國立高雄第一科技大學

資訊管理系

碩士論文

人機互動設計於行動學習系統建構之研究

A Study in Developing a Mobile Learning System based on Human-Computer Interaction Design

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中文摘要

現今，無線網路的精進及手持式裝置的可攜性，使得資訊的擷取、記錄與攜帶都非常便利，結合手持式裝置應用於戶外及實驗室的教學活動已相當普遍，而在一般傳統教室的教學活動中，此裝置亦可作為支援教師進行教學活動之利器。鑒於傳統式的課堂教學因師生比例落差大，學生易困於被動式的學習瓶頸中，加上教師也無法有效記錄學生的個別學習歷程，進而給予適當的回饋或輔導，本研究在一般大學課堂教學情境中，提出從人機互動設計的觀點，建置可用之行動學習系統 (Mobile Learning System; MLS)於個人數位助理(Personal Digital Assistant; PDA)當中，並透過實驗設計加以驗證其優於傳統教室教學的實用性。

然而，良好的小螢幕介面設計將是此行動學習系統績效的關鍵因素；其次，由於橫式介面的設計具發展趨勢，本研究除強調藉由小螢幕介面設計準則，來提升 MLS 的運用績效外，亦一併探討橫式介面在內容設計上的適用性。透過課程任務分析、文獻回顧及實驗設計，彙整運用小螢幕介面設計原則及發現潛在的人機互動問題，設計出易於操作使用且具有高度親和性的 PDA 介面，最後藉由主觀性問卷評量系統績效及受試者滿意度。此系統將有效區別專為設計於桌上型電腦(PC)或筆記型電腦(Laptop)之數位學習系統，且有利於課程互動時訊息之有效率傳遞以及互動模式之持續改善。實驗的結果顯示，MLS 確實能輔助學生更主動、更自決自主地學習。此外，不論是否考慮課程內容的組合，受試者以偏好橫式介面展示為居多。

關鍵詞：人機互動 (HCI)、行動學習系統 (MLS)、小螢幕介面設計

ABSTRACT

Today, the convenience to retrieve, record, and move information is due to advanced wireless and portable handheld. As we know, the conventional classroom learning appears the passive bottleneck because the learning model is that one instructor faces on many students. Moreover, instructor cannot effectively record students' individual learning history for instant and suitable feedback. In this study, we developing a usable mobile learning system (MLS) into personal digital assistant (PDA) based on the principal of human-computer interaction (HCI). And we evaluating the digital learning assistant model is superior to conventional one.

At the same time, the well-designed small-screen will be the critical factor for promoting the MLS performance. The next, we observed the tendency of horizontal interface development. So the research appeared the adaptive contents design in that except focusing on small-screen design. We utilized task analysis, literature review, experimental design, small-screen design, and potential issues appearance for designing a friendly PDA interface, analyzing the performance and user's satisfaction by a subject questionnaire. The MLS prototype of PDA will be very different from PC or laptop and will effectively enhance learning interest and interactive model in the conventional classroom.

By the results of the experiment, we found that the mobile-based classroom learning providing appropriate mobile tools would help students to become capable, self-reliant, self-motivated and independent. The findings also demonstrate that variations among students' preference or content are associated with differences in presented mode.

Keywords: Human-Computer Interaction (HCI), Mobile Learning System (MLS), Small-Screen Design

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論文完成，意味著碩士生涯結束。想當初一頭栽入這個不熟悉的領域，是老師不厭其煩地教導，讓我慢慢的學習瞭解，其中，學到從不同的角度看待問題以及處理事情的態度，還有老師的幽默生活哲學最讓我佩服懷念。

在此我要特別感謝我的指導老師蘇國瑋 博士,總是大大地給予我正向的鼓勵，儘可能提供我們所需的研究資源，若能課業上的或是生活上有小小收穫，對我而言最感謝的是您。 並且也非常謝謝我的口試委員林迪意 教授以及李慶章 博士給予我許多寶貴的意見，使得我的論文能夠更加完備。

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郭孟芳 謹誌於

國立高雄第一科技大學資管所

中華民國九十五年六月

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CHAPTER 1 INTRODUCTION

1.1 Background

The offspring of desktop computers, portable devices, are quickly becoming as common as the desktop. Portable devices (Pocket PC, Tablet PC, Personal Digital Assistant (PDA), and Smart Phone etc.) are prevalent in all aspects of society, from the business world to the classroom. Now, new devices are becoming even smaller and more portable. As manufacturers create smaller and smaller devices, with increasing power and memory, at lower costs, portable devices will become ubiquitous. With the increasing use of small portable computers, this emerging communications infrastructure will enable many new internet applications. From a technology perspective, they are more affordable today than before. New technologies and tools offer all members of society greater flexibility, easier access to information and the opportunity to match learning to their specific needs and circumstances. Obviously portable devices, connected wirelessly to the today campus network, will certainly change the way we learn and communicate.

In a recent study of students in higher education in the United States, 82% owned cell phones (Kvavik, 2005). In the same study, however, less than 12% owned PDA. While the new technologies open new horizons for personal development, the true potential of e-learning as 'anytime, anywhere' has finally started to be realized with the advent of mobile learning (m-learning). Mobile learning (m-learning) is a burgeoning subdivision of the e-learning movement, further evidenced by European initiatives such as m-learning and Mobilearn (Chinnery, 2006). An m-learning educational process can be considered as any learning and teaching activity that is possible through mobile tools or in settings where mobile equipment is available.

The M-based classroom learning approach has some similarities with m-learning, especially in terms of technology use. Classroom setting is the key factor. For example, students are given PDA to use in conjunction with traditional teaching. During the lecture, the instructor can suggest exercises that require an interactive input from the students such as mini-quizzes, brainstorming, estimating and role-play. Shotsberger and Vetter (2001) found that in mobile-based classroom environment, instructor can see immediately how well students comprehend a specific topic they have presented, thus, that students are more comfortable responding to a question when they see others doing the same. The answers are put into the PDA by the students, leaving the collection, analysis and presentation to be done by the mobile learning system (MLS). The process would help to keep students thinking about the material, and the instructor could more easily evaluate the students' level of understanding during a lecture.

To deserve to be mentioned, Microsoft recently released a new version of its operating system like Windows Mobile 5.0 for mobile devices. This version also offers QWERTY keyboard support and landscape as well as portrait display orientation. With the study, we hope to help users make a well-informed choice when considering readability for present mode of small screen. We also hope to help designers build small devices that provide clear learning benefit.

1.2 Importance

The potential value of learning via mobile devices or m-learning has been widely realized (Leung & Chan, 2003; Naismith, Lonsdale, Vavoula, & Sharples, 2005; Sharples, 2000). A number of pilot projects have tried to find out how these technologies can be integrated into learning settings (Chen, Myers and Yaron, 2002; Roschelle and Pea, 2002; Lundby, 2002). Ring (2001) found that students enjoyed reading course outlines and texts on mobile phones while commuting, and Thornton and Houser (2003) found that students highly rated web and video teaching materials viewed on mobile phones and PDA. In the long run, says Quinn (2002), "we'll realize that learning should move from an organizational function to an individual necessity".

Mobile interactions with the physical world, meaning a person uses his/her mobile device as mediator for the interaction with a physical object, get more and more popular in industry and academia. We can see the development that mobile devices effectively support the flow of information from instructor to student. Successful educational technology fuels educational collaboration. When the student is stymied by the lack of direct contact with his or her instructor and peers, PDA offers new forms of communication that break down traditional barriers to education. PDA has been popular among m-learning in the last few years. PDA is more often associated with m-learning than cell phones, likely due to larger screen size and higher resolution. Their use has been integrated into various disciplines within high schools, universities, and medical schools (Carlson, 2002). Dufresne, Gerace, Leonard, Mestre, and Wenk, (1996) described the ClassTalk system, in which students use networked PDA to answer quizzes during short breaks in lectures, allowing lecturers to immediately view students' responses, and adjust the lecture to correct any misconceptions. The projects experimented with a wide range of educational activities on PDA and cell phone (Houser, Thornton, and Kluge, 2002). These projects show that the unique combination of features in mobile devices - portability, connectivity, and low cost — makes them valuable educational tools.

The main reasons given for using handheld devices for traditional classroom learning are that they assist students' motivation, help organizational skills, encourage a sense of responsibility, help both independent and collaborative learning, act as reference tools, and can be used to help track students' progress and for assessment. Although, the display of PDA is much smaller than desktop, and the volume of such intelligent mobile device is smaller and lighter. The intelligent presentation of data is required to explore the layout of display and architecture of information of the intelligent mobile device with minimal loss of information. It becomes a critical issue for achieving an effective communication among the participants.

1.3 Objectives

The study as reported here is to design an adaptive MLS as a learning aid by taking into account users' profile and device capability, in such a way, to create one kindly of interface with content presentation for small display devices.

The objectives of this study are described as follows:

1.) To develop a usable MLS into PDA based on the principles of human-computer interaction (HCI).

2.) To design the adaptive contents for presenting on the interface of portrait/landscape version based on the guidelines of small-screen design.

3.) To evaluate the users' satisfaction and preference of MLS through effective questionnaire.

4.) To promote MLS in a classical learning environment and to achieve collaborative learning, organizational learning, and dynamic knowledge creation in a group.

1.4 Research Framework

This thesis is organized as follows. In chapter 1, the background, importance and objectives are described. Some literatures are reviewed in chapter 2 to introduce the development of m-learning and find out the suitable principles on small display for designing interface of MLS. In chapter 3, the prototype of MLS is embedded into PDA to support traditional classroom learning. Furthermore, Chapter 3 presents an experimental design for evaluating the MLS. Chapter 4 is the result and discussion of experiment and posterior questionnaire. And finally, chapter 5 is some concluding remarks for the result.

The skeleton of this thesis is exhibited in Figure 1.1.

