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iLearning: The future of higher education? Student perceptions on learning with mobile tablets

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Abstract: The growing use of mobile technology on college campuses suggests the future of the classroom, including learning activities, research, and even student-faculty communications, will rely heavily on mobile technology. Since Fall 2010, an interdisciplinary team of faculty from Indiana University – Purdue University Indianapolis (IUPUI) has experimented with the use of iPads in the classroom. This paper includes the preliminary results of a study on student impressions of mobile technology in the classroom. The paper will report both opportunities and limitations for incorporating mobile technologies in learning environments.

Keywords: Future classroom, faculty/student relationship, learning styles and technology, information and technological literacy, collaborative learning, mobile learning

I. Introduction.

Changes in technology continue to alter possibilities for learning and create new challenges for pedagogy. Over the last two decades, colleges and universities adapted and responded to the Internet, email, chat and instant messaging, course management software, podcasts, personal digital assistants (PDAs), and much more. The growing use of mobile technology at colleges and universities is the most current trend forcing educators to evaluate the merits and limitations of a new technology. A recent EDUCAUSE report revealed a stunning increase in college-age students using mobile technology, such as smart phones: from 1.2% in 2005 to 62.7% in 2010 (Smith & Caruso, 2010). The Pew Internet and American Life Project reports similar trends, particularly among students 18–29-years (Smith, 2010). Further, projections suggest that by 2015 mobile tablets will overtake desktop usage (IDC, 2011) and 80% of all people accessing the Internet will be using a mobile device (Ericsson, 2010). Consequently, mobile technology figures prominently in the future of higher education, particularly in its integration into teaching and learning.

Mobile tablets burst onto the market with the release of the first Apple iPad in March 2010. In the following academic year (2010-2011), an interdisciplinary team of faculty from Indiana University – Purdue University Indianapolis (IUPUI) studied the use of mobile technology for learning using the Apple iPad 1 as part of a Faculty Learning Community (FLC). This FLC explored student perceptions of learning and engagement when iPads were used as a supplemental learning tool in the classroom. The team used iPads for in-class learning activities and assessment, for communication, for research support, and much more. For example, students used concept-mapping applications (apps) to trace connections between communication theories.

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Music students practiced with ear and interval training apps. The accelerometer built into every iPad in tandem with motion graphing apps allowed students to study the physics of human motion. These activities represent only a fraction of the learning activities developed by faculty in this study. This article reports major themes that emerged from student responses to learning with mobile tablets, specifically iPads.

II. What is Mobile Learning?

A. Defining Mobile Learning.

A review of the literature reveals that the definition of mobile learning, especially in higher education, remains unclear and uncertain. To construct a fixed meaning for mobile learning is untenable as mobile learning is the summation of multiple, evolving concepts (El-Hussein & Cronje, 2010). In addition, discourse on new technologies often involves a miscellany of terms and preliminary conclusions that represent a wide range of uses and functions (Guri-Rosenblit, 2005). For example, the keywords *mobile learning, m-learning, hypermedia-assisted learning, ubiquitous computing, mobile instruction technologies, handheld learning* and *e-learning* represent only a sample of terms that variously point towards related functions and concepts (Alexander, 2004; Carver, Howard, & Lane, 1999; Corbell & Valdes-Corbell, 2007; Dearnley et al., 2009; EDUCAUSE, 2006; Guri-Rosenblit, 2005; M. El-Hussein & Cronje, 2010; Traxler, 2007; Vesisenaho et al., 2010; Zywno & Waalen, 2002). Moreover, rapid advances in technology outmode previously constructed definitions and conceptual frameworks.

Definitions that withstand technological innovation are broad in scope and carefully consider the terms *mobility, mobile devices,* and *learning.* This knowledge led El-Hussein & Cronje (2010) to define mobile learning as "any type of learning that takes place in learning environments and spaces that take account of the mobility of technology, mobility of learners, and mobility of learning" (p. 20). Cobcroft, Towers, & Smith (2006) confirm that "mobile technologies are able to support learners' engagement in creative, collaborative, critical, and communicative learning activities" (p. 25). In a subsequent review of the literature, Traxler (2007) makes two suggestions: mobile learning is uniquely placed to support learning that is personalized, authentic, and situated; and the future will find mobile learning facilitating a wide variety of teaching methods. Following these definitions and recognizing that meaning continually evolves, the research team defines mobile learning as *the efficient and effective use of wireless and digital devices and technologies to enhance learners' individual outcomes during participation in learning activities*.

B. Potential of Mobile Learning.

The story of mobile learning is no longer a narrative about devices—iPods, phones, tablets, PDAs, or similar "always connected" wireless machines (Johnson, Smith, Willis, Levine, & Haywood, 2011). A NESTA Futurelab report asserts that learning activities incorporating mobile technology will move further out of the classroom and further into the learner's physical and virtual environments, amplifying learning to be more situated, personal, collaborative and lifelong (Naismith, Lonsdale, Vavoula, & Sharples, 2004). Due to more affordable technology and improving digital networks, many people turn to mobile devices as their first choice for connectivity (Johnson et al., 2011).

Learning with mobile technology allows students, then, to expand discussion and investigation beyond the walls of the classroom. It enables students to collaborate and create knowledge and to interact with a larger range of content. Thus, mobile learning supports a social constructivist view of learning because it enhances students' ability to learn and apply course content in context with other students (Alexander, 2006; Bryant 2006). The FutureLab report mentioned above also found that mobile learning enables students to apply knowledge through "participatory simulations" and "immersive recreation of dynamic systems" (Naismith et al., 2004).

Effectively matching student learning styles to instruction is a proven factor in contributing to academic achievement (Felder & Soloman, 1998; Felder & Spurlin, 2005; Peacock, 2001). Integrating technology into instruction expands possibilities for creating learning activities that engage student's multiple learning styles (Naimie, Siraj, Ahmed Abuzaid, & Shagholi, 2010). Studies using data from the National Survey of Student Engagement (NSSE) found positive correlations between the use of educational technology and student engagement, notably in collaborative learning and student-faculty interaction (Chen, Lambert, & Guidry, 2010; Nelson Laird & Kuh, 2005). Zywno and Waalen (2002) confirm the hypothesis that hypermedia instruction, or instruction using hypertext and multimedia, enhances academic performance in students across learning styles. In particular, classes that combine information and communication technologies with face-to-face traditional learning increase the engagement of students by intersecting learning styles (Cobcroft et al., 2006).

