use either half-duplex or full-duplex conversation mode. Full-duplex conversation mode, also named "Conference Call", is a better conversation mode in a high bandwidth and high quality communication system. On the other hand, VoIP over WLAN has a limited network bandwidth and a lower quality in delivering voice streams. Thus, it can only support a very limited number of simultaneous users with what is called "double talk" problem. However, half-duplex conversation mode, which has a popular name, "Push-to-Talk" (PTT), consumes less network bandwidth such that it can support more simultaneous users. Furthermore, it allows only one user to talk at a time such that it can tolerate much longer MED delay to avoid double-talk problem. Therefore, PTT is chosen to be implemented on the NCCU-MLP system.

6.1.2.3 Subsystem Design and Implementation

As a result, the PTT functionality is implemented in Java programming language and is an integral part of the NCCU-MLP System. A group management system is deployed in a server located in the Mobile Communication Lab. The server also performs the re-broadcast function. Subjects of this study push a button on the NCCU-MLP system to acquire the right to talk. The server will grant the right to only one subject. The one that obtains the right can talk to the group. The system uses G.711 Codec to convert the voice into packets and sends them to the server. These voice packets are then broadcast to all other subjects. (Since G.711 consumes 64k bps bandwidth, it will be replaced by either iLBC or G.729a Codec to reduce bandwidth consumption.)

6.1.3 Positioning Subsystem

The current most popular positioning systems are GPS (Global Positioning System), infrared, ultrasonic and RF (Radio Frequency). Among them, RF suits the best for this study for the following reasons. First, since the activity is conducted indoors, GPS fails to meet the needs. Second, infrared or ultrasonic positioning usually needs more receivers installed for good coverage, and thus is not cost-effective. Third, PDAs or small laptops equipped with mobile users are embedded with WiFi which uses RF to connect to AP (Access Point) to access Internet, and can penetrate walls and thus have better coverage than infrared systems. As a result, using RF-based positioning system is the most promising and convenient for this study.

6.1.3.1 RADAR and Its Limitations

Among all RF-based works, RADAR and its variations are probably the most famous and popular ones [1, 12]. RADAR refers to a positioning system which requires a construction of a RM (Radio Map) by measuring RF SS (Signal Strength) for every grid point of any given space before it can be used. The biggest disadvantage of the process of constructing RM, known as calibration, is time consuming because in order to achieve accuracy, more calibration data in RM is required be measured manually to fight the otherwise fading channel.

With this limitation in mind, RADAR would not be ideal for this study. In the following section, a modified RF-based positioning subsystem is proposed to maintain the accuracy while reducing calibration efforts.

6.1.3.2 Modified RF-based Positioning Subsystem Design and Implementation

In order to achieve acceptable accuracy while reducing the time and man-power investment in positioning subsystem, the following measures are taken. First, instead of measuring SS for many points manually, a few points, one, three or five, in any given space is measured in the offline calibration phase. After the few points are measured, researchers, then, carry the WiFi device to walk around this space and pause 3-5 seconds at random spots for the system to collect data. Third, after this process, the system can automatically "learn" or trace the most possible path using HMM (Hidden Markov Model) and wireless channel propagation model in order to complete the RM necessary for positioning system to function.

In this study, a space with a dimension of 11X52 meters is used for testing. With one, three, and five calibration points measured prior random trace points are learned, Figure 8 below demonstrates how our modified positioning subsystem increases accuracy with the increase of "learned" trace points.

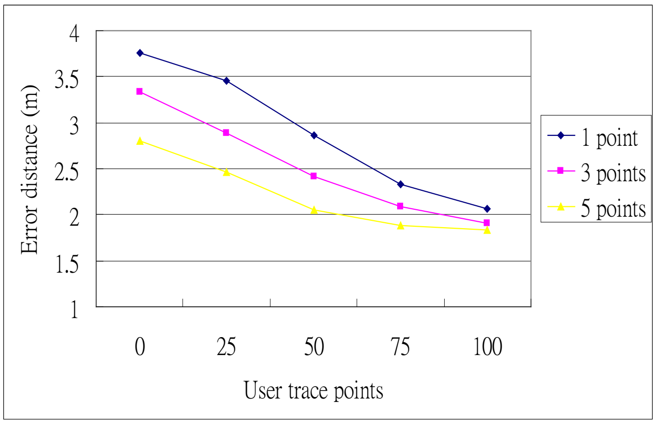


Figure 8: Accuracy of reducing calibration effort

Compared with RADAR and its modification Microsoft positioning system, the proposed modified positioning subsystem adopted in this study performs the best with the least time investment as shown in Table 2 below.

