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Final Report On Professional Development Grant**

Exploration of Wireless/Handheld Devices for Electronic Learning

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Project Summary:

Wireless communications in form of Short Message Service (SMS) and Wireless Access Protocols (WAP) browsers have gained tremendous global popularity recently. Yet, not much has been done to extend the usage of these devices in electronic learning. This project explores the extension of e-Learning into wireless/handheld (W/H) computing devices supporting WAP, with the help of a mobile learning (m-learning) framework. This framework was utilized to develop WAP based tools such as WML website, SMS alerts, discussion board and chat. The prototype m-learning website goals were to help determine whether W/H devices are effective learning tools in courses at our university. The m-learning applications developed from this grant are available via any WAP-supported mobile device from Wapsite <http://miscom.uml.edu/forums/wiportal> and from Website <http://miscom.uml.edu/forums>. Registration (first time) and login is required to access the materials (see Appendix A for instructions). The tools were pilot-tested for over a two semesters at our campus. A total of 53 students from three undergraduate and graduate courses at College of Management used the m-learning environment with W/H devices and reported their experiences through a survey and interviews at the end of the semester. The feedback from this study is being used to further revise and enhance the m-learning environment for the next academic year 2004-05. We hope that results from this exploratory study will lead to proper investments in mobile/wireless technology and more studies on understanding the role of W/H devices in higher education.

PROJECT ISSUES & RESULTS

Despite the tremendous growth and potential of the Wireless/Handheld (W/H) devices and networks, wireless e-learning or mobile learning (m-learning) is still in its infancy and in an embryonic stage. *M-Learning* intersects mobile computing and e-learning; it combines individualized (or personal) learning with anytime and anywhere flexibility (Quinn, 2001). It is facilitated by a convergence of Internet, e-learning, and the W/H devices. With a W/H device, the relationship becomes one-to-one, always on, always there, location aware and personalized (Herman, 2002). Still, two major technical problems confronting these devices are reliability of connection and support for heterogeneous platforms (Quinn, 2001). But, there is improvement in both these areas indicating a fertile area for research in mobile applications. For example, the National Science Foundation has funded \$6 million to three tribal colleges in Nebraska to integrate wireless technology into e-learning programs over a four-year period (Anonymous, 2001).

The benefits of using a W/H device for e-learning are its' personalization capability and extended reach; this has the potential attracted more and more learners, especially adult learners, for whom the work-life balance is critical. A W/H device can help in time-management by converting their dead-time into a productive one (BenMoussa, 2002). W/H devices have the potential to change the way students behave and interact with each other. A typical scenario is that of a learner who is enrolled in an e-learning class for MBA program. While waiting for her flight at an airport, she can access class materials or interact with her classmates and instructors or download an assignment via her wireless PDA device. According to Robert Meinhardt, AvantGo's VP of Enterprise Marketing *"Wireless is an important key to e-learning [as] it takes e-learning to the field, where the best hands-on learning takes place."* (Setaro, 2001).

This research explored the development and adoption of m-learning in higher education, either in Distance Learning (DL) or traditional classroom environments. It investigated the usage of W/H devices such as PDAs and phones, which support the Wireless Access Protocols (WAP) in form of Short Message Service (SMS) and Wireless Markup Language (WML) browsers. The WAP protocols have gained tremendous global popularity for personal and business communications in W/H devices. Yet, not much has been done to extend e-Learning to these devices. This study's objectives were to develop a framework to guide in the development of m-learning tools for W/H devices, as well as, take advantage of the benefits provided by SMS, WML and other next generation wireless technologies in e-learning. As part of this study, I have customized or developed WAP-based tools like a personalized course website, message alert system, discussion board, and chat system which are accessible through a W/H device (see Appendix B for instructions). The m-learning Wapsite has been pilot tested to evaluate the effectiveness of this technology with students enrolled in online and on-campus courses at our university. Results have been presented below. I plan to continue revisions with the feedback received from the students the next academic year (2004-05) with the funds received from this grant.