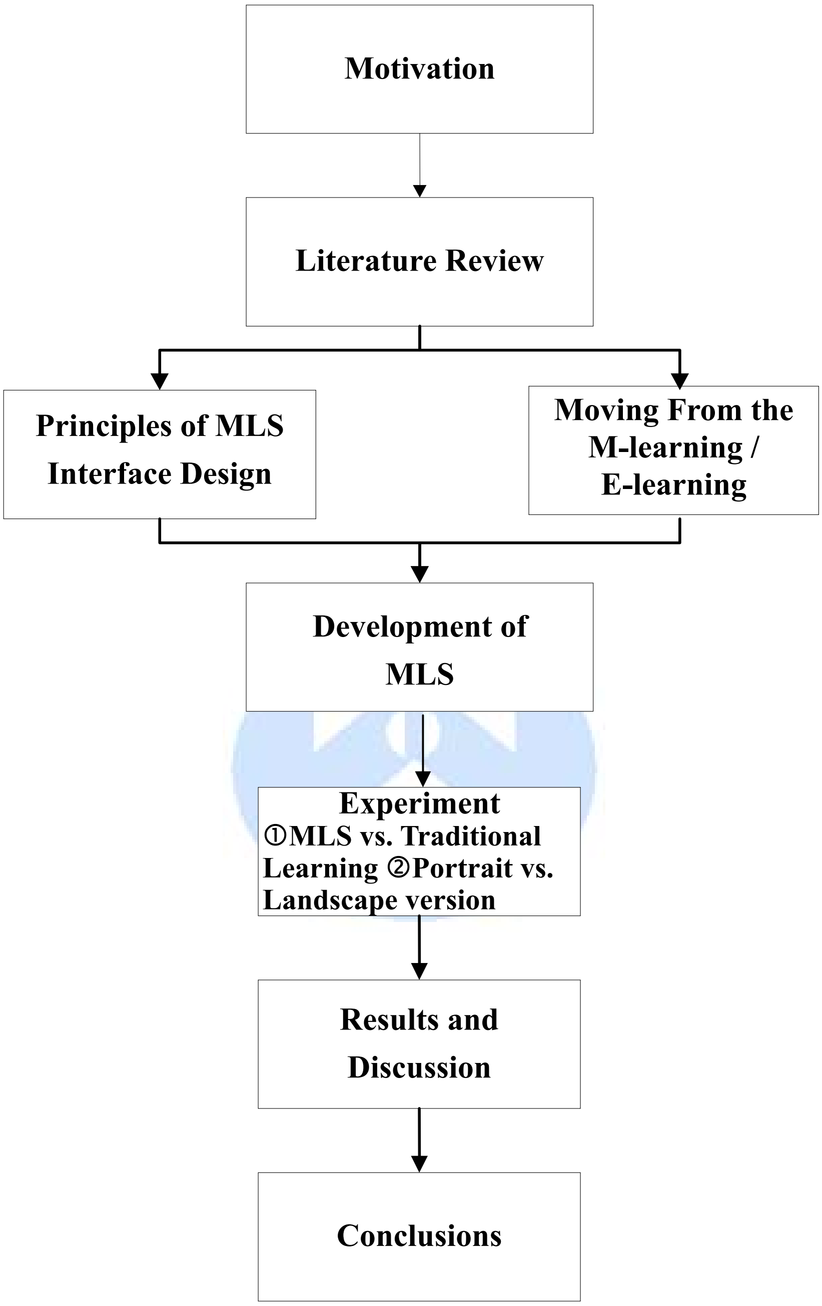


Figure 1.1 Research framework

CHAPTER 2 LITERATURE REVIEW

The past a few years have seen a rapid growth in research, development and deployment of mobile technologies to support learning. The new technology includes multimedia-equipped mobile phones, PDA and pen tablet computers; the new emphasis in education is on supporting the student, in collaboration with peers and instructor, both within and outside the classroom. Sharples (2000) identified m-learning is the next generation of e-learning and is based on mobile devices. But there might have some potential problems in the interaction with small screen and the design of user interface. Therefore, the proper interface design of small screen becomes important for m-learning. This chapter will discuss the needs and challenges of designing the user interface of MLS. The development of m-learning will be reviewed at first, and the related issues of small interface design will be reviewed in the next section.

2.1 Development of M-Learning

Although the desktop will continue to serve as the dominant platform for generating content, both instructor and students will increasingly use wireless devices to access and manage information. Therefore, m-learning has received a lot of attention these years as the next wave of learning. In this section, the main focus is on the development of m-learning. Some relevant issues, such as the features of instructional mobile devices and M-based classroom are reviewed.

2.1.1 Instructional Mobile Devices

Wireless handhelds offer new opportunities for innovative user interaction, communication, and connection with sensors—both in the classroom and on field trips (Roschelle and Pea, 2002). From a pedagogical perspective, m-learning supports a new dimension in the educational process. Characteristics of m-learning include (Chen, kao, Sheu, & Chiang, 2002):

- Urgency of learning need
- Initiative of knowledge acquisition
- Mobility of learning setting
- Interactivity of the learning process
- Situating of instructional activities
- Integration of instructional content

Researchers in the United States have developed several educational programs for PDA (Soloway, Norris, Blumenfeld, Fishman, Krajcik, and Marx, 2001). Designed for elementary schools, these programs allow educators to freely experiment with m-learning. These programs include the game — like quiz *Bubble Blasters*, the science simulation *Cooties*, and the concept map editor *PiCoMap*. Starting in 2000, Chen et al. (2002) explored this technique during two second-semester chemistry classes, with about 100 students each. Surveys showed that students preferred using handhelds over other alternatives, such as raising their hands. Another classroom idea is to adapt SlideShow Commander for use as a note-taking tool. Instructors can save their annotations as public notes, while student annotations would be private notes (Myers, 2005). Georgia Tech's eClass project has shown that similar features are useful (Beyer and Holtzblatt, 1998).

Deborah, Roschelle, Vahey, and Penuel (2003) pointed out many teachers simply used the handhelds as portable word processor or other productivity devices such as calendaring programs. They appreciated the increased access to technology brought by the handhelds, especially for writing assignments. During 2001-2002, SRI International, in collaboration with Palm Inc., conducted a systematic large-scale evaluation of handheld technology for education. The Palm Education Pioneers (PEP) program distributed handhelds through a competitive grant program and examined how the 100 selected teachers used them in the classroom (Vahey and Crawford, 2002). These teachers reported greater student engagement, more effective collaboration, and increased student autonomy on lessons that integrated handheld computer use. They also said that handhelds let them bring more and better use of technology to a wider range of students and circumstances.

2.1.2 Promotion of Mobile-Based Classroom

M-learning is defined as the ability to learn anytime and anywhere. In our context, it is defined as the ability of using handheld devices (such as PDA) to access learning information in the classroom. Klopfer, Squire, and Jenkins (2002) identify five properties of mobile devices (PDA in this case) that produce unique educational affordances: portability, social interactivity, context sensitivity, connectivity and individuality. To fully appreciate the potential of mobile technologies for learning, we must look beyond the use of individual devices and consider their use embedded in classroom practice, or as part of a learning experience inside the classroom.

Many researches investigated the distinct characteristics of mobile wireless classroom in order to discover its strengths and weaknesses which are able to offer design prescriptions to enhance the interactivity of the interface, thus improving classroom learning performance. The unique characteristics of the mobile wireless classroom environment are possessed as follows.

1.) Real-time learning efficiently

The instructor can control the question number and whether to display the results. Shotsberger et al. (2001) have shown that experiment results in contrast to the typical 2 to 3 percent response rate in a more traditional classroom setting, all of the students participating respond to the instructor's questions. The integration of these technologies into an educational setting will result in a significant reduction in cost and a commensurate increase in the effectiveness of instruction (Abowd and Mynatt, 2000).

2.) Integration of content within learning

The wireless learning environment integrates many information resources and supports students to do un-linear, multi-dimensional, and flexible learning and thinking (Chen et al., 2002). Mobile device could give instructors a highly portable way for record keeping the resources and results both in the classroom; meanwhile, it can scaffold students to comprehend the whole structure of a reading article. Jones, Marsden, Mohd-Nasir, Boone, & Buchanan (1999) have suggested, services for PDA should be well focused and well organized.

3.) Expansion of knowledge acquisition

Anecdotal evidence suggests that students enjoy the technology and become more active in their learning when handheld devices are used in the classroom setting. There is every indication that in the near future wireless data devices will be as widespread as cell phones are now. Wireless access to MLS articles from PDA increases the interactivity and ease of obtaining information. Instructor can collect student values and respond in a more timely fashion than with paper-based traditional learning.

4.) Interactive questions and intelligent help

Research has consistently shown that frequent communication between instructor and student can significantly enhance learning rates and overall student performance (McKeachie, 1999). Teachers and the teaching literature both report that the most valuable learning opportunities occur when students can ask questions while they are actually working with scientific data (Gleason and Novak, 2001). Similarly, interactions between students can enhance peer-to-peer discovery, problem solving, and knowledge acquisition.

The emerging technology of mobile wireless devices offers a promising tool for helping instructors create a more interactive, student-centric classroom, especially when teaching large courses. This study intends to enhance the learning materials by utilizing mobile devices to increase accessibility and flexibility of learning for students.

2.2 User Interface Design

To present information effectively on a PDA interface, the course designer must minimize the inherent limitations in that interface, the most obvious being the restricted size and resolution of the interface. Selecting the information and elements to present on the screen is discussed as a substantial part of interface design, and in particular to small screen devices. Central factors in designing for small screen devices are highlighted and exemplified. In this section we will describe some of the theories that have influenced the M-based classroom interface design.

2.2.1 Mobile Human-Computer Interaction (HCI)

Although the PDA has great potential in supporting mobile wireless classroom, but several studies have shown that screen size does have an effect on performance (Watters, C. J. Duffy, & K. Duffy, 2001) – the small screen space can display relatively little data at a given time, resulting in difficulties in using the device for complex tasks, as well as the reason why research on the mobile human-computer interaction (HCI) primarily concentrates on presenting information on a small display, and emphasis on user experience, reflection, and collaboration. The most significant difference between desktop computers and handheld devices is not the computation power, but the size of the screen. The rich desktop environment is in contrast to the "impoverished" interfaces of mobile, handheld devices. On the positive side, the promising characteristics of handheld devices are (Smith, Mohan, & Li, 1999):

- small size and high portability;
- instant access with no waiting for boot-up;
- flexibility for supporting a wide range of learning activities; and
- the cost of the technology is relatively cheap.

Therefore, the desktop metaphor and the multiple windows metaphor are not so effective for the small screen of a PDA. While screen size is of course an important consideration, there are other issues, such as running costs, bandwidth and application availability, that must be considered by course content developer. Another major difference between PCs and small screen devices is the input method. The main concern in structuring principles on a screen is not how it is intended from the designer, but how the user perceives them. The design of mobile devices and services cannot be merely technology-driven (as it often happens today), but needs to be prompted by human needs and has to properly take into account human abilities, limitations, and preferences.

For mobile device designers, they are in face of five main challenges (Dunlop and Brewster, 2002):

- Designing for mobility
- Designing for a widespread population
- Designing for limited input / output facilities
- Designing for (incomplete and varying) context information
- Designing for users multitasking at levels unfamiliar to most desktop users

Mobile services will not be successful if we do not understand mobile users and design for their contexts, which are very different from the ones traditionally studied in HCI. Users will not enthusiastically adopt mobile computing devices if we are not able to prevent the pains and complexities of interacting through very limited input and output facilities. In addition, wirelessly enabled mobile devices allow users to connect to the internet, providing access to even more data. To that end, the design of interfaces on mobile devices is increasingly being addressed in the human computer interaction (HCI) community. The recent papers presented at HCI conferences and published in journals illustrate the prevalence of this interface design field.

In the last years we notices a raising interest in physical mobile interactions in research and academia. This research field deals for instance with mobile interaction with enhanced physical objects (Kindberg et al., 2002; Rukzio, Schmidt & Hussmann, 2004; Rohs & Gfeller, 2004), sensing the environment to get awareness of the context of the user (Hinckley, Pierce, Sinclair & Horvitz, 2000; Gellersen, Schmidt & Beigl 2002), mobile interaction with public and semi-public displays(Ferscha, Kathan & Vogl, 2002; Greenberg, Boyle & Laberge, 1999), mobile interactions in smart environments (Shahi, Callaghan & Gardner, 2005) mobile annotations (Smith et al., 2003) or using the mobile device as a universal remote control (Myers, 2002). Figure 2.1 illustrates typical examples of physical mobile interactions in which the user interacts via the mobile device with things, peoples and places (Kindberg et al.,

2002) in the physical world.