One of the principal features of mobile learning is the flexibility for students to engage in the educational process and material anywhere, any time (Dew, 2010). Mobile technologies address a modern need for convenience, like the option of downloading learning resources in an increasing number of electronic formats (Fallaize, 2010). Growing numbers of students expect the ability to "work, learn, and study whenever and wherever they want" (Johnson et al., 2011, pg. 3); further, students experience frustration when this expectation is not met. Researchers have found that access to information has benefits in many learning and professional contexts. For example, in healthcare, access to information at patients' bedsides not only augments the learning process, but also improves patient care and health outcomes (Farrell & Rose, 2008).

C. Cautions for Mobile Learning.

Even though there have been many reports on the benefits and potential of mobile learning, a number of researchers have found reasons to advise caution on its full adoption. Long has there been an ongoing discussion on the digital divide, the multidimensional phenomenon concerning global, social, and democratic disparities arising from utilitarian integration of and individual access to the Internet, in higher education (Norris, 2001). Some researchers maintain that, while the Internet and digital technologies unequivocally heighten the potential access to higher education, unprepared students and faculty require intensive and steady institutional support (Corbell & Valdes-Corbell, 2007; Guri-Rosenbilt, 2005). Particular to mobile technologies, Common Sense Media exposes an emerging "app gap" wherein lower-income children (ages 0-8) have more than 50% less experience using mobile devices than higher-income children in the same age group (Rideout, Saphir, Tsang, & Bozdech, 2011, p. 10). Only 2% of lower-income children have access to a mobile tablet in the household, compared to 17% of the higher-income group (Rideout et al., 2011, p. 22). Corbell & Valdes Corbell (2007) forewarn that mobile

learning activities could create a sense of isolation in non-technical students who are not familiar with technologies (p. 54).

Beyond the problems of digital and technological divides, Guri-Rosenblit (2005) identifies a concern in the adoption of new technologies: "The problems and questions that the digital technologies assist in solving in teaching/learning practices are blurred and not clearly defined" (p. 18). Though not specifically directed at mobile tablets, this point is easily applicable in consideration of professed "magical" devices claiming to augment traditional computing. Researchers studying the implications of the iPad recommended the study of students' perceptions of the mobile tablet for teaching and learning (Bansavich, 2011). Wang, Wiesemes, and Gibbons (2012) report that problems with the size of mobile devices and failures of wireless Internet (Wi-Fi) connectivity cause frustration and disappointment in students (p. 573-74). Thus, these cautions articulate the need for inquiry into student learning and engagement with the use of mobile tablets in the classroom.

In recent studies of student perceptions on the integration of emerging technology into classroom instruction, students generally report positive experiences with the technology; however, findings also reveal that instructional design and comfort with technology are significant factors (Armstrong, 2011; de Winter, Winterbottom, & Wilson, 2010; Enriquez, 2010; Shuler, Hutchins, & LaShell, 2010; Yang & Lin, 2010). Students have attributed negative qualities to instructional technology due to ineffective implementation in classrooms and learning activities (Armstrong, 2011, p. 224). Concluding that a significant amount of the potential for success in using new technology is dependent upon the instructor, the literature suggests that support for instructors is vital. A study on the perceptions of students and teachers on the affordances of new technology found that supporting teachers in integrating technology into teaching can contribute to useful pedagogical outcomes (de Winter et al., 2010). Further, researchers found that new technologies (wikis, digital video, podcasts, PDAs, game consoles, and tablet computers) can support social construction of learning, assessment, motivation, differentiation and personalization of, and engagement in learning for students (de Winter et al., 2010; Enriquez, 2010). Students have also reported activities using tablet computers in class foster productive collaborative learning and improve interactions with peers and instructors (Shuler et al., 2010). Similar studies of student perceptions of learning with mobile devices and tablet computers call for research in multiple courses and across multiple sections for a larger sample (Enriquez, 2010; Yang & Lin, 2010).

III. Purpose and Methodology.

The purpose of this study is to explore student perceptions of learning and engagement that occurs as a result of using iPads in the classroom. This methods section is organized in four key areas: (a) arrangement for conducting the study, (b) selection of subjects, (c) instrument design, and (d) treatment of the data.

A. Arrangement for Conducting the Study.

This study was conducted at Indiana University – Purdue University Indianapolis (IUPUI), an urban institution with an annual enrollment of approximately 30,000 undergraduate, graduate, and professional students seeking degrees from Indiana University (IU) and Purdue University (PU) programs. In June 2010, IUPUI's Center for Teaching and Learning and University

Information Technology Services issued a call for applications to create a Faculty Learning Community (FLC) to explore the use and implications of iPads in technology-enhanced pedagogy. Interested instructors submitted proposals detailing how iPads could help achieve course learning outcomes and increase student engagement. Out of nearly sixty applicants, eight IUPUI faculty members were selected for the 2010-2011 FLC on Mobile Tablets. Faculty members met biweekly during the Fall 2010 pilot and the Spring 2011 study to share observations, reflect on their classroom experiences with the iPads, and to design this study. Seven of the eight instructors in Music, Communication Studies, Tourism Management, Physical Education, English, Organizational Leadership and Supervision, and Library Science participated in the research study to measure students' perceptions of iPad usage.

Prior to an iPad activity, class instructors requested specific apps to be installed on the iPads and designed iPad activities that promoted active learning, collaboration, and/or student engagement. At the beginning of each activity, individual students or small groups of students were loaned an iPad to use for the class period. If required, the instructor gave instructions for connecting the iPad to the Internet and setting up email. Many times students were free to move about the room and/or pass the iPads around to view others' work. Following the activity, the students submitted their work to the instructor through email or a file sharing application such as Dropbox. The iPads were then collected by the instructor and given back to the technology administrator who would reset the iPads removing all student work and login information, and prepare the iPads for use in the next class. Over the course of the semester, the number of exposures the students had to the iPads ranged from 1 to 7 times depending on the class in which they were enrolled (Table 1).

B. Selection of Subjects.

In total, 209 IUPUI students participated in the study. This was a convenience sample, as the students who participated in the study were in the classes of the instructors in the FLC cohort. All students in the selected courses were eligible for participation in this study, but participation was voluntary and anonymous. Students' participation had no bearing on their status in the course and did not affect their grade in any way. All data collection and analysis procedures were performed in accordance with the Institutional Review Board of Indiana University.

