The increasing capabilities of mobile or smart phones are positioning them as the technology of choice, replacing PCs, for many users, especially college students. As such, the use of these devices must be contemplated as an inevitable learning tool available to higher education. This paper explores the evolution of the smart phone into a potentially powerful learning tool by providing a literature review on smart phone’s use in higher education, and lays a foundation for future research that examines the digital gap between teacher and student related to knowledge and use of smart phone in an existing university setting because through observation the author speculates that gap exists, especially within the classroom context.

LITERATURE REVIEW

From PC to Mobile/Smart Phone

The first generation PC was developed in 1945 and took 60 plus years to grow into today’s mature technology. Nowadays PCs are by far the most widely used technology with far-reaching significance. However, use of another technology is now growing at a faster rate than PCs—the mobile phone. In 1979, the first commercial cell telephone system began to operate and attracted significant number of subscribers for its service by the mid-1980s (Lacohee, Wakeford, & Pearson, 2003). According to an RBC Capital analyst, Dan Frommer, mobile phone sales are expected to outstrip PC sales in 2011, and the smart phone users worldwide will more than triple from 165 million to over 500 million from 2009 to 2012 (2009, as cited in Hanson, 2011). Amanda Lenhart in The Pew Internet and American Life Project also reported that as of 2010, 82 percent of American adults owned a mobile device; the percentage was found to be even higher for younger adults aged 18-29; 55 percent access Internet with their phones at least daily, 43 percent use mobile Internet service several times daily (2010, as cited in Hanson, 2011). These statistics tell us a trend -- mobile phone use is growing at a rapid pace, and as such, the devices are becoming ubiquitous around us.

Defining the Smart Phone & Features

In the early inception of mobile technology development, mobile phones were elite devices primarily used by middle and upper class people (as cited in Lacohee, Wakeford, & Pearson, 2003). Compared to old-fashion landline phones, mobile phones of today are free from the
constraints of location specificity, apart from the basic capability of communication (Lacohee, Wakeford, & Pearson, 2003). As mobile phones evolve, more and more features have been added, such as full color screen, texting function, mp3 function, and embedded camera, etc. According to the research done by Caverly, Ward, and Caverly, mobile phones have replaced computers as the primary wireless Internet access portal for Hispanic American (68%), and African American (65%), far beyond White (33%), whom prefer to use laptops (Caverly, Ward & Caverly, 2009). It was projected by Anderson and Rainie that by 2020 mobile phones would become primary means for the Internet access (Caverly, Ward & Caverly, 2009).

The trend of existing mobile phone’s development is that they are getting smarter (hence the nickname — smart phone) and more user-friendly. In Defining the Smartphone, Litchfield (2010) examined the top five most accepted definitions of smart phone, and concluded that there was no single, accepted definition. Due to the constantly evolving nature of mobile phone technology, the line between “smart” and “dumb” phones is unclear. Actually, even “dumb” phones can have some “smart” phones’ features, such as a touch screen and a proper operating system. At the conclusion of his research, Litchfield offered the definition of smart phone in 2010 as a phone that “runs an open operating system and is permanently connected to the Internet” (Litchfield, 2010).

However, it is important to know the “smart features” on smart phone nowadays. Today’s smart phones, just like PCs, also incorporate operating systems which allow the add-on applications (or software) to run on top. The hundreds and thousands of applications, which operate as software in PCs and allow users to do what they want, are the core sources of facilitation and convenience for people’s lives. Customized to its owner, every smart phone has different interface and applications to adapt to its owner’s needs. They also have constantly evolving computing power and capabilities as opposed to old “feature phone”. Also today’s smart phone has constant internet connectivity allowing users to stay informed and to have unlimited services available at their fingertips. The QWERTY keyboard, either physically or virtually available on smart phones, also makes typing as easy as on a PC. Finally, all smart phones on the market have touch screen now. Needless to say, smart phone has basic functions as feature phone has, such as phone call, text messaging, and camera. All these current features are allowing smart phones to have the same capabilities as computers but with the added bonus of mobility.

Smart Phones Changing College Student Lives

Smart phone technology, with its pervasive acceptance and powerful functionality, is inevitably changing peoples’ behaviors. Young adults are especially dependent on smart phones today. A survey conducted by CourseSmart, the world’s largest provider of eTextbooks and digital course materials, found that college students can’t go long without checking their digital devices, including smart phones, laptops and more (CourseSmart, 2011). It’s very common to see college students checking email, Facebook, Twitter, or other social network sites using smart phones with their constant web connection feature nowadays. According to the infographic research
done by HackCollege.com, 57 percent of college students use smart phones, 60 percent feel addicted to their phone, 75 percent sleep next to their phones, 88 percent texted in class before, 97 percent who have smart phones use them for social networking, and 40 percent used smart phones to study before test (as cited in Alexander, 2011).