Table 2: Comparison of different positioning systems

	Our Modified Subsystem	RADAR [1]	Microsoft [2]

Mean error distance (m)	2.89	1.92	9.19
Reduced calibration effort percentage	99%	0%	90%

6.1.4 WiFi Multimedia Subsystem

6.1.4.1 System Architecture

The NCCU-MLP is implemented as a client-server model. The WiFi Multimedia subsystem (except WiFi Monitor) is based on a VLC (VideoLAN) media player framework as shown in Figure 9. VLC media player is a highly portable multimedia player for various audio and video formats (MPEG-1, MPEG-2, MPEG-4, DivX, mp3, ogg, etc.) as well as DVDs, VCDs, and various streaming protocols. It can also be used as a server to stream in unicast or multicast in IPv4 or IPv6 on a high-bandwidth network.

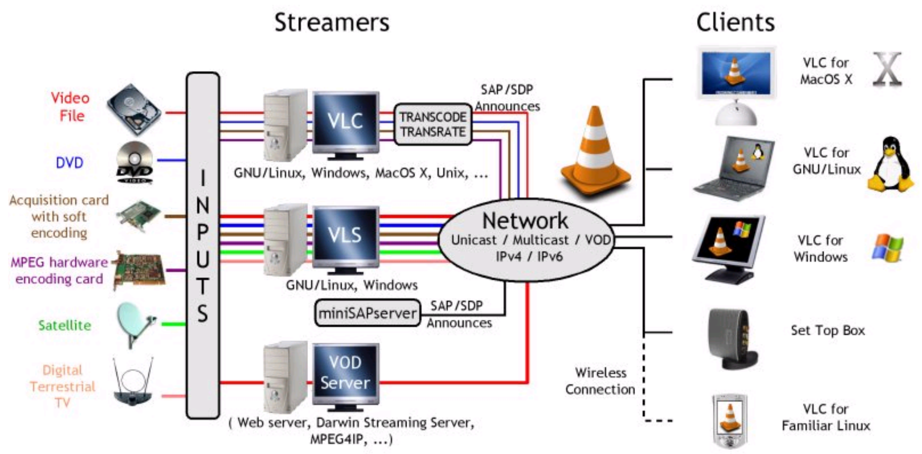


Figure 9：VLC media player framework (http://www.videolan.org/vlc)

6.1.4.2 Server Side

At the server side, video is captured by a Video Capture Filter. The capture filter will then select appropriate Video Compress Filter to compress the video according to the bandwidth of information flow and hardware equipment. All those processes for the audio are done in a similar way. Both the compressed video and audio will be mixed by a Video and Audio Mixed Filter. At last, video and audio streaming is sent through Network Transfer Filter.

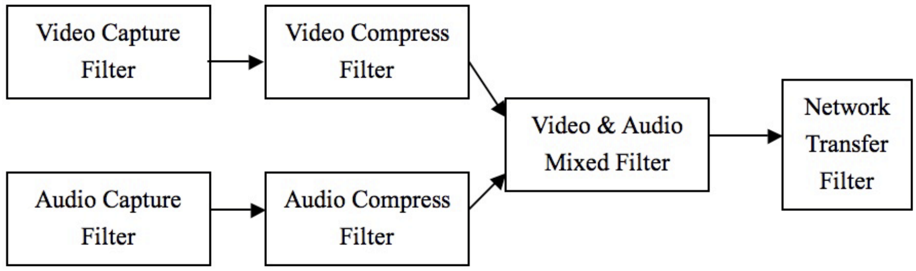


Figure 10：Media process at the server side

6.1.4.3 Client Side

Client retrieves the information flow through WiFi, and separates this flow into video and audio through Splitter Filter. Both the split video and audio are sent to Video Decompress Filter and Audio Decompress Filter, respectively. The decompressed video is received by Video Receiver Filter, and audio by Audio Receiver Filter. Output devices can be any kinds of monitors and speakers.

