

App Development in the Miami University Mobile Learning Center

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Abstract—The Miami M-Learning Center is a joint venture between the Miami University School of Engineering and Applied Science, the Armstrong Institute for Interactive Media Studies, and Information Technology Services. The primary mission of the center is to provide guidance to faculty, staff, and students on the best practices in m-learning so that use of mobile technology for education goes beyond just acquisition of technology towards the full integration of mobile devices in the life and education of students. A major aspect of the activities of the M-Learning Center is app development to support educational and research needs at Miami University. As a component to this activity, the center provides experiences for students in computer science, software engineering, and interactive media studies to collaborate on multi-disciplinary projects with students and faculty across the entire university in ways that were previously unavailable. With the excitement being generated across the institution on how mobile technology can be used in the classroom and for education, these new opportunities provide these students with a structured and formalized entrée into the field of mobile computing and app development.

I. INTRODUCTION

Mobile technologies are an integral part of the lives of today's learners. As educators of these *mobile natives*, it is important for instructors to understand how to engage these students in order to turn them into mobile learners (m-learners) [1]. Specifically, we want to empower students to seize every opportunity to acquire new knowledge regardless of where they are physically located. In this new environment, students are no longer constrained by access to the physical school building or university campus; the learning environment travels with them.

At Miami University, engaged learning lies at the foundation of a vision for the 21st-century learner [2]. M-Learning is an extension of engaged learning, whereby mobile technologies become an integral part of the way students collaborate with other learners and access, collect, and synthesize new knowledge via 24/7 access to information and tools [3]. A great deal of excitement was generated by the introduction of the Apple iPhone and iPod Touch. In addition, when Apple made available their SDK to allow developers to create software applications, or “apps”, the flurry of activity in the marketplace and on campuses was mindnumbing. That is, the explosion

of apps and the proliferation of options made the landscape confusing for many.

The Horizon Report, a publication of the New Media Consortium [4] has listed mobile computing and mobile learning among the top priorities for adoption in higher education. Like many of the college campuses around the country, a great deal of interest was generated at Miami University. While Miami was not in the position to go the route of Abilene Christian University, a small university that had created buzz around their iPhone initiative for distributing iPhones to incoming freshmen [5], Miami was ready to begin studying how to best use mobile technology for education. This occurred via the establishment of the *Smart Phone Faculty Learning Community*.

At Miami University, Faculty Learning Communities, or FLCs, are cross-disciplinary groups of faculty and staff that meet on a regular basis to discuss shared topics of interest. In general, by the end of the year-long FLC meetings, participants are required to do some project or other activity that uses topics or skills learned via participation in the FLC. It was the discussions of the Smart Phone FLC that formed the genesis of the *Miami University Mobile Learning (M-Learning) Center*. Specifically, it was recognized that there was a need to unify all of the interest in mobile computing for education within a central group within the university.

The Miami M-Learning Center is a joint venture between the Miami University School of Engineering and Applied Science, the Armstrong Institute for Interactive Media Studies, and Information Technology Services. The primary mission of the center is to provide guidance to faculty, staff, and students on the best practices in m-learning so that use of mobile technology for education goes beyond just acquisition of technology towards the full integration of mobile devices into the life and education of students. A major aspect of the activities of the M-Learning Center is app development to support educational and research needs at Miami University. As a component to this activity, the center provides experiences for students in computer science, software engineering, and interactive media studies to collaborate on multi-disciplinary projects with students and faculty across the entire university

in ways that were previously unavailable. With the excitement being generated across the institution about how mobile technology can be used for pedagogical purposes inside and outside the classroom, these new opportunities provide our students with a structured and formalized entrée into the field of mobile computing and app development.

In this paper, we describe the Mobile Learning Center's infrastructure and present the experiences we have gained in providing the app development service to the university community. The remainder of the paper is organized as follows. Section II presents the formal structure of the M-Learning Center. Section III describes our educational and software development activities, and finally, Section IV concludes and describes future work.