Text messaging plays an important role in college student’s life, too. A survey conducted at the University of Colorado and several other universities in 2010 found that text messaging and emailing are two of the most commonly used functions on smart phones among college students, followed by reading news, watching video and reading books (Dean, 2010). With more and more functionalities added to smart phones nowadays, voice call, which is the oldest functionality of mobile phones, is becoming relatively less significant and less used. When both calling and messaging options are available, people prefer to send text messages today. Turkle’s (2011) book, Alone Together, perfectly explains the psychology behind this social phenomenon. It explains that people like text messaging more because they feel phone calls are —intrusive, and they have more contemplation when replying to a text message and more freedom to choose to reply or not to a message they receive (Turkle, 2011). Other research conducted at University of Brighton in the United Kingdom shows text messaging also has the potential to aid high school graduates in making a smooth transition from high school to college. The University of Brighton uses a desktop computer application called student messenger which allows professors and administrators to send text messages, such as reminders, due dates, meeting times, etc., directly to freshmen. The students who used this system gave overall positive feedback because they said it gave them a sense of — belonging and also made them feel they would do better academically (Harley, Winn, Pemberton, &Wilcox, 2007).

Mobile Computing/Smart Phones Driving Changes at College and in the Classroom

Meanwhile, some colleges sense this new technology evolution, and are striving to go mobile in order to accommodate their students’ adoption of new technology. Until now, many colleges and universities have their own mobile applications, on which students can access basic campus information through their smart phones. Ryerson University, a Canadian university with 25,000 student base, started to offer a mobile library service in 2008. A modified smart phone friendly site version from their main library web site was created. The mobile library website allowed students to look up library hours, workshops schedules, and basic library contact information. In 2009, according to the research about Ryerson University students’ experience and expectancy with their mobile library site, “searching for articles, reading eBooks, checking out books, and contacting librarian/getting research help” were students’ top future request. However, the study found that it is unlikely to provide a large scale of library scholarly research through mobile devices (Wilson & McCarthy, 2010).

Given the situation of prevalent smart phone usage among college students and universities’ gradual embrace on mobile campus, it is reasonable to consider how smart phone might be taken advantage for college students’ learning too. In fact, smart phones have a huge potential to be
used as learning tool in higher education. Currently, smart phones are being used for education in three major ways. First, the Web browser embedded smart phones links to great wealth of material. Second, inexpensive but useful applications within smart phones are being utilized for different purposes. Third, two-dimensional barcode labels on object can be scanned by smart phones and direct to information regarding that object. Williams and Pence’s literature review (2011) indicates smart phones as a powerful tool are already being used in chemistry classroom. The American Chemical Society iPhone app allows users to search over 850,000 scientific research articles. Chemical data tables are present either related to the elements or compounds on smart phone apps. 3D visualization of biomolecules is also possible on smart phone, provided by RCSB Protein Data Bank. In addition to these specific apps for chemistry, many apps could be generally used in any classroom, which allows teachers to link “pictures of their students with class rosters, logging observed data, capturing notes from a whiteboard, scanning documents”, or do concept mapping with smart phones.

The two-dimensional barcode technology in smart phones is a popular use for education, and it is a subcategory under Augmented Reality technology. Augmented Reality means “combination of digital information with images from the real world”, which branches into markerless and markered augmented reality. “Markerless augmented reality adds digital information to the image on a cell phone camera based on the global positioning system (GPS) location; markered augmented reality uses a physical reference point, such as a two-dimensional barcode to connect a cell phone to information”. Some common formats of 2D barcode include Quick Response (QR) code, Microsoft tag, and Scanlife code, and by far the most popular one is QR code. The objects with 2D barcodes are called “smart objects”, and those barcodes are converted from URL (uniform resource locator). The label with 2D barcode on object, such as a bottle of chemicals, can be scanned by smart phone and direct to a Web site related to that object. A barcode on a physical object makes the object clickable to a smart phone” just like hyperlinking on a general Web page. One practical use example of this barcode in chemistry classroom would be an instrument with those barcodes on, which connect users to correct operating instructions (Williams & Pence, 2011).

