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Making Mobile Learning Work: Student Perceptions and Implementation Factors

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Abstract

Mobile devices are the constant companions of technology users of all ages. Studies show, however, that making calls is a minimal part of our engagement with today's smart phones and that even texting has fallen off, leaving web browsing, gaming, and social media as top uses. A cross-disciplinary group of faculty at our university came together in the *mLearning Scholars* group to study the potential for using mobile devices for student learning. The group met bi-weekly throughout a semester and shared thoughts, ideas, resources, and examples, while experimenting with mobile learning activities in individual classes. This paper summarizes student perceptions and adoption intent for using mobile devices for learning, and discusses implementation issues for faculty in adding mobile learning to a college course. Outcomes reflect that mobile learning adoption is not a given, and students need help in using and understanding the value in using personal devices for learning activities.

Keywords: Mobile Learning, GenM, TAM, Activity Theory, Responsive Web Design

Introduction

Mobile learning is a popular topic in the learning literature, and it is widely represented in both education and training blogs around the world. Current research approaches the topic from the viewpoint of determining where it fits with existing learning theory and justifying it as a valid learning method. Missing from the current research is a view of how students feel about the presentation of learning content on a small platform, and their interest and ability to adopt mobile learning. Additionally, other than examples from the blogging world, a missing element is how other educators have added mobile learning into their courses, along with an exploration of available and inexpensive tools to enable mobile learning methods. The goal of this study is to address the missing elements of student acceptance and educator adoption of appropriate tools. Additionally, student feedback leads us to question the appropriateness of the "digital native" label often associated with today's college students.

This study draws upon several theoretical areas, including *technology acceptance models*, which view the physical aspect of presenting content on a small platform, along with adoption and use of the technology. Additionally, *activity theory* emphasizes students' ability to learn by their involvement with technology and the content. The following section gives a brief overview of recent work in these areas.

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Theoretical Foundations & Definitions

Today's college students are the foundation of Generation M*, digital natives* who are assumed to be heavy users of mobile technology and avid adopters of social media (Cvbetkovic & Lackie, 2009). A recent UK study found that respondents used their smart phones for an average of 221 tasks per day (MacNaught, 2014). Other studies explore ways to add tasks that turn mobile devices into active and effective learning tools; several address how to engage both students and working adults in learning activities, replacing or supplementing aspects of traditional content delivery; still others demonstrate the possibilities of reaching remote geographical areas using mobile devices for instruction. Unanswered questions include how students feel about expanding their mobile device use to include learning endeavors and what the impact will be for faculty who wish to make this happen.

Definitions of mobile learning (mlearning) vary across disciplines and research areas. Some views focus on technology, including "any educational provision where the sole or dominant technologies are handheld or palmtop devices" (Traxler, 2005, p. 33). Other definitions specify the size of the device (Quinn, 2000) or lack of a predetermined location (O'Malley et al., 2003).

While some authors consider mlearning to be a natural evolution of elearning, there are differences in both terminology and technology that distinguish the two, as well as their relevant content. Comparisons describe the two learning activities as *spontaneous* vs. *interactive*, or *connected* vs. *hyper-linked*. The content itself is described as *lightweight* vs *media-rich*, *situated* vs. *distance*, and the learning process as *informal* vs. *formal* (Laouris & Eteokleous, 2005). Mobile learning efforts require consideration of both the capabilities of the technology and the abilities of the user. Feser (2010) supports the position that mlearning is not elearning on a mobile device. Speaking more from the perspective of workplace learning, he notes the following differences:

- *timing* - when learning is expected to take place and for typically short periods
- *information access* – immediate duration related to need
- *context* –situational drivers, e.g., a pre-flight check list for an aircraft pilot
- *assessment* – immediate application of the information, e.g., reviewing drug interactions before prescribing medication

Laouris and Eteokleous (2005) emphasize the importance of defining and understanding the mobile learning process and call for an educationally relevant definition that "embraces not only technical, methodological and educational aspects, but also considers social and philosophical dimensions" (p.1). The distinction, they argue, is important so that a complete and accurate definition can drive and focus implementation efforts. They agree that a mlearning definition requires consideration of time, space, learning environment, content, and technology, but also add mental abilities and learning methods (Laouris & Eteokleous, 2005).

The *eLearning Guild*, a training industry organization, provides this working definition: "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" (Wexler et al., 2007, p. 6). They see mobile learning as a dominant method for workforce training. El-Hassein and Cronje (2010) more recently examined various aspects of mobile learning, separately addressing mobility of the technology, mobility of the learner, and "the mobility and dynamism of the learning processes and flow of information" as key components to be addressed (p. 12).

Other researchers refute the simplicity of these definitions, while Traxler (2009) notes that our early definitions were "too technocentric and imprecise" (p. 2), as well as unstable, as technology itself changes so rapidly to challenge the concept of what portability or mobility really means.

Traxler references the work of Arnedillo-Sánchez, Sharples, and Vavoula (2007), which describes the benefits of mobile devices to take learning to the individual while enhancing and enriching traditional learning activities.

When searching for an appropriate theoretical foundation, some researchers view learning on mobile devices through the lenses of several important pedagogical theories, including *behaviorist* (drill and feedback) and *constructivist* (self discovery). Metcalf (2006) takes a different approach and views mobile learning as an augmentation process, letting the brain do what it does best in terms of pattern matching and data analysis, while enhancing our weaker abilities at rote operations. The latter weakness, he feels, results in errors of memory and performance that mobile devices can reduce when we use them as a reference tool, thereby augmenting performance. While this is a reasonable approach for on-the-job performance, the question remains as to how well we can influence learning with mobile delivery in higher education. If used for supplemental or repeated practice that is supportive of learning, content may easily move out of the classroom on mobile devices to the benefit of our students.

Another promising area of relevance is *activity theory,* built upon the works of Vygotsy (1978). He defined learning as a *system* where technology assumes an important role. He tells us that learning and development are active processes mediated by tools. This was a far-reaching perspective, developed long before today's technological capabilities expanded the possibilities we see today. Studies on activity theory in education have been growing (Levy, 2008; Lim & Hang, 2003; Mlitwa, 2007; Scanlon & Issroff, 2005), as well as in the area of system design (Mwanza, 2001), and in the use of mobile devices in workplace settings (Marken, 2006).