II. MOBILE LEARNING CENTER

The Miami University Mobile Learning (e.g., M-Learning) Center has a mission of promoting and supporting the use of mobile technologies for student learning. The initiative is focused on three primary goals:

- 1) To capture and distribute best practices for integrative use of mobile technologies in learning,
- 2) To provide coordination and leadership that establishes linkages between existing development expertise and educators interested in applying mobile technologies for learning, and
- 3) To provide faculty, staff, students and practitioners with support on the use and development of mobile applications through coordination of research and educational activities.

The M-Learning Center is involved in helping shape Miami's mobile strategy through development of university-wide partnerships that examine innovative uses of mobile technologies. The M-Learning Center is involved in developing courses that will work towards building a workforce that is well-versed in the creation of mobile technologies, with an emphasis on the creation of applications that support learning.

In addition to the above, the M-Learning Center is engaged in developing mobile solutions for a number of customers, both internal and external to the university. This activity provides students (under the direction of faculty advisors) with experience and expertise in developing applications for mobile platforms. Heretofore, our efforts have been focused on iOS development, but we are in the process of expanding our capacity to support other platforms including Android-based devices. Finally, the M-Learning Center is working towards establishing an M-Learning presence locally, regionally, and statewide through hosting forums that bring policy makers, educators, and technologists to discuss the future of education and the ways that mobile technologies can enhance learning.

A. Collaboration

The M-Learning Center is, by its nature, a highly collaborative entity that draws expertise from a number of different units. While officially a center housed within the School of Engineering and Applied Science, it is strongly affiliated

with the Armstrong Institute for Interactive Media Studies, and Information Technology Services. In this section, we describe the role and philosophy of the collaboration from the perspective of each of these units.

1) *Role of SEAS:* The School of Engineering and Applied Science (SEAS) offers programs in engineering, computing, technology, and nursing. SEAS exists within a university (i.e., Miami) that is recognized for its liberal arts tradition. As such, the placement of an engineering and applied science division in this context makes it quite unique. Specifically, engineering within the liberal arts tradition (*liberal education* or "liberal-ed" in Miami lingo) provides a context in which exposure to a diversity of thought is the norm. As a department in SEAS, Computer Science and Software Engineering (CSE) has a unique opportunity to be able to interact and collaborate with a wide variety of disciplines outside of SEAS, perhaps more so than other disciplines within SEAS. It is within this context that the M-Learning Center exists; it is formally housed within SEAS and managed by faculty in the CSE Department.

2) *Role of AIMS:* The Armstrong Institute for Interactive Media Studies (AIMS) is an interdisciplinary, degree-granting program that studies how digital media is disrupting traditional disciplines. AIMS faculty and students bring disciplinary interest and expertise that spans business, art, design, engineering, and education and those interests manifest themselves in curricula in gaming, visualization, social media, and other interdisciplinary spaces. It is in *all* of these spaces that mobile media, and mobile learning in particular, has been key to ongoing disruption and their improvement. Since AIMS faculty and students shared this interest in mobile media (and had been conducting some work in the area), partnering to build the M-Learning Center was a natural next step.

AIMS students bring graphic design, social media, game design, user experience design, marketing, and other academic areas to the M-Learning Center and, in partnership, are able to learn more about mobile platforms and development and the contextualization of learning and knowing via mobile devices.

3) *Role of IT Services:* The mobile phenomenon represents a shift away from the laptop era, allowing for more ubiquitous technology access. This represents challenges in support; however, it also represents an opportunity to create a stronger relationship with academics and IT. Traditionally, IT has been represented as having a strong administrative and infrastructure focus, with less direct support to the academic mission. The M-Learning Center is one step in moving to a more collaborative relationship with academia.

