Promoting a Ubiquitous E-learning Framework

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Abstract—Mobile learning development is, most of the time, the privilege of practitioners with support from a technical team. The deep learning curve involved understanding the native mobile operating systems and developing mobile applications keeps most of the non-technical teachers and researchers away. We explore what innovation mobile technologies and Web 2.0 can bring that allows teachers to author their own mobile learning environment and how best we can leverage the emerging technologies to better prepare students for the digital world. We hope our study will help build teachers’ confidence and skills through learning the affordance of mobile Web 2.0 technologies in the process of developing mobile learning environments for their courses. In this paper we will describe our design-based research in our efforts to 1) develop a generic mobile learning based platform for all (MEPA) that allows easy access to device’s core functions as well as web-based learning contents and social tools; 2) encourage instructors without a programming background to implement these functions for teaching and learning; 3) document lessons learned to inform future research.

Keywords-component: ubiquitous learning, mobile learning, elearning, cloud computing, emerging technology

I. INTRODUCTION

Web 2.0 expedites the pedagogical shift from teacher-centered to student-centered learning in education. This social media form breaks down the “wall” of traditional classrooms and is creating a participatory culture that “offers exciting new opportunities to pull learners into conversations and turn passive, knowledge-receiving students into active, knowledge-making student.” [1] Friedman [2] states “the world is flat” in that information and resources can be effectively and efficiently accessed and exchanged globally from the social and economic perspectives. Emerging technologies are also flattening classrooms. As Dede [3] states, “teachers dictating the learning experience are replaced with students following their own trails of interest scaffolded by teachers, peers, and tools for thinking and learning. Students, in turn, engage learning through multiple modalities with varying degrees of complexity, make connections, reformulate ideas, and reach their own conclusions.” To keep up with these macrotrends [4], competent and confident teachers are needed to adopt social networks as a teaching platform for promoting effective informal learning anytime anywhere.

Worldwide ownership of mobile devices is increasing, exceeding traditional computer market share. Mobile learning is a rapidly developing paradigm often defined as learning that takes place with the help of portable electronic tools [5]. Advances of mobile technologies allow students to get access to Web 2.0 social software through a mobile device’s native applications or web browsers. This maximizes one’s opportunity of participation and collaboration anywhere anytime. We are one step closer towards Prensky’s [6] vision, “What can you learn from a cell phone? Almost anything!”

However, currently the application of cognitive theory to the educational use of mobile technologies is still lacking. Mobile learning development is, most of the time, the privilege of practitioners with support from a technical team. The deep learning curve involved understanding the native mobile operating systems and developing mobile applications keeps most of the non-technical teachers and researchers away. We’d like to explore what innovation mobile technologies and Web 2.0 can bring that allows teachers to author their own mobile learning environment and how best we can leverage the emerging technologies to better prepare students for the digital world. We hope our study will help build teachers’ confidence and skills through learning the affordance of mobile Web 2.0 technologies in the process of developing mobile learning environments for their courses.

In this paper we will describe our design-based research in our efforts to 1) develop a generic mobile learning based platform for all (MEPA) that allows easy access to device’s core functions as well as web-based learning contents and social tools; 2) encourage instructors without a programming background to implement these functions for teaching and learning; 3) document lessons learned to inform future research.

II. CONSTRUCTING ONE’S OWN IMAGINARY WORLD

From constructivist’s perspective, this pedagogical shift to learner-centered education creates a potentially effective learning environment, where students are no longer passive receivers of instructions from instructors or textbooks. Instead, they can actively search for truths, discover theories and rules associated with the real world, and test the fit of their experiential world through collaborating with others. Bruner [7] states “this process provides multiple perspectives to each learner, and this negotiation process between peers should lead to enhanced understanding.” Also, as Lorsbach [8] describes, in the process, their ideas gain in complexity and power, and with appropriate support they develop critical insight into how they think and what they know about
the world as their understanding increases in depth and detail. Such environments encourage students to constantly try out new ideas, propose challenging questions, reflect on feedback, and make sense of the new situations and fit it to their existing imaginary world. Thus, when a student’s imaginary world correctly reflects the objective real world, he or she can make rational decisions when solving problems.