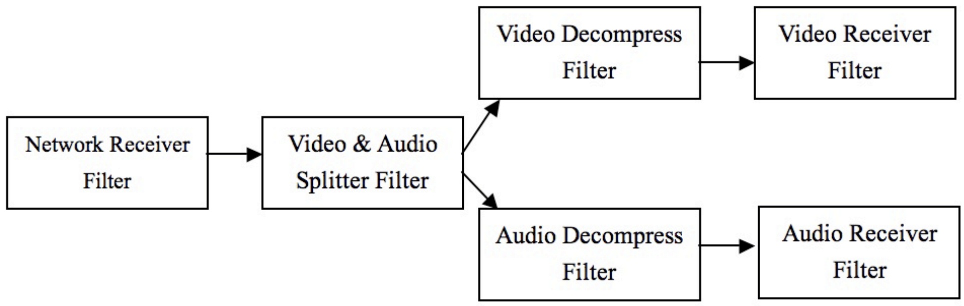


Figure 11：Media process at the client side

Figure 12 shows the main page of NCCU-MLP. On the left side, there are “Talk to Others”, “Video”, “Media”, and “Questions” buttons. The logo of our system displays on the right side. Pressing the “Talk to Others” button, subjects of this study will be prompted a small window of two parts to the left side of the original window. The window above is for Push to Talk, the window below is for Instant Message. Before subjects talk or write to others, they should select group of persons from the contact list. “Push to Talk” button and “Stop to Talk” button are used to start and end the talk session, respectively. Once the button of “Push to Talk” is pressed, subjects’ voice will be sent to each person in the group. When using Instant Message, subjects only need to type messages and press the “Send” button. Pressing the “Video” button, subjects will be prompted with a tour navigation video. One of the videos will be intelligently selected according to the locations the subjects are on campus. As long as the mobile learning device is on, subjects’ locations will be dynamically tracked by the Positioning Subsystem. Pressing the “Media” button, subjects can access all multimedia services, such as WiFi TV, WiFi Radio, WiFi Theater, WiFi Music Station and WiFi Monitor. Pressing the “Questions” button will bring subjects to the learning assessment system.

Figure 12: The main page of NCCU-MLP

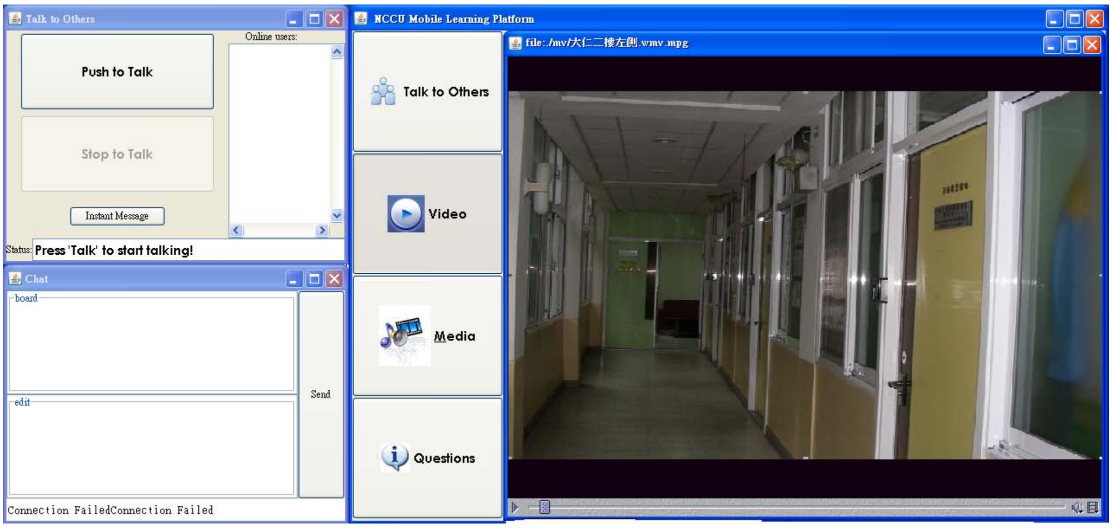


Figure 13: The “Talk-to-Others” and tour navigation video of NCCU-MLP

6.2 Activity Design

With the above technical support, the mobile learning activity is designed as follows:

6.2.1 Subject

A total of 18 students from one English Honors Program freshman class were chosen as the subjects of the pilot study. Another group of 37 students from two English Honors Program classes were chosen as the subjects of the main study.

Students' average English proficiency is high as their Joint College Entrance Exam English score ranked as top 1% among all freshman students. In pilot study, students were divided into 5 groups of 4 or 5; while in main study, due to the limited amount of mobile devices, two sessions of main study were conducted. Again, students in each session were divided into 5 groups of 4 or 5. Each group was assigned to one of the five buildings on campus to fulfill several tasks designed by the research team.