At Miami we are using this trend as a powerful change agent to align IT staffing skills, interests, and expertise to directly support research and pedagogy. IT wins because this relationship helps to facilitate a fundamental understanding of challenges in the classroom, and it allows IT the opportunity to help participate in the development of standards and approaches. Faculty benefit by having greater resources to encourage making technology more of a tool, rather than an obstacle. The students ultimately benefit because they have better access to learning opportunities in the mobile

environment that is increasingly a part of their lives.

B. M-Learning Center Activities

The M-Learning Center is involved in a number of activities that correspond to the goals listed above. In the remainder of this section, we describe some of the educational, outreach, and policy activities that we have been involved in, while Section III describes our development activities.

1) *Outreach*: In order to help educators learn more about how to use mobile technology for education, we hosted a small conference called the Miami University Mobile Learning Summit in the Fall of 2010. The purpose of the summit was to share the latest vision, trends, and best practices on m-learning. Speakers from industry included representatives that spoke on future vision for mobility (Cisco) and the current state of mobility from an industrial perspective (Apple). Higher education was represented by speakers from the Illinois Institute of Technology reporting on their iPad initiative, and a speaker from Kent State University discussing some of the more recent developments in mobile learning. The highlight of the summit was a presentation by a K-12 educator from St. Mary's, Ohio speaking on the mobile learning project in their schools that reaches over 300 students in grades 3–6.

With over 80 attendees, the summit also provided an opportunity to showcase student projects that were part of the Miami University Interdisciplinary Technology Development Challenge, a yearly competition on the creation of technologies that serve a societal need. The projects for the current year were focused on the use of mobile computing devices. The entries included a real-time bus tracking system, a home automation system, and a system for assisting in pediatric therapy.

2) *Policy*: With tight budgets plaguing several school systems across the US, mobile learning is being considered as a potential solution to reducing the cost of education while increasing student engagement. In order to gain a better understanding of the current state of m-learning, the M-Learning Center has been working with KnowledgeWorks (<http://knowledgeworks.org>), an educational think tank, in evaluating and analyzing multiple m-learning practices and techniques. As a result, we have been able to extrapolate information necessary for developing a set of recommendations and policies aimed to improve the quality of education across Ohio schools through the use of mobile technology.

In analyzing the advantages and disadvantages of each approach, we used FRAME (Framework for the Rational Analysis of Mobile Education) [6], a model that uses three different categories to describe how social interactions, mobile technologies and human learning capacities all work together in forming an ideal m-learning environment. Although FRAME is one of the few frameworks that attempts to catalogue different m-learning techniques, it proved difficult for analyzing current m-learning trends due to the broadness of the categories. Therefore, we developed Augmented FRAME in order to facilitate a more fine-grained and systematic analysis of the approaches [7]. Augmented FRAME assisted us in

determining whether or not certain educational goals (e.g., reading, authoring, collaboration, etc.) were being satisfied by different m-learning approaches. This, in turn, proved to be instrumental in establishing our recommendations for m-learning adoption in a broader context [8].

III. SMARTPHONES IN THE CURRICULUM AT MIAMI

In this section, we describe how we have used mobile technology in the classroom, and the infrastructure that we have created at Miami University to support mobile application development. One of our primary goals is to provide experience to students in the development of mobile applications while providing a service to the university community. A secondary goal of our work in this area is to focus on applications that have a strong mobile learning component. That is, our projects focus on development of applications that are oriented towards education, either formal or informal.

A. Usage of Smartphones and Mobile Devices

There are a number of apps that are useful for m-learning. For instance the IEAR website (<http://www.iear.org>) contains a number of categories of apps that are targeted towards the K-20 educational space. We have identified a number of interesting applications and uses for mobile technology [9], a number of which are applicable to computer science and software engineering, although not specifically targeted for these fields. For instance, we have used Poll Everywhere (<http://www.polleverywhere.com>) as an alternative to clickers that accepts a number of different forms of user contribution, including e-mail, webpage, and mobile texts. Another system we have used extensively is Dropbox, a multi-platform cloud solution that provides access to shared file space for a number of devices including mobile phones. Our future investigations include identification of discipline-specific app bundles that address the needs of m-educators and m-learners.