While mlearning may be a promising application of activity theory, Sharples, Taylor, and Vavoula (2005) further define mobile learning as "a cultural-historical activity system, mediated by tools that both constrain and support learners" (p. 1). A simplified version of their research model appears in Figure 1. Their work views the subject (user) as taking control, applying technology, and achieving some degree of change, ideally in the form of learning. *Control* is an important construct in the mobile learning framework and an obvious success factor in mobile learning adoption.

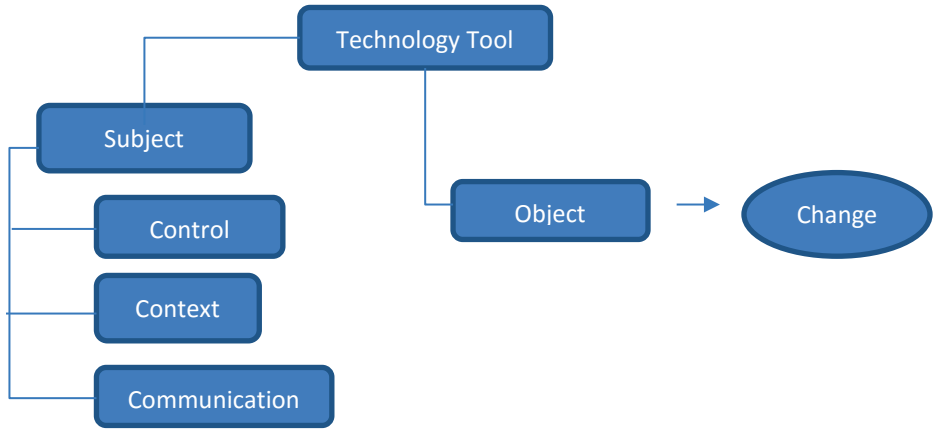

Figure 1. Mobile Learning Framework (Adapted from Sharples, Taylor, & Vavoula, 2005)

A number of studies have applied modified technology acceptance models (TAM) to mobile learning. Wang, Wu, and Wang (2009) evaluated *intention to adopt* mlearning in a mixed population of students and business professionals in Taiwan. Building upon UTAUT (Venkatesh & Davis, 2000), Wang, Wu, and Wang note that mlearning differs from the traditional IT context. To accommodate user factors, they added constructs of *playfulness* and *self-management of learning* to UTAUT factors of *performance expectancy*, *effort expectancy,* and *social influence*. Their out-

comes supported the relevance of all five constructs and concluded that performance expectancy was the strongest predictor of intention to adopt. Their initial hypotheses that age and gender would play a role in moderating key effects was supported, particularly related to social influence. This work provides important support for mlearning design, suggesting the importance of a focus on ease of use to attract new users, as well as the value of the medium in supporting performance expectancy. Early adopters will typically share benefits with their peers, demonstrating the construct of social influence. Additionally, the Wang et al. (2009) study supported the benefits of making the mlearning playful and enjoyable to further attract users, supporting the renewed interest in gamification for learning.

While Sharples and others have made some major progress toward a theory of mobile learning, the search for a comprehensive definition, supportive theory, and appropriate assessment measures continue. Current research seems to diverge into two major groups: those who feel the learning foundation is most important, and those who view technology adoption theory as the starting point. While both are certainly important, our goal as educators is to carefully explore new media to determine value for classroom use. If we can adapt or develop new activities for mobile devices that challenge the student user, as well as uncover workable methods to assess outcomes, adoption by faculty level is worthwhile. This paper addresses some of the challenges of mlearning development and adoption in a business course.

Mobile Learning Experimentation

Mobility implies that the learner has the ability to take their learning environment with them as they move (Barbosa & Geyer, 2005). It is generally agreed that laptops do not fall under the realm of mlearning, as most models lack the "instant on" feature of a smart phone or tablet that encourages device use in various environments for various amounts of time. This will undoubtedly be challenged by new form factors that offer better mobility and connectivity.

Trainers and instructional designers across the globe were among the earliest adopters of mobile learning. Performance technology experts embraced mobile learning to supplement or replace in-house classes, prepare employees for new product releases, and reach busy executives. Industry case studies also show the use of mobile devices in the field has the potential for building closer customer relationships by presenting faster solutions and service times, as well as easier dissemination of data for analysis and decision-making (Quinn, 2011).

Remote areas of the world have also demonstrated early adoption of mobile learning, often where traditional technology required landlines that were not available or reliable. In developing countries, mobile devices may function as the sole training and support platform. For example, medical organizations send personnel deep in country to serve the local population with their only outside access being mobile assistance and digital references (Kiyan et al., 2010).

Motiwalla (2007) addressed the potential for personalization presented by mobile content, while empowering learners to choose their own time and place for engaging with learning materials. Bansal and Joshi (2014) evaluated the use of a single mobile app to enhance learning and communication for a group of future educators. The majority of their students felt the improved access to faculty and social interaction with other students contributed to enhanced learning. Fuller and Joynes (2014) took a different approach, suggesting there should be less emphasis on whether mobile learning *should be* implemented, and more on developing mobile learning that is "*comprehensive, sustainable, meaningful and compulsory*" (p. 153). In their area of healthcare education, workplace learning is closely tied to the future use of mobile devices. They reference a UK physician poll in which 59% of doctors surveyed used their mobile devices to access clinical information during a typical work shift. They call for more research to understand how students are learning with mobile devices, and how we can help them carry this process on into the workplace.

In higher education in the United States, formal experiments with mobile learning have moved slowly. The University of West Florida and Wake Forest University developed fully mobile courses, creating the "Pocket Campus" and "Pocket Classroom," respectively. While students could potentially complete an entire course via a mobile device, neither program was being offered at the time of this research. Abilene Christian College was an early adopter of mlearning and remains an active proponent, choosing to standardize on a single device platform by providing an *iPhone*™ or *iPod Touch*™ to all incoming students. Platform standardization offers significant benefits for the custom development of learning applications, and removes the large variability of mobile operating system features, mobile web browsers, memory, and storage limitations.