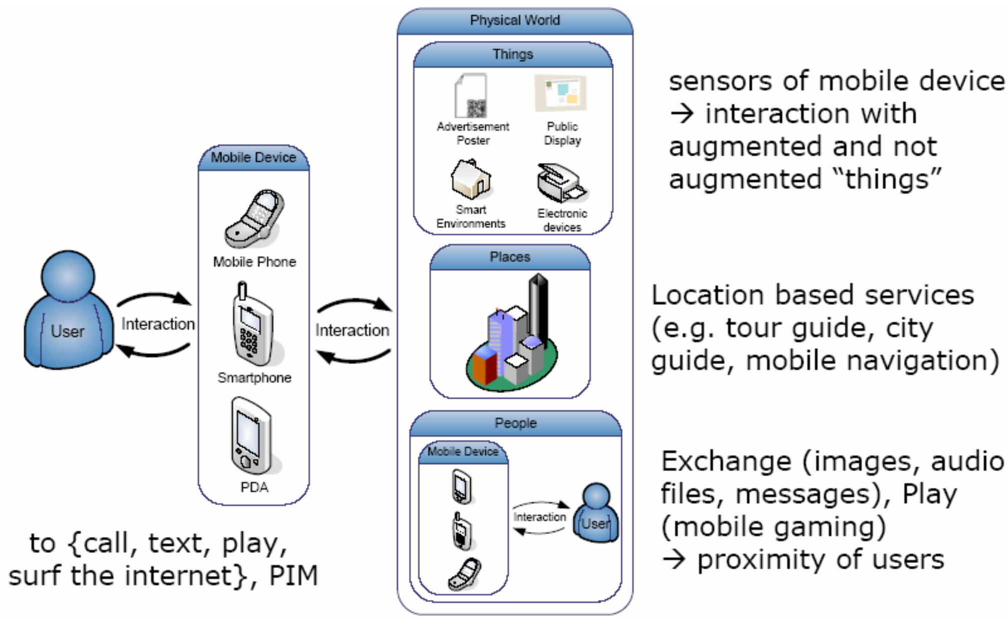


Figure 2.1 Physical Mobile Interactions

(Rukzio, Wetzstein & Schmidt, 2005)

2.2.2 Information Display on Small Screen

Wireless technology is rapidly being introduced throughout the world for education, business, and commerce. Wireless technology, however, like any other technology, is not in itself a panacea (Clark, 1994). Reflection on how it can be used to support and encourage the teaching / learning process through the enhancement of interaction, socialization and engagement is required (Bleed, 2001). The multitasking nature of student behavior requires m-learning interfaces designed to support users' limited attention. As mobile technology improves, the features of mobile devices will become equivalent to those of desktop computers, except for the screen size. Their tiny screen sizes were deemed "unsuitable for learning new content but effective for review and practice" (Thorton & Houser, 2002). Thus, the m-learning interface should be developed to compensate for the limited visual display of the devices. The study found many such projects in Asia, Europe, North America and South America. These projects were set in universities, elementary schools, corporate training programs, and distance learning programs. The study (Jones et al., 1999) suggested that users did not want to use the conventional page-to-page navigation as it was interactively very costly on the small screen. Rather, a much more direct, systematic approach requiring less scrolling was seen as appropriate. Michael (2001) mentioned that to prevent users from getting lost in complex directory trees, developers will need to make wireless content shallow, based on a two- or three-level architecture. Developers are learning to tailor content to the unique characteristics of wireless devices, therefore, quick and easy access is the main concern. In particular, the research addresses user interface issues on portable devices and how we put in use for mobile environments, thus are increasing the efficiency of the application.

2.2.3 Guidelines for Small Screen Design

The background for exploring this field is the introduction of PDA within the field of education. Especially in the setting of students in a classroom, it is essential that the design of the interface is usable, that is, effective to use, efficient in use and satisfying to use. Interface designer can think about how the interface should be organized to present the information clearly, what information should be presented, what guidelines exist for designing interfaces, how to design for usability and how the users perceive the information presented. As Tufte (1990) states: “Clutter and confusions are failures of design, not attributes of information". Certainly the influence of human interactions on knowledge construction is so pervasive that a proper understanding of learning cannot be achieved without taking into account its social dimension. Since much learning is done within a social context, it becomes important to understand how dialogue between an instructor and students, and among students, can be used to enhance student learning. To develop effective m-learning interface, we need a reference framework that informs us on how user interfaces are shaped. Thus several design guidelines were identified to help ensure that handheld applications for student are designed appropriately.

1.) Information Selection

Clearly screen size has a major impact on user performance. Even more than with desktop applications, the handheld's user interface design must take into account the context of use. Several studies have shown that screen size does have an effect on performance (Kamba, Elson, Harpold, Stamper, & Piyawadee, 1996). The studies by Jones et al. (1999) and Watters et al. (2001) examined the effect of screen size on the overall metric of task performance and they found that the smaller screen size impeded task performance. Therefore, the information communicated through the screen is the utmost important element. For information content on screens, Nielsen (1993) states, "Less is more", user interfaces should be simplified as much as possible. The ideal is to present exactly the information the user needs at exactly the time and place where it is needed. Another ideal presented by Nielsen (1993) is that information that will be used together should be displayed close together, and at minimum on the same screen.

2.) Layout for the Screen

When text used on the screen, the legibility is utmost important. The resolution of a computer screen compared to printed material is greatly inferior in quality.

MLS operates within a width of 240 pixels, and a height of 320 pixels. Darroch, Goodman, Brewster, and Gray (2005) indicated that a font size between 10 and 11 is preferred for reading text on a PDA. Götz (1998) suggests that text on the screen should be at least 10 point, but at best between 11 and 14 point. And the corresponding title type size should be between 14 and 20 point.

As regards the font type, Bernard, Chaparro, Mills, and Halcomb (2003) focused on the readability and legibility of varying 10- and 12-point sizes of both Times and Arial on computer monitors. However, designs are improving; some screens now accommodate up to seven lines of text (Clyde, 2001). Furthermore, it is important that the letters on the screen are properly spaced. Götz (1998) recommends a tracking of 5 to 10 units for improving legibility. Interlinear spacing is an important element in making text easy to read, and it should be set to a more generous value on screen than for text on paper, and recommended in Götz (1998) is that the line spacing is set to about 150% or more.

3.) Interface Element Design

Not only information must be carefully selected, but also every element to put on the screen should be treated. Scrolling (both horizontal and vertical) in a screen to get an overview of the information should be avoided. The reason for this is that the user will be occupied with keeping track of the changes rather than paying attention to what they are trying to achieve. However, Skogen (2004) stated that when unavoidable, deeper hierarchies are to prefer in front of long scrolling pages and to shorten hierarchies, indexes can be used to provide direct access to content. General guidelines for interface design concern the use of type and color. Color should be limited to no more than 5 to 7 different colors since it is difficult to remember and distinguish the implication of color from larger numbers. Moreover, owing to the percentage of people being colorblind, the interface should be able to use without the color coding. Color should only be used to categorize, differentiate, and highlight, not to give information, especially quantitative information. Image quality is an important factor in users' subjective preferences. It has been found that an increase in image quality results in an increase in subjective performance rating for both paper and on-line reading (Jorna, 1991).

Generally speaking, the interface design of mobile devices ensure they are effective in communicating information are tolerant of error, need minimum physical effort and are a convenient size, and the designs need to ensure they can be used by people with diverse abilities, be flexible and be simple to use. Overall, a lot of progress has been made in adding human factors to the interface design process.

CHAPTER 3 RESEARCH METHODOLOGY

3.1 Development of MLS Prototype

Mobile usage of PDA offers even more challenges, as not only do the issues of miniaturization have to be addressed but also the completely different user environments. By studying the available literature on designing for screen and interaction, the main issues will be presented in the pursuing sections. Issues concerning the construction of MLS and its interface design will be discussed. The final is to conduct an experiment to verify the performance of MLS for learning efficiency and compare with different screen type for user preference.

3.1.1 Profile of MLS

When wireless and mobile devices are beginning to offer stunning new technical capabilities for collaborative learning, then researchers in this field must recognize the importance of complementing these technical advances with improved understanding of the patterns of classroom activity that most need support. MLS can serve as catalysts for creating a more interactive, student-centric classroom in the lecture hall, thereby allowing students to become more actively involved in constructing and using knowledge. This enhanced communication assists the students and the instructor in assessing understanding during class time, and affords the instructor the opportunity to devise instructional interventions that target students' needs as they arise.

By facilitating a shift from a passive, instructor-centric classroom, toward an interactive, student-centric classroom, a MLS helps to create a classroom environment that accommodates a wider variety of student learning styles, making the learning of science a much more positive experience for students. MLS are unique tools that instructor can use for facilitating learning and for improving students' attitudes toward science. A MLS-supported interactive lecture offers the opportunity to create a truly active learning environment in a large group format and addresses some of the concerns listed above. In terms of faculty resources, there is an initial time commitment necessary to become comfortable with the system and to design appropriate interface for student consideration. In a MLS-facilitated lecture, there is still a place for presentation of material or demonstrations to ensure that students are exposed to specific ideas. For example, a short presentation can be used to set the stage for having students answer a particular set of questions or to clarify issues raised by students following the class-wide discussion of a question.