6.2.2 Activity development

The activity is a timed activity. Subjects have 50 minutes to finish answering five questions regarding the campus historical buildings. At the end of the 50 minutes, subjects are required to submit answers of these questions on line to the researchers. With the technical support, Tablet PC is chosen as the mobile learning device.

In accordance with the features of these five buildings, researchers designed five questions for each building. In order to foster group and peer communication on the move, the questions were categorized into three types. They are "compare and contrast", "current events" or "on-site interviews", and "important dates, numbers or figures". Compare and contrast questions require subjects to compare and contrast information with other groups. For example, subjects need to exchange information in order to answer which building is the oldest on campus. Current event or on-site interview emphasizes the mobility in this activity. For example, subjects are required to find out one professor's teaching schedule for the semester. Important date, numbers or figures, on the other hand, expect subjects to collect information from different floors in the building to answer questions like the total amount of labs in that building.

Most important of all, among the five questions that are given to subjects who are assigned to a certain building, only one is related to that building. The rest of the four questions are questions for other buildings. With this design, subjects are forced to do constant communication using the mobile device they have while walking up and down the building they are assigned.

Additionally, an online questionnaire in relation to content, procedure, technical support and mechanism was designed and used to verify the effectiveness of the group activity and students' motivation.

6.2.3 Procedure

With the consent of students, the pilot study was conducted on June 8, 2007 and the main study on December 13 and 14, 2007. After students were divided into 4 or 5-person groups and assigned to five different buildings on campus with Tablet PCs at hand, a 20-minute orientation concerning the steps, tools and equipments used was given. Subjects were firstly asked to learn the history of the building they were assigned using the NCCU-MLP presented on their Tablet PCs. Then, within the following 50 minutes, each group was asked to communicate with other group members using Push-To-Talk, whiteboard, and other technology supported by the PC. At the meanwhile, through learning and sharing information of the building, subjects were asked to download a worksheet containing questions related to different buildings, give answers to the questions and then submit them via the mobile device to the Sever. At the end of the activity, subjects were asked to fill out an online questionnaire to verify the content, feasibility, user-friendliness, and mobility of the developed materials. Subjects' every communication during the activity was recorded and transcribed for evaluation and study. A quantitative analysis was applied to students' online questionnaires.

A brief of the study result and its limitations will be discussed in the last section of this chapter below.

7. Results, Limitations and Future Possibilities

To assess the effectiveness of this group activity, improve students' motivation for language learning and assist in developing a model for m-learning in universities, an online questionnaire in relation to content, technical support, procedure and mechanism was designed. Subjects in both pilot and main studies filled this questionnaire. Quite a few technological flaws were improved and debugged after the pilot study and the analysis of questionnaire result.

7.1 Results

In this section, only the result of the main study will be discussed briefly below. In this survey, 30 respondents from two classes out of 37 subjects ranked their degree of satisfaction concerning the criteria mentioned above and further provided additional information for this learning experience by responding to 4 open-ended questions. The followings are the four charts illustrating the outcome of the online questionnaire.

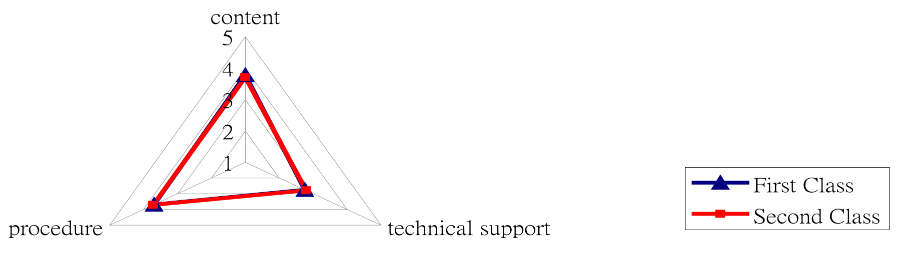


Figure 14: Overall response to content, procedure, and technical support of this activity