Research Design and Methodology

This section discusses the process, challenges, and outcomes resulting from a mobile learning experiment in a core course in a college of business. The primary goal of this study was to explore student acceptance of mobile learning. A secondary, yet important goal was to explore mobile learning preparation and find available tools that would allow an educator to design and develop effective content for the mobile learning platform. New methods that are too time consuming, or beyond the scope of a department technology budget, will clearly not be adopted in spite of the expected benefits.

In the process of gauging student acceptance, an additional goal of this experiment was to promote student engagement. Core courses typically present challenges for educators, as students tend to focus on their major area of study and are less interested or have less time to excel in courses designated for foundation skills. Additionally, at our school, these courses are typically large sections, limiting in-class activities and participation that might encourage higher levels of student engagement.

The *mLearning Scholars* group was launched with the express purpose of exploring the meaning, scope, faculty interest, and student acceptance of mobile learning. Following on the heels of hybrid/blended and online education, the potential for using mobile devices as a learning tool seemed compelling. Media development, podcasted lectures and small screen activities seemed to be a natural fit given the rapid market penetration of small tablets, the many capabilities of existing devices like the *iPod Touch*™, and continued growth in the smart phone segment. Mobile devices represent many interesting possibilities for learning both inside and outside the classroom. Interested faculty wrote competitive proposals to identify a specific course that might benefit from a mlearning approach. Some disciplines, such as music education, seemed to be ideally suited for mobile technology; for example, deploying a piano practice application on a tablet or sending out audio files for transcription were easy additions to the curriculum. A geography instructor found a graphing calculator application for class field work, and a linguistics professor had students use recording capabilities to capture previously undocumented African dialects.

Our business intelligence course replaces a traditional introduction to information technology for all business majors. In this course, we changed from a focus on technology to explore the various ways data are gathered, analyzed, and used for business decision making. When our graduates enter the job market, they are expected to use quantitative tools in their work. These tools include spreadsheets, small databases, and often, visualization tools supported by large data-driven systems that organizations adopt for human resource management, inventory and supply chain control, customer relationship management (CRM), and enterprise resource planning (ERP). We teach students to recognize the value of data and to apply various quantitative tools to solve problems and make logical and ethical business decisions. It seemed possible that the introduction of content and study aids delivered via mobile devices, along with assignments that incorporated their use in creating content, could support learning and increase student engagement. Moving

beyond simple memorization to problem solving and interactive simulation holds great promise in reinforcing learning. The first challenge, therefore, was how to make elements of the course mobile, and then determine if students would see the potential of using mobile technology for learning and buy-in to the new format.

The research design was essentially survey research, with the added benefit of a stimulus/response environment. By assigning the full class specific activities that used mobile learning, we could immediately collect student thoughts and perceptions. Open feedback was collected on course blogs on our Blackboard learning management system, and structured surveys were created in the Qualtric survey system. The size of the class and resulting amount of data collected did not require analytical tools beyond the scope of Excel and simple comparative statistics.

The population consisted of members of one section of the BI course that met on a Tuesday and Thursday schedule. Before the start of the semester, a short description of the experiment and the opportunity to acquire a new mobile device at half price was posted on the course Blackboard site. Students were encouraged, but not required, to participate in mobile learning activities and respond to a series of surveys. Of the 47 students enrolled in the BI course, 22 signed up for a $150 credit toward a new 32-Gb *iPod Touch,™* subsidized by our Center for Teaching and Learning. Some members of the class already had smart phones, netbooks, or laptops they could use, so declined to purchase another device. All class members indicated interest in the study and agreed to participate in surveys, with appropriate human subjects paperwork introduced the first day of class. A full set of data responses was collected from 33 students.

Mobile Learning Content & Tools

With the joint goals of exploring mlearning adoption and building student engagement, the multi-platform problem presented some immediate challenges for mobile content development. Student devices varied from the Apple line of *iPhone™, iPod Touch™ and iPad™*, to smart phones including *Android*, *Blackberry™*, *WebOS™*, and *Windows7™*. Other students had browser-capable devices such as netbooks, MacBooks™, and Windows™ or Linux laptops. Mobile development tools on the market at the time of the study tended to be platform-specific, primarily targeting Apple or Android. The only logical solution to meeting the multi-platform challenge for this experiment was to adopt an open approach so content could be delivered on any device. As such, it was also apparent that the deliverables would have to be very basic. Content that focused on key concepts in the course or used basic business applications like spreadsheets seemed feasible, along with exam study aids and podcast media for course assignments. HTML5 standards were minimally supported on mobile browsers at the time of this experiment.

Table 1 summarizes the applications and tools used during the semester, along with a brief purpose of each tool, key features of how they were used, and outcomes. Mobile style sheets with basic HTML web pages were one of the most successful content delivery tools, as a single document was easily viewed on any sized device. Web-based study applications such as *Quizlet™*, along with mobile clients for downloading Quizlet flash card study decks were very popular with students. *MicroPoll™* was used via mobile browsers for in class polls, and while *Twitter™* was used for some class communications, it was less well received by students.