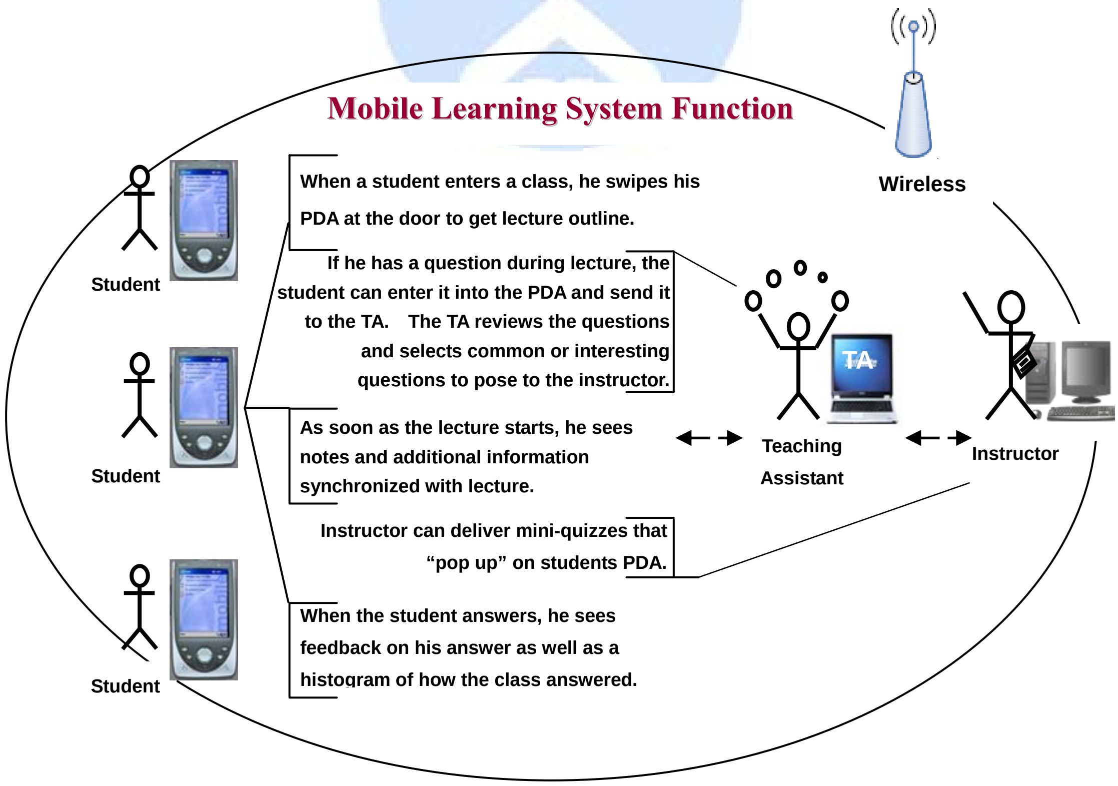


Figure 3.1 A constructive M-Classroom activity for MLS

As Figure 3.1 shows, in M-based classroom learning environment, instructor, students and Teaching assistant comprise a team dedicated to learning. The student using a handheld device facilitates communication with the instructor, peers, and materials fast and effectively. Using wireless devices eliminates the need for instructors to wait for access to a typically limited number of computers with an internet connection and allows them to research web resources or send quizzes (or documents) to students at their convenience, and students can post questions to the newsgroup without interrupting the flow of the lecture. Teaching assistant can answer questions immediately, either during lecture when they have the option of passing questions on to instructor. Teaching assistant monitoring the students' responses during class can signal the instructor when a particularly interesting or frequent question is raised. In turn, the students can address that concern immediately. Within this environment the instructor can create tasks or questions in a variety of styles, present them to the audience by projection or by downloading questions and/or text to the PDA, and if desired, provide response-specific feedback to the student. Programming contained in the central unit permits the instructor to examine the collected responses, display the results to the audience, and store them for future analysis. MLS includes facilities for incorporating active learning exercises into the lectures, providing instructor with instant feedback on student comprehension in the form of quizzes and interactive polling.

The construction of MLS has three layers. The first layer is the front page of MLS. The second layer has four parts: course content, take quizzes, instant message and Q&A. The third layer is the contents of the above layers. The topics of these contents were based on course designs and objectives. Figure 3.2 shows the structure of MLS.

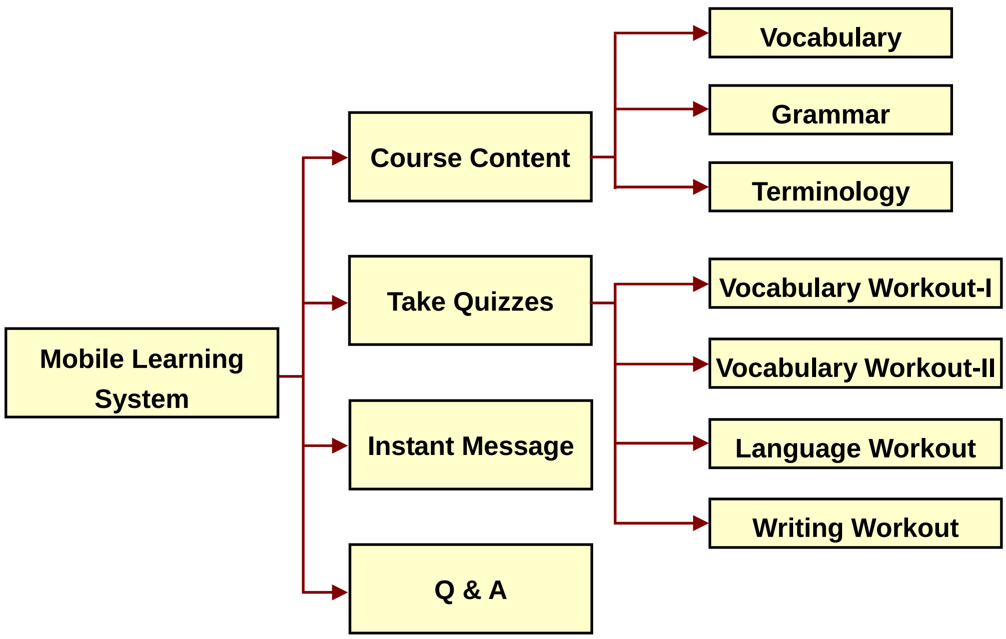


Figure 3.2 The structure of MLS

3.1.2 Design of MLS Interface

The interface development of MLS is shown from Figure 3.3 to Figure 3.4. Figure 3.3 is the front page of MLS. The users have to input username and password to enter the MLS. It was important for us that the students did login to our server so that we could collect attendance data.

Figure 3.3 The front page of MLS

Figure 3.4 is the function listed in MLS. In this mobile learning course, the following functionalities are used on PDA. There are four functions: course content, take quizzes, instant message, and Q&A. The four functions can be clicked and selected to enter among them.

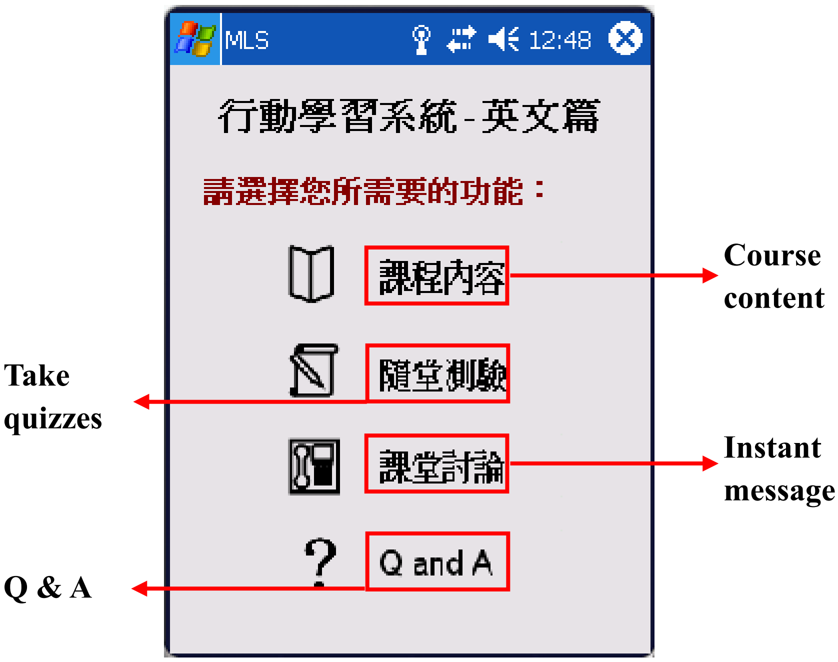


Figure 3.4 The function list in MLS

As Figure 3.5 shows, we delivered short mini-lessons to students, sent in discrete chunks so as to be easily readable on the tiny screens, such as sending vocabulary words and idioms, definitions, and example sentences via LMS in a spaced and scheduled pattern of delivery.

Figure 3.5 The course content of MLS

Furthermore, some mini-quizzes has been developed which allows the student to read and answer questions in the target language, and requesting feedback in the form of quizzes and follow up questions. Students are tested immediately and compared to groups that received identical lessons via the MLS. Figure 3.6 is the 'take quizzes' function in MLS.

In the evaluations, multiple choice tests on the key features of the party species or other workouts were administered before and after the section.

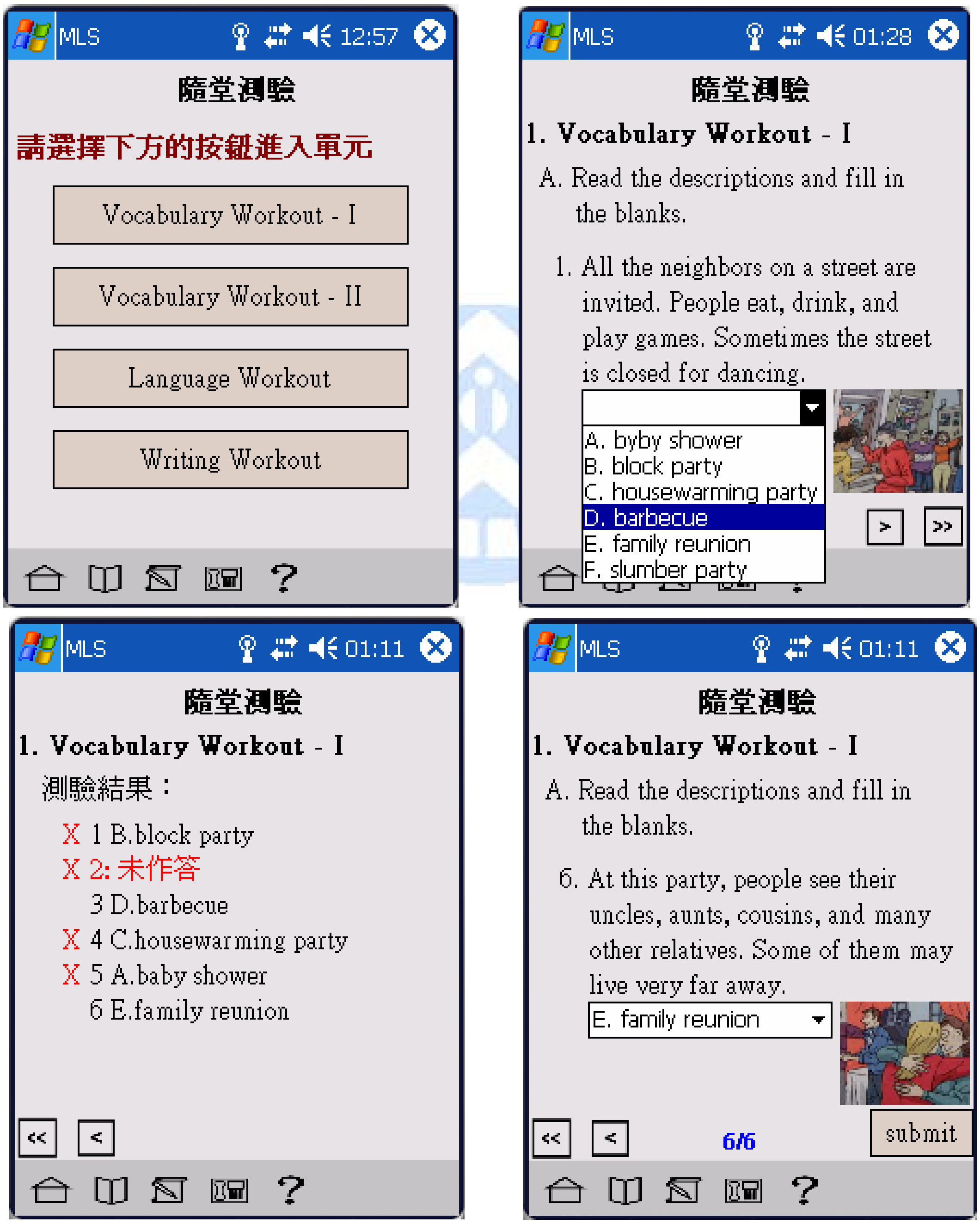


Figure 3.6 A series of "take quizzes" function for MLS

Figure 3.7 shows three screenshots of the instant message function that illustrate the work items:

- 「Send Message」: send message to somebody.
- 「Message Box」: review all of messages.