III. UBIQUITOUS LEARNING VIA MOBILE DEVICES

The activities enabled by mobile devices happen outside the traditional classroom most of the time. For instance, they could occur at home, in the office, during a vacation, or on the road. We call it informal learning, which Coombs [10] defines as the spontaneous, unstructured learning that goes on daily in the home and neighborhood, behind the school and on the play field, in the workplace, marketplace, library and museum, and through the various mass media (p. 92). In such a setting, students may not even realize that learning is involved when they interact with materials or others. Weiser [11] states “the most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.” With the affordances of ubiquitous computing, technology can remain in the background, pervading our physical surround on a variety of scales. Users obtain ever-present connectivity and access to capture, process, send, and receive information through multiple devices anytime and anywhere [3]. Mobile devices are the exact learning tools we’d like to adopt to enable the embodiment of ubiquitous learning.

Mobile phone is the most widely used electronic devices in the world. The smartphone market is set to exceed computer users by 2014 when its market is expected to reach 30% of the worldwide cellphone market [12]. Mobile devices have much of the computing capability and expandable storage capacity of laptops at a fraction of the cost [3]. A national survey by the Kaiser Family Foundation found [13] that the amount of time young people spend with entertainment media has risen dramatically- an average of 7 hours, 38 minutes to daily media use - an equivalent of a full-time job! It also found that heavy media use is associated with several negatives, including behavior problems and lower grades. Therefore, teachers’ active participation and effective intervention via a ubiquitous mobile learning channel is much needed.

IV. METHODOLOGY

This is a kind of design-based research that involves the analysis of the use and performance of designed artifacts to understand, explain and very frequently to improve on the behavior of aspects of Information Systems [14]. Introduced by Brown [15], design research was developed as a way to carry out formative research to test and refine educational designs based on principles derived from prior research [16]. Consistent with the design research framework, the MEPA design research is carried out in the following five steps: 1) Awareness of Problem: identify the problem by analyzing the deficiencies of the existing systems and describe how to make improvement. 2) Suggestion: review the related literature and previous research. Describe how the system can be designed and implemented with feasible, optimized solutions. 3) Development: develop and implement the MEPA application according to the suggested solutions. 4) Evaluation: evaluate the partially or fully successful implementations according to the functional specification. 5) Conclusion: discuss and draw conclusions based upon findings in the process of system design as well as the evaluations.

The first three steps above are often iteratively performed in the course of the research effort. This involves reiteration from partial completion back to Awareness of the Problem is a necessary process that allows us to quickly identify potential problems and solve them in a timely manner to avoid disastrous system failure in the future. It allows us to develop robust designs for other application variants in other domains based upon the same framework.

V. MEPA - MOBILE ELEARNING PLATFORM FOR ALL

University of Illinois’s (http://ed.uiuc.edu/uli/) vision of ubiquitous learning is exciting: “ideas without barriers, Inspiration without limits. Innovation without boundaries.” Affordable and user-friendly mobile devices help push it a step closer towards the ideal of ubiquitous learning. We’d like to take advantage of affordances of mobile technologies and design a generic framework that can be adopted by faculty in specific subject domains to promote ubiquitous learning and mediate collaborative learning activities.

Next, we will describe how everyone can get involved in promoting ubiquitous learning by designing learning content, activities and pedagogical strategies using our mobile learning framework. As noted by Riel [17], “…new tools alone do not create educational change. The power is not in the tool but in the community that can be brought together and the collective vision that they share for redefining classroom learning (p.35).”

Our design guidelines are: 1) we should provide a mobile framework for everyone to get involved in learning content design – programmers, researchers, teachers, web developers, or students; 2) the framework should be generic enough to be applied to difference subject domains; 3) mobile learning modules should be reusable and scalable;

VI. MEPA’s SYSTEM ARCHITECTURE

Based upon our design guideline above, we built our mobile system framework illustrated in Figure 1 using iPhone. A mini Mac operating system drives iPhone, which supports Objective-C, an object-oriented programming language that requires a deep learning curve for a novice to pick up. It allows programmers to get access to the iPhone’s native functionalities and applications such as phone calling, geo-location, vibration, address book, YouTube, Podcast, iPod, etc. These features give users seamless access to Web 2.0 and other media pulled from virtual servers, computing clouds, via mobile devices. But the technical challenges of developing native applications keep nonprogrammers from getting fully involved. In our case, most instructors do not have the skills and confidence designing their own course modules via mobile devices.
We address this issue through a hybrid application approach. It adds an adapter to the complex iPhone software development kit (SDK), allowing instructors to use simple web technologies (e.g., HTML, CSS, JavaScript) to author learning modules. Also, this hybrid approach allows instructors to call iPhone’s built-in functions through the adapters using JavaScript. This will encourage instructors who are comfortable using web authoring tools, such as MS Word, Macromedia Dreamweaver, or FrontPage, to continue their practice and have the option of moving instructional contents off the desktop and into students’ pocket. All the learning contents can be hosted in the clouds, in the remote servers, that instructors don’t need to maintain their own software and hardware.