Table 1: Mobile Applications & Tools Explored

Application/ Tool	Purpose	Features	Outcomes
Mobile formatted web pages, using mobile style sheets	*Top Ten Topics* chapter summaries for class prep and exam study	Simple web pages with mobile device meta-tags linked from the course website for each chapter. Must be a website available; simple HTML coding used; once template with mobile styles was developed it was reusable for new pages	Students across all platforms could easily access & use web pages for class prep and exam study. Many preferred this option over loading a specific app to their device
Quizlet™ (www.quizlet.com) Basic account at Quizlet.com is free with small annual fee for content creators to add images	Flashcard decks on topics, terms & concepts for each chapter for class prep and exam study	Decks built & stored on the site are accessible via web or mobile client apps. Many apps were free although paid apps included features such as ability to create new decks on the device, keep track of study progress or mark difficult cards for restudy. Decks are reusable from semester to semester	Most students used a mobile client (Quizlet now has its own). Students who used the tool regularly reported they felt they did better on exams. As a bonus, students found other study decks for GMAT, LSAT exam prep, or for other classes
Twitter™	Pre-class announcements, weekly in-class activity reminders, notice of bonus point opportunities	Primarily one-way communication; low traffic, sent at standard times. Some students used their account to send clarifying questions or comments	Some students pushed-back on the use of this tool; they didn't want another "account," or didn't want to use personal accounts for classwork
MicroPoll™ (www.micropoll.com) Free polling application	Poll/survey app used during class: a. poll student position on current topics; b. vote on decisions after an ethics case; c. discuss alternative actions	Polling site for simple surveys with results displayed graphically as users respond. Several basic formatting choices, limited questions per poll for free version. No way to determine who voted or limit votes per student	Students could access with any device & vote anonymously; shy students could participate with low risk. Weak Wi-Fi signal in classroom caused some issues with in-class use of site
QR Codes http://www.qrstuff.com	Easy shortcut for mobile users to access web links, email, etc.	QR client app required but available for many platforms; code on screen readable by student devices throughout room	Simple way to avoid typing URLs. Used for quick access to polls & other course sites
TextNow™ http://www.enflick.com	Interactive texting tool to respond to student questions	Free texting service for Wi-Fi devices such as *iPod Touch* to avoid having to use personal cell number	Occasional use for course questions; students can find instructor anywhere, anytime

Camtesia and iTunesU™	Podcasts replaced chapter lecture content of the course	Two versions allowed students to listen to a MP3 file, or view a MP4 movie	Most student used audio formats as being quicker to download & less storage space
Device Cameras & Audio Recordings	Student developed media	Enhanced content was added to traditional case activities	Students added interviews & photos to written work

Data Collection

At several points over the course of the semester, structured surveys were used to gather student participation levels and opinions. At the beginning of the semester, students completed a technology experience survey to set expectations about current skills, and the *Index of Learning Styles* instrument (Felder & Soloman, 1999) captured student reported learning styles. Students responded to several sets of discussion questions on the course blog mid-point in the semester, and a final survey collected student perceptions about their overall mlearning experience and intent to adopt at the end of semester. A full set of surveys is available in the Appendix.

The technology experience survey is an in-house instrument we use regularly to measure student ability with various technologies at the start of a semester. Results from the full class survey showed members had slightly less experience and access to technology than those taking the survey in prior semesters. Table 2 shows an abbreviated set of results on key technologies and student experience with them.

Table 2: Summary Results from Technology Experience Survey

Questions to Determine Experience Level	Positive Response	
	n	**%**
1. Have a computer at home	44	94%
2. Have broadband Internet access at home	40	86%
3. Have a laptop or netbook	42	90%
4. Have a mobile device that plays MP3s	36	78%
5. Have a mobile device that plays video	29	63%
6. Have a phone with web browser	29	63%
7. Have viewed videos on YouTube	46	98%
8. Have uploaded videos on YouTube	22	48%
9. Subscribing to podcasts or newsfeeds	24	52%
10. Subscribing & listening to podcasts from iTunesU	13	28%

Students in this course tended to be more consumers of media rather than creators, with minimal experience listening to educational podcasts. This was emphasized further when two weeks after receiving their devices only a small number of students had completed the first assignment of finding a mobile learning tool or educational application.

The first ten minutes of each class meeting were used to cover device or application issues, but students seemed reluctant to ask questions in the full group. To encourage more student involvement, an in-class exercise on team process was modified to include a mobile element. Students

self-selected into small groups by their device type or operating system. The team goal was to share applications they discovered, search for useful learning applications, ask and answer group questions, and post a team summary to the course technology blog.

Some students found course-related content on *YouTube*^{TM}, *Ted*^{TM} sessions on related course topics, PDF readers, and other small applications that they shared on the course technology blog. The majority quickly adopted *Quizlet*^{TM}, an application to view and study flash cards of course concepts developed for them, and in the process found other categories of card decks to help them prepare for graduate or law school admissions exams, or content for other classes. Some students clearly saw the potential for using mobile devices as study aids and were eager to continue the process. Students seemed more likely to ask questions of each other during this small group activity than in the full class, and most claimed to have learned something new about their mobile technology and capabilities in their team blogs.

GenM Students Speak Out

A surprising aspect of this study was in discovering how students viewed their relationship to technology. Several semi-structured blogging activities resulted in interesting and unexpected responses. The first activity asked students to discuss their thoughts on the definition of *generation mobile* (*GenM*), and opinions about using mobile technology for lifelong learning. While most students agreed with the definition of *GenM* provided, supporting Cvbetkovic and Lackie (2009), few were ready to say mlearning was a long-term learning solution. Some, in fact, lamented the constant use of technology and noted that their peers no longer knew how to read a map or do basic math functions without technology. Table 3 summarizes the category definition and discussion questions, along with selected student responses.

Table 3: GenM Definition & Student Thoughts (blog responses)

Question: "Gen M, those born from 1980-99, is alternately defined as the "*millennials*," "*multi-taskers*," "*multisensory*," and, of course, "*mobile*." What do you think of this classification? Is the stereotype of a wired, tech-savvy generation accurate? Are we ready to say that life-long learning is enabled by our mobile devices?"
"I would say that this is a fairly accurate summation as some of the greatest technological advances in America occurred during the given time frame. The multitasking generation, that I am a part of, was born into this rapidly growing system of communication, advertising, etc. We have come at a time when the internet and data phones are really accessible to most people. I don't know if this is a good thing though. Some people would make the argument that multimedia is the best way to obtain information for our brains. Studies show however that when reading on screen or watching on screen we retain 15% - 20% less info and read 20% - 30% slower."
"I think that the classification of our Gen M, is fairly accurate. Overall, those years are the times of big technological break-throughs that have defined our generation. We have been introduced to the i-phone and Zunes of our time and used and adapted them to our needs. We make things simpler with our mobile devices; however I do not believe that we are ready to say that life-long learning will be enabled by our mobile devices. The technology is close but not there yet. We still need some time to invent all the things we need to make mobile learning successful as the books and pen and paper of older times have been."