The use of mobile devices to gather feedback from students during a session being delivered by 「Instant Message」 function that emphasizes the integration of mobile devices into existing teaching practice, not the replacement of it. The key features of the「Instant Message」function were timeliness and appropriateness, such that students could be directed as appropriate to either Teaching assistant or peers. MLS facilitate whole-class drill and feedback activities by allowing instructor to present content-specific questions, and gather student responses rapidly. These questions can range from simple review to probing questions at the heart of the subject matter. Suggested solutions are invited by way of multiple choice options on the students' devices. This also aids the teacher in assessing the current level of understanding in the class as a whole.

Traditional education can be enhanced by integrating mobile communication and related services to increase its learning effectiveness. It is obvious that mobile technology is playing a key role in facilitating online learning communities with the dynamics of enhanced expression and added convenience in traditional learning.

Figure 3.7 A series of "instant message" function for MLS

We do have a Q&A function available through this system (as figure 3.8). This Question and Answer (Q&A) function allows students to look for course content according to topic. It offers students a more way to read course material.

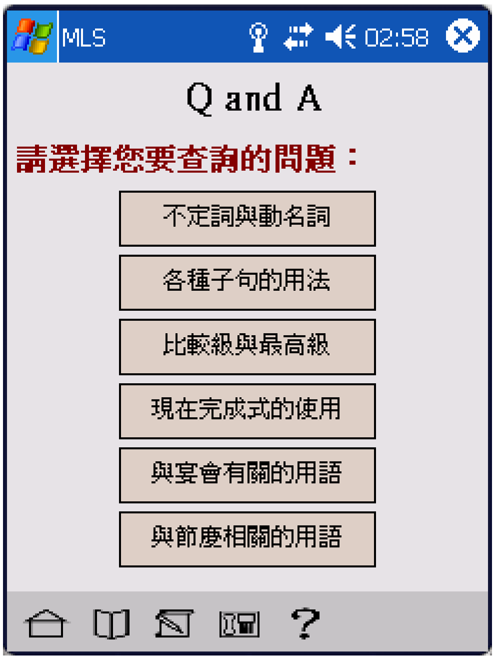


Figure 3.8 An "Q&A" function for MLS

The development of interface is based on principles of small screen design (Shneiderman and Plaisant, 2004; Jones et al., 1999; Clyde, 2001), and is summarized as follows:

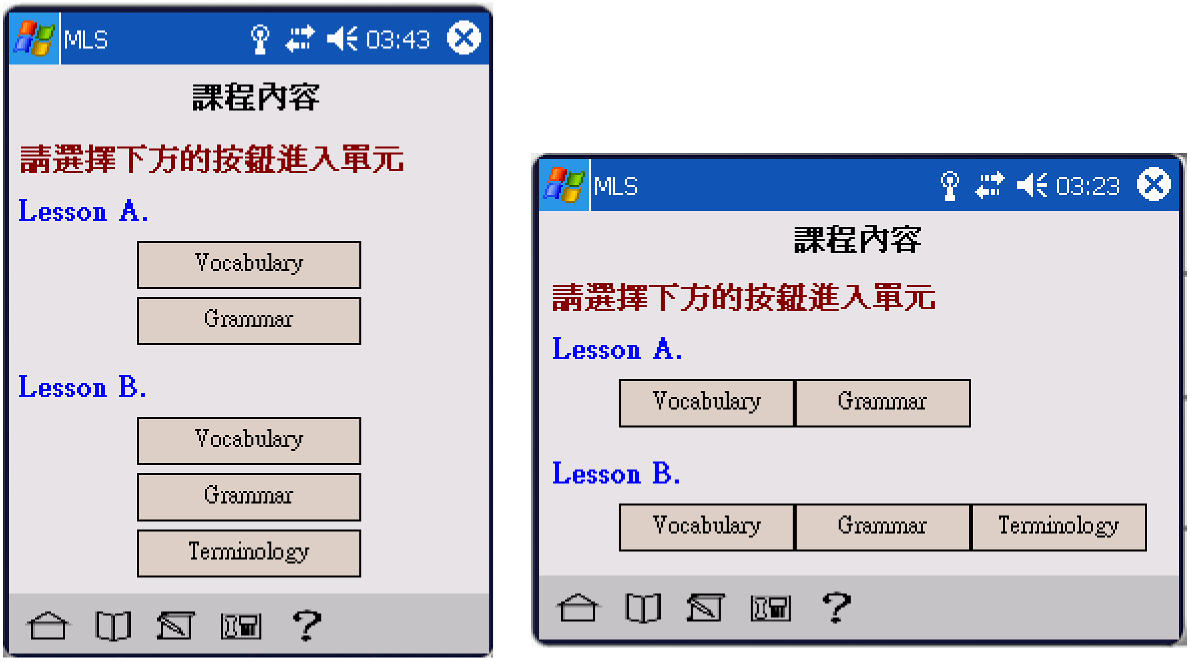
- Principle of Feedback: as shown in Figure 3.6 and Figure 3.7, the system should also provide positive feedback, and should provide partial feedback as info becomes available.
- Principle of Mapping: as shown in Figure 3.4, metaphors are a possible way to achieve a mapping between the computer system and some reference system known to the users in the real world. Icons often should be used to strengthen a metaphor.
- Reduce short-term memory load: as shown in Figure 3.6, the list was used to suggest the answer information, so that this design can reduce the memory loading of students.
- Lines of text should be short: the lines of text were up to 7 in all of small screen

interface design.

- Cater to universal usability is included in each screen: as shown in Figure 3.4 to Figure 3.9, the 'Shortcut bar' at the button of displays. Users should be allowed to jump directly to the desired location in large information spaces.
- The hierarchy of menu options or data choices is shown to reflect the aggregate view: as shown in Figure 3.4 to Figure 3.9, the function buttons was used to reflect the aggregate view, and these buttons can be clicked and selected to enter system among them.
- Thumbnail sketches may replace full images as default with full images by request: as shown in Figure 3.5 and Figure 3.6, the small illustration (72x56 pixels) was used to support the students in the language learning.
- Recommendations for text sizes from previous studies have indicated font size 10-12 of Times for young to middle-aged adults and the line spacing is set to about 150% or more. As shown in Figure 3.4 to Figure 3.9.

3.1.3 Portrait and Landscape Presentation Modes

Two versions of display type to access mobile learning system were used for the study as figure 3.9 (a) (b). We prepared one version of each type of document for MLS. The content of each type of document remain the same, only the page layout changed. The portrait/landscape content is a composed of texts, tables and pictures (plain text, plain table, plain image, text & table, text & image, text & table & image), in which the landscape mode was redesigned to be the maximum number of lines that would fit on the Palm Pilot without requiring scrolling.



(a) (b)

Figure 3.9 A presented mode for Portrait (a) and Landscape (b)

In the PDA landscape condition, the window was 6 x 8 cm and there were maximally about 45 characters per line (cpl) and 4~5 lines per page. In a vertical orientation the screen has approximately lines with approximately 35 cpl and 6~7 lines per page. In this study, we compared the user preference for portrait and landscape mode for a set of tasks on using the PDA. The preference is measured in a post-experiment questionnaire.

3.2 Experimental Design

3.2.1 A Learning Scenario

What tasks in the instruction process could be aided by a mobile context? The task analysis searches to answer three questions: what are the users trying to achieve, why are they trying to achieve it, and how are they going about it (Preece, Rogers and

Sharp, 2002). The study found mobile wireless devices to be a useful tool not only for engaging students in active learning during the lecture hour, but also for enhancing the overall communication within the classroom. Participants will be hypothesizing a scenario of use that will enhance users' interactive experience with their mobile devices. They were given basic exercise in the use of the PDA and its applications before the experiment starts. The following learning activities can be carried out by a student:

- The texts can be read, vocabulary are linked with the corresponding meaning description. If needed, the student can click the '<' ('>') buttons. This button acts like a browser 'BACK' ('FORE') button, and returns to a previous (next) page.
- Each text includes mini questions which the student has to answer and submit via PDA. Hints for the correct answers to the questions are provided in the following way: when the student clicks on the submitted button, the sentences that could provide the answer are highlighted. Moreover, the grammar and its large amount of information on the construction of semantically and syntactically correct sentences are always accessible simultaneously with the texts.
- The any questions can be sent to a learning partner or to a human tutor (Teaching assistant) for correction.
- In order to increase the incidentally obtained vocabulary knowledge, a text can also be practiced as a fill-in-the-blanks exercise.
- Extra text sentences can be built in the 'terminology' when calling the "more examples" feature of the system.
- Users can seek answers according to topic in the 'Q&A' function.

3.2.2 Environment and Apparatus

The study developed a prototype application for the experiment, written in Visual .NET 2003, which is executable on Pocket PC device, HP hx2400. An HP iPAQ hx2400 which has a 65,536 color TFT screen with a 3.5 inches screen, resolution of 240*320 pixels, a touch-screen pen interface, and an on-screen keyboard used with a pen. (see Figure 3.10). The handheld runs the MLS, which communicate with the PC through any available wireless connection—802.11 or Bluetooth. With HP hx2400 you can easily switch to portrait and landscape mode when choosing your custom resolution. This is very convenient when an application needs more horizontal than vertical space (like word editors), but the default orientation is portrait.

Figure 3.11 depicts the overall architecture of the M-based classroom. The system was implemented using a wireless ad-hoc networking environment, comprising of a (Teaching assistant's) notebook with a WiFi wireless LAN card that acted as the local server, and student PDAs with 802.11 LAN cards. On the PC side, a back-end server (such as Learning Management System) monitors the communication and interacts with PDA applications. We use the following languages scenario, based on a real classroom activity, to introduce the MLS interface design. Our studies showed that the user could place the PDA beside the keyboard and use it with the nondominant hand for various activities.

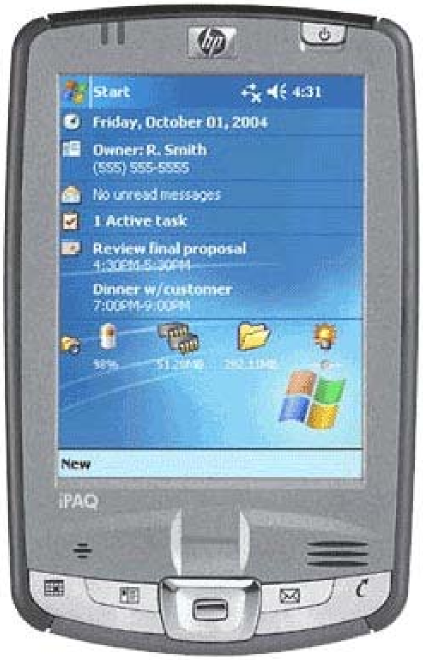


Figure 3.10 An HP iPAQ hx2400 (www.hp.com)