C. Instrument Design.

Students were asked to complete a survey with both Likert-scale and open-ended responses after the final class session in which iPads were used for a learning activity. This concurrent mixed method approach allowed for the collection of both qualitative and quantitative data. The instrument was reviewed by the entire FLC, which represented expertise in mixed methods survey design. The intent of the review was to verify that the questions compiled in the survey were understandable and clear, were sequenced in a logical format, and avoided leading statements, closed-ended questions, and ambiguity. The complete survey is provided at the end of the study (see Appendix A).

Table 1. Discipline-Specific iPad Use.

School/ Department	Course(s)	Activities	Number of Class Sessions with iPads
Tourism Management	Global Tourism Seminar; Mechanics of Meeting Planning	Evaluate tourism applications; view virtual venue tours, select meeting sites, design meeting rooms, plan menus, and create staffing grids.	3
Organizational Leadership and Supervision	Leadership for a Global Workforce	Create and access open source learning modules.	1
Music	Musicianship 2; Musicianship 4	Train musicians to measure intervals and hear the differences between two notes sounding together or in part.	3
Communication Studies	Introduction to Communication Theory	Demonstrate connections between communication theory and real-life scenarios with mapping applications; explore news apps and websites.	7
English	Communication Skills for International Teaching Assistants; English for Academic Purposes II	Provide active learning experiences for international students studying English for Academic Purposes.	2 and 4, respectively
Physical Education	Biomechanics	Measure human movement using the iPads' native accelerometers and video analysis apps.	7
University Library	Computer Methods for Journalism	Improve academic honesty by teaching when and how to cite another's work.	1

This study focuses primarily on rich, thick descriptive data collected in the four open-ended questions of the survey:

1. Describe how the iPad activity helped or limited your learning of the class content.
2. Describe at least two things you liked about using iPads in this class.
3. Describe at least two things you disliked about using iPads in this class.
4. Do you have any suggestions for other ways to use the iPads in learning class content?

This study also includes a sample of the quantitative data from twelve Likert-scale survey questions used by all researchers (eight optional questions have been omitted from this data set because they were not included in every survey). The twelve Likert-scale questions are included in Table 2.

Table 2. Likert-scale Survey Questions (5 point scale: Strongly Disagree to Strongly Agree).

Select how strongly you agree or disagree with the following statements.
1. The iPad activity helped me apply course content to solve problems.
2. The iPad activity helped me learn the course content.
3. The iPad activity helped me connect ideas in new ways.
4. The iPad activity helped me participate in the course activity in ways that enhanced my learning.
5. The iPad activity helped me develop confidence in the subject area.
6. The iPad activity helped me develop skills that apply to my academic career and/or professional life.
7. The iPad activities motivated me to learn the course material more than class activities that did not use the iPad.
8. I participated more in class during the iPad activities than during activities that did not use the iPad.
9. My attention to the task(s) was greater using the iPad.
10. The iPad was more convenient compared to a desktop or laptop computer.
11. It was easier to work in a group using the iPad than in other group activities.
12. iPad activities are an important supplement to this class.

D. Treatment of the Data.

The quantitative analysis of the data was conducted using Statistical Package for Social Sciences (SPSS). Frequencies, mean scores, and standard deviations were initially computed and a variety of descriptive statistics was utilized to determine the sample characteristics. Survey responses were manually scored (Strongly Agree = 5, Agree = 4, Neutral = 3, Disagree = 2, Strongly Disagree = 1) and entered into a SPSS database.

Student responses to the open-ended questions were compiled and recorded in an Excel spreadsheet. Following Creswell's (2003) description of several strategies encouraged to ensure the qualitative study's rigor and credibility, two investigators reviewed the open-ended responses independently and generated a preliminary coding rubric to categorize recurring themes in the data. The two researchers then met to discuss negative or discrepant information, to clarify any researcher bias, and modify the themes. Using member-checking strategy, the other FLC

researchers reviewed the preliminary common themes and the research team used triangulation to finalize the theme results, including current and past studies conducted on student perceptions toward technology use and other research reports.

IV. Findings.

Surveys were collected from 209 students in 9 courses. The researchers collected demographic information for gender and age. Table 3 displays the demographic information and Table 4 displays the distribution by course.

Table 3. Demographic Information.

Gender		**Age**	
Male	107 (51.2%)	18-28	173 (82.8%)
Female	91 (43.5%)	29-44	26 (12.4%)
Did not identify	11 (5.3%)	Did not identify	10 (4.8%)

Table 4. Number of Students by Course.

Course	**Number of Student Responses**	**Percent**
Introduction to Communication Theory	36	17.2
English for Academic Purposes	55	26.3
Communication Skills for International Teaching Assistants	18	8.6
Biomechanics	32	15.3
Computer Methods of Journalism	23	11.0
Musicianship 2	9	4.3
Musicianship 4	11	5.3
Leadership for a Global Workforce	10	4.8
Global Tourism Seminar: Mechanics of Meeting Planning	15	7.2
Total	**209**	**100.0**

A. Quantitative Data.

The twelve Likert-scale survey questions were categorized into questions about student perceptions on learning (Table 5) and student perceptions on engagement (Table 6). The variance in *n* is a result of incomplete surveys where a respondent skipped a question.

Table 5. Survey Questions on Perceived Learning.

Question	*n* =	*m* =	*sd* =
1. The iPad activity helped me apply course content to solve problems.	205	4.092	0.8
2. The iPad activity helped me learn the course content.	204	4.044	0.818
3. The iPad activity helped me connect ideas in new ways.	204	4.343	0.792
4. The iPad activity helped me participate in the course activity in ways that enhanced my learning.	207	4.188	0.809
5. The iPad activity helped me develop confidence in the subject area.	208	3.923	0.89
6. The iPad activity helped me develop skills that apply to my academic career and/or professional life.	205	4.044	0.851

Table 6. Survey Questions on Perceived Engagement.

Question	*n* =	*m* =	*sd* =
7. The iPad activities motivated me to learn the course material more than class activities that did not use the iPad.	209	3.612	.851
8. I participated more in class during the iPad activities than during activities that did not use the iPad.	208	3.505	1.148
9. My attention to the task(s) was greater using the iPad.	207	3.657	1.087
10. The iPad was more convenient compared to a desktop or laptop computer.	207	3.942	1.119
11. It was easier to work in a group using the iPad than in other group activities.	209	3.789	1.1
12. iPad activities are an important supplement to this class.	207	3.802	0.945

When calculating the averages for the perceived learning and perceived engagement variables, any case with a missing value for a question was not included in the calculation. This left 192 and 206 usable responses for perceived learning and perceived engagement respectively. Figure 1 shows the distribution of means for the aggregated perceived learning and perceived engagement variables.