A Mobile Learning Framework

The use of information technology has improved learning, especially when coupled with more learner-centered instruction (Zhu & Kaplan, 2002), or convenience, where learning and exchange with the instructor can take place asynchronously at the learner's own pace or on an as-needed basis (Palloff & Pratt, 2001). The issue of access to the instructor and to the information shifts how learning in higher education occurs. When wireless technology is integrated into this pedagogy, a new form of 24x7 learning model, known as *"mobile or m-learning"* may emerge. Besides being available anywhere and anytime, wireless devices are much more *individualized* and *collaborative* communications tools. As such, wireless technology can give faculty powerful tools for enhancing existing methodologies and exploring new pedagogical possibilities.

The m-learning framework presented, in Figure 1, attempts to provide a methodology to answer the questions raised from the literature reviewed in the previous section. The mobile connectivity research suggests the content delivery is more effective when a combination of push and pull mechanisms are used. Similarly, the content delivered should be both personalized as well as collaborative thereby allowing the user to control the content in terms of what information is received and communicated. The analysis of e-learning research suggests the pedagogical techniques that have worked successfully with the use of Internet and PCs in learning. Our research utilizes the framework to develop a set of WAP tools that can be used for the m-learning environment.

Personalized Content
Collaborative Content

PUSH Mechanism

Pedagogical Agents & Mentors
Communication Aids

PULL Mechanism

SMS, IM, Alerts, Scheduling Calendars
System Tools & Resources
Simulated Classrooms
WML websites, Discussion Boards & Chat Forums
Alerts, Scheduling Calendars, WML websites
SMS, IM, Discussion Boards & Chat Forums
WAP Tools

Figure 1: An M-Learning Framework

The mobile learning framework raised the following research questions:

- Q 1. Is the use of W/H for m-learning more effective with the higher level of anytime and anywhere flexibility?
- Q 2. Is the use of W/H for m-learning more effective when the content delivered is personalized and collaborative?
- Q 3. Is the use of W/H for m-learning more effective when the content delivered via push mechanisms or when the content is delivered via pull mechanisms?
- Q 4. Is the use of W/H for m-learning more effective when they are used as pedagogical agents and mentors, or as systems tools and resources, or as communication aids or in simulated classrooms?
- Q 5. Is the use of W/H for m-learning more effective when it alters the time/space configuration, or content delivery or communication interaction or student/instructor roles?

Project Results

The implementation phase consisted of purchasing and customizing e-learning applications to support the m-learning environment. An internal university grant provided the funding to purchase a few popular mobile devices, applications, and a student research assistant to setup a WAP compatible website on a Web server with a discussion board and chat room. First a WML website, see Figure 2 was developed for our courses. The website provides a general welcome and ability for user to customize the site using the "myhome" page concept used in portal sites like Yahoo, AOL or MSN.

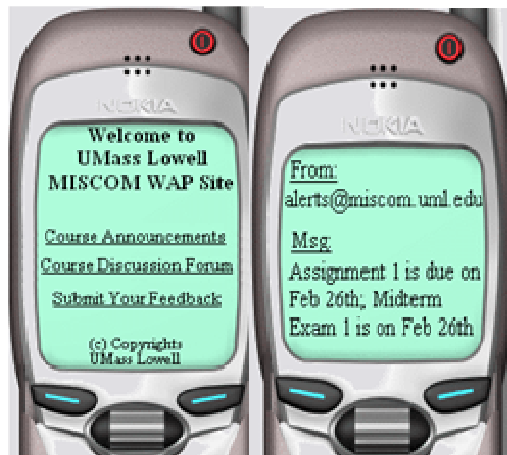


Figure 2: WML Website

Second, a vBulletin™ application was selected to be used in the project for discussion forums and chat. vBulletin Board (VBB) is one of the more popular server-side applications for running bulletin boards. There are many others available, but VBB is the best in terms of support for WAP and security. Unlike other discussion forums applications, VBB is a dynamic discussion board utility developed using PHP software language and MySQL database. It removes the need for configuration with file permissions or worrying about security of the files because the database server takes care of permissions and security.