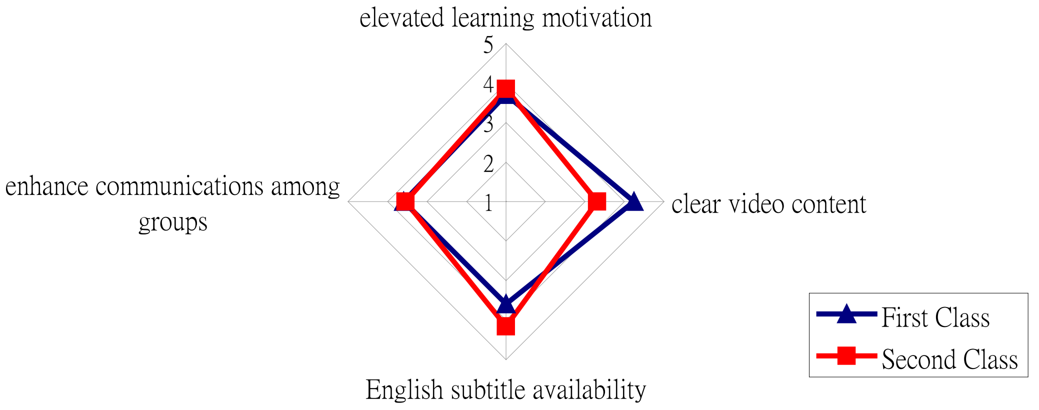


Figure 15: The analysis of content

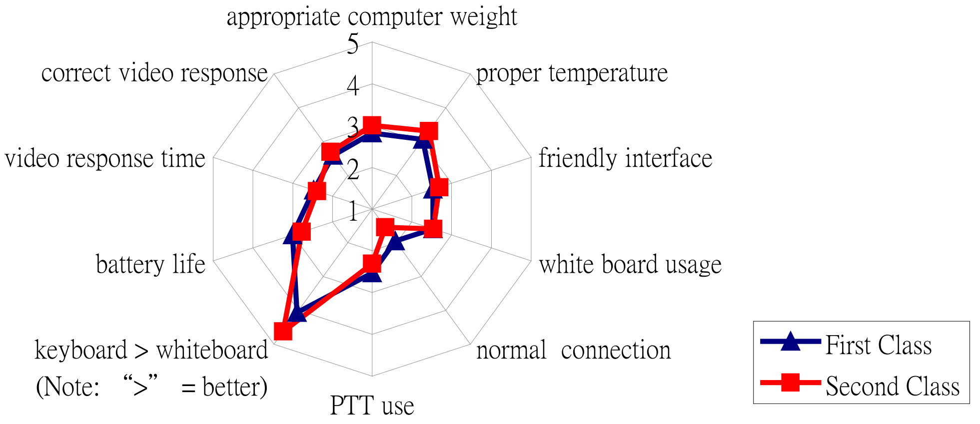


Figure 16: The analysis of technical Support

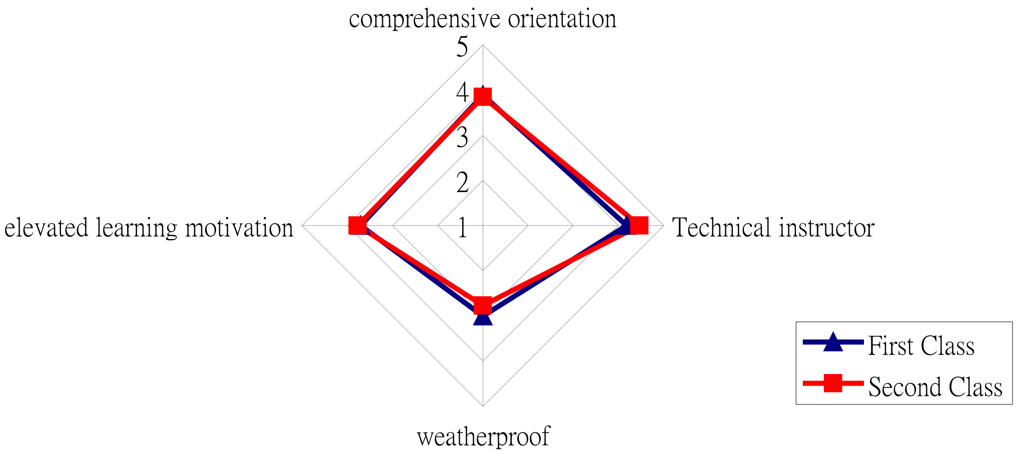


Figure 17: The analysis of procedure

Figure 14 shows an overall evaluation in terms of these 3 criteria concerning content, technical support and procedure. It indicates that the study result of these 2 classes is consistent with each other. They had a close rapport with the use of content and the implementation of the procedure, but ranked technical support a bit lower than the other 2 criteria.