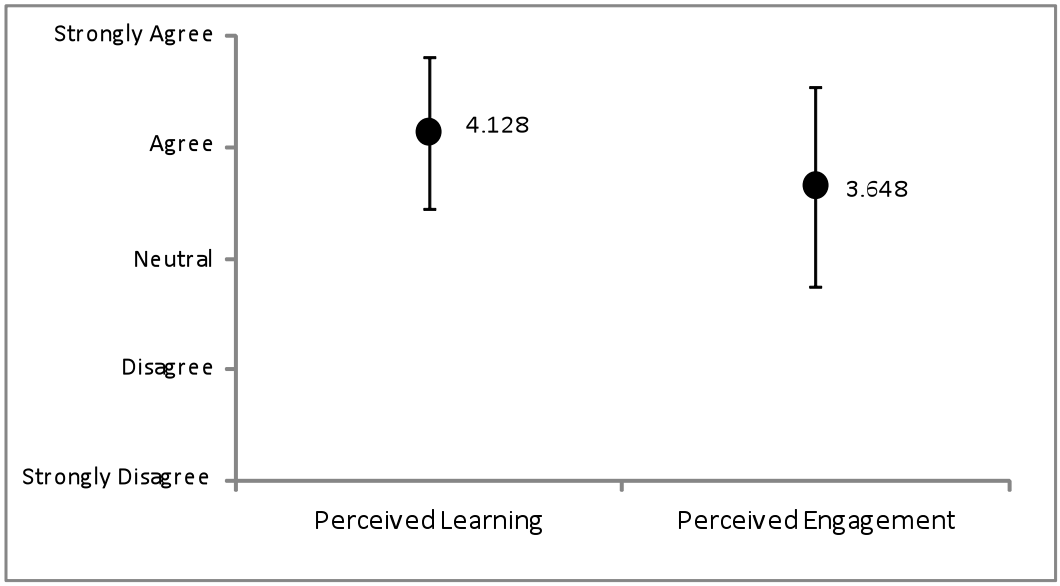

Figure 1. Distributions of Mean Perceived Learning and Engagement.

B. Qualitative Data.

The investigators identified five major themes in student responses to the open-ended questions. Each theme featured both opportunities and limitations for the use of mobile technology in the classroom (Table 7). The themes include: 1) access and availability of information, 2) sharing and collaboration, 3) novelty, 4) learning styles and preferences, and 5) convenience and functionality. This section uses evidence from student responses to illustrate and support the limitations and opportunities for each theme.

Access and Availability of Information. In many activities, students were required to use the Internet browser or tools such as the IUPUI University Library mobile web site to locate resources and find information. Student responses prominently featured both positive and negative attitudes towards the impressive availability of information that mobile technology affords. One student reported, "We can find information online in class and share with one another." Another student wrote, "By having the Internet readily available I was not limited to the textbook." Students responded positively to the ability to expand their search for and discussion of knowledge beyond the walls of the classroom by "find[ing] examples that were relevant to class topics on the web." A journalism student using the library's mobile website to access databases felt that "it was easier to stumble upon new/various information." Rapid access to information was particularly valuable in courses that relied on online course management tools (i.e. Blackboard, Angel). The "resources were right there in class" when faculty referenced specific course documents online. Another student wrote, "All the tools you need [to learn] are right there and customizable to your needs."

Table 7. Opportunities and Limitations of Mobile Learning (Summary).

Theme	Opportunities	Limitations
Access and Availability of Information	Research Real world problem solving	Distraction Undeveloped information literacy
Sharing and Collaboration	Collaborative learning and group work	No ownership of technology/shared resource
Novelty	New learning tool Dynamic learning environment	Lack of training Rapidly "outdated" technology Orientation to technology distracts from traditional learning time
Learning Styles and Technology Design	Design elements include more learning styles (tactile, kinesthetic, visual, auditory)	Design elements negatively impact learning (keyboard, size, app availability)
Convenience and Usability	Ease of use Intuitive design Variety of apps	Connectivity troubles paralyze learning Unstable/unreliable applications impact learning

Students also reported downsides to easy information access and availability. Perhaps the biggest limitation relates to students' ability to access popular distractions: social networking, email, and games. Many students admitted to checking "email and Facebook rather than participating because it was easier to hide." Others found themselves wanting to "play with the apps or search the web rather than focus on course material." The iPad "limited [one student] from learning because [the student] got distracted by all of the apps." Another simply "lost attention after a while." Students found it "hard to have discussion when attention was focused on the iPad" and students reported difficulty listening to the professor while exploring iPad apps.

Sharing and Collaboration. Student responses indicated that mobile technology supports collaborative learning environments in which students are expected to discuss concepts, debate questions, and build knowledge together. Students noted how iPads promoted greater interaction and sharing during in-class activities and discussions. For example, one student reported, "I feel like I got more involved with class discussion and group discussion when using iPads rather than just lecturing." Another wrote, "The iPad gave me a chance to connect concepts and ideas quickly and efficiently with my peers." Students remarked specifically on the advantages for group work. For example, the iPad helped "because it encourages active input from groups." One student summed up the benefits of mobile tablets for collaborative learning: "It helped me because everyone in my group could work separately but together at the same time."

One of the most significant drawbacks of mobile technology in this study is that the iPads were a shared resource. The researchers had access to 40 iPads, which could only be used in class and in some cases the iPads had to be shared among students. Students reported that "it was hard to look at the screen with a group of people" and "it was harder to see what the other people

in my class were doing compared to a regular desktop." One student claimed "working in groups is difficult." Another noted, "We have to share. We should have one for each person."

Novelty. Students reported enthusiasm for the novelty of mobile learning. The iPad "brings in a new style." The devices provide "something different and make class more interesting." They offer "a nice change of pace to the normal routine." One student described the mobile learning activities as a "fresh" way to learn. Another called the iPads "fun, exciting, easy, [and] futuristic." In fact, many students used the words "fun" and "interesting" when describing their experience with the iPads, indicating a favorable experience with mobile learning. One response summarizes the general sentiment about the novelty of mobile learning: "It's nice to switch things up, and using the iPads was a 'fun' way to learn something that's useful towards our degree." Students also reported their enthusiasm for "getting familiar with newer technology" and "emerging technology." A student appreciated the ability to "use new technology [they] don't have" and another celebrated the opportunity to use "something new that I wouldn't get the chance to do anywhere else." Students reported a value in the "opportunity to engage the tech of the future." As one student claimed, "We live in the technology age so using technology is important to help develop proficiency." In addition, during the time these surveys were administrated the iPad 2 was being introduced to the market. Illustrating the excitement over new technology, some students noted that "the newest generation would be cooler" and commented on when and if they would test the updated version of the mobile technology.