VBB is platform independent, meaning it can work equally well on Windows or Unix-based operating systems. Every aspect of the interface can be edited with the comprehensive template system included, which can also be fully customized. The VBB software was very easy installation and configuration process. After uploading the software to a server configured with PHP and MySQL database application, we had to run the integrated web-based installation utility that comes with VBB. Next, we changed a few settings on the Web server to get the VBB operational. In the sum, the installation and configuration process was relatively easy. The customization process was equally simple. Applying the forum headings and groups was also a painless task using the VBB's administrator control panel. We then categorized the discussion groups into two areas - Undergraduate and Graduate courses. Under each main category, all the offered undergraduate and graduate courses sub-forums were created. Other minor changes were then made to make the discussion forum more user-friendly. A template was then installed to the VBB to make the forums user-friendly.

In addition to VBB, a WAP-enabling application called Wi-Forums™ was installed to create a mobile version of the discussion forum. This allows users to access the VBB using WAP enabled devices, or other handheld devices like Pocket PC, Palm, etc. Wi-Forums™ is an add-on for vBulletin. This mobile version has very simple and user-friendly interface. More features will soon be added to the mobile version, for example, students will be able to take small quizzes using their cell phones, handhelds etc. Wi-Forums also feature a chat capability (called WiChat), which lets two or more online users on a mobile device to chat in real-time. It automatically shows on the device that how many users are currently online and let user give the permission to send invitation to join Wi-Chat. This is a very outstanding feature since it gives user feeling of instant messaging.

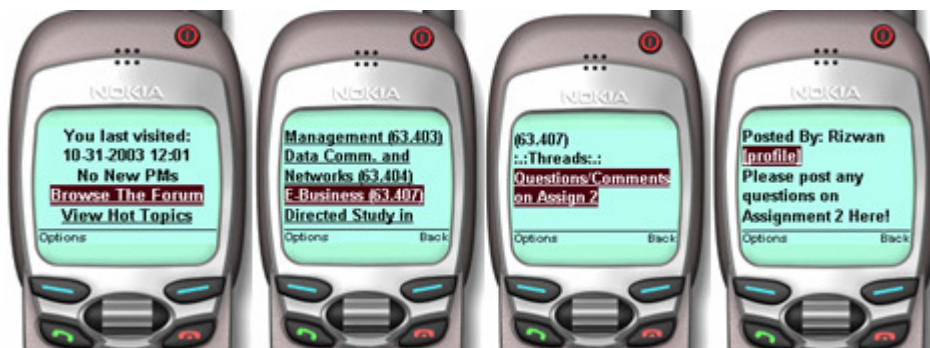


Figure 3: Wi-Forums Application

One great feature of this application is that the messages can be posted and accessed via VBB or Wi-Forum by the students. This means students having W/H devices can exchange messages with students using PCs or notebooks. This provides considerable flexibility to the providers as critical mass (network effect) of W/H device users is not essential for the m-learning bulletin board

or chat rooms. It value-adds the flexibility of anywhere access to users with anytime and anyplace access.



Figure 4: Your Wap Simulator

The WAP tools developed based on our framework were pre-tested in a regular classroom and in an online course for approximately two weeks during the Fall 2003 semester. The group to test these tools was 19 undergraduate students from a MIS elective course offered on campus. Several of the students did not have WAP enabled phones to test the software hence they were instructed to download a WAP-enabled phone simulator applet from www.yourwap.com (see Figure 4). Using the simulator, students were asked to login to the website to access the materials and participate in the discussion board and chat room.

The students were given written instructions on how to access the WAP site through a handout which listed the steps on how to use the phone to login, access the website, and participate in the discussion board and chat. A fixed chat time and day to participate in the chat and discussion questions were posted on the bulletin board. Students were given the incentive to participate in form of class participation grade for graduate students and extra-credit for undergraduate students.

