

Developing Mobile Based Instruction

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Abstract

This paper describes an instructional design class's experience developing instruction for the mobile web. The class was taught at a southeastern university in the United States in a master's level computer based instruction course. Two example projects are showcased and student reflections on design issues are highlighted. Additionally, challenges and lessons learned from this experience are described. This case study will benefit those who are considering teaching a course on designing mobile learning; also to those who are considering developing mobile instructional websites.

Keywords: Mobile based instruction, Mobile web development, Mobile Teaching, Mobile Learning, Design Experience

Distance education is on the verge of another major shift. The increasing availability of low cost mobile devices, constant access to the wireless network, and the development of interactive educational content for mobile devices, provides for new opportunities in education. There are now 5.9 billion mobile cellular subscribers worldwide (International Telecommunication Union, Dec, 2011). Among these, 1.4 billion subscribers are from developed countries, and 4.5 billion from the developing countries. The mobile learning market in the United States reached \$958.7 million in 2010, and is projected to reach \$1.82 billion by 2015 (GSMA Mobile Education Landscape Report, 2011). The rapid growth of mobile devices and the convenience of accessing information anytime from anywhere through mobile technology

gives the learner the freedom to learn at their convenience and engage in meaningful learning activities whenever and wherever they want (Franklin & Peng, 2008; Traxler, 2009). As a result, educators and researchers are in the process of determining best practices for the design and development of mobile content for instructional purposes (Ally, 2009). This case study describes the design and development of mobile websites in a Master's level Instructional Technology course at a southeastern university in the United States.

What is Mobile Learning?

Mobile learning, also called m-learning, is seen as the natural evolution of e-learning. M-learning is the intersection of mobile computing and e-learning and includes anytime, anywhere resources; strong search capabilities, rich interaction, powerful support for effective learning, and performance-based assessment (Quinn, 2000). Stevens and Kitchenham (2011) define mobile learning as "the use of a wireless handheld device; a cell phone, personal digital assistant (PDA), mini-computer, or iPod to engage in some form of meaningful learning" (p. 3). The E-learning guild defines it as;

"Any activity that allows individuals to be more productive when consuming, interacting with, or creating information, mediated through a compact digital portable device that the individual carries on a regular basis, has reliable connectivity, and fits in a pocket or purse."(eLearning Guild 360 Mobile Learning Research Report, 2007, p.6)

Designing M-Learning

Traxler (2009) identifies six emerging mobile learning categories: Technology driven m-learning, Miniature but portable e-learning, connected classroom learning, Informal/personalized/situated mobile learning, Mobile training/performance support, and remote/rural/development mobile learning. The focus of this paper discusses the “miniature but portable e-learning” development (p.12). With an interest in e-learning to be delivered on mobile devices, it has become important for instructional designers to be trained to design for the mobile platform. Yet, there is minimal research on miniature e-learning that can be utilized in designing for the mobile domain. To effectively design for the mobile web, it is essential that we review the literature on designing for m-learning and mobile usability.

It has been a challenge to develop learning material for mobile delivery. Ally (2009) provided design recommendations to use the multimedia capabilities of the latest mobile phones to make the learning experience stimulating, and to design the instructional material in manageable chunks. Some of the tips that Griffin (2011) recommended to help design mobile learning content are to divide content into two minute segments, deliver content in conversational style, deliver how to instructions that can help one be better, smarter and faster, identify and deliver content in areas that one needs to do better, and develop mobile learning that make the experience elegant and emotional. Clark Quinn's (2011) new book titled *Designing mLearning: Tapping into the Mobile Revolution for Organizational Performance* explains that m-learning, if correctly implemented, helps people to do their jobs and to learn whatever they want, whenever they want. He adds that m-learning is not about formal learning in classrooms, but about augmenting one's learning and performance, which means to bridge the gaps that exist by learning activities using mobile devices.