Despite the enthusiasm for these new devices, the novelty of the iPads proved detrimental to some students' classroom experience. Students said that the device was "confusing at first" and that they were "not familiar with using [the iPad]." Some students expressed frustration with a technological learning curve. For example: "Understanding of how to use the iPad was a barrier," and "I felt as though I spent more time figuring out how to use [the iPad and different apps] than I did concentrating on the lesson." Another student "spent more time trying to use the iPad than being productive." Students disliked that the set-up of the iPads seemed to take "more time to prepare for class to start" and that once set-up, they still required "class time to practice." Students reported a need for more instruction on the device before "jumping right in." This instruction and set-up time "took away from … class learning."

Learning Styles. Students reported that mobile technology offered a change from more standard lecture and discussion-based activities in college classrooms. The devices "helped solidify the things we learned in class, and helped give us an alternative method of practicing those ideas and concepts." The devices also proved valuable for students who needed different learning paces. One student reported that "the iPad helped in learning by going at the pace of the user. This helped [the student] focus on specifics." A total of 117 students reported a specific way the iPad suited their learning styles, preferences, and speeds. For example, one student reported that the "iPad helped my learning by keeping me involved with the learning because instead of sitting and listening I was actually involved and getting hands on experience." This tactile learning enhanced the material for many students: "You do it yourself, so it's hands on, but it's also visual that you learn it well."

Despite the overwhelming benefits, some students' reported that the iPads hindered their ability to learn. Elements of the iPads' design caused some barriers to learning. The most often cited frustration was the touchscreen keyboard, which caused typing troubles for many students. The keyboard elicited unfavorable comparisons to other note-taking methods: "I am faster at writing notes on paper than with an iPad" and "[t]akes a little longer to type than a [standard] keyboard." Students also had trouble with the touchscreen feature in general. Some students

were frustrated by the touch screen sensitivity and accuracy, which hindered their ability to engage a lesson or activity. Only two students seemed to reject the iPad as a learning tool outright. The most strident rejection of the technology came from a student in a class where iPads were incorporated only once: "Very limited; No need, no keyboard – The iPad is a toy and has no place."

Convenience and Usability. Mobile technology is touted for its intuitive use and convenient portability. Although students reported a slight learning curve, many students quickly recognized the convenience and ease-of-use for the iPads such as the student who said simply: "Helped by the technology and it was easy to use!" Students noted the following features of mobile technology as contributing factors to its convenience in a learning environment: speed, portability, intuitive functions and navigation, comfortable design, and small size. According to one student, "The iPad is a quick resource for students to use in the classroom. It creates a more productive class meeting." Students also juxtaposed the iPad's convenience to more familiar computer technology. For example, one student appreciated the ability "to move around as opposed to being stuck at a desktop." Another found it more convenient "than carrying my laptop with me." The following response linked the convenient functioning of the iPad with activities that directly complement learning: "It was convenient and fun. It was nice having something up to date to work with and have work properly. It kept my attention and allowed me to see things in real activities. The portability of them made it easier to discuss with the professor."

Although convenience was a strong theme in the responses, one major inconvenience garnered more criticism than any other feature of the iPads: connectivity. The majority of students commented on "slow connections," "internet issues," "problems staying online," and other variations on this theme that clearly signaled how vital high speed Internet access is for the utility of these devices. Another inconvenience is the stability and design of applications. One student noted, "Some of the example [applications] were buggy and ineffective." Another observed, "Apps can be unstable." Students also criticized the functionality of some applications: "The apps are somewhat limited;" "Some apps had mistakes;" and "The controls on some apps were not intuitive." Between connectivity concerns and application bugs, students disliked the "time wasted when the iPad wasn't working properly."

V. Discussion.

Amidst the release of mobile tablets such as the iPad 1 and iPad 2 and the rapidly growing market for such devices, this study attends to the limitations and opportunities of mobile tablets for learning in college classrooms. Heavy focus on the physical operation of particular mobile devices has undermined previous understanding on the topic of mobile learning. Recent reviews of mobile devices in education highlight the need "to understand and embrace the changes in learners, teachers and institutions in concert with associated [information and communication technology] advances, whilst acknowledging the risks" (Cobcroft et al., 2006, p. 21). In other words, research on mobile learning must "describe in detail the various advantages and disadvantages of mobile instructional devices as tools for the delivery of higher education" (El-Hussein & Cronje, 2010 p. 20). Thus, this research follows the call to consider learners' experiences with mobile technologies in education and it investigates how mobile learning can be used to make a unique contribution to the advancement of higher education and learning (El-Hussein & Cronje, 2010; Traxler, 2007).

A. Amplifying Advantages of Mobile Technology.

Through the last decade, students increasingly benefit from online courses and content delivery, podcast lectures, educational apps on mobile tablets, and collaborative activities through social networking platforms, all of which allow students incredible freedom over when and how to pursue the learning process. More than any previous mobile learning technology, tablets provide students immediate and far-reaching access to information, course resources, and real world application of knowledge. More important, students perceive this access as beneficial to their learning. The three strongest perceptions in the findings were "The iPad activity helped me connect ideas in new ways" (m = 4.343, sd = 0.792), "The iPad activity helped me participate in the course activity in ways that enhanced my learning" (m = 4.188, sd = 0.809), and "The iPad activity helped me apply course content to solve problems" (m = 4.092, sd = 0.8). The qualitative data corroborated these findings, particularly student responses in the themes of novelty, information access, collaboration, and learning styles.

First, new technology often evokes feelings of both excitement and anxiety from students and faculty, and the iPads proved no different. Student responses indicated that the novelty of the iPads contributed positively to learning: the "fun" experience resulted in better student learning and engagement. One student explained, "During the whole semester, I paid more attention in class while using iPads than when I wasn't using [them]." Students responded that the iPad "motivates me to learn the class content" and "made me want to come to class." In addition, they said that the mobile learning activities "kept my attention" and "kept me involved." Another student claimed that the favorable and novel experience of iPad learning activities "helped to improve my skills instead of the usual routine."