Figures 15 and 17 show the analyses of these 3 criteria respectively. Figure 15 focusing on content indicates students considered the material design and interaction among groups rich and English subtitles essential. Over half of students agreed that the questions designed in the activity can enrich communication in teams and collaboration through discussions with others at a distance. Furthermore, 21 students would like to consult English subtitles when replaying the video clips, while 4 students did not consider it essential. However, they had different views on if the video clips were explained clearly. 23 students agreed the oral descriptions of the video clips were of such clarity, while 4 students remained neutral and 3 disagreed upon this item.

Figure 16 illustrates that students needed more technical support from some improvements in the mobile devices themselves, the interface, the use of whiteboard, mobile network connection, etc. The limitations of technical support will be further discussed in 7.2.

Figure 17 shows students were satisfied with the procedure of this group activity in relation to the inclusion of some technical instructors and a comprehensive orientation, except for the inconvenience and a certain lack of mobile device effective performance caused by the unpredictable weather condition. Around 26 students have proved that technical assistants played an important role in implementing this activity.

Also, around 21 respondents were pleased with the comprehensive orientation given at the beginning of the activity.

In general, these 4 figures illustrate that students showed great interest in using this innovative learning method; however, they felt a bit frustrated and overwhelmed when technical part was not so supportive and helpful.

In the following section, limitations and future possibilities will be discussed in more details.

7.2 Limitations

Mobile computing and communication systems are in general more vulnerable than those on fixed networks, such as PC on desktop. The followings are the limitations found in the experiments:

- Battery life is limited so that it is difficult for NCCU-MLP to support any long activity over two hours.
- The transmission quality of wireless radio signal is highly dependent on the weather conditions, especially on rainy days. As a consequence, the stability of mobile network connection is lower than fixed networks. The design of mobile learning environment must take this into consideration.
- The software system in a mobile computing environment is much more complicated than that on fixed networks. Thus, it needs more effort to make the software system robust.
- Compared with whiteboard, the pen-based word recognition system supported by Windows XP operating system is less ideal for group communication because of time concern. With pen-based word recognition system, it consists of time of carefully typing the character, character recognition, and character correction due to wrong recognition. On the other hand, whiteboard reflects input to all the other subjects in terms of image. There is no time wasted in both recognition and correction.
- Compared with voice communication tool, like PTT, whiteboard is even less ideal for group communication. First, people are used to talk than to write. Second, voice communication is much faster than that of hand-writing. Third, whiteboard is a groupware. Images from different ends can easily be mixed up and then reflected to each end. In other words, whiteboard fails to transmit images correctly and clearly.
- In some special environment such as library, the use of voice communication will be limited. This may hurt the efficiency of collaborative learning. A simple earphone, wired or wireless, will easily solve the problem.

- Users prefer full-duplex conversation mode to half-duplex mode. However, it remains a great technical challenge to offer group voice communication in full-duplex conversational mode under limited bandwidth.
- In order to achieve high accuracy in a positioning system, the more numbers of AP in any given space are better.

With regards to the activity design and content, the followings are some limitations found:

- In this activity, whether during video-watching or group discussion, any enclosed quiet learning environment such as library, embarrassed our students. Consequently, the limited use of voice communication was not encouraging and the interaction among groups in collaborative learning was inefficient.
- As for the video content, the researchers were restricted by the authenticity and accessibility of the materials. In other words, the researchers had to make great effort to find motivating, informative authentic material on campus. They also had to help students apply new knowledge and skills, and integrate these into the learners' world to make learning effective. As a result, students complained about the content of these video clips not exciting and intriguing enough.
- The students heavily relied on their technical assistants mainly because there was considerable anxiety among them about high-tech use. It may prove that students need a certain amount of related prior learning and training.

7.3 Future Possibilities

The followings are the future plans for the development of a better (or more powerful) group communication system:

- Making both the group communication and positioning systems more robust;
- Porting the system to the newer WiMAX wireless communication system;
- Porting the system to light-weighted, small-size, powerful UMPC (Ultra Mobile PC) platform；
- Installing formative evaluation to track learner's improvement over time.

Again, with regards to the activity design and content, the followings are some future possibilities:

- Improving and enriching the quality and quantity of the content to enhance learning and motivation as some students suggested the creative use of interesting anecdotes about the buildings to add interest and liveliness to the group activity, while others showed interest in learning more about other buildings and areas on campus.

- Redesigning a competition game like “Treasure Hunting” to elevate learning interest.