> "It is absolutely fair to say that Gen M are "millennials," "multi-taskers," "multisensory," and, of course, "mobile." I recently witnessed my two-year old nephew enter the passcode to get into his mother's phone. He also turned on the television, the Wii and chose his movie of preference on Netflix. A two-year old! Imagine what he can do when he gets older. Now, he doesn't belong in the Gen M categorization, perhaps he will be known as Gen T for "technology"? For those that fit in the Gen M era, I truly believe that the "m" description fits. It is true that everywhere on campus, you can't help but notice students glued to their phone walking from to class. Although we rely on our mobile devices every day, to say that it will enable life-long learning is premature. We are social people and use these devices for "friends" but it is up to the individuals to decide that learning comes out of it. I'm just not ready to "learn" from my phone, I don't know if I'll be using my phone that much if it was created for learning purposes."

Regarding students' self-reported ability to use various technologies, or degree of *self-efficacy*, (Venkatesh & Davis, 2000) many students felt they were part of *GenM* and had confidence with technology, even though they did not always demonstrate this ability with their mobile devices in class. From activity outcomes, they did not appear to be rapid adopters of mobile learning applications beyond typical gaming or social media use. As noted by one student:

> "Generation M is much less tech savvy than people assume. The ability to efficiently use important applications such as Microsoft Excel is very rare among people my age. The stereotype is dead wrong when it assumes that people of this age already have real, useful technological skills." (blog response)

This study hints that the *digital native* definition applied to college students by Cvbetkovic and Lackie (2009) is not a given. While they have access to technology as never before, it is still individual preference as to what and how much technology they adopt and use on a regular basis. Early in the course, students demonstrated reluctance to experiment with their new devices, or even to search for appropriate educational applications. Only with encouragement and perhaps a bit of peer pressure when asked to perform on a team, did they take the extra step of exploration beyond their comfort zone. This supports the work of Wang et al. (2009), regarding performance expectancy. Throughout this experiment, unless students expected to benefit from a tool or technology, they were reluctant to devote time to it.

Results of this study also show that students' desire to learn on their personal mobile devices should not be an automatic assumption, as some of them feel strongly about keeping their personal lives separate from their academics. For example, some students declined to use their *Twitter*^{TM} accounts for class and were reluctant to create a second account for school use. The reluctance to use "personal" space or tools for learning is an interesting observation that could use more study and interpretation, as well as the aspect of motivation for adopting mlearning and a possible relationship to learning style.

Outcomes Identified Related to Objectives

A series of questions were asked to gauge student pre-course study habits, expectations about the use of mlearning, their actual use, and their perceptions about future use. Total usable responses represented 33 students (70.2%) who completed all surveys. Early in the course, students reported on their current study and time management skills, with outcomes shown in Table 4. They generally felt they were good at self-direction, goal setting, and time management, all important qualities for successful use of learning content outside of class.

Table 4. Student Perception of Study Skills

Question: What are your current views of your study skills? 5=high, 1=low						
	5	**4**	**3**	**2**	**1**	**Total**
When it comes to learning and studying, I am a self-directed learner.	13	12	6	1	1	**33**
	39.4%	36.4%	18.2%	3%	3%	**100%**
In my studies, I am self-disciplined and find it easy to set aside reading & homework time.	8	10	10	4	1	**33**
	24.2%	30.3%	30.3%	12.2%	3%	**100%**
I am able to manage my study time effectively and easily complete assign-	10	18	3	2	0	**33**
	30.3%	54.5%	9.1%	6.0%	0	**100%**
In my studies, I set goals and have a high degree of initiative.	12	10	7	3	0	**32**
	37.5%	31.2%	21.9%	9.4%	0	**100%**

Students generally had high expectations at the beginning of the course that mobile learning would be useful to them, although 30% were neutral or negative on the topic as shown in Table 5. They also expected that mlearning tools would be easy to use, with 78.8% reporting high or above average confidence that they could become proficient with them. In other words, the performance expectancy variable impacted intention to adopt as noted in Wang et al. (2009).

Table 5. Expectations for mlearning at the Start of the Course

Question: What expectations did you have about mobile learning at the beginning of this course? 5=high, 1=low						
	5	**4**	**3**	**2**	**1**	**Total**
1. mlearning would be useful in my learning process.	7	16	6	2	2	**33**
	21.2%	48.6%	18.2%	6%	6%	**100%**
2. Using mlearning would help me accomplish learning activities more quickly.	7	15	9	0	2	**33**
	21.2%	45.5%	27.3%	0	6%	**100%**
3. Using mlearning would increase my learning productivity.	6	14	9	2	2	**33**
	18.2%	42.5%	27.3%	6%	6%	**100%**
4. Using mlearning would increase my chances of getting a better grade in class.	8	12	8	3	2	**33**
	24.2%	36.5%	24.2%	9.1%	6%	**100%**

5. It would be easy for me to become skillful at using mLearning	11	15	6	1	0	**33**
	33.3%	45.5%	18.2%	3%	0	**100%**
6. I would find mlearning tools easy to use.	8	15	7	3	0	**33**
	24.2%	45.5%	21.2%	9.1%	0	**100%**
7. Learning to operate mlearning tools is easy for me.	11	17	4	1	0	**33**
	33.3%	51.5%	12.2%	3%	0	**100%**

In the post-course survey results shown in Table 6, students shared their experiences and opinions over various aspects of using mlearning in the course. In all cases, the majority of respondents strongly agreed or agreed there were benefits to the use of mobile devices for learning and that it added value to the course (81.8%).