Second, students reported that the immediate access to information enhanced in-class discussion because they could easily search for information to share with small groups or the class: "We can find information online in class and share with one another." The growing number of mobile websites and databases further facilitate the ease with which students can "find examples that were relevant to class topics" and "stumble upon new/various information." Information accessibility augments the ability to connect classroom concepts to real-world applications. Students noted that the iPads allowed them to "apply what [the class was] learning and see it demonstrated in a different way than just lecture." For example, a biomechanics student who used the iPad's accelerometer to graph different patterns of human motion believed that mobile technology "helped link examples and apply information [from class] to real movements." Likewise an English as a Second Language student benefited from applications that allowed the student "to describe places and give directions using a map." Wide-ranging information access also streamlined the learning process. For instance in the music theory course, iPads singularly satisfied a learning process that requires the ability to play a piano keyboard, practice interval and pitch recognition, access sheet music, record and playback music, and assess accuracy through quick tests. Thus, This study's findings support the literature that suggests today's students desire and benefit from "flexibility and ubiquity, that is, 'anywhere, anytime, and any device' learner engagement" (Cobcroft et al., 2006, p. 21).

In order to maximize the benefits of "anywhere, anytime" information access, instructors must carefully orchestrate and manage in-class activities. As previously cited, instructional design and the implementation of technology chiefly affects student perceptions of learning (Armstrong, 2011, p. 224). To be sure, mobile technology provides seemingly boundless access to information, but "information differs significantly from knowledge," and "[o]nly expert

teachers and professionals can guide novices to construct meaningful and relevant knowledge (particularly at the undergraduate level)" (Guri-Rosenblit, 2005, p. 16). Therefore, when students gain access to vast amounts of information, educators must provide direction and aid lest students become lost or overwhelmed. It is vital for educators to carefully test and curate reliable resources and to evaluate the validity of the information available within any given application. Educators must cultivate mobile information literacy in students so that they might make better evaluations and judgments when accessing information on their own. Furthermore, without innovative activity design, mobile tablets may simply repackage old content and mimic ineffective learning approaches (Corbell & Valdes-Corbell, 2007). In order to maximize the benefit of mobile tablets, educators must carefully adapt the technology to specific learning goals and outcomes.

Third, it appears that one way to capitalize on information access for learning is to maximize the collaborative potential of mobile tablets. iPads are suited for collaborative learning because the devices allow for easy viewing and sharing of online resources, and they encourage interaction between group members. Using iPads as the mobile device, this research follows up on criticisms of mobile devices for their small screens and potential for collaboration with shared digital displays (Yang & Lin, 2010). The 9.7 in (250 mm) diagonal screen size and portability of mobile tablets make them ideal for small group discussions and interactions. They are as easily shared among students as a paper notebook or textbook and are less cumbersome than sharing a laptop. If students are grouped around desks or a table, they do not have larger devices creating physical barriers among them. They also have enough space for other class materials, as needed. More important, mobile technologies can be synchronized to one another through wireless networks. They offer the ability for students to collaborate across devices on a single project through a shared screen.

iPads also promote a collaborative learning environment due to the proliferation of mobile apps programmed for cooperative use. Faculty members on the research team found many applications that capitalized on the collaborative potential of the iPad design, and the number of applications that support collaborative learning and shared knowledge creation continues to grow. For example, classes in Communication Studies and English as a Second Language used Popplet, a concept mapping application for both web and iPad. Students created a concept map that was saved online and then invited other iPad (or web) users to contribute to the map. When users wirelessly connected several iPads to collaborate on the same map, they could all share a digital board and update the creation in real time. Together, access to information and the collaborative potential of mobile devices enable educators to maximize learning that intentionally connects educational content to real-world application.

Paradoxically, the collaborative benefit of mobile technologies is enhanced by individual ownership. Our research suggests that the benefits of collaboration and information access are diminished when students do not have access to individual devices or when they do not own the devices. In some cases multiple faculty conducted iPad activities on the same day, which resulted in fewer iPads per classroom, and consequently, students often shared devices in a classroom. In some cases, this limitation highlighted the importance of mobile technology design for collaborative learning. In other cases, the lack of ownership proved frustrating for students. Students established stronger group connections and reported stronger collaborative learning when each person had control over a mobile device. Given the trend toward mobile technology use, faculty must continue to discover the advantages and applications of mobile devices for collaborative learning activities.

Fourth, mobile technology appears to be versatile and highly adaptable for many learning styles and preferences. Mobile technology offered a change from more standard lecture and discussion-based activities in college classrooms. Students predominantly agreed that the iPads helped them "participate in the course activity in ways that enhanced" learning (m = 4.188, sd = 0.809). In order to maximize this potential, faculty must carefully design lesson plans and select applications that appeal to multiple styles of learning and that allow new and varied styles of content delivery. These multi-modal activities may be strengthened when assigned to groups because the use of iPads complements both the collaborative nature of group work and the multiple learning styles that may be present in a given group. For example, when using the iPads, students can access visual material such as videos or photographs online and then incorporate these materials into notes or charts using apps in an activity that appeals to tactile, visual, and auditory learners.

Students identified unique visual learning opportunities afforded by activities using the mobile tablet. The blend of lecture, discussion, and visual content on the iPad helped the following student connect to English language content in a course for non-native English speakers: "The first thing, it helped me to motivate to listen the class content. I believe visual things help students to learn better, if they use it individually." Another language learning example is applications like multi-sided "flashcards" that include words, pictures, and sounds. Likewise, students studying the physics of human motion benefitted from the visual display of acceleration and movement using the iPads accelerometer: "Being able to see the graphs that correspond with velocities, forces, heights, etc. helped me to understand the concepts rather than just imagining what would happen." Another student reported, "[the] iPad kept me involved to where I was learning and getting visual representation at the same time."

Mobile technology benefited aural learners most obviously in the music classroom. One student reported, "Working with the iPad helped my aural skills in terms of identifying intervals and chords. Practicing on the iPad was more efficient than practicing as a class." In a class where some students may take longer than others to learn pitches and intervals, there are clear benefits to a mobile device with sound and headphones that allows in-class, between-class, and at-home practice with immediate feedback. A music student included in the study explained that an ear training application proved beneficial because "you can move at your own pace, so if you need to drill something over and over, you can do that without holding up the class." Another music student wrote, "It helped because it made repetition so easy within the musical apps. It also helps because it randomizes the questions for you, something you can't do by yourself." The application of the mobile tablet in music classes allowed for a unique blend of individual practice and classroom interaction that suited for the needs of the learning environment.