Kwun and Lee (2010) identified four design principles of m-learning for ESL: (i) to apply learning activities of English teaching and learning process to contents structure, (ii) to support of contextual learning or situated learning, (iii) to considering mobile display characteristics for design graphic interface and (iv) to design content layout with multi-device. Bradley, Haynes, Cook, Boyle, and Smith (2009) examined the design and development of multimedia learning objects for the mobile phone. Their study used design principles such as interface design, navigational techniques, and interactive functionality suggested by Flash Lite templates in the itera-

tive development process for the development of the mobile learning objects. They found that peer use and testing, student feedback was valuable in the development process. Baird and Whitear (2006) in their study recommend splitting the content into bite size chunks so that it did not overcrowd the screen. Pierre and Diamantini (2009) used the Mobile Learning Objects approach in which modules were ten minutes long, and included text and audio format. Their study found that the users preferred the ease of use of the mobile device, the usefulness of the mobile device to keep learners occupied in situations like traveling on a train, and also taking a course via a mobile device was engaging and fun.

Mobile Usability

Nielsen (1993) defines usability as “a quality attribute that assesses how easy user interfaces are to use”. Nielsen (1993) also refers usability as “methods for improving ease-of-use during the design process” (p.1). Mobile usability issues have been a common concern among researchers as this is an emerging area within the more general field of usability. Nielsen (2011) reported that website use on mobile devices received very low scores on usability, especially when users accessed “full” sites that weren't designed for the mobile platform. In Nielsen's mobile studies, the average success rate was 59%, which is considerably lower than the 80% success rate when they tested websites on a personal computer. Success rates are percentage of tasks that users complete correctly (Nielsen, 2001). The usability issues in the study were categorized into four main hurdles: small screens, awkward input, download delays and mis-designed sites. Later, when websites specifically designed for mobile devices were tested their success rate averaged 64%. An 11% increase on user performance led Nielsen to believe in the importance of creating mobile-optimized sites. These sites were pleasant to use and also received higher subjective satisfaction ratings.

With a variety of mobile devices in the market, each manufacturer has a different interface. Nielsen (2011) also reported that bigger the screen, the better the user experience was when accessing websites. Average success rates on mobile experience were based on the screen size of feature phones (38%), smart phones (55%) and touch phones (75%). Nielsen's study reported that a) designing content and navigation to be noticeable to make it easy on the users and (b) designing for a small screen and for slow downloading speeds are two major issues in designing for the mobile web. Learnability,

ease of use, and time required to complete a task are prevalent dimensions in the decision making of using mobile websites. The complex interfaces that offer enhanced capabilities may have a toll on the user efficiency of the mobile web.

Mobile Web Application (Mobile Websites)

“A mobile native application is software that runs on a handheld device (phone, tablet, e-reader, iPod, etc.) that can connect to WIFI or wireless carrier networks, and has an operating system that supports standalone software” (Gahran, 2011). Mobile native applications can be downloaded directly onto a mobile device using the application store on the mobile device or can be downloaded from a computer (i.e. via Apple iTunes) and connected to a mobile device. They are very easy to use and range in type, style, genre, and purpose.

Mobile web applications or mobile websites are custom built sites designed and developed to be accessed via the mobile device. The mobile web refers generically to web access or use of Internet-connected apps from a mobile device. Access today suffers from interoperability and usability problems. Interoperability issues result due to the platform fragmentation of mobile devices, mobile operating systems, and browsers. As reviewed in the previous section, usability problems are centered on the small physical size of the mobile phone features such as limited resolution screens, user input, and operating limitations. Accessing the web from mobile devices provides for a large number of limitations depending on the phone used. These limitations include: small screen size, lack of multiple windows, navigation ability, lack of javascript and cookies, type of pages accessible, speed, broken and compressed pages, size of messages, and cost involved. Subsequently, there are a number of things to consider when deciding to develop a mobile web application instead of a mobile native application. These will be described further in this paper.

Mobile Instructional Tutorial Development Case

An instructional technology graduate program at a southeastern university in the United States, offers three courses where mobile design and development are explored. Through these courses, the program has examined the many facets of mobile development. The courses include *Designing and Developing Mobile Learning, Gaming and Simulation*, and *Computer Based Instruction*. In Spring 2011, the *Computer*

Based Instruction course taught students how to develop mobile instruction for the mobile web using Adobe Dreamweaver. The class demographics included graduate students (age 23+) comprised of six females and two males.

