Mobile Learning: The Beginning of the End of Classroom Learning

Edward J. Cherian and Paul Williams

Abstract– **Mobile learning has evolved from electronic learning, which has evolved from distance learning. Barriers previously available for mobile learning have now all but disappeared, and the number of adult learners available for mobile learning represents a sizeable student population. Studies indicate no significant difference between most forms of distant learning and tradition face-to-face learning, which may represent the last barrier to fall in the march toward the adoption of widespread mobile learning.**

Index Terms–**Distance Learning, Mobile Learning**

I. INTRODUCTION

Mobile Learning (M-Learning) is no longer a novelty. It is a mainstream, pervasive learning delivery medium relied upon by thousands of post-secondary education institutions and millions of workforce and distance-educated students worldwide [1].

About 3.5 million students in post-secondary education are taking at least one online course, according to The 2007 Sloan Survey of Online Learning, which involved more than 2,500 colleges and universities in the United States. This represents a nearly 10 percent increase from a 2006 study, which found 3.18 million online learners nationwide [2].

There are variants of what 'access' means, but all higher education institutions — even those that don't have online courses — overwhelmingly believe that online programs serve an audience that is not well served by classic face-to-face programs," said Jeff Seaman, survey director for The Sloan Consortium. The number-one driving factor is that there are people out there who want an education, but the traditional method of driving to a campus and sitting in class just doesn't work for them [3].

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The mobile revolution is finally here. Wherever one looks, evidence of mobile penetration is irrefutable: cell phones, PDAs, MP3 players, portable game devices, handhelds, tablets, and laptops abound. No demographic is immune from this phenomenon. From toddlers to seniors, people are increasingly connected and are digitally communicating with each other in ways that would have been impossible only a few years ago [4].

We are undergoing an explosion of M-Learning as a learning medium. The explosion is driven by mobile workforce demands and enabled by technologies as described by Wagner. However, the question remains as to whether M-Learning is as effective as traditional Face-to-Face (FTF) learning – the 'leading contender' in the learning space; one that will ostensibly remain the yardstick against which all other learning strategies will be measured.

There are few barriers to the distribution of digitized course content in an M-Learning environment; content hosting and network infrastructures exist, and media devices capable of downloading content are omnipresent. It now remains for organizations and administrators entrenched in classical andragogical methodologies to push the envelope, employing advanced multimedia instructional design methodologies, and overcoming what have simply become mere artificial and superficial hurdles that stand in the way of providing a growing constituency of adult learners' access to education.

The physical distance of today's students from the conventional campus has increased proportionately with the global dissemination of information:

Particularly in the last decade, the Internet has emerged as a simple means for the instantaneous global dissemination of information. The Internet is especially well suited to providing access to data and applications information on innovative materials and products as soon as the data are available [5].

There exists great demand for workers who possess a post-secondary degree preparing them for productive participation in this knowledge economy: "As our society is entering a knowledge-based,

Internet/Web-driven economy, college education becomes a necessity for any individual who wants to be competitive and successful, regardless of his or her age, gender, and race" [6]-[7].

In July 2006 Don Francis, president of The Association of Independent Colleges and Universities of Pennsylvania (AICUP) said; "Regardless of time and place, providing access to education for those wishing to be successful in this economy should become the cornerstone of educational institutions' attempts to prepare students for success . . . this is what we all hope that education will do . . . what the data are showing is that education is leveling the playing field for people from different socio-economic categories" [8].

II. MOBILE LEARNING EVOLVES FROM ELECTRONIC LEARNING, WHICH EVOLVES FROM DISTANCE LEARNING

As D-Learning came to rely more heavily on technology it evolved into E-Learning. In turn, E-Learning gave way to M-Learning as a host of technology resources and learning needs aligned; network infrastructures and small information appliances matured and learners became increasingly mobile (Fig. 1).

Fig.1. The Place of M-Learning as Part of E-Learning and D-Learning [9]
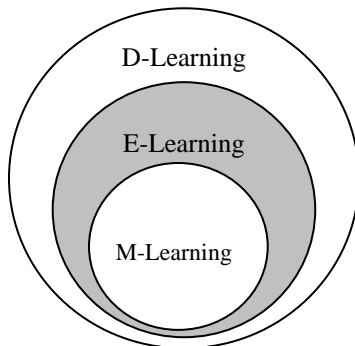
M-Learning is a different and alternate approach to D-Learning and E-Learning, it provides the ability to create homogenous learning objects for heterogeneous mobile devices, and does so by utilizing wireless connectivity. This approach benefits a growing audience of post-secondary institution and workforce learners, e.g. those in hard to reach, isolated locations, away from their home or office, or in FTF environments where a need to augment the classroom experience exists. It creates an environment of anywhere, anytime learning [10]-[11]-[12].