Table 6. Opinions of mlearning after Semester Experience

What is your level of agreement with the following statements about mlearning? 5=high, 1=low						
	5	**4**	**3**	**2**	**1**	**Total**
Mobile learning allows instant access regardless of your location	7	12	10	3	1	**33**
	21.2%	36.4%	30.3%	9.1%	3%	**100%**
Mobile learning is useful to supplement to an existing course	8	16	6	1	2	**33**
	24.2%	48.5%	18.2%	3%	6.1%	**100%**
Mobile learning is an effective learning aid or assistant for students	8	14	7	4	0	**33**
	24.2%	42.4%	21.2%	12.2%	0	**100%**
Mobile learning allows you to convert any wait (dead) time into productive time	12	13	7	0	1	**33**
	36.4%	39.4%	21.2%	0	3%	**100%**
Mobile learning allows convenient access to discussions – anywhere and anytime	8	14	8	3	0	**33**
	24.2%	42.4%	24.2%	9.1%	0	**100%**
Mobile learning that sends information to you via messages (push) may be better	10	9	11	3	0	**33**
	30.3%	27.3%	33.3%	9.1%	0	**100%**
Mobile learning can be used as a supplemental tool for any existing course	10	14	7	2	0	**33**
	30.3%	42.4%	21.2%	6.1%	0	**10%**
Using mobile learning tools adds value to course learning	9	17	7	0	0	**33**
	27.3%	54.5%	21.2%	0	0	**100%**

One objective of this study was to create engagement in the course, and results in Table 7 show the experiment was partially successful with 48% agreement or strong agreement, 33% neutral, and 18% (6) disagreement. The majority of students liked the study decks available through *Quizlet* and mobile web pages that summarized content for exams, with 73% stating they had helped improve exam performance. This was also a positive vote for basic, open source learning solutions to support key content areas. A few students, unfortunately, felt the mobile aspect of the class was distracting and commented that some students spent class time "browsing or playing" instead of participating in class discussions.

Table 7. mlearning Impact on Course Interest & Exam Scores

Please respond to the following questions about mlearning activities used in this course. 5=high, 1=low						
	5	**4**	**3**	**2**	**1**	**Total**
Course mlearning activities increased my interest and engagement in this course?	2	14	11	5	1	**33**
	6%	42%	33%	15%	3%	**100%**
Course mlearning activities improved my performance on course exams	4	20	5	3	1	**33**
	12%	61%	15%	9%	3%	**100%**

As far as how they felt about using mlearning in the future, the majority of respondents indicated they would likely continue using mobile devices for learning activities if content was available in other classes. See Table 8.

Table 8. Likelihood that Students will Continue Using Mobile Devices for Learning

What do think about using mobile devices for learning going forward?					**5=high, 1=low**	
	5	**4**	**3**	**2**	**1**	**Total**
I intend to use mlearning in the future.	7	14	7	2	2	**32**
	21.9%	43.8%	21.9%	6.2%	6.2%	**100%**
I predict that I will use mlearning in the future.	6	19	5	1	1	**32**
	18.8%	59.4%	15.6%	3.1%	3.1%	**100%**
If available, I plan to use mlearning in the future.	7	15	7	1	2	**32**
	21.9%	46.9%	21.9%	3.1%	6.2%	**100%**

With regard to what content or activities students would like to see available on mobile devices, 70% of respondents asked for practice quizzes. One of the clear messages from students is that they would like to see mobile device content used as a *supplement* to course content, supporting Metcalf's (2006) thoughts on the use of mobile devices to augment learning. This further highlights the importance of having a goal and plan in place before embarking on a mobile learning effort. The notions of personalization and control with mobile learning merits more research, along with more exploration of the *self-efficacy* construct (Venkatesh & Davis, 2000). Extending the work of Wang et al. (2009), a deeper look at the relationship between previous positive tech-

nology experience and the performance expectancy construct will likely also impact adoption outcomes for mobile device learning.

A primary goal of the study was to examine adoption levels, or to what extent students actually used their mobile devices as learning tools. The end of the course survey asked which technology students used the most for mobile learning activities. An interesting outcome is that about half of the purchasers of the *iPod Touch* fell back to other technology for learning activities as shown in Table 9.

Table 9. Predominant Device used for mlearning

Please indicate which mobile device you used most often for class activities.		
	n	**%**
iPod Touch™	11	33%
iPhone™	3	9%
iPad™	1	3%
Android™ Phone	10	30%
Windows™ Phone	0	0%
Blackberry™	0	0%
Netbook	0	0%
Laptop	10	30%
Macbook™	2	6%

Student reasons for not using their mobile devices more varied from not always having WiFi access, already having their laptop booted up when they needed to study, or screen size.

One comment from the discussion blog summed it up:

> "I'm not sure if I'm exactly going to learn more through my "mobile device" or aka my phone or a Touch simply because its so small. I feel like I learn more from use of a laptop than those things. Are they helpful to maybe get small messages out? Yes, I think so, however I don't want to only have access to a whole assignment on my smaller devices. That just seems really silly to me. I think they are going to be more useful for reminding me that I need to do something for class, or if I need to look something up for my class quickly. That is where I see the most use coming from mobile learning. For the most part I still see laptops being the most useful, along with lectures and being in a classroom. People have been and will continue to learn regardless of if they have a mobile device or not; learning always will take place." (blog response)

In their first attempt at mobile learning, students tended to choose a favorite content format and focus on that for course use. While many commented that they preferred viewable web content (48%) over downloaded applications, the highest tool use was *Quizlet™* and its variety of application clients (52%), along with the web-viewing option, as shown in Table 10.

Table 10. Mobile Content used on Mobile Devices

During the course of the semester, which of the mobile content did you access with your mobile device? (select all that apply)		
Content Type		
	n	**%**
Chapter objectives & Top Ten mobile web pages	5	15%
Quizlet™ TopTen Flashcard decks	18	55%
Course Polls	9	27%
Blackboard™ via Blackboard Mobile™ App	6	18%
iTunesU™ Podcasts	0	0%
Lecture Capture recordings	1	3%
Course Tweets	6	18%
Other	1	3%

Mobile Content Development Options

It is not desirable or good time management for faculty to replicate learning content in multiple formats or build applications for various platforms. A growing number of elearning vendors are bringing mobile development environments to market that address cross-platform challenges, with two distinct models developing. The first is the traditional model of a purchased software license per developer, often with a base development package and various add-on modules; the vendors typically provide mobile clients for various platforms. Developed content may be accessible on various platform-specific clients, including desktop, tablets, and mobile platforms. The modular approach offers an interesting range of learning formats such as simulations, games, puzzles, flashcards, and active learning options. Prices vary with features ($500-$3,000 with education discount), and some require an annual renewal fee. The purchased license model includes *Articulate™*, *Rapid Intake™*, and *Adobe Captivate™*, all major elearning software providers, as well as a smaller startup called *ReadyGo™* that generates web output for a variety of platforms.