B. Mobile phone platforms as the subject of study

As part of our desire to educate CSE and AIMS students, we are actively involved in project-based courses that engage students in creation of mobile apps. In CSE, we offer courses that have a mobile emphasis in client server systems (where students build mobile web apps), service oriented computing, (where students build XML services accessed with native apps on the front-end), and a course on mobile app development (where the focus is on native apps). CSE and AIMS are also working towards creation of a mobile development course for non-majors. Finally, the capstone courses in both CSE and IMS have had mobile development projects.

As part of our educational model, we make extensive use of the *inverted classroom* model [10], whereby students are required to view video content as their “homework”, and work on assignments or other laboratory work during class time. In this way, active learning occurs in a collaborative environment with other learners and in the presence of the instructor, while passive learning (sitting through lectures) occurs outside of class.

In our instructional context, we loan devices to students for a semester to allow them to gain experience within the environment. Increasingly, it is becoming the case that we need to lend out fewer devices as students acquire their own. In early iterations of the courses, we allowed students to propose their own projects. More recently, as described below, we have sought projects from external clients.

The primary difference between what students have had to learn in the past and what they have learned in our mobile-oriented courses has been the notion of the development environment and the deployment environment. While our client-server course (which focuses on web-based three-tiered architectures) has had some element of that, the fact that students have had to focus on the constraints of the mobile devices has forced a need to revisit assumptions made about how applications are developed. Another challenge for students has been, at least in our situation, the use of the Objective-C language and Apple development environment Xcode. The main issue has been in the notational differences and the memory management model used within the language. Also, students are limited to using Apple Mac computers when most have used PCs.

C. Projects

Our philosophy is that meaningful educational experience comes from providing students access to realistic and authentic projects. To facilitate this, we have made an extra effort to identify projects with external customers. These clients have come from a number of different contexts ranging from business and industry to research projects. Projects that we perform are generally mapped to three different tiers according to the desired quality of the outcome. Specifically, projects that are more exploratory in nature are assigned to teams within courses. Clients that desire a higher quality product have their projects mapped to either a capstone team or to the M-Learning Center's software development team. In most cases the clients pay a nominal fee to help cover costs of devices or, in the case of projects that require an extra level of quality, pay for students under employ of the M-Learning Center.

The portfolio of apps that the M-Learning Center in which has been involved includes the Miami University iPhone app, an application that provides access to university information including maps, dining menus, directories, sports and university news, events, and libraries [11]. In addition, we have been involved in the development of projects for both internal and external customers, including an app for heart health, a business analytics app, and a slew of other applications that are for the most part oriented towards some form of education.

D. M-Learning Center Development Team

The M-Learning Center Development team is a multi-disciplinary team made of up students majoring in graphic design, computer science, software engineering, and electrical engineering. The students employed by the M-Learning Center are advanced developers and designers that are typically in

their final year in their degree program, and have been recruited based on their experiences and skills sets. This team is considered our top-tier team and is typically given projects that carry a high priority of completion and quality.

The process used by the team for developing software is the following. After eliciting requirements from the customer, the graphic designer begins by creating mockups of the user interface of the application. The mockups are typically based on use cases and scenarios developed by the full team. The style of architecture used for the applications we have developed thus far has been three-tiered with the mobile application comprising the client tier, and the server and data tiers supporting access to live and dynamic data. While the graphic designers focus on the user interface, the software developers begin to create the design of web services and other software needed to support the backend processing of the application.

To facilitate collaboration amongst the developers, clients, and project leaders, we have employed usage of social media including Facebook and Google Buzz. While the interaction with the primary customers happens in face-to-face meetings, we have used social media as a day-to-day medium for interacting with customers and potential user communities in order to get feedback on the progress of the application, pose questions to users, and to clarify understanding of requirements. We have used both Facebook and Buzz to record status and as a forum for interaction between developers. Specifically, we typically have a Facebook group that is made up of both developers and users so that questions about the requirements can be posted and commented on, and images of mockups can be shared.