Figure 1 illustrates how stakeholders in such a learning environment collaborate with each other. Instructors facilitate learning by designing learning contents and mediate learning activities through our mobile learning framework. They have easy access to the device’s core functions and can implement these functions for teaching and learning. Programmers can continue to develop educational games and other activities and embed them as one of the learning modules to the framework.

Figure 1. Generic Mobile Learning Framework (This illustrates how stakeholders collaborate in a user-centered mobile learning environment.)

VII. PROTOTYPE DEVELOPMENT AS A PROOF-OF-CONCEPT

We implemented the initial prototype in an undergraduate computer literacy course, AC101, in which computer concepts and hands-on experiences are the focuses of the course. Also, as with any courses, self-assessment is an effective way for learning reinforcement and collaboration is an integral part of the learning process. Figure 2 shows a proof-of-concept of our effort creating a mobile learning environment that allows students to check on announcements, weekly schedules, lecture notes, or readings online. It has been a common practice for instructors to post these materials online for students to check through a Learning Management System, such as Blackboard. Therefore, it won’t create a large amount of extra work to make it happen. They just need to adopt some mobile themes or styles that display the same content through the much smaller mobile device screens in a user-friendly way.

Figure 2. Prototype I: Learning Content (Traditional e-Learning Content Integrated with Web 2.0 Tools.)

For those who’d like to add more interactive features such as online assessment through quizzes, we have developed our second prototype: an authoring environment that allows instructors to post their quizzes in a simple structured text format (e.g., CSV or XML) to the clouds. Our quiz shell is developed in Objective-C. It can parse quiz content in XML or a simple text file from the web. Usually it would require an application update if the quiz data is shipped with the application. We would prefer to avoid an application recompile because our assessment interface has not changed. This separates application data from the program functionality and makes it easier for instructors to focus on the design of the quiz content. We choose Good App Engine as our testing web services offered through the Clouds. Therefore, instructors do not need to maintain a server, database, or hardware, which is offered and maintained for free by as utility services. This eliminates another system administration layer, making the constructing of learning content a simple and straightforward process.

Figure 3. Prototype II: Mobile-based Assessment (Instructors put the quiz data to the clouds, which is then parsed to a mobile device’s quiz engine for real-time assessment)

Through practice-and-drill via a touchable screen, users will get immediate feedback. Instructors can track students’ performances through reports delivered from the server. With our assessment prototype (Figure 4), teachers can
develop their questions in Notepad or Word. They then post these quizzes through Google App Engine. These questions can be in comma separated format or XML files. The MEPA assessment engine will pull the structured data from the cloud and parse it to iPhone’s quiz application. This process makes this traditional learning process less formal, more fun, and ubiquitous.

![Prototype II: Mobile-based Assessment Data Flow](image)

**Figure 4.** Prototype II: Mobile-based Assessment Data Flow (Instructors push the quiz data to the clouds, which is then parsed to a mobile device’s quiz engine for real-time assessment)

### VIII. DISCUSSION

We evaluated MEPA using the internal evaluation method. Our main focus is on the evaluation of system performance, addressing the questions: “Will a system like MEPA be easy to scale up?” “What tools do teachers need to develop contents on a mobile platform?” “How to distribute learning contents?” “How can such a mobile framework support collaboration?” This is an iterative design process. We evaluated the advantages and disadvantages of using different sets of technologies. We then looked at ways to standardize our design so that this framework can be developed and deployed to other local contexts easily.

The following research questions guided our research. The first three questions are the main focuses of this paper. Our m-learning prototype design leads to a few implications for designing and conducting future mobile learning courses. It also poses new directions for future research.

1) **Is a system like MEPA easy to scale up?**

New technologies emerge on daily basis. We should try to avoid reinventing the wheel or developing a prototype that may soon become obsolete. Web 2.0 provides web-based applications and services through cloud computing. These applications can interface with each other. For instance, Blogging tools have Application Programming Interfaces (APIs) to talk with other tools such as RSS, Twitter. But the way native mobile application is designed is quite opposite – native mobile applications don’t have APIs to communicate with another native application. They are like scattered building blocks that cannot scale up to make a more comprehensive application. But, the advantages of native mobile applications are 1) better performance, as they can call the native functions directly; 2) offline storage capacity, which is idea for offline informal learning; 3) built-in features such as accelerometer, geo-location, or Address Book.