The second model is a software-as-a-service (SaaS) method, such as *Mobi21™* or *LearnCast™*. Content development is web-based, with a monthly charge for content pushed from the site. Another model requires users to obtain an appropriate client from the vendor site and subscribe to the content for a time-based fee ($4-10/user per month). Course materials may be as detailed as an *ebook* or as simple as flashcard study decks. Most of these organizations also provide development services for organizations with a budget. The online tools are in their early stages, and often have a tedious process for adding content. Upload capabilities are considered to be among future enhancements.

Some elearning tools such as those from *Articulate™*, *Rapid Intake™*, and *Adobe* offer the advantage of developing problem-based learning scenarios and interactions that can extend the value of mobile learning efforts beyond content review. The primary challenge with this type of learning content has been collecting scores or evaluating student performance. *Articulate™* is a promising tool in this category, as learning module output is a SCORM-compliant package that will upload to course management systems and exchange assessment data with the grade book. These modules require the use of *Flash™*, so will be useful on a device-specific basis, and notably not supported by *Apple™* products.

There is a strong opinion among learning experts that web delivery is the best option for mobile platforms, using the foundation of HTML5 with mobile style sheets (CSS). All devices, however, must be able to support the rich HTML5 features in a consistent manner before this is a viable option. HTML5 development requires structure and work effort, but the finished product promises better overall accessibility to users with various devices and operating systems. It is unclear whether we can capture scores from these standalone learning tools, or if they will be supported by popular learning systems in the future. *Articulate's* offshoot product called *StoryLine*™ surpasses the original Powerpoint-linked product by generating output as a SCORM package or as HTML5 code for web delivery. The SCORM standard allows packaged content to be linked to a learning management system for assessment collection, while the HTML5 web content offers the advantage of delivering content to a variety of devices via the web but in a standalone mode without captured assessment outcomes. There is still a Flash component in the finished package that the company addressed by releasing a mobile player application.

Responsive Web Design Approach

Since we will rarely have control over the devices our students own and use for class, we need to design learning materials that are "flexible and fluid across multiple screens, intelligent learning, that always points learners to a single URL, and avoids at all cause the need for installing different native apps for different mobile operating systems" (Jacquez, 2015). *Responsive Web Design* (RWD) is a promising approach that produces that kind of flexibility and yields web content that is accessible on multiple platforms with various screen sizes.

RWD is the ultimate example of reusability in support of the mlearning design process. If a single modular course design is usable with variable content throughout the life of a course, we have solved one of the major challenges of mobile learning. It is better yet, if the module can be easily modified for a variety of courses as needed. Anyone with some basic knowledge of style sheets (CSS) can use this method, and, for faculty with a web development background, many open source tools are available to help manage CSS and make it readily reusable. *Media queries*, for example, were introduced to style sheets in CSS3 and allow us to test for device screen size and specify how content will appear. The example in Figure 2 specifies a screen as the target device, and checks for a size of 480 pixels:

```
@media only screen and (max-device-width: 480px) {
        }
```

Figure 2. Media Query Screen Size Check (Tabor, 2016)

The style sheet checks the device screen size and adapts the way the content displays to accommodate any device screen size from desktop to mobile. Developer and author Ethan Marcotte (2010) shares an excellent example of responsive design (http://alistapart.com/d/responsive-web-design/ex/ex-site-mini.html) which shows how cleanly content is rearranged when we resize our browser window from full to mobile size. The well-designed large screen view is reduced in size without content loss, moving to stacked menu items on a mobile screen. Other style code resizes graphics to fit mobile devices using alternative layouts, and changes or resizes type to enhance the reading experience on a small screen.

CSS gets bulky quickly, however, when we add tags to test for multiple device sizes and specify content response, so more experienced web developers use tools to organize and simplify the process. Tabor (2016) addresses using open source tools to build a responsive design model. The following example, written in a community-supported tool called Sass (www.sass-lang.com), tests the device size using self-commenting variables. Considered a pre-processor, Sass creates neat code with easily read variable names and, when processed, creates usable CSS for mobile web pages.

```
$mobileSize: 568px + 10;
$tableMinSize: $mobileSize + 1;
$tableMaxSize: 960px;

iframe#trailer {
  @media screen and (max-width: $mobileSize) {
      width: 300px;
      height:  169px:
  }

 @media screen and (min-width: $tableMinSize) and
    (max-width:  $tableMaxSize) {
      width: 560 px;
      height:  315px;
  }
}
```

Figure 3. Mobile Style Rules Written in Sass (Tabor, 2016)

Some faculty may find this process less than desirable, but might be able to seek university support for their efforts, either with staff coding help or with funds to have a basic reusable design module developed by a professional. In either scenario, testing is a major pre-requisite for all mobile learning designs, via a localhost site, or external sites with simulators used to view device layouts by type and size. Once a mobile learning design is developed and tested, it should remain reusable for content changes as needed.

Conclusion & Future Research on Mobile Learning

Whether we pursue a new learning trend or technology platform, a major concern for educators is that the outcomes include a positive return on time investment for both faculty and students. Having reusable learning content with an acceptable life is critical. For faculty in the IT field, particularly, it is easy to become enamored with new technology, and thus we must be careful to allocate time to worthwhile endeavors. Learning experts emphasize the importance of an organizational plan for mobile learning, which includes a development budget and access to tools and applications to lighten the content conversion load. Add to that a careful consideration of the kind of content and activities that add value and extend learning for the course. Schools that standardize on a single platform and take an enterprise view to mobile learning have better control over content creation and make part of the adoption and development process much easier.

This experiment examined student adoption and use of mobile learning materials and study aids that enhanced engagement and success. General outcomes support the challenges of technology acceptance including *self-efficacy* and *performance expectancy*, and activity theory concepts of *control* and *positive outcomes*.

1. Students indicated the mlearning process did encourage engagement and added value to the course. Using early adopters to sell the platform to their classmates is an important adoption practice and can enhance performance expectancy as shown in Wang et al. (2009).
2. Active users reported better exam performance using mobile study tools, supporting the notion of activity theory (Vygotsky, 1978) and user control leading to a positive change (Sharples et al., 2005).