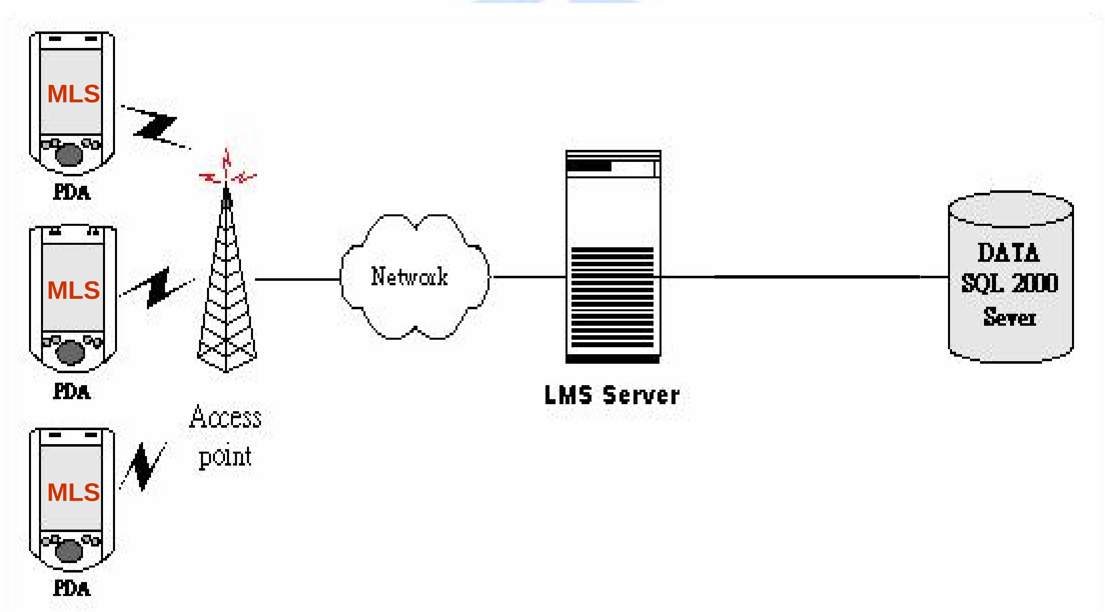


Figure 3.11 Screenshots of the system architecture

3.2.3 Participants

Twelve student participants from Information Management department of National Kaohsiung First University of Science and Technology completed the experiment. Ages ranged from 20 to 27 years, median 23 years. Participants had no or very minimal experience of PDA before the experiment. Each participant was exposed to two simulated systems that realized a portrait and a landscape version. They were asked to perform two tasks (task A: workout in lesson A; task B: workout in lesson B). The tasks were different in both systems. Six of the participants performed the tasks first on the vertical (portrait) version and then on the horizontal (landscape) version (as shown in table 3.1). The other six participants performed the tasks first on the landscape version and then on the vertical version. All the participants were given a short tutorial of about 8 minutes on both versions. After performing the tasks on both systems the participants were asked to fill out a subjective user satisfaction questionnaire. The questionnaire drew responses to a post-course questionnaire from 12 students in one undergraduate course. The questionnaire asked the participants to rate 3 sections on a 1-5 scale (1 being poor and 5 being excellent).

Table 3.1 The task of experimental for each participant

Display / Task	Portrait	Landscape
Task A	$S_1\sim S_6$	$S_7\sim S_{12}$
Task B	$S_7\sim S_{12}$	$S_1\sim S_6$

3.2.4 Research Questions and Hypotheses

A set of items designed to measure language learning from always-online environment formed a reliable, unidimensional index for these sections. These questions will be tested with Cronbach's Alpha.

Q1: Can we obtain a measure of language learning from always-online environment that will have high internal consistency?

Q2: Can we devise measures of small interface design that will have high internal consistency?

An "independent" or contextual variable may influence students' preference in MLS portrait/landscape orientation. In our research, the composed of content and present mode are considered as independent variables. Do content differences affect the present mode? We present our Hypothesis as follows:

Hypothesis 1: Out of consideration for content, the student's preference in presented orientation will be difference.

Hypothesis 2: There is relationship between the composed content and interface variables.

CHAPTER 4 RESULTS AND DISCUSSION

The last section outlines the experiment implemented in this study. The results from the experiment are then presented and discussed. Some areas for further investigation are suggested. Finally the conclusions drawn from our study experiences are given.

4.1 Experimental Results

In this chapter, the performance of all participates was evaluated by these three sections: the always-online environment, interface assessment, and comparing with portrait and landscape version. Our project was to control the appearance of the variance as carefully as possible and remove it as a factor in the outcome of the experiment. In this section we report on the results of a user study that compare the preference of two types for the display and use of guidelines on small screen. Table 4.1 shows the raw data of experiment for each participant. The raw data gathered from the experiment was analyzed by using SPSS™. Regarding their gender, 33.3% are females and 66.7% are males. In addition, 83.3% of these participants are junior level students and 16.7 % are senior level students.

Table 4.1 Demographics

		Number	Percentage
Gender	Female	4	33.3%
	male	8	66.7%
Current Grade	Junior	10	83.3%
	Senior	2	16.7%

4.1.1 Reliability

The mobile learning questionnaire is constructed in three parts. The first part, in accordance with mobile learning components, measures the assumed key competencies in using mobile devices of learning activities and measures the learning experiences of the learners who have used the devices. The second part measures the usability of the interface design in MLS. Finally, we also hope to help users make a well-informed choice when considering readability for present mode of small screen. In the questionnaire these issues have been operationalised. Subjects were therefore well able to appreciate the aims of M-Classroom learning and the questionnaire study from the NKI distance Education (2004) information provided where content validation was appropriate within the target context.

Reliability analysis showed satisfactory result (As shown in Table 4.2), which has high internal consistency (section1: Cronbach's α coefficient = 0.861, section2: Cronbach's α coefficient = 0.845). The Cronbach's Alpha of over 0.85 indicates high internal consistency for the set of items. Therefore, these results answer the research question 1: we have a good measure of students' language learning from always-online environment. Over eighty percent of the students felt that they have found the PDA to be more useful than the study anticipated. Seventy-five percent of the students thought MLS improved their learning quality (mean=3.92). Compared to a typical learning, seventy-five percent of students thought MLS make it easier to study the content of the case.

Students were also asked about the small interface design for MLS prototype. Table 4.2 (see Section2) shows that over half of the assessable items were good by guidelines. Therefore, table 4.2 (see Section2) shows the answer for research question 2. They were combined into a single index, which has high internal consistency (Cronbach's Alpha=0.845).

Table 4.2 Summary of Measurement Scales

Questionnaire Category: SA=Strongly Agree; A=Agree; N=No opinion; D=Disagree; SD=Strongly Disagree; S. D.=Standard Deviation

Section 1 The always-online environment

Measure	SA	A	N	D	SD	Mean	S.D.
It was easy to use the PDA in this mobile-based classroom learning course.	16.7%	75.0%	8.3%	.0%	.0%	4.08	.52
Motivate me to do best work.	25.0%	58.3%	8.3%	8.3%	0%	4.00	.85
Course learning objectives can be met by mobile learning	8.3%	66.7%	25.0%	.0%	0%	3.83	.58
I would recommend the integration of the PDA into the classroom to others.	33.3%	25.0%	33.3%	8.3%	0%	3.83	1.03
Overall, I have found my PDA to be more useful than I anticipated.	33.3%	50.0%	16.7%	.0%	0%	4.17	.72
Evaluation and questioning in the mobile learning system (MLS) was effective.	25.0%	75.0%	.0%	.0%	0%	4.25	.45
Communication with the instructor / teacher assistant / peers by instant message functioned well.	41.7%	50.0%	8.3%	.0%	0%	4.33	.65
Do you think that the user interface of the prototype is easy to use?	25.0%	75.0%	.0%	.0%	0%	4.25	.45
Does the MLS prototype present to you here show enough evidence that it can be a good complement to the classroom learning?	16.7%	66.7%	16.7%	.0%	0%	4.00	.60
Does the prototype show enough evident that it will bring more convenience to the user?	33.3%	58.3%	8.3%	.0%	0%	4.25	.62

Learning quality is improved by MLS.	16.7%	58.3%	25.0%	.0%	0%	3.92	.669
Compared to a typical learning, did the MLS make it easier to study the content of the case?	16.7%	58.3%	16.7%	8.3%	0%	3.83	.835
I found the lessons presented through the PDA to be more effective than previous lessons done by note-taking.	41.7%	41.7%	16.7%	.0%	0%	4.25	.754

Cronbach Alpha (α) = 0.861

Questionnaire Category: VG=Very Good; G=Good; A=Average; P=Poor; VP=Very Poor; S. D.=Standard Deviation

Section 2 Interface Assessment

Measure	**VG**	**G**	**A**	**P**	**VP**	**Mean**	**S.D.**
Font Size	33.3%	50.0%	16.7%	.0%	.0%	4.17	.718
Font Type	41.7%	25.0%	25.0%	8.3%	.0%	4.00	1.044
Font Color	25.0%	33.3%	41.7%	.0%	.0%	3.83	.835
Backcolor	16.7%	50.0%	25.0%	8.3%	.0%	3.75	.866
Interline Space	16.7%	75.0%	8.3%	.0%	.0%	4.08	.515
Characters Per Line (CPL)	16.7%	58.3%	25.0%	.0%	.0%	3.92	.669
Lines Per Page	25.0%	58.3%	16.7%	.0%	.0%	4.08	.669
Image Quality	8.3%	50.0%	25.0%	8.3%	8.3%	3.42	1.084
Table (font size, column width, row height...)	8.3%	58.3%	25.0%	8.3%	.0%	3.67	.778

Cronbach Alpha (α) = 0.845

4.1.2 Chi-Square Goodness of Fit

The Chi-Square Goodness of Fit test determines if the observed frequencies are different from what we would expect to find (we expect to see equal numbers in each group within a variable). Following is sample output of a Chi-Square Goodness of Fit test. We wanted to see if different interface groups are equally represented among students' choice. First, we see a frequency table for each group (Table 4.3). The "Observed N" presents how many cases are in each group. The "Expected N" shows how many people we expected to find in each group, if there is no difference between groups. Here we see that we expected to find 36 cases in each group. Next, we see the results of the Chi-Square test. There is a significant difference ($p=.018^{*}<0.05$, $\chi^2=5.556$). Therefore, we can say that there are not equal numbers of students' choice from each interface group. This result shows that students highly prefer the landscape mode of MLS than portrait.

Table 4.3 Test result of hypothesis 1

Frequencies (interface)

	Observed N	Expected N	Residual
portrait	26	36.0	-10.0
landscape	46	36.0	10.0
Total	72		

Test Statistics

	interface
Chi-Square[a]	5.556
df	1
Asymp. Sig.	.018*

a. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 36.0.

4.1.3 Chi-Square Test of Independence

The Chi-Square Test of Independence tests the association between 2 categorical variables. Following is experimental output of a Chi-Square Test of Independence. We wanted to see different composed of content is related to students' choice for present mode. That is, are different content more likely to influence students' choice?

First we see the "Case Processing Summary" (Table 4.4). There are a total of 12 people who participated in our study, but there are six present models. Thus, our valid number of cases (Valid N) is 72. Next we see the contingency table. Because of more than 20% of the expected values may be less than 5 (see Table 4.4 contingency table (**original**)). Then, this would make it necessary to merge cells and response categories. It searches for the best merge of adjacent intervals by minimizing the chi-square criterion applied locally to two adjacent intervals: they are merged if they are statistically similar.

As shown in Table 4.4 contingency table (**modify**), we can look to the marginal, or the ends of each row or column, to find the total number for that category. For example, there are 26 cases which chose portrait model. The contingency table also gives the percent of total for each cell. Finally, we see the results of our Chi Square Test of Independence. We see that our Pearson Chi-Square value is 11.679. We have 2 degree of freedom. Our significance is .003 (Cramer's V is ~.403 and significant, p = .003). There is a significant difference (our significance level is less than .05). Therefore, we can say that the two variables are associated. The data supports the hypothesis 2 that different composed of content seem to be related to students' choice for present mode.