For the mobile web project, students were asked to develop a 10-minute instructional tutorial on a topic of their choice that could be viewed on any mobile web browser. The students worked on these projects individually, basing projects on own area of interest. More detail of the project requirements is discussed in the ‘Sample Course Project’ section. To begin this project, students were taught the basics of Adobe Dreamweaver using a PC. It was assumed that all students had no prior programming experience. Design practices, as illustrated above in the literature review, for mobile devices were presented. Students were given class time to begin developing their mobile websites. During class time, the instructor facilitated student design and development. The instructor demonstrated the basics of Dreamweaver and how to develop webpages using Dreamweaver. Students were also presented with video tutorials created by the instructor on some of the techniques involved in web design.

To test their websites, students used the web-server installed at the university for publishing and iPod Touches for testing. The iPod touches were selected because they function just as the iPhone when they are connected to wireless Internet; the only major difference being that they do not have the ability to make and receive phone calls. The iPods were received as part of a university grant to explore mobile learning in higher education classrooms. These devices gave students the ability to test their project without having to worry about having phone data service or using their own devices.

Once student projects were completed, they were published to the web. The instructor tested the websites using both Android and Apple iOS to ensure they appeared correctly on the mobile browsers. Students then presented their mobile websites to the class and were asked to reflect on the design process. At the conclusion of the semester, eight students reflected on the mobile learning design experience.

Sample Course Projects

In this section, two student projects are showcased. These projects offer not only an opportunity to design for mobile delivery, but also to develop instructionally sound products, complementary to delivery on a mobile device. Students were assessed on their final

product and their application of the multimedia principles to the instruction. Requirements for the project included: Creating an introductory screen (Screen 1) that introduced the topic and explained why the learner needed the information and an objective screen (Screen 2) that outlined what the learner would be able to do at the completion of the course. After each content screen/section, simple interactions should be provided for learners to practice what they learned (Screen 4). Each option for the practice page should provide feedback (Screen 5) for both correct and incorrect answers. Full instructional assessment was not required for this assignment.

The first example, displayed in Figure 1, is a mobile instructional tutorial on rattlesnake identification at the Saguaro national park reflected on the mobile design and development experience. The purpose of this tutorial was to teach visitors of the Saguaro National Park how to identify rattlesnakes and what to do if they encounter a rattlesnake in the park.

The second example, displayed in Figure 2, is a mobile instructional tutorial on knowing how to evaluate information from library resources. The purpose of this tutorial was to introduce users to the principles of evaluating information using the acronym, "CRITIC."

Student Reflection on Design Issues

Designing for mobile delivery posed several challenges. The following section describes three design considerations (size, usability and content design) that students recommended after developing their mobile instructional projects.

Size. The small screen dictated many of the design and content decisions for the project and put limitations on the amount of content that could be delivered without overwhelming the learner. With the smaller screen size, content had to be concise and sentences short for readability. One of the students commented "... you know, the size of a phone, of an Android or iPhone or something, then you don't have as much room. You have to really make good choices about what it is you are going to put in there. ...it can get cluttered really quick, because everything is so much smaller, obviously it looks different on the computer than it does on the phones." Although each page of the module was limited to three to five sentences, some scrolling was unavoidable. Scrolling once or twice seemed appropriate for the content.

Usability. Navigation and organization had to be simplified to facilitate usability. Unlike computer-based web sites that offer several naviga-

tional options, navigation on a mobile device was more restrictive. Popups or widgets can quickly clutter a small screen. Users no longer click a link, but touch it. User input also becomes awkward on a mobile device. Considering these differences, the module was designed with a clear, linear navigation between pages to keep the user from getting lost. Large buttons were used instead of underlined links, and, users could only go forward, back, or home. One of the students in the class commented on usability saying "You have to take out all the fluff and, uh, try to fit as much content on the actual screen without the user having to scroll as much. And, the use of a header, a content and a footer, an actual framework, um, was really important so that you could have consistency through each page."