Our experience in the M-Learning Center has been primarily on development for the iOS platform. As such, much of the development work has used the Xcode IDE environment. The graphic design work is performed on Adobe Creative Suite and Photoshop. Templates specific to the iPhone genre are used for the creation of the mockups that are shown to the customers and user community during early stages of our development. For testing, we make extensive use of the Instruments tool for profiling the execution of the applications, and the Xcode debugging system. On the backend, we typically use Microsoft IIS servers to host .NET web services.

As for the Apple iOS SDK licenses, we have chosen to acquire all three levels of licenses: developer, enterprise, and university. These three tiers allow us to create developer distributions (university), institutional distributions (enterprise), and public distributions through the Apple App Store (developer). These tiers also allow us to use the university license portal as our general sandbox by providing students with the ability to create local deployments without having to go through the App Store.

E. Lessons Learned

In our short time as a center at Miami University, we have learned some valuable lessons that have shaped how

we approach app development projects. The remainder of this section summarizes those lessons.

1) *Partnerships and Collaboration*: The M-Learning Center's software development activities rely heavily upon the partnerships and collaborations that have been built between the different entities identified above. The collaborations necessarily have benefits for all involved. For SEAS, the collaboration provides opportunities for students to gain a great deal of experience in developing mobile applications. For AIMS, the collaboration facilitates expansion of their mission to include mobile media and mobile development. For ITS, the collaboration allows ITS to become directly involved in the academic mission of the university by being more proactive and integrated in research and education, rather than exist as a separate entity in the university landscape. On a more practical level, the collaboration allows the university to eliminate repeated effort by unifying how we adopt and use mobile technology for learning, and more importantly, how we develop mobile applications. For instance, our collaboration has allowed us to create a unified look and feel between the Miami University iPhone app and the multi-platform Miami University Mobile Web app (<http://m.muohio.edu>).

2) *Small, Agile Teams*: From a more localized developer's point of view, one of the decisions we made in forming our development team was to keep the group small. Many of the applications we build are relatively small compared to traditional, non-mobile systems. We have chosen teams that have expertise in three different areas: graphic design, mobile application development, and service-oriented computing (rather than merely a homogenous group of just programmers). This experience is completely different than what the students have experienced in the past within the disciplines. Our approach to development has relied heavily on social media with a mentor-mentee interaction occurring on an as-needed basis. We have found that this approach has made it easy to manage the projects, making status meetings merely an activity of clarification and demonstration, rather than status and reporting.

3) *Service Orientation*: The basic architecture from which we base our systems is three-tiered. Specifically, we make extensive use of web services in order to provide users access to live data. Off-loading data management to services has also required us to develop content management systems for supporting administration of content. The additional benefit has been that it has allowed us to support other groups around the Miami campus that are developing applications (mobile or otherwise) that need to access the data that we are providing. Again, as an example, the Miami University iPhone app and the Miami University mobile web app share content via the use of web services we have developed in the M-Learning Center.

IV. CONCLUSIONS

Many reports indicate that there is a growing trend towards the use of mobile technologies [12]. On the college campus

this trend is evident [13]. As these trends continue, a number of issues arise including how educators decide to meet student need. In CSE and IMS, we are positioned to have an interesting impact on how mobile computing is addressed on the college campus. For students within these computing fields, many opportunities exist to gain valuable experience in the development of mobile apps, especially given the growing needs and increasing excitement over how m-learning can be used in the higher-education setting.

The Miami University M-Learning Center is by necessity a multi-disciplinary and highly collaborative effort. Our interest lies in both promoting m-learning and in educating students to enter a workforce that is highly dependent upon mobile computing. Our experience has thus far been extremely positive and we have found a wealth of opportunity to engage in many different kinds of research and educational projects.

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