3. Students tried many of the tools provided to them, but were not willing to use them exclusively for course preparation or exam study; adoption was selective, further supporting the Wang et al. (2009) study results on performance expectancy. Those who couldn't see the ultimate advantage of the medium were less willing adopters.
4. While some students were supportive of trying new methods and indicated they will use mlearning tools when available, others were less interested in using what they considered personal entertainment devices for the learning process.
5. Students may not be as technology savvy as the *GenM* or *digital native* labels imply, as in their own comments they expressed a lack of interest and/or skill set to adopt some technologies; this is an important aspect of successful adoption, and some students will require more training and encouragement to adopt mobile learning methods.

This was a small study and outcomes are clearly subject to sample size bias. Mobile learning options must be further tested to determine a statistically significant evaluation of student adoption, satisfaction, and performance outcomes. More research is also needed to find the most effective content and design for the mobile learning platform. In terms of contribution, this paper also delves into the challenges and easy successes that educators interested in the area of mobile learning can learn from and explore within their discipline.

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Appendix – Survey & Blog Discussion Questions

Pre-Course: Technology Experience Survey

Please answer the following questions about the technology you regularly use:		**Yes**	**No**	
Q1	I have a computer at home			
Q2	I have broadband Internet access at home			
Q3	If you have a fast Internet connection, what is your download speed in Mbps?			
Q4	I have a laptop or netbook computer			
Q5	I have a mobile device that plays audio files (MP3)			
Q6	If you have a mobile audio device, what kind/model?			
Q7	I have a mobile device that plays video files (MP4)			
Q8	If you have a mobile device that plays video, what kind/model?			
Q9	What make and model of mobile phone do you use?			
Q10	Do you have a 3G or better data plan with your phone?			
Q11	Do you have an unlimited texting plan with your phone?			
Q12	Does your phone have a web browser?			
Q13	If yes to above, what operating system is on your phone? (Android, Windows Mobile, IOS, Blackberry, etc)			

		1 none	2 a little	3 some	4 quite a bit	5 a lot
Q14	Please indicate your level of experience with the following technologies: (1=none, 5=a lot)Watching videos on public Internet sites such as YouTube					
Q15	Listening to audio from public sites such as Internet radio.					
Q16	Subscribing and listening to podcasts from any source					
Q17	Subscribing and listening to podcasts from iTunes					
Q18	Subscribing and listening to podcasts from iTunesU (educational materials)					
Q19	Contributing to a wiki					
Q20	Receiving tweets on Twitter					
Q21	Sending your own tweets on your own Twitter account					
Q22	Maintaining your own Facebook page					
Q23	Maintaining your own LinkedIn presence					
Q24	Maintaining your own blog					
Q25	Maintaining your own web site (other than those mentioned already)					
Q26	Doing your own digital audio recording					
Q27	Using any audio editor such as Audacity					
Q28	Doing your own video recording					
Q29	Using any video editor such as Windows Movie Maker					
Q30	Uploading your videos to YouTube or another public site					
Q31	Doing screen recordings with a tool such as Camtasia that adds audio to PowerPoint, or captures screen content					
Q32	In addition to what was asked about already, do you use any other hardware or software to listen to, watch, create, edit, or publish digital audio or video materials? If so, please list what you use and what you use it for.					
Q33	In addition to what was asked about already, do you use any other social networking tools or sites? If so, please list what you use and what you use it for.					
Q34	Do you have a job that involves extensive work with or support of computers or information technologies? If so, please explain what you do.					
Q35	Do you have any other experience with computers or IT you'd like to mention?					

Early Course Blog Post

GenM Definition & Student Thoughts (blog responses)

Question: "Gen M, those born from 1980-99, is alternately defined as the "*millennials*," "*multi-taskers*," "*multisensory*," and, of course, "*mobile*." What do you think of this classification? Is the stereotype of a wired, tech-savvy generation accurate? Are we ready to say that life-long learning is enabled by our mobile devices?"

Mid-Course Surveys

Student Perception of Study Skills

Question: What are your current views of your study skills?	5=high, 1=low				
	5	4	3	2	1
1. When it comes to learning and studying, I am a self-directed learner.					
2. In my studies, I am self-disciplined and find it easy to set aside reading & homework time.					
3. I am able to manage my study time effectively and easily complete assignments on time.					
4. In my studies, I set goals and have a high degree of initiative.					

Expectations for mlearning at the Start of the Course

Question: What expectations did you have about mobile learning at the beginning of this course? 5=high, 1=low					
	5	4	3	2	1
1. mlearning would be useful in my learning process.					
2. Using mlearning would help me accomplish learning activities more quickly.					
3. Using mlearning would increase my learning productivity.					
4. Using mlearning would increase my chances of getting a better grade in class.					
5. It would be easy for me to become skillful at using mlearning					
6. I would find mlearning tools easy to use.					
7. Learning to operate mlearning tools is easy for me.					

End of Course Surveys

Opinions of mlearning after Semester Experience

What is your level of agreement with the following statements about mlearning? 5=high, 1=low					
	5	**4**	**3**	**2**	**1**
1. Mobile learning allows instant access regardless of your location					
2. Mobile learning is useful to supplement to an existing course					
3. Mobile learning is an effective learning aid or assistant for students					
4. Mobile learning allows you to convert any wait (dead) time into productive time					
5. Mobile learning allows convenient access to discussions – anywhere and anytime					
6. Mobile learning that sends information to you via messages (push) may be better than accessed sites (pull)					
7. Mobile learning can be used as a supplemental tool for any existing course					
8. Using mobile learning tools adds value to course learning					

mlearning Impact on Course Interest & Exam Scores

Please respond to the following questions about mlearning activities used in this course. 5=high, 1=low					
	5	4	3	2	1
1. Course mlearning activities increased my interest and engagement in this course?					
2. Course mlearning activities improved my performance on course exams					

Likelihood that Students will Continue Using Mobile Devices for Learning

What do think about using mobile devices for learning going forward? 5=high, 1=low					
	5	**4**	**3**	**2**	**1**
1. I intend to use mlearning in the future.					
2. I predict that I will use mlearning in the future.					
3. If available, I plan to use mlearning in the future.					

Biography

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