Content design. The content had to complement the delivery, as well as be instructionally sound. Mobile delivery of instruction requires a very simple design so that content can take center stage. The module was designed using HTML and optimized for a mobile device, such as an iPod or Smartphone, so that the learner would not have to adjust the display. The site used a simple table format with forward, back, and home navigation controls at the top and bottom of the screen. The heading portion of the screen displayed the topic of the page. Although screen space is at a premium, the addition of a bottom navigational element indicated the end of the page and provided a link to move on without scrolling back to the top of the page. Images were optimized so that

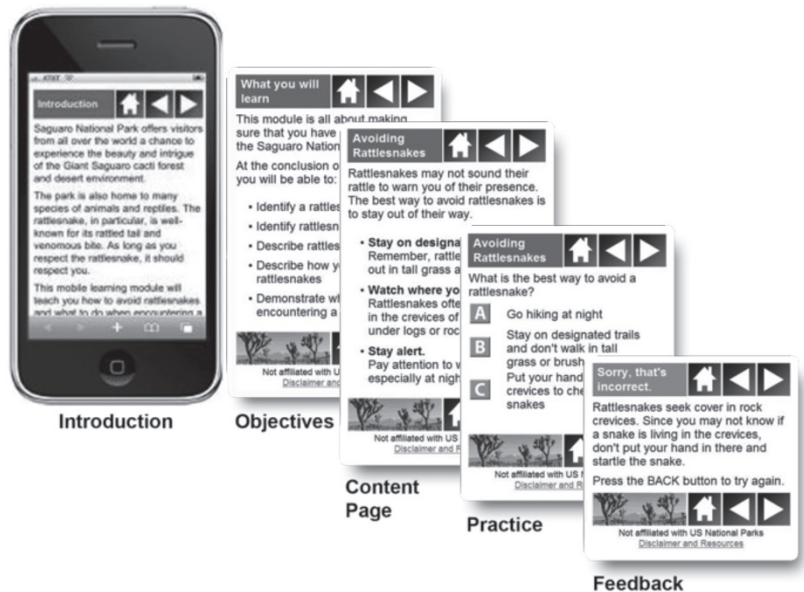


Figure 1. Screenshots from the How to Identify Rattle Snake mobile instructional module

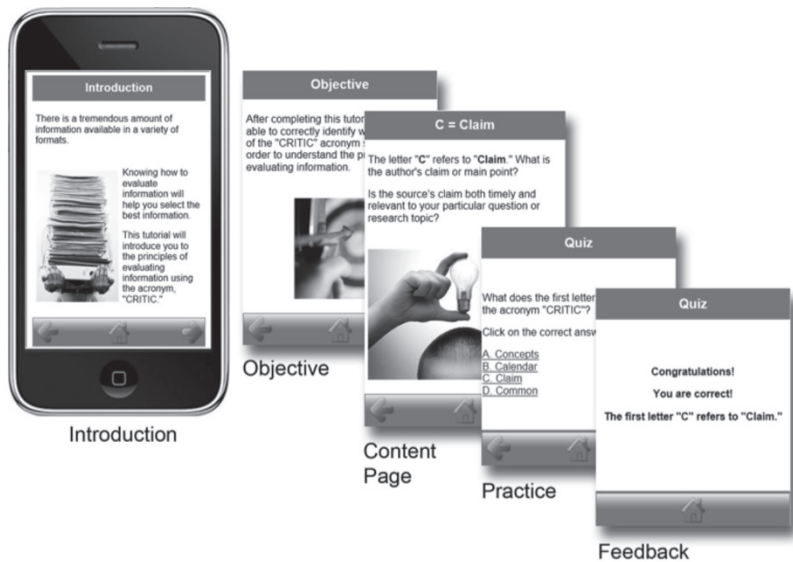


Figure 2. Screenshots from the How to Evaluate mobile instructional module

download speed was not compromised. A student commented “I don’t know that you’re going to be able to do a lot other than just quick reference job aids...I would think that job aids and things that you can learn quickly are the realm of smart phone development.”