According to user's preference, the content of "plain text" with "plain table" and “text + image” with “text + table + image” was found to be more appropriately to use landscape mode, “plain image” with “text + table” being more appropriately to use portrait mode.

Table 4.4 Test result of hypothesis 2

composed * interface Crosstabulation **(original)**

			interface		Total
			Portrait	Landscape	
composed	plain text	Count	2	10	12
		Expected Count	4.3	7.7	12.0
		% of Total	2.8%	13.9%	16.7%
	plain table	Count	2	10	12
		Expected Count	4.3	7.7	12.0
		% of Total	2.8%	13.9%	16.7%
	plain image	Count	7	5	12
		Expected Count	4.3	7.7	12.0
		% of Total	9.7%	6.9%	16.7%
	text + table	Count	8	4	12
		Expected Count	4.3	7.7	12.0
		% of Total	11.1%	5.6%	16.7%
	text + image	Count	2	10	12
		Expected Count	4.3	7.7	12.0
		% of Total	2.8%	13.9%	16.7%
	text + table + image	Count	5	7	12
		Expected Count	4.3	7.7	12.0
		% of Total	6.9%	9.7%	16.7%
Total		Count	26	46	72
		Expected Count	26.0	46.0	72.0
		% of Total	36.1%	63.9%	100.0%

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
composed_new * interface_new	72	100.0%	0	.0%	72	100.0%

composed_new * interface Crosstabulation **(modify)**

			interface		Total
			portrait	landscape	
composed_new	plain text & plain table	Count	4	20	24
		Expected Count	8.7	15.3	24.0
		% of Total	5.6%	27.8%	33.3%
	plain image & text + table	Count	15	9	24
		Expected Count	8.7	15.3	24.0
		% of Total	20.8%	12.5%	33.3%
	text + image & text + table + image	Count	7	17	24
		Expected Count	8.7	15.3	24.0
		% of Total	9.7%	23.6%	33.3%
Total		Count	26	46	72
		Expected Count	26.0	46.0	72.0
		% of Total	36.1%	63.9%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	11.679[a]	2	.003	.003	
Likelihood Ratio	11.827	2	.003	.003	
Fisher's Exact Test	11.310			.003	
Linear-by-Linear Association	.801[b]	1	.371	.456	.228
N of Valid Cases	72				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.67.

Symmetric Measures

		Value	Approx. Sig.	Exact Sig.
Nominal by Nominal	Phi	.403	.003	.003
	Cramer's V	.403	.003	.003
	Contingency Coefficient	.374	.003	.003
N of Valid Cases		72		

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

4.1.4 Data Results from Open-ended Questions

From the questionnaires, we also analyzed some responses from open-ended questions. Students were asked to comment about what they think should be improved for MLS prototype. The students' responses to this question included:

- "Need to practice listening comprehension, pronunciation and speaking drills, and oral presentation"
- "The simple drop-down menu can transform it into a Scroll Bar available with all of the options"
- "Students need more exercises for workout"
- "Instructors should be available online for two or three hours everyday so that students can ask questions whenever they want…"
- "The pictures were too small"

When students were also asked what they liked best in the MLS, answers included:

- "Interaction (Students also expect more interaction with their instructors)"
- "Convenience"
- "Ease of use"
- "Less pressure"

- “User-friendly interface”
- “Language learning is a good choice as a field of the use of mobile devices”
- “The dynamic nature of content and the sharing of experiences among peers”
- “Being connected between students and instructor”
- “Clearly and openly express opinions without fear"

Overall, the results of the above questions suggested that students found the MLS beneficial and useful to them. Many students felt that MLS have benefited their learning motivation and have improved their learning quality.

4.2 Discussion

Portable devices are becoming increasingly important within education and it is recognized that "mobile devices can become efficient and effective teaching and learning tools" (Roibas & Sanchez, 2002). Learning and teaching with mobile technologies is beginning to make a breakthrough from small-scale pilots to institution-wide implementations. Mobile technologies provide for each student to have a personal interaction with the technology in an authentic and appropriate context of use. This does not mean, however, that the use of mobile devices is a panacea. Significant technological and administrative challenges are encountered along with a more ill-defined challenge: how can the use of mobile technologies help today’s educators to embrace a truly learner-centered approach to learning? These devices share a common problem: attempting to give users access to powerful computing services and resources through small interfaces, which typically have tiny visual displays, poor audio interaction facilities and limited input techniques. They also introduce new challenges such as designing for intermittent and expensive network access, and design for position awareness and context sensitivity.

Our project was based on the M-based classroom learning, with the assumption being that providing appropriate mobile tools would help students to become capable, self-reliant, self-motivated and independent. The findings are as follows: (1) students found the MLS were beneficial and useful; (2) many students think that MLS should be continued in future classes; (3) students were reported to be highly motivated and impressed—particularly by the mini-quizzes and message delivery functions—but expressed difficulty in using pointers and virtual keyboards for data entry. Empirical user based studies and ethnographical analysis in user needs requirements were strongly promoted research areas in the mobile HCI community. We believe that this research aids in highlighting the developing maturity of the field and those topics within the development of mobile systems that need further work from HCI researchers.

CHAPTER 5 CONCLUSIONS

5.1 Contributions

Mobile technologies provide an opportunity for a fundamental change in education away from occasional use of a computer in a lab towards more embedded use in the classroom and beyond. Education as a process relies on a great deal of coordination of learners and resources. Mobile devices can be used by instructors for attendance reporting, reviewing student marks, provides course material to students.

Based on the previous studies, the development of MLS in this study has some contributions as follows:

- At anytime during our class instantly see how students are responding to questions and how they compare to the overall group.
- View data collected in the classroom through the use of a Report Wizard that organizes student response data.
- View student responses in real-time grouped by demographic type for an individual question.
- Accumulate assessment points, grade quizzes and tests automatically. Review via LMS reports or export into campus enterprise systems.
- Use comparative links to present a question to students－later in the class present the same question and automatically display a side-by-side comparison of the results.
- Reward students with more points for responding to questions fast.

In this paper, the results suggest that MLS definitely improved students' language learning in the M-based classroom. The findings demonstrate that variations among students' preference or content are associated with differences in presented mode.

5.2 Limitations of Experiment

M-based classroom learning can provide the opportunity for rapid feedback enabling students to direct their studies to areas where they have identified a gap in their knowledge. Besides, it encouraged collaboration and communication both between the students and between the students and their instructor. Notwithstanding its benefits, M-based classroom also poses related challenges. For instance, inherent in the portability of mobile media are reduced screen sizes, limited audiovisual quality, virtual keyboarding and one-finger data entry, and limited power. Other deficiencies of experimental environment design were as follows:

1.) The experiment was conducted in laboratory, and the accident in the real situation was hard to simulate in the experiment, therefore, it may influence the experimental results.
2.) While handhelds are usable and flexible tools that have succeeded in supporting a variety of classroom activities, we need to examine the impact these tools have on student learning.
3.) Only a small number of participants were included in undergraduate courses at a single university. Future research is needed that looks at a much larger data set, preferably from multiple universities, and adds additional functions such as listening comprehension exercises into the MLS.
4.) The default page content limit is "table + image".

5.3 Future Work

Clearly handheld computers are flexible tools that can be adapted to suit the needs of a variety of teaching and learning styles. It is about to bring forth a new shift of paradigm to conventional foreign languages learning. The increasing learning outcome from M-based classroom is undeniable. As a future work, we see several directions:

1) In the study, one of the major purposes is to design an MLS and compared with the traditional classroom learning. Therefore, the future study can test the performance of different small interface design to find out some potential factors.
2) At all stages communication and cooperation with schools, instructors and students will continue to ensure functionality and suitability. This should result in a system that is accepted by instructors, where they are sure that the content is curriculum-specific and the technology is used naturally and appropriately to enhance the educational experience.
3) The classroom culture and different user cultures set clashing expectations towards mobility and mobile learning. From the wider cultural perspective the access to different sources of information requires new approaches towards knowledge building and learning among both instructors and students.
4) Deeper analysis of user behavior in order to study and improve the learning process.
5) Another topic for research is how newer mobile devices and the use of digital audio as well as text-based materials, may affect the process of participation in, and perceived learning from MLS.
6) We believe that the user interaction with landscape mode presented here is still

not complete or optimized. Further study is needed to investigate how design principles affect the landscape presented.

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APPENDICES

Appendix One: Research Questionnaire

Dear members:

This experiment has been designed to determine the usability and performance of mobile-based classroom learning. The results of this questionnaire will inform future developments in this area.

To find out suitable for content format, we would like to know your views on the portrait and landscape mode of Mobile Learning System (MLS).

Best Regards,

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Meng-Fang Kuo, Graduate Student
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Personal Information

First, please tell us about yourself….

1. Name:___________

2. Gender:___________ (Male or Female)

3. Age:___________

4. Current Grade:____________
(e.g. freshman, sophomore, junior, senior, etc)?

5. Do you own a PDA (personal digital assistant), pocket PC or palmtop? Y / N

Section 1. The always-online environment

Please circle the ONE answer choice that best describes your position.

1. **It was easy to use the PDA in this mobile-based classroom learning course.**

   Strongly agree Agree No opinion Disagree Strongly disagree

2. **Motivate me to do best work.**

   Strongly agree Agree No opinion Disagree Strongly disagree

3. **Course learning objectives can be met by mobile learning.**

   Strongly agree Agree No opinion Disagree Strongly disagree

4. **I would recommend the integration of the PDA into the classroom to others.**

   Strongly agree Agree No opinion Disagree Strongly disagree

5. **Overall, I have found my PDA to be more useful than I anticipated.**

   Strongly agree Agree No opinion Disagree Strongly disagree

6. **Evaluation and questioning in the mobile learning system (MLS) was effective.**

   Strongly agree Agree No opinion Disagree Strongly disagree

7. **Communication with the instructor / teacher assistant / peers by instant message functioned well.**

   Strongly agree Agree No opinion Disagree Strongly disagree

8. **Do you think that the user interface of the prototype is easy to use?**

   Strongly agree Agree No opinion Disagree Strongly disagree

9. **Does the MLS prototype present to you here show enough evidence that it can be a good complement to the classroom learning?**

Strongly agree Agree No opinion Disagree Strongly disagree

10. **Does the prototype show enough evidence that it will bring more convenience to the users?**

Strongly agree Agree No opinion Disagree Strongly disagree

11. **Learning quality is improved by MLS.**

Strongly agree Agree No opinion Disagree Strongly disagree

12. **Compared to a typical learning, did the MLS make it easier to study the content of the case?**

Strongly agree Agree No opinion Disagree Strongly disagree

13. **I found the lessons presented through the PDA to be more effective than previous lessons done by note-taking.**