How can we make the best use of both approaches? Hybrid mobile application is the answer. Hybrid mobile applications take advantage of both native and web mobile approaches, giving users experiences of native mobile applications with content pulled from the Internet. When there is a lack of wireless coverage, it can store mobile contents and tools for offline access. We chose a currently dominant hybrid package called PhoneGap in our prototype. PhoneGap are driven by contents from the local phone. We improve the architecture to make it work with the web based content. We found that, once such a hybrid mobile shell is developed, we could easily focus on the development of mobile learning contents for further mobile learning studies.

2) **What tools do teachers need to develop contents on a mobile platform?**

The content developed should also be interoperable across mobile platforms through flexible delivery options. We created a generic m-learning development process based upon the widely adopted web authoring tools such as Dreamweaver, MS. Word, FrontPage, MS Visio Studio, etc. For starters, we developed some mobile interface templates for faculty. We believe it’s the first step to help teachers rapidly develop contents that could hopefully generate more thoughtful insights on such issues as human-mobile interface design.

3) **How to distribute learning contents?**

Traditional, elearning contents are distributed through FTP or HTTP protocol to a web server. The advantage of the FTP protocol is that files can be uploaded with structures intact. The downside is that the FTP server has to be set up that allow it to happen. Through HTTP, individual files can be uploaded. But the process is tedious and it’s hard to maintain a structure among the files. If we have hundreds of files to be pushed to the server, that may pose a big headache. Now companies like Amazon and Google are providing cloud-computing infrastructures that allow user to use their hardware and software from the remote with a modest utility fee. This is good news for non-programmers because it not only lowers the initial costs, but also decreases the learning curve of setting up servers and software for their elearning content. For instance, we used Google’s App Engine Cloud to host our mobile learning contents in our pilot study. For the new faculty who will use MEPA, they just need to follow instructions to get the Google App Engine up and running at the first time. Through a simple button click, all the files with structure can be synced from their local to the remote server(s).

4) **How can such a mobile framework support collaboration?**

While computer-based learning has been widely adopted by instructors for blended learning, mobile learning is still limited to faculty with technology background. This is because they need to design their curriculum on top of a mobile OS, which requires technical competence to understand how to get access to built-in mobile features.
Now a generic platform like MEPA, non-technical faculty without programming background can get started immediately. Our demonstration of the MEPA prototypes has allowed us to start to talk with other faculty about implementing MEPA to other courses. It shows the idea of developing mobile-based learning is in great demand but it is still keeping most people away due to its technical challenges.

5) How to encourage informal learning?

As students spend more time online socializing, exploring web pages, educators need to find a more effective way reaching out to them as a learning facilitator. Through the affordance of mobile devices and technologies, teachers can now help promote informal learning through authoring learning contents, design activities, and facilitate social interactions in a pervasive way. Social tools such as Facebook, Twitter, or Blogs are available to most mobile phones as native mobile applications. They are also available in mobile web forms that allow users to read the content in a mobile-friendly interface pulled directly from the web. Authoring contents, posting assessment, and hosting other learning materials can also be easily achieved through MEPA’s hybrid approach. It can serve as an integrated test bed for researchers to address more questions. For instance, on the mobile screen, space is so limited that textual output to the user can easily become overwhelming. For applications whose main function is not to read verbal data, instead, visual knowledge representation such as images and icons should be used wherever possible to communicate ideas and functionality to the user.

IX. CONCLUSION

As Norman [18] cautions, new technologies may streamline process, but before they are introduced and studied in practice “it isn’t always obvious just which parts are critical to the social, distributed nature of the task, which are irrelevant or detrimental. Until we understand these aspects better, it is best to be cautious” (p. 145). Thus it is not only the construction of the mobile learning framework, but also its affordances and limits that must be critically examined before, during, and after integrating a tool into a learning environment.

We developed this generic framework to encourage educational practitioners who do not have computer science background to be easily involved in the design and development process to generate more mobile learning theories, document good practices, and derive more pedagogical strategies to improve the engagement of learning in a ubiquitous approach through mobile devices.

We hope, through developing more specific mobile learning modules in various subject domains in the near future, we will be able to examine the affordances and limits of mobile learning that must be critically examined before, during, and after integrating a tool into a learning environment. We will also explore how to better design learning materials to cater the intricacies of mobility, and how to better facilitate learning in large blended classrooms.

REFERENCES