An empirically validated survey instrument developed by Wang (2003) for measuring learner satisfaction for e-learning systems was customized for our pilot study. Although the survey only measures learner satisfaction, we added other measures to determine the answers for our research questions. The results from the student satisfaction survey as well as informal discussions conducted after the two week session are shown in Table 1 below.

Table 1: Results from 1st Survey of 19 Students

W/H Device Survey (N = 19)

	Average
M-learning system is an useful to the existing course	3.79
M-learning is a good Discussion Tool	3.53
M-learning system was easy to use	2.68
M-learning system was easy to understand	3.00
M-learning system has a good forum for interaction	3.58
M-learning system was easy to discuss course material w/ other students	3.42
M-learning system was easy to discuss course material w/ the instructor	3.32
M-learning was an convenient to access course discussions	3.79
Satisfaction with M-Learning system	3.16
M-learning has potential to become good learning tool	3.74

5 = strongly agree, 3 = neutral, 1 = strongly disagree

Background Questions

	Percent
Do you have a wireless device?	84.21
Can access Internet?	43.75
Can send SMS?	87.50
Willing to use wireless for e-learning?	57.89

The results from the survey indicated some satisfaction (> 3) on some of the criteria of the first version of the WAP tools we have implemented. A follow-up study with two courses was conducted in the Spring 2004 semester. The system was simplified to provide easy access and login for the students. The students tested this system for three weeks to discuss class materials and answer the essay questions of their final exam. The results of the second study are shown in Table 2 , below.

Table 2. Results from 2nd Survey of 44 Students

W/H Device Survey (N = 43)

	Average
M-learning system adds value to e-learning	2.25
M-learning system allows instant access regardless of your location.	1.73
M-learning system is useful to supplement to an existing course	2.36
M-learning is an effective learning aid or assistant for students	1.80
M-learning system is an effective method of providing personalized information	

	2.30
M-learning system allows to convert any wait (dead) time into productive	
	2.11
M-learning system allows convenient access to discussions - anywhere and anytime	
	1.95
M-learning system that sends the information via messages may be better	
	2.50
M-Learning system that also allows access to information from the website	
	2.20
M-learning system can be used as a supplemental tool for any existing course	
	2.67

5 = strongly agree, 3 = neutral, 1 = strongly disagree

Background Questions

	Percent
Do you have a wireless device?	86.36%
Is your wireless device a Cell or Mobile Phone	79.55%
Can your wireless device access data services?	63.64%
Do you plan to have data services access from your wireless device?	59.09%
Would you be willing to use a wireless device for online learning/education?	64.63%

In general, this project has been a very useful exercise in extending wireless/handheld devices into e-learning. While the current device limitations reduce the usefulness of these devices for e-learning, they are useful tools to complement existing e-learning environments. It may not be feasible to provide all course materials on these devices or conduct e-learning only via W/H devices. However, they can be easily used to complement existing online or on-campus courses. Another problem with m-learning is that most learners in the U.S. have access to the Internet via PCs but a much lower percent of the learners in Asia, Africa and Europe have on-demand access to Internet from everywhere and anytime. On the other hand, mobile device penetration with access to data services and Internet is much higher in these countries than in the US. Therefore, m-learning has much higher scope in Asian, African and European countries than in US. This does not mean that US universities can ignore this form of learning. Learning, like other industries, is highly global and therefore, many of the e-learning or distance education programs in the US have students from countries around the globe. M-learning can increase the access of US higher education institutions to students who do not have unlimited access to Internet or PCs.

BUDGET EXPENDITURE REPORT

The funding from the grant was used as follows for the current A.Y. 2003-04:

Salary

\$1,614.00 - Salary for student assistant, College of Management, U. Mass, Lowell

Hardware/Software

\$1,624.38 - Purchased mobile device, WAP bulletin board & Chat software, wireless access and miscellaneous software for the project.

The remaining amount of the grant will be utilized for additional hardware, software and travel over the next academic year 2004-05.