M-Learning has shattered the requirements for students to be seated for lengthy periods at a given time and place. It enables students to take courses at their convenience: 1) at a location they desire, 2) at a time they choose, 3) untethered, and 4) facilitated by inexpensive, ubiquitous multimedia players.

D-, E-, and M-Learning all provide communication between teacher and student. This characteristic often causes confusion and often leads to the methods being referred to interchangeably. To clarify, D-Learning is defined as learning at a distance. E- and M-Learning are subsets of D-Learning and thus, although they have their own peculiarities based on object delivery medium and audience; they represent a means to the same D-Learning end.

D-Learning:

. . . [a] General term used to cover the broad range of teaching and learning events in which the student is separated (at a distance) from the instructor, or other fellow learners [13].

The acquisition of knowledge and skills through mediated information and instruction, encompassing all technologies and other forms of learning at a distance [14]

E-Learning (D-Learning utilizing electronic devices):

. . . learning from any device dependent upon the actions of electronics, such as television, computers, microcomputers, videodiscs, video games, cable, radio interactive cable, videotexts, teletext, and all the other devices in the process of being invented that are electronic in nature [15].

M-Learning (. . . an approach to E-Learning that utilizes mobile devices)" [16]:

[the] . . . intersection of mobile computing (the application of small, portable, and wireless computing and communication devices) and e-learning (learning facilitated and supported through the use of information and communications technology) [17].

The maturation of M-Learning as a viable alternative to D-Learning and E-Learning has been enabled by many factors: The introduction of the cell phone, and PDAs are probably the most significant. As advances are steadily being made in the small information appliance industry we expect to see them incorporated into the M-Learning paradigm; handheld devices, mobile phones, smartphones, and iPods, etc. Sharples refers to these technologies as the, ". . . software, hardware, communications and interface

designs of a handheld learning resource, or HandLeR" which enable 'handheld learning' [18].

III. FACE-TO-FACE LEARNING

The roots of FTF learning can be traced to philosophers in ancient Greece, Egypt, China, and India as far back as the teachings of Confucius (551 – 479 B.C.) [19]. More recently, during the Middle Ages in Europe (5th to 15th centuries), the Roman Catholic Church assumed responsibility for learning, removing the practice from private citizens and loosely-bound, semi-formal institutional relationships. Learning was instead allocated to monasteries and unique, formal 'Learning Centers'. Eventually, these centers turned into what are now recognized as universities [20]-[21].

The 17th and 18th centuries saw a shift in focus from education generalizable across all ages to the unique art and science of educating children, commonly referred to as 'pedagogy':

> . . . the Ancient Greek word paidagogas, which is derived from the word for the slave (pais) who leads (agogas) the children (also, pais) to school, and then comes to mean the mode of instruction itself [22].

In 1950, attention was drawn to the art and science of learning specifically designed to address the needs of the adult learner. It was not until 1970, however, that a term referring to this process was coined; attributed to Malcolm Knowles, the process was labeled 'andragogy' (adult learning) [23]. Knowles' theory has been described as, ". . . an attempt to develop a theory for all adult learners . . . adults tend to be self-directed and expect to take responsibility for decisions . . . education programs need to accommodate these fundamental aspects" [24].

This environment is especially well suited to M-Learning; learning objects can be downloaded and consumed at the adult learners' leisure (self-direction). Further, under this learning strategy students are provided with the opportunity to participate or not based upon their penchant. Subsequent evaluations, based upon quality of work, will ostensibly be aligned with their level of participation (taking responsibility for decisions).

Andragogy differentiates between the teaching strategy nuances that exist between children and adults as learners; "In pedagogy, the concern is with transmitting the content, while in andragogy, the concern is with facilitating the acquisition of the content" [25]. With its focus on the post-secondary audience, this paper focuses on andragogy.

Between 1945 and 1965 interest intensified in the study of European andragological principles. Later

coined the 'cognitive revolution' [26], the period saw scholars and scientists such as Jean Piaget and B.F. Skinner conduct andragological studies. These researchers began to move away from the study of knowledge acquisition and behaviorism of previous periods to the study of information and the way it is processed [27].

After the marriage of learning and IS models it took little time for educators and systems developers to capitalize on it and introduce IS-based education models, D-Learning, E-Learning, and M-Learning alike, e.g. the 1969 introduction of the United Kingdom's Open University televised course network. As small information appliances and network infrastructures emerged, e.g., the Internet (circa 1970), [28] cell phones (1973), World Wide Web (1989), [29] and PDAs (1993), etc., IS-based learning projects were provided a platform upon which to build.

Fig 2 depicts D-Learning as the foundation for E-Learning and E-Learning as the foundation for M-Learning. What differentiates the four delivery methodologies is the way in which learning objects are delivered . . . most notably electronic versus non-electronic. Learning content can be delivered through each model but the transmission channel typically differs.