In conclusion, students found the m-learning environments enjoyable and creative. In addition, m-learning provides flexibilities, practicality, and usability for various learning styles. However, as the questionnaire illustrated, students depend heavily on technical assistants to execute the activity. In other words, even many students are digital natives, prior learning and training seem necessary for m-learning activity implementation. Last, for teachers and researchers, the challenge remains in how to design and develop relevant and interesting learning environments based on sound pedagogical principles to foster the use of mobile learning devices.

References

1. Bahl, P. & Padmanabhan, V.N. (2000, March), "RADAR: An In-Building RF-based User Location and Tracking System," *IEEE INFOCOM, Vol. 2*, 775-784.
2. Chai, X. & Yang, Q. (2005) , "Reducing the calibration Effort for Location Estimation Using Unlabeled Samples," *3rd IEEE International Conference on Pervasive Computing and Communications (PerCom'05)*, 95-104.
3. Chen, Y-S, Kao, T-C, Yu, G-J & Sheu, J-P (2004) , "A mobile butterfly-watching learning system for supporting independent learning," *2nd IEEE International Workshop on Wireless and Mobile Technologies in Education*, JungLi, Taiwan, 11-18.
4. Engeström, Y. (1987) , *Learning by expanding: An activity-theoretical approach to developmental research*, Helsinki, Finland: Orienta-Konsultit Oy, *http://communication.ucsd.edu/LCHC/MCA/Paper/Engestrom/expanding/toc.htm, (retrieved Nov. 14, 2008)*.
5. Engeström, Y. (1999) , "Activity theory and individual and social transformation," In: Engeström, Y., Miettinen, R., Punamäki R.-L. (Eds.): *Perspectives on Activity Theory*, Cambridge University Press, Cambridge, 19-38.
6. Georgiev, T., Georgieva, E. & Smrikarov, A. (2004) , "M-Learning - A New Stage of E-Learning, From d-Learning, to e-Learning, to m-Learning," *International Conference on Computer Systems and Technologies - CompSysTech'2004*, *http://ecet.ecs.ru.acad.bg/cst04/Docs/sIV/428.pdf, (retrieved July 28, 2006)*.
7. Jang, H.C., Wang , Y.X. & Chen, C.W. (2006) , "Implementation of Mobile Multimedia Applications Service Platform on Windows Mobile 2003/2005," Multimedia and Networking Systems Conference, I-Shou University, Taiwan.
8. Jin, M.H., Wu, E.H.K., Liao, Y.B. & Liao, H.C. (2003, December) , "802.11-based Positioning System for Context Aware Applications," *IEEE GLOBECOM 2003, Vol. 2*, 929-933.
9. Jin, M.H., Wu, E.H.K., Wang, Y.T. & Hsu, C.H. (2004), "An 802.11-based Positioning System for Indoor Applications," *ACTA Press Proceeding, 422.*
10. Kao, C.L (2006) , "The Study of Using Mobile Learning Device to Assist Elementary School Students to Study Aquatics at Campus'Eco-education Garden," Master's Thesis, Taipei Municipal University of Education.
11. Keegan, D (2000) , "From d-Learning, to e-Learning, to m-Learning," *40th anniversary celebrations of Shanghai TV University*, *http://www.nettskolen.com/forskning/From%20d%20learning.doc*, *(retrieved*

July 28, 2006).

12. Krumm, J. & J. C. Platt (2003) , "Minimizing calibration effort for an indoor 802.11 device location measurement system," Tech. Rep. No. *MSR-TR-2003-82, Microsoft, ftp://ftp.research.microsoft.com/pub/tr/tr-2003-82.pdf, (retrieved Nov. 7, 2007).*

13. Lantolf, J. P. (2000) , "Introducing sociocultural theory," In J. P. Lantolf (Ed.), *Sociocultural theory and second language learning*, Oxford: Oxford University Press.

14. Laouris, Y., & Eteokleous, N. (2005) , "We need an educationally relevant definition of mobile learning," *mLearn 2005, http://www.mlearn.org.za/CD/papers/Laouris%20&%20Eteokleous.pdf, (retrieved August 20, 2006).*

15. Ling, F.T. (2004) , "A Study on Mobile Learning Device Applied to the Nature Science Class in Elementary School. Unpublished Master's Thesis. Taipei Municipal University of Education.