B. Mitigating the Limitations of Mobile Technology.

Corbell and Valdes-Corbell (2007) warn that mobile learning may offer advantages for tech-savvy learners; yet, they also present challenging learning curves for non-technical students (p. 54). This study both supports and challenges this observation. Despite survey data that indicated most students agreed that an "iPad was more convenient compared to a desktop or laptop computer" (m = 3.942), this prompt also featured the second largest variance (sd = 1.119) and some students expressed discontent with the time taken for learning the new devices. These findings challenge literature that suggests tech-savvy, "millennial generation" students possess advanced "digital literacy" or an "information technology mindset" (McMahon & Pospisil, 2005;

Oblinger, 2003; Oblinger, 2004). While students may have proficiency with a specific technology or function such as playing music or chatting via smart phones, students do not always possess the refined critical thinking skills that would allow them to adapt this knowledge to other devices and uses.

Educators must continually gauge students' level of knowledge and comfort with new information and communication technologies, and they must not assume that students are prepared for new technologies. This study found that it is essential to devote some classroom time to allow students to acclimate to the devices. In order to enhance students' feeling that mobile technologies are "easy to use" the study team incorporated 10-15 minutes of "play time" in any class using new mobile technologies for the first time. Allocating time for students to experiment with the devices, navigate to different applications, and help one another with interface questions appeared to mitigate frustrations with the learning curve. This small block of time for self-teaching and peer-assistance significantly decreased the number of questions and distractions related to functionality and appeared to improve the students' perception of convenience. In addition, the frequency of classroom use became an important factor in students' response to the devices. Students who used the iPads only once or twice during the semester struggled more than those who used them regularly throughout the semester. In order for the experience to be positive and productive, students needed to feel comfortable with the iPad and the applications. The potential disparity in technological acumen, however, provides an opportunity for student empowerment and encouragement. Faculty can rely on tech savvy students as peer educators. Inviting these students to help orient their peers and permitting them to share knowledge about mobile devices with other students may inspire higher engagement and confidence. In the long run, this learning curve could also prove to be an added value to a student's education, rather than a detriment.

Although the novelty of the iPads initially appeared to be an opportunity for enhancing student excitement and engagement, this feature quickly became a limitation without clear activity design. In classes where students used the iPads without a clear purpose, the devices became more distracting than "fun". Therefore, it is essential that educators design activities with clear instructions and student roles. Unstructured learning activities create idle time that allows students to lose focus and explore games or other interests on the Internet. These distractions impacted both group discussion and lectures. In this way information access becomes a detriment to learning when students become too consumed with the learning tool. When the balance of attention shifted heavily toward the iPad and away from classmates and professors, students reported diminished learning. Instructors should set "rules" for iPad classroom use and manage the students' engagement with the devices. This may mean that the instructor needs to move around the room answering questions, monitoring student activities, and requiring students to close iPads when not using the devices for class work.

Although "convenience" emerged as a strong theme that supported iPads in the classroom, many students reported trouble with the keyboard and typing interface. This discrepancy could be due to the types of activities students were asked to complete in different courses. In classroom activities that required more text input, the sense of convenience may have diminished while the frustration over the use interface increased. However, in classes that used mobile technology for Internet searches or that used activity-specific applications, such as ear training for music or physics graphing tools in human motion, the sense of convenience may have increased. This study's preliminary findings suggest that faculty should be attentive to avoid activities that require large amounts of typing. Until the typing interface improves or until

more students are familiar with the dexterity required for touchscreen typing, the mobile technology is best served for activities that require limited text-input and typing.

The largest impediments to learning and strongest challenge to the "convenience" of the devices appeared to be wireless connectivity and the stability or reliability of applications. This reaffirms the earlier observation that failure of Wi-Fi leads to disenchantment with mobile devices, as applications using Wi-Fi often have the potential of being the most useful (Wang, Wiesemes & Gibbons, 2012 p. 573-74). These recurring critiques in student responses only bolster our previous observations about the learning benefits of mobile technology including the importance of collaboration, the ability to sync devices, and the quick access to information: when connectivity troubles prevent these outcomes, the devices severely hamper the learning process and detract from the classroom environment. While this downside to mobile technology is largely outside of faculty control, administration at an institutional level must insure that they are making plans to improve the wireless infrastructure of their university, particularly in classroom spaces. As mobile technology continues to grow and develop, colleges and universities cannot be caught with a wireless infrastructure incapable of handling the demand for connectivity. For their part, educators should ensure that their classroom spaces receive strong Wi-Fi signals or they should avoid activities relying on heavy Internet access. Furthermore, faculty who rely on available apps to craft educational activities will find that some applications crash or become unstable with heavy use. Many applications must be purchased for US$0.99 to US$14.99 or more. If students have their own mobile devices, faculty must weigh the benefits (and ethics) of requiring students to purchase applications that may not prove valuable beyond the scope of a given assignment or class activity.

VI. Conclusion.

New technologies develop rapidly; the pace only appears to be quickening. Guri-Rosenblit (2005) observes that our human capacity to respond to and adapt to the pace of new technologies is significantly slower and more limited. Therefore, educators using iPads or other mobile devices in the classroom must be committed to learning how to use devices effectively in classroom instruction and to working through the learning curve associated with new technology. Toward that end, this study offers preliminary findings and observations on the use of mobile tablets (specifically iPads) in the classroom as well as student perceptions of the learning environment and their engagement when these devices are introduced to the classroom. The interdisciplinary nature of the research team work and the multiple uses of mobile tablets across different teaching styles, subject matter, student profiles, and more lends strength to the observations in this study. They are not isolated case studies tied only to one classroom, but broader observations and visions for the implementation of mobile learning. However, several factors limit the observations in this study.

First, this study is limited by the exclusive use of the Apple iPad 1. While the study team believes the observations and findings regarding mobile tablets are applicable to the rapidly growing number of devices on the market, additional research that moves beyond branded technologies is necessary. Second, as this study used convenience sampling, the extent to which results can be generalized may be limited by the nature of the population and the unique setting. For future studies, researchers should consider a random sampling method or replicating this study in an alternative setting to increase external validity. Third, this study did not include ownership of mobile tablets. Guri-Rosenblit (2005) notes the paradox that complex information

and communication technologies with extensive functions and uses are mostly employed as "add-ons" in a traditional classroom. Indeed this study typifies this paradox. Because the learning activities in this study were almost wholly classroom based and mainly limited to individual class settings, students did not have opportunities to pursue more complex activities or use the devices in their own time. As discussed above, ownership of the technology appears to be a key factor in how well students learn and use the learning tool. The literature suggests that mobile learners desire the ability and flexibility to choose their location and time for learning (Cobcroft et al., 2006). Greater access to personal mobile tablets might allow learners greater opportunities to collaborate with others and construct knowledge in real world experiences in their daily lives. Some smaller, private institutions have provided iPads or other mobile devices to incoming students in the past two years (Johnson et al., 2011). An iPad for every student is not practical for many schools, particularly universities with large enrollments or state funded schools facing substantial budget cuts.