Fig 2. A Hierarchy of Learning Methodologies [30]
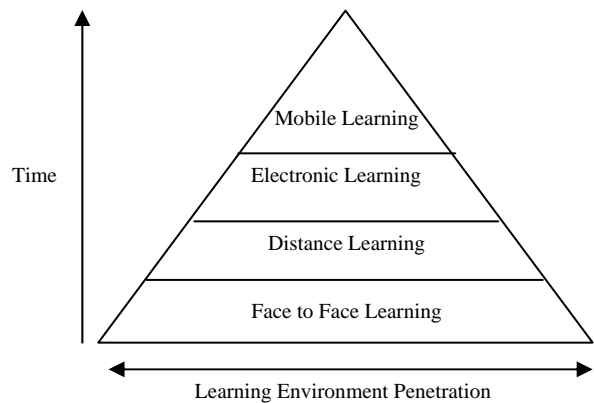
IV. M-LEARNING

The next big killer application for the Internet is going to be education. Education over the Internet is going to be so big it is going to make e-mail [usage] look like a rounding error [31].

M-Learning technologies may continue to broaden the boundaries of the conventional classroom, making it possible for the learning strategy to become as prolific and, possibly, as effective as FTF learning.

As the number of distance students continues to rise [32] – e.g. military personnel stationed overseas,

workers in isolated locations, stay-at-home parents, disabled persons, and traditional students with a desire to augment their FTF experience, etc. –a proportionate increase in demand for learning objects targeted at distance learners has occurred [33].

The expanding inventory of M-Learning capable media available includes portable devices used for communication or for running applications: iPods, PDAs, cell phones, smartphones, etc. The reliance on these wireless, mobile small information appliances is the primary distinguishing characteristic between M-Learning and D-Learning and E-Learning. These devices provide the ability for students to work untethered from a distance and are capable of capturing a variety of learning objects in various formats, e.g. audio, video, text, etc. The growing library of educational content designed for the devices has situated M-Learning, ". . . clearly in the future of learning" [34]-[35]-[36]-[37].

With the requisite architecture now in place – infrastructure, tools, and teaching strategies, etc. – it seems almost inexcusable to prohibit individuals from acquiring an education simply because of time, travel, and proximity constraints; a simultaneously abhorrent and preventable situation. These individuals who opt, or are forced to be away from the classroom should be supported; provided with an opportunity to have access to educational experiences equivalent to FTF.

The PDA (introduced in 1990 as the Apple Newton) and smartphone (which emerged in 2000) demonstrate mixed sales forecasts through 2010 (Table I).

Table I. Handheld Computer Segment Sales Estimates 2000 – 2010 (projected) [38]

Unit Sales ($Millions)	2000	2003	2005	2006	2008	2010
U.S. Market						
PDA Sales	5.98	6.09	6.21	6.31	6.54	6.81
Smartphone Sales	-	0.34	3.77	7.58	16.37	26.39
WorldWide (WW) Market						
PDA Sales	11.43	12.75	13.51	13.88	14.82	15.97
Smartphone Sales	0.31	7.40	46.55	69.23	114.60	163.80

Worldwide PDA sales estimates remain flat for the 10 year period. During the same time, U.S. PDA sales slowly rise. Meanwhile, worldwide smartphone sales explode. The U.S. smartphone market also grows, but at not quite an impressive clip.

In the small form factor PC market, May 2007 saw more notebooks sold than desktop computers – a milestone in PC history. Wireless connectivity also

proliferated, ". . . one year ago (2006), over 20 percent of retail notebooks did not include wireless. Today, that number is less than 5 percent" [39].

In 2002, the Massachusetts Institute of Technology began a U.S. $100m initiative to make instructional materials for all of its more than 2,000 courses available free over the Internet [40]. Its OpenCourseWare (OCW) initiative was supposed to be, ". . . a limited online offering . . . not about online degree programs. It isn't even about online courses for which students can audit or enroll . . . it was intended to be nothing more than 'the content that supports an MIT education'" [41]. Since 2002, the initiative has grown in scope. OCW is now being used by organizations/institutions such as UNESCO and the French University of Egypt for use in the delivery of accredited and audited courses [42].

With M-Learning devices now ubiquitous and the learning object library vast, a remaining concern is the means for hosting and delivery of course content. Commonly available post-secondary institution content-hosting platforms such as Blackboard, WebCT, Angel, Moodle, and IntraLearn, etc. are able to host M-Learning multimedia content (audio, video, text, etc.) with minimal setup. In addition, where systems administrators are reluctant or cannot modify their virtual learning environments, [43] Apple Computer stepped forward with a solution – a free hosting system it rolled out in May 2007 called, 'iTunes University' (iTunesU) [44]. Pilot studies of the technology began in 2004.