A Closer Look at Mobile Learning

The literature tells us that, in general, modern technology-aided learning is found in three stages ranging from conventional e-learning to m-learning to context-aware u-learning (Liu & Hwang, 2010). Conventional e-learning refers to using computer and the Internet for learning. This is where computer plays a vital role in modern education and pedagogy. M-learning (or mobile-learning) is realized with mobile devices and wireless communication. Context-aware u-learning (or ubiquitous-learning) requires mobile devices equipped with sensor technology and wireless communication (Liu & Hwang, 2009). Context-aware u-learning could be classified under m-learning actually because as more smart phones enable sensor technology, m-learning will become indistinguishable from context-aware u-learning.
By definition, mobile-learning (m-learning) is learning using wireless devices that can be used wherever the learner’s device can receive unbroken transmission signals. The mobile devices include not only smart phones but also devices like mobile tablets and personal digital aids (PDAs). The definition for m-learning contains three key components – mobility of technology, mobility of learners, and mobility of learning processes. Mobility of technology refers to the mobile nature of installed hardware and software that enable constant wireless Internet connection. Mobility of learners means learners are no longer physically attached to one or several learning sites, and they can be mobile and learn at the same time as long as the mobile devices are around. Finally, mobility of learning is the result of mobility of both the technology and learners (El-Hussein & Cronje, 2010).

According to the review of mobile learning by Goh and Kinshuk (2006), generally research in mobile learning can be grouped into these categories – games and competition in learning, classroom learning, laboratories learning, field trip learning, distance learning, informal learning, pedagogical and learning theory, learning and teaching support, mobile learning architecture, and mobile evaluation, requirements, and human interface. One example with regard to games and competition in learning is young people using phone-based games improves their spelling and reading and mathematics skills. Classroom learning “uses mobile devices in the laboratory environment to support individual learning as well as collaborative learning”. One example of classroom learning would be using mobile smart phones to brainstorm, take quizzes, and vote. Laboratory learning is similar to classroom learning but has data acquisition as extra function. One example here is doing hands-on scientific experimentation with “PDAs to control a robot in a maze to facilitate programming and algorithm development”, and learners’ experiences are enriched because they are closer to the real activities. Field trip learning is enabled with mobile devices’ mobility outside the classroom. One research example done by Chen, Kao & Sheu (as cited in Goh and Kinshuk, 2006) is a mobile learning system developed for bird watching based on a scaffolding concept, which showed improved learning for children. Distance learning uses mobile devices to support synchronous and asynchronous learning. One example here would be use “videophone to deliver home education for students with severe physical impairment”. Informal learning is enabled with context aware technologies. The setting of informal learning can include gallery, garden, aquarium, museum, and etc. One example would be a tour guide system developed by Chou, Lee, Lee, and Chang (as cited in Goh and Kinshuk, 2006) for mobile learning in a museum, and the system is intended for both individual and group visitors. In the pedagogical and learning theory category, researchers explore varied theory of using mobile devices for educational purposes, which is also the most important aspect of mobile learning. Vavoula, Lefrere, O’Malley, Sharples, and Taylor (as cited in Goh and Kinshuk, 2006) suggested 10 pedagogical guidelines for teachers and educators if they want to use mobile learning technologies. The guidelines are a list of dos and don’ts, which include costs, usability, choice of technology, roles, equipment management, support for teachers, administration, collaboration, services and applications, and security and privacy. Learning and teaching support category “uses mobile devices to supplement learning and formal teaching”. One example is that through a collaborative note taking system on mobile smart phones, students can share their notes with others. Mobile learning architecture mainly focuses on architecture issues in develop mobile learning systems. Context-awareness architecture for mobile learning could be one example. Finally, mobile evaluation, requirements, and human interface primarily look into human
computer interface issues. One research done by Houser and Thornton (as cited in Goh and Kinshuk, 2006) under this category is evaluating the typing speed of mobile devices, and they found that Japanese students were able to take notes in Japanese on their mobile smart phones, but needed some training to do same things in English.

Note the difference between m-learning and traditional classroom lecture-form learning. M-learning is learner-centric learning as opposed to classroom lecture-form learning which is teacher-centric. The traditional forms of learning requires learners to be present in one fixed location, where with m-learning students can be anywhere as long as there is internet connectivity. The advantages of m-learning are obvious. Conventional e-learning enables learners from a distance with a PC and internet connection so that they can learn and interact with others online. However, the size and weight of PCs is a limitation because learning process is tied to computers’ locations. Mobile phones solve this problem and promote —learning anytime and everywhere as was touted at MLEARNING 2004, an international conference on mobile learning (El-Hussein & Cronje, 2010). If m-learning could be achieved via the use of smart phone on college campuses, students would most probably see it as a great advantage.

Web 2.0 technologies such as blogs, wikis, and interactive websites have ushered in a whole new era of information sharing and collaboration. This notion of sharing and collaboration could be furthered when applied in an m-learning context. Learning is more effective and efficient if learners can collaborate rather than remain in isolation. There are also a growing number of mobile applications that are learning-focused. One example of such an application involves a college professor posting an article assignment online. Once the article & assignment is posted all the professor’s students can get a notification about that post from a specifically designed learning application which will redirect and open up the article via their smart phones. Students are then free to read the article whenever/wherever they want--while they commute, wait in line, or have other free time occasions. They no longer have the constraint of reading from their PCs. Following the reading of the article, the students can post questions, engage in discussions, and possibly post answers to questions via the same application. In this way students are always connected and updated throughout the learning process.