Strongly agree Agree No opinion Disagree Strongly disagree

Section 2. Interface Assessment

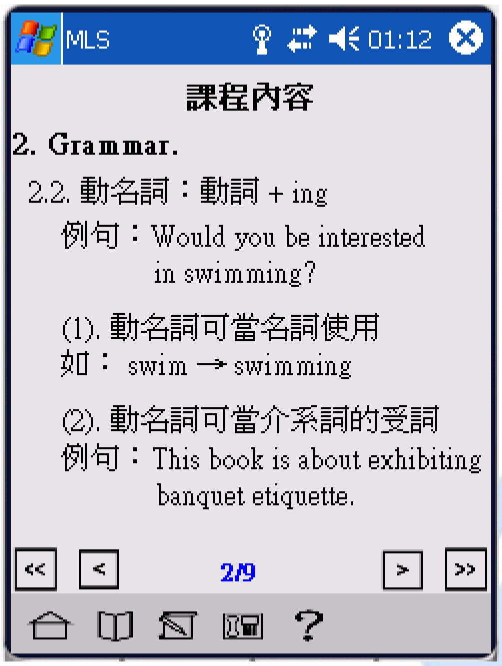
Please rate the small interface design in terms of the INSIGHT IT GIVES into the following

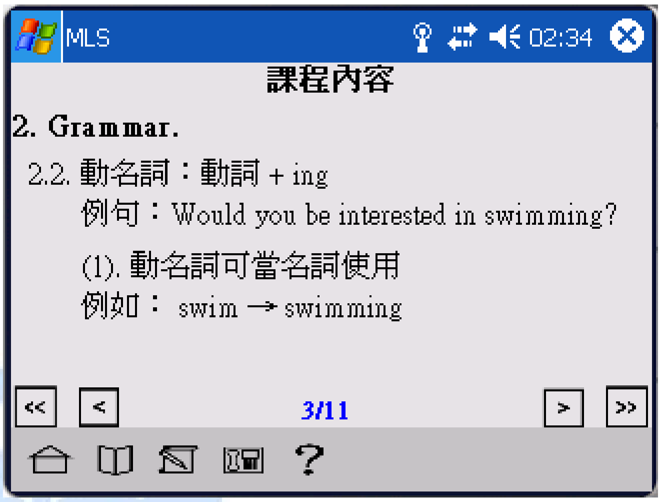
	Very Good	Good	Average	Poor	Very Poor
1. Font Size	☐	☐	☐	☐	☐
2. Font Type	☐	☐	☐	☐	☐
3. Font Color	☐	☐	☐	☐	☐
4. Backcolor	☐	☐	☐	☐	☐
5. Interline Space	☐	☐	☐	☐	☐
6. Characters Per Line (CPL)	☐	☐	☐	☐	☐
7. Lines Per Page	☐	☐	☐	☐	☐
8. Image Quality	☐	☐	☐	☐	☐
9. Table (font size, column width, row height…**)**	☐	☐	☐	☐	☐

Section 3. Comparing with Portrait and Landscape Version

If you had a choice which of the following present models what would your preferences be?

1. Plain text





Portrait **Landscape**

extremely	slightly	neutral	slightly	extremely
☐	☐	☐	☐	☐

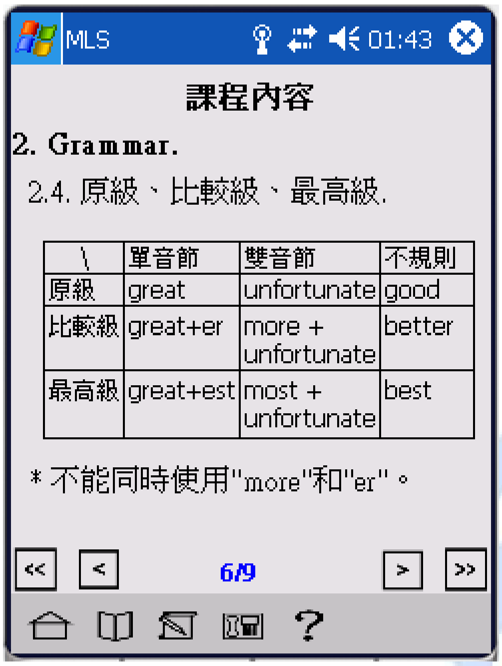
Please give reasons:

a.--

b.--

c.--

2. Plain table



Portrait				**Landscape**
extremely	slightly	neutral	slightly	extremely
☐	☐	☐	☐	☐

Please give reasons:

a. --

b. --

c. --

3. Plain image

Portrait				Landscape
extremely	slightly	neutral	slightly	extremely
☐	☐	☐	☐	☐

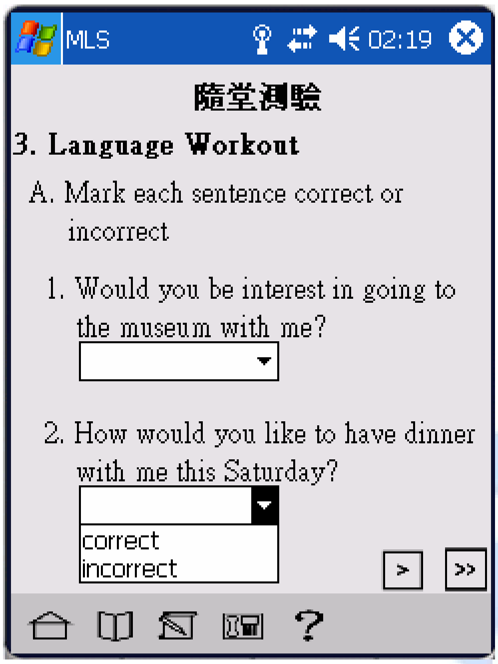
Please give reasons:

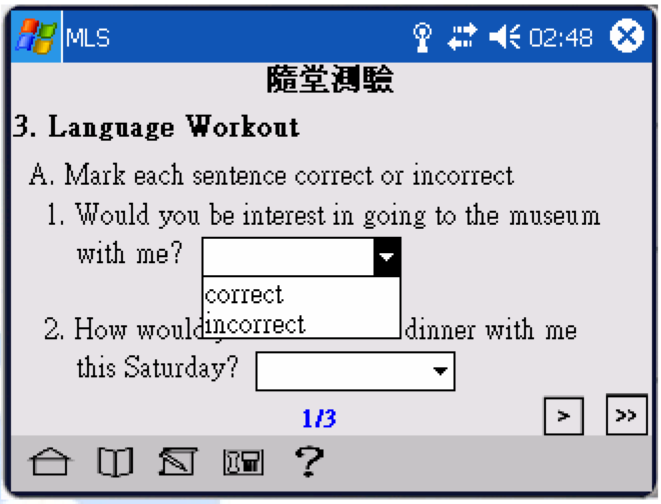
a. --

b. --

c. --

4. text + table





Portrait

Landscape

extremely	slightly	neutral	slightly	extremely
☐	☐	☐	☐	☐

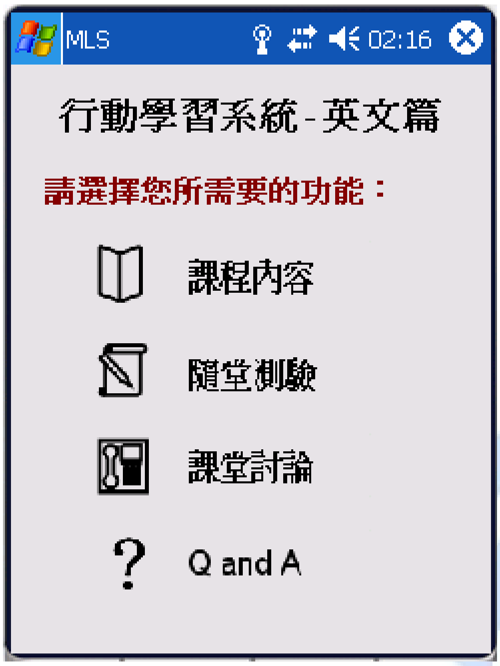
Please give reasons:

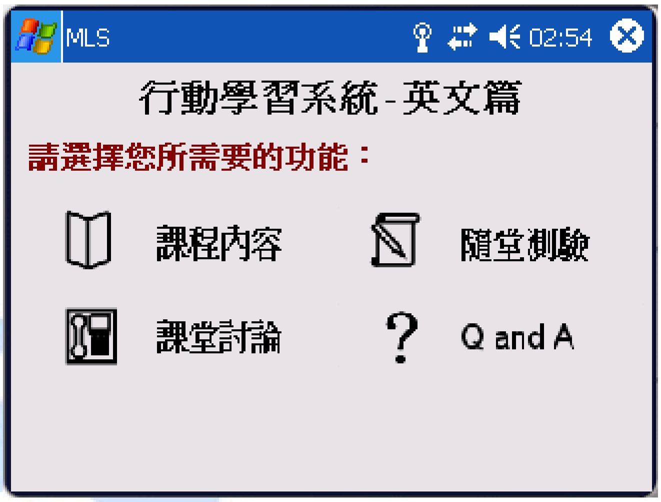
a. --

b. --

c. --

5. text + image





Portrait **Landscape**

extremely	slightly	neutral	slightly	extremely
☐	☐	☐	☐	☐

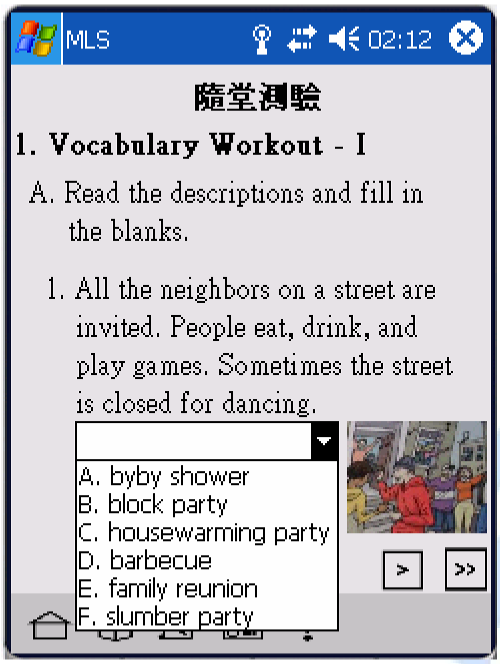
Please give reasons:

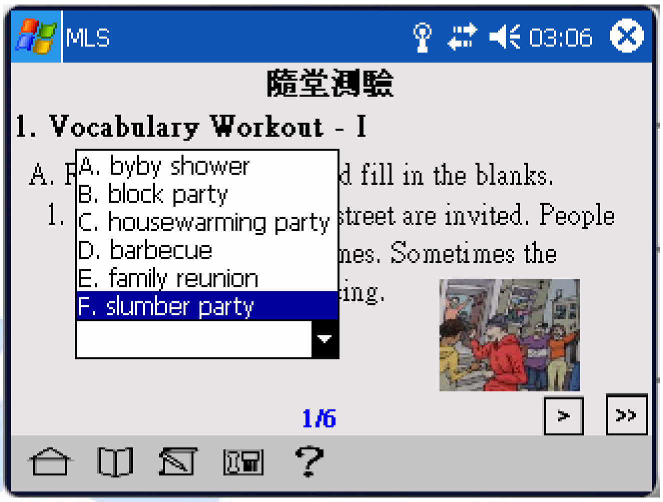
a. --

b. --

c. --

6. text + table + image





Portrait | Landscape

extremely	slightly	neutral	slightly	extremely
☐	☐	☐	☐	☐

Please give reasons:

a. --

b. --

c. --

Please specify any other comments you wish to make about the MLS.

If you were to suggest one additional function in the prototype, what would it be?

List up to three things that you like <u>most</u> about the MLS

Thanks Again for Your Assistance！

If you have any questions or would like to learn more from our research work, please do not hesitate to ask.