The iTunes U interface is similar to the popular iTunes store. While connected to the Internet, users download rich multimedia content, store it on their computers, and synchronize it to their iPod or compatible media player.

iTunes U was created in collaboration with colleges and universities to extend downloadable content to include courseware. More than half of the nation's 500 top schools currently subscribe to the iTunes U service [45].

iTunes U has arrived, giving higher education institutions an ingenious way to get audio and video content out to their students. Presentations, performances, lectures, demonstrations, debates, tours, archival footage — school is about to become even more inspiring [46].

V. M-LEARNING AS AN EDUCATION PLATFORM

Further differentiating M-Learning from other mediators is the specificity of its content. Although input/output agnostic, M-Learning by nature is a

platform through which learning content is broadcast. If the M-Learning platform does not create and distribute learning objects, it becomes a generic mediator platform, not one of learning.

In an effort to ensure that the M-Learning platform is delivering learning objects as opposed to generic multimedia content, principles of instructional design have been developed to assist in the creation of learning objects, e.g. the transformation of FTF to learning objects [47]-[48]-[49]-[50]-[51]. One driving factor behind this initiative is a desire to minimize the number of occurrences where FTF is simply recorded and made available as-is to mobile learners. Ko and Rossen discuss this; "If you simply post your lectures and syllabus on the Web, you haven't necessarily created a viable tool for our students. The missing element here is instructional design" [52].

When FTF is recorded and transformed to a learning object without consideration to the principles of instructional design, M-Learning provides little added learning value. As an example of what M-Learning instructional principles must overcome, designers and developers must consider what, ". . . the learner will be doing when the learner is using the courseware" [53], e.g. will the learner be riding a train, driving a car, or walking along the street, etc.? FTF delivery methods do not have to take this into consideration.

These principles of instructional design are similar to those governing sound FTF practices – the Socratic method [54], case-based teaching [55], etc. As scholarly research and practitioner time continues to be devoted to similar principles of instructional design specifically developed for the M-Learning platform, credence is lent to the platform being an education platform and not just a 'cool and novel' technology solution to the issues of distance learners.

Ko and Rossen [56] further discuss the conversion of FTF to M-Learning; "Putting your class online doesn't mean copying your lectures and syllabus word for word." Ko and Rossen not only recognize the M-Learning paradigm, but have published a variety of means to assist instructors in using the platform effectively.

VI. CONCLUSION

Investments in, and widespread availability of, wireless-fidelity (Wi-Fi) networks, shrinking costs of data hosting/storage solutions, and the availability of a variety of inexpensive small information appliances have created an environment that is capable of providing access to course content from around the globe. The ubiquity of these M-Learning components has provided economies of scale that afford low cost of ownership and increasing levels of quality and fidelity.

In the United States nearly half (47%) of all adult Americans now have a high-speed Internet connection at home. This figure was 30% in early 2005 and 42% in early 2006 [57]. The proliferation of high speed broadband access bodes well for learning object delivery. Even large objects can be downloaded quickly to PCs and transferred to mobile devices via Bluetooth or USB connectivity.

Data can be transferred to any one of 233 million cell phones in use today across the United States. 2.1 billion are in use across the world. With a population of ~303 million, United States cell phone penetration is ~77%. In 2007 SNL Kagan reported that in the United States mobile phone penetration is estimated to be 100% by 2013. This percentage has already been eclipsed in other countries – it is not uncommon for a single user to own several mobile, wireless-enabled devices [58]-[59]-[60]. Across the planet, mobile phone penetration is 32% [61]-[62]. Multimedia player penetration is also increasing; in Q3 2006, over 8.7 million iPods were sold [63].

As each constituency ponders the implementation of M-Learning projects, they are taking into consideration the effectiveness of M-Learning and also its profitability and return on investment [64]. However, will M-Learning become another contribution to Russell's body of research where a 'No Significant Difference Phenomenon' (NSD) [65] exists? One where:

> . . . [the] amount of learning produced by different media is similar (NSD) but adequate to meet our instructional goals, [where] all treatments are equally valuable for learning but . . . usually differ in their cost and convenience [66].

If so, this would indicate that M-Learning is no less effective than FTF. Alternately, are there enough significant, distinct, advantageous and practical differences between M-Learning and FTF that will prove the former to more effective than the other? In summary, there are still hurdles to leap as we 'mobilize' learning (continuation of research into principles of instructional design and learning objects, etc.), but the attention thus far paid to M-Learning is encouraging. The scholarly and practitioner research devoted to the M-Learning paradigm continues. This appears to demonstrate that M-Learning is a credible education platform and not a fad. We should ensure that adequate and unique attention continues to be paid to M-Learning as a viable learning platform in and of itself as opposed to a mere extension of FTF learning principles and the traditional learner therein.

> There is a time and place for learning; it should be a learner's time and place [67]

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