Challenges and Lessons Learned

Several challenges were encountered and lessons were learned throughout the project process. It is our recommendation that one should consider the following when developing for the mobile device.

Mobile development and delivery methods. The first challenge encountered prior to designing this project for students was to decide whether to develop mobile apps or mobile websites. There are several characteristics to consider when deciding whether to build a mobile website or a native mobile application. These included accessibility, development, and functionality. *Accessibility* refers to the ability of users to access the app or website on their device. Mobile applications are device dependent. This means that if one develops a mobile app for the iPhone, one is excluding users for all other devices, including Android, Windows, and Blackberry. On the other hand, mobile websites can be accessed on all devices because all smartphones have an HTML browser. Since our students had multiple devices it became apparent that a mobile website would be our best option.

The next characteristic, *development*, refers to the ease at which each could be developed.

Many app development packages use their own versions of C++ (iPhone) or Java (Android), which are object oriented programming languages. Thus developing an app requires an in-depth understanding of computer programming and is not easy for the average web developer or instructional designer. On the other hand, using basic HTML via Adobe Dreamweaver to develop a mobile website is easier for the average user as they do not need to understand advanced programming and can focus on design rather than programming.

Finally, *functionality* refers to the ability of the software to interact with the web and device. Apps have the ability to access hardware within the phone, such as the internal GPS. Mobile websites do not have this capability. Additionally, it may be more difficult to develop rich interactions on the mobile web due to limited software compatibility on the mobile devices. For instance, iPhone is not compatible with Adobe Flash and most interaction will be limited to HTML. Thus it was important for us to determine the type of functionality the students would need. Considering that we were only going to show them the basics, we decided that students would not need advanced functionality and thus mobile websites was the most appropriate solution for our class.

Product testing. Another challenge encountered during this process was testing the mobile websites during the development process. Normally when developing a website one can easily test the page at every step by simply opening the page in the browser, even if they are offline. The problem with the mobile webpage is that when one opens the page in the browser it does not look like it might on the phone, so one needs to test on the phone. The only way we found to successfully accomplish this was to publish the file on the World Wide Web and open it in the mobile browser on the device itself. While this option was not challenging, it did require extra development time compared to regular website development. Additionally this means that in order to conduct a project like this, students will need a space to publish their sites in order for them to test them. For this project we were able to use our schools webspace, which is free for all students and this worked out well. If one did not have this option, we recommend that students purchase their own webspace.

Developing from a distance. A final challenge was to give students the chance to test their sites outside of the classroom and work on them at a distance. In class, students had iPods to work with, however, outside of class, some students

did not have smart phones or an iPod to work with. Thus we had to find an emulator. An emulator is a program, displayed on your PC monitor, that mimics a device. Thus, the computer monitor would have a cell phone emulator that looked like an iPhone and was similar in size. After testing several different emulators, which included TestiPhone.com, iphonetester.com, and iPhone4Simulator.com, we came to the conclusion that none were as precise as a mobile device; what appeared to look correct on the emulator might not look right on the mobile device and vice versa. The emulator gives one a feel for the navigation, and flow of the site, but may not give the exact look and feel of the site when compared to a real device. However, we did not have another option for students working from a distance. Thus it is recommended that those seeking to work on this type of project at a distance without a proper device use an emulator with caution as things may not appear as they do on a device.

Conclusion

The mobile device has the potential to aid the teaching and learning experience. The increasing use, availability, and low cost of equipment invites educators to begin finding ways to successfully use these devices in their classrooms. Additionally, with increased interest from business and industry on mobile based instruction, it is becoming important for instructional designers to learn to develop mobile instructional content. As a result, it is important for graduate programs to teach students to design and develop instructional content for the mobile web. This paper described a course project where students were given the opportunity to develop mobile-based instructional tutorials. Descriptions of the project, reflection on the design process and lessons learned are described. It is hoped that this paper can guide other educators who plan to teach to design and develop mobile-based instruction in their courses.

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