Mobile tablets entered the market in 2010; thus, the research into mobile tablets is only beginning. The limitations of this study point toward future research possibilities. Future work should study the learning habits and practices of students who own mobile tablets and have incorporated these tablets as their primary resource for learning. Focusing on such "power users" may reveal greater insights as to the possibilities for educational use. In addition, although the interdisciplinary nature of this study is a strength for a broad overview of mobile tablets in the classroom, future research should isolate specific uses of mobile tablets. For example, how do students respond to e-texts on mobile devices? Do students learning a second language benefit from using translation applications or using mobile tablets for auditory, oral, and writing practice? Since mobile tablets may not suit every learning style or every content area, additional research is needed that might isolate disciplinary strengths and weaknesses.

This study is also limited to student perceptions of learning and engagement. The interdisciplinary nature of this study made assessing student learning outcomes difficult due to the varied expectations and learning outcome measures from the arts and humanities to the hard sciences. Therefore, future research should include discipline specific studies that measure how mobile technology effects specific learning outcomes. For example, would using an iPad to research a public speaking topic, to watch and discuss public speaking examples in class, and to collaborate on public speaking outlines result in better speech performance or deeper understanding of public speaking skills? Or do music applications designed to practice pitch and interval identification help music students learn these skills more effectively? Future research should also include comparative analyses of student work and learning outcomes between courses and semesters where one set of students used the mobile tablets and one set did not, but the course requirements and assignments otherwise remained the same. Finally, Dew (2010) observes that more and more working adults are returning to school in order to expand their knowledge base and skill sets. Future research should also consider whether the opportunity to engage emerging technologies such as mobile tablets—or whatever the next technological advance may be—will help these students be more competitive and adaptable despite initial frustrations as they learn to navigate the technology.

In addition to specific studies on learning outcomes, future research might also investigate how mobile tablets improve or enable faculty work. Do they facilitate faster or more educative feedback on assignments? Do features such as voice recording or dictation applications that transcribe speech prove to be valuable methods for faculty to respond to student work? Future research might also include collaborative efforts between faculty from any discipline

working in partnerships with departments such as Computer Science or Informatics to help students design course or content specific applications that might capitalize on the convenience of mobile technologies for a course or discipline. Although design features such as text input caused frustration, those obstacles appeared to be outweighed by the advantages of multiple modes of learning. Therefore, working with application design teams to refine learning apps and develop interactive learning platforms may prove valuable.

In sum, mobile information and communication technologies such as tablet computers will feature prominently in the future of learning and classroom environments. Mobile tablets such as the iPad offer benefits such as seemingly boundless access to information and advantages for collaborative learning. However, these devices also carry the potential to distract learners and create frustration in the classroom. When incorporated into the classroom prudently and reflexively, educators can maximize their potential to enhance learning and minimize their interference with learning.

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Appendix

You are invited to participate in a survey to get your feedback on the effects of using iPads in the classroom. Your participation is completely voluntary and anonymous. Whether or not you complete this survey will have no bearing on your grad in this class. You may choose to skip any question you do not want to answer and stop completing the survey at any time.

Select how strongly you agree or disagree with the following statements.

The iPad activity (OR a specific application) helped me	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. apply course content to solve problems.					
2. learn the course content.					
3. connect ideas in new ways.					
4. participate in the course activity in ways that enhanced my learning.					
5. develop confidence in the subject area.					
6. develop skills that apply to my academic career and/or professional life.					

Select how strongly you agree or disagree with the following statements.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
7. The iPad activities motivated me to learn the course material more than class activities that did not use the iPad.					
8. I participated more in class during the iPad activities than during activities that did not use the iPad.					
9. My attention to the task(s) was greater using the iPad.					
10. The iPad was more convenient compared to a desktop or laptop computer.					
11. It was easier to work in a group using the iPad than in other group activities.					
12. iPad activities are an important supplement to this class.					

13. Describe how the iPad activity helped or limited your learning of the class content.

14. Describe at least two things you liked about using iPads in this class:
1.

2.

15. Describe at least two things you disliked about using iPads in this class:
1.

2.

16. Do you have any suggestions for other ways to use the iPads in learning class content?

Tell us about yourself.

17. Age:	Under 18	18-28	29-44	45 and over
18. Gender:	Female		Male	

19. Before using iPads in this class, what was your comfort level using handheld mobile computing devices?
    [ ] Not at all comfortable
    [ ] Not very comfortable
    [ ] Fairly comfortable
    [ ] Very comfortable

20. After using iPads in this class, how likely are you to use a handheld mobile computing device for e-learning or professional development.?
    [ ] Not likely
    [ ] Somewhat likely
    [ ] Likely
    [ ] Extremely likely
    [ ] Unsure

21. Considering face-to-face classes that use e-learning technology [such as handheld devices, online research guides, Oncourse, or other course management systems] in the classroom which of the following best fits your preference?
    [ ] Classes that make little or no use of e-learning technology.
    [ ] Classes that use a moderate amount of e-learning technology.
    [ ] Classes that make extensive use of e-learning technology.
    [ ] No preference.

22. Do you own a handheld mobile computing device that is capable of accessing the Internet (whether or not you use that capability)? Examples include iPhone, BlackBerry, other Internet-capable cell phone, iPod touch, PDA, iPad, Kindle, etc.
    [ ] No, and I don't plan to purchase one in the next 12 months.
    [ ] No, and I plan to purchase one in the next 12 months.
    [ ] Yes.
    [ ] Don't know

23. If yes, how do you use handheld mobile computing devices? Check all that apply.
    [ ] Access Oncourse
    [ ] Access other e-learning tools
    [ ] Browse the Internet
    [ ] Download and listen to music
    [ ] Download and listen to podcasts/audio books
    [ ] Download and read e-books/print-based content
    [ ] Download and view streaming movies/video clips
    [ ] Make phone calls

[ ] Play interactive games
[ ] Search for information
[ ] Send and receive e-mail
[ ] Send and receive instant messages (IMs)
[ ] Send and receive pictures (MMS)
[ ] Send and receive short text messages (SMS)
[ ] Use camera to take and share pictures
[ ] Banking
[ ] Calendar
[ ] Maps
[ ] News
[ ] Shopping
[ ] Social networking
[ ] Sports
[ ] Twitter
[ ] Weather
[ ] YouTube
[ ] Other. Please specify: _____

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