Another advantage of m-learning technologies over conventional e-learning is the ability to incorporate context-awareness. Context awareness involves having sensors in smart phones that are capable of detecting the student learning behaviors in the real world and then stimulates more adaptive learning activities (Hwang, Wu & Chen, 2007). In order to better understand the power of sensor enabled m-learning, Liu and Hwang (2010) designed a case to show the learning conditions. A butterfly garden with host plants labeled with different RFID tags was constructed. Students then moved around the garden and scanned the RFID tags on the plants with their sensor-enabled smart phones. The smart phones would detect students’ location, recognize the RFID information, and then conducted an assessment about the plant to evaluate the students’ learning. Specifically, students were asked to identify some features of the plant and the shape of the leaves for instance. If students answered incorrectly, the application would direct them to plants for re-examination (Liu & Hwang, 2010).
Hesitance to Use Mobile/Smart Phones in Colleges & Classrooms

Unfortunately, smart phones with their many existing features and future potential uses, are not currently widely accepted nor and utilized in colleges/universities. One reason is that the technology and applications are not fully ripe yet. Researcher Motiwalla (as cited in Wang, Wu, & Wang, 2009) claims that learning on mobile smart phones can never replace classroom or conventional e-learning methods, and learning with mobile could only be complementary to traditional learning and e-learning. In Siau, Lim and Shen’s research (as cited in Wang, Wu, & Wang, 2009), they collectively conclude some mobile devices’ current technological limitations for learning – small screens and small multifunction key pads, less computational power, limited memory and disk capacity, shorter batter life, complicated text input mechanisms, higher risk of data storage and transaction errors, lower display resolution, less surfability, unfriendly user-interfaces, and graphical limitations.

Another reason is that people’s resistance to adopting learning with mobile smart phones. When investigating the factors that affect people’s behavior intention to adopt leaning with smart phones, Wang, Wu and Wang (2009) found following determinants – performance expectancy, effort expectancy, social influence, perceived playfulness, and self-management of learning, are collectively significant. Among these, performance expectancy, which refers to users’ perceived benefit of learning with mobile for themselves, was the strongest determinant of behavioral intention to use smart phones for learning. Effort expectancy means the degree of easiness using smart phones for learning as perceived by users. Social influence refers to the extent to which a person thinks other people believe that person should adopt learning with mobile. Perceived playfulness refers to how much of playfulness a person can get out of using mobile smart phone for learning. “Self-management of learning is defined as the extent to which an individual feels he or she is self-disciplined and can engage in autonomous learning” (Wang, Wu, & Wang, 2009).

Today’s younger generation has grown up with electronics and technologies surrounding them and has significant exposure to digital devices such as smart phones, while many professors do not. Michael Evan (2009) points out in his paper that this younger generation of students is referred to as digital natives by Prensky, which contrasts with their teachers and parents who are referred to as digital immigrants. It is understood that educators are working with students that have —far greater experience, expertise, and comfort levels with mobile, wireless technologies and new digital medial. Even though it may be impossible for professors/educators in older generations to catch up with the younger generation with regard to experience with new technologies and digital devices, they must still strive to embrace them as powerful new learning tools.

Until now, smart phones have been seen more as a distraction in the classroom rather than a learning tool. If students have phones with them in class, more often than not, they are asked to
put them away or turn them off. The idea that many features of these phones were designed for entertainment and pleasure purposes early on has still not faded away either. Overall, research shows that educators do not have very positive attitudes towards mobile phones as tools for learning in higher education to date. It is true, however, that students’ attention in class needs to be managed. Williams and Pence (2011) bring up a good idea to manage students’ attention in the long run. They encourage professors and educators to design some portions of classes as — technology on and other portions as — technology off (Williams & Pence, 2011).

PROPOSED RESEARCH AND METHODOLOGY

The literature review to date has shown that smart phone technology has unquestioned potential to be used as a learning tool by professors and students alike and in and out of the classroom. Although the research has only begun, we have uncovered many examples of how smart phone technology can be leveraged in the classroom and have uncovered strong evidence that smart phones will be the technology tool of choice in the future. We have also discovered through research and experience that regardless of these facts, there is more than an anecdotal — gap between professors and students. At this juncture, we propose to investigate that gap in a University context. With the support of our University CIO, we will investigate the — digital divide between professors and students with regard to smart phones using a survey methodology. In fulfillment of an undergraduate thesis project, we intend to examine a spectrum of issues beginning with smart phone ownership to smart phone knowledge to smart phone use in the classroom. Not only will our research lend to existing theory about the — gap but it will provide a practical guide for our University as we attempt to develop a new IT strategic plan.

References