16. Naismith, L., Lonsdale, P., Vavoula, G. & Sharples, M. (2005) , "Literature Review in Mobile Technologies and Learning," *Futurelab Series*, Report 11, *http://www.futurelab.org.uk/download/pdfs/research/lit_reviews/futurelab_review_11.pdf, (retrieved Aug. 20, 2006).*

17. Nasseh, B. (1997) , "A Brief History of Distance Education," *http://www.seniornet.org/edu/art/history.html, (Retrieved August 20, 2006).*

18. O'Malley, C. et al. (2003), "Guidelines for Teaching/Learning/Tutoring in a Mobile Environment," *http://www.mobilearn.org/download/results/guidelines.pdf (retrieved July 28, 2006).*

19. Prensky, M. (2001), "Digital natives, digital immigrants," *On the Horizon*, *9*(5), 1–2, *http://www.marcprensky.com/writing/Prensky%20-%20Digital%20Natives,%20Digital%20Immigrants%20-%20Part1.pdf (retrieved Aug. 20, 2006).*

20. Quinn, C. (2000) , "mLearning: Mobile,Wireless, In-Your-Pocket Learning," *LiNE Zine, http://www.linezine.com/2.1/features/cqmmwiyp.htm (retrieved Aug. 20, 2006).*

21. Sharples, M. (2005) , "Learning as conversation: Transforming education in the mobile age. Paper presented at Conference on Seeing, Understanding, Learning in the Mobile Age," Budapest, Hungary, April 2005, *http://www.eee.bham.ac.uk/sharplem/Papers/Theory%20of%20learning%20Budapest.pdf, (retrieved Aug. 20, 2006).*

22. Sharples, M., Taylor, J. & Vavoula, G. (2005) , "A Theory of Learning for the

Mobile Age," To be published in R. Andrews (ed.) The Handbook of Elearning Research. London, *http://www.nottingham.ac.uk/lsri/msh/Papers/Theory%20of%20Mobile%20Learning.pdf, (retrieved Aug. 20, 2006).*

23. Su, L.H. (2003) , "The Wireless Technology into the Outdoor Activities of Bird Watching for Observation and Reflection in the Mobile Learning Situation－the Team of Experts to Adapt to Try and to Become Mature in the Using Up-to-date Wireless Technology," Master's Thesis, Taipei Municipal University of Education.
24. Tate Modern and Antenna Audio Ltd., "Tate Modern multimedia tour pilots 2002-2003," *http://www.tate.org.uk/modern/multimediatour/phase1_keyfindings.pdf, (retrieved Aug. 20, 2006).*
25. Thornton, P. & Houser, C. (2004) , "Using mobile phones in English education in Japan," *Journal of Computer Assisted Learning*, *21*, 217–228.
26. Tsai, I.H. (2004) , "A Study of the Development of Courseware for Mobile Learning and Students'Learning Effectiveness in Primary Education: Using Wetland Crabs as an Example," Master's Thesis, National Tsing Hua University.
27. Tsai, T.C. & Li, C.L. (2006, October) , "Reducing Calibration Effort for WLAN Location System using Segment Technique with Autocorrelation," *IEEE First International Conference on Communications and Networking in China(Chinacom2006),* Beijing, China.
28. USjournal.com, LLC., "The advantages of distance learning," *US Journal of Academics*, *http://www.usjournal.com/en/students/help/distancelearning.html, (retrieved Aug. 20, 2006).*
29. Valentine, D. (2002), "Distance Learning: Promises, Problems, and Possibilities," *Online Journal of Distance Learning Administration*, *5*,(3), *http://www.westga.edu/~distance/ojdla/fall53/valentine53.html, (retrieved Aug. 20, 2006).*
30. Wagner, E. D., & Wilson, P. (2005, Dec.), "Disconnected: Why learning professionals need to care about mobile learning,"*T+D, American Society for Training and Development,* 40–43.
31. Wu, Wen-Hsuan (2006) , "Applications of Learning Cycle Based Mobile Learning to Enhance Primary School Students'Learning about Aquatics," Master's Thesis, Taipei Municipal University of Education.
32. "Mobile and wireless Internet 2005," *Foreseeing Innovative New Digiservices, http://www.find.org.tw/eng/news.asp?msgid=222&subjectid=10&pos=1, (Retrieved August 20, 2006).*

33. “Mobile phone subscribers Q1 2006,” *Foreseeing Innovative New Digiservices*, *http://www.find.org.tw/eng/news.asp?msgid=249&subjectid=13&pos=1*, *(retrieved Aug. 20, 2006).*