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M-LEARNING FRAMEWORKS: A REVIEW

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M-Learning Frameworks: A Review

Arman Rasool Faridi*

Aligarh Muslim University, Aligarh, India

Abstract – M-Learning is slowly gaining popularity with the advancement in smartphones & cellular technologies namely 4G or Fourth Generation Cellular Networks. M-Learning requires ubiquitous connectivity & rich supply of educational materials which should be accessed from anywhere in the world and at any time. Smartphones, tablets, notebooks etc. have become light weight, compact, powerful & possess high-definition screens. M-Learning frameworks are needed to upgrade themselves to fully use these devices capabilities & to provide rich experience to its users. The study aims to provide the readers with the abridged review of the M-Learning frameworks in the current state. This study will focus only between the year 2009 to the year 2013.

Keywords— M-Learning, M-Learning Frameworks, E-learning, 4G Cellular, Network

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I. INTRODUCTION

M-learning or Mobile Learning is a derivative of distance learning which employs teaching methodology that uses mobile handheld devices like PDA's, notebooks, smartphones, mp3 players, laptops etc. for teaching. Recently with the rise of Web 2.0, social networking sites like Twitter, Facebook, video sharing sites like YouTube, NPTEL, MIT Open Courseware and educational websites like Wikis, Blogs, Forums have also enriched educational contents for mobile platforms. According to ECAR research study [1] on undergraduate students, 67% mobile devices, 64% e-book readers & 82% tablets are used by students for academic purposes regularly. Richard C. Emanuel [2] performed a survey on the usage of cell phones by college students. In this survey, total 403 usable survey from students were taken which represents 8.5% of the total 4,746 college students in which 59% were female students and 41% were male students. This survey lays some important facts: Only two out of 403 respondents don't possess a cell phone, 91% students can connect to internet in cell phones, 83% students were using cell phones for four or more years, 73% students use cell phone to access information right away, 77% students use often or fairly often cell phones when they feel bored. All these facts show the increased dependence & immersion of younger generation on technologies, especially the mobile device. Furthermore, this dependence on mobile devices will only get increased as technology gets further developed. Technology has developed hugely especially in last two decades in publishing, but it is not still sufficient to fulfil the book requirements of many book-poor countries. A survey by UNESCO [3] done on 16 sub-Saharan African countries concludes that most of primary schools there have few or no books, in South Africa survey found that 51% of households have no leisure books & only 7% of schools have libraries and in USA poor neighbourhoods have ratio of 300:1 with children to book.

Georgiev et al [4] defines M-Learning as a part of E-Learning hence also a part of Distance Learning which allows the learning to happen everywhere at any time without the need of a permanent fixed cable network connection. Sharples et al. [5] describes the learning process of M-Learning as the cybernetic process which involves continuous negotiations & explorations which replaces the traditional curriculum-based constraint transfer or construction of knowledge that earlier enables a solid ground for education. Sharples et al [6] defines M-Learning with the definition of mobile in M-Learning as

Mobility in physical space: People on the move are using M-Learning wherever possible when life don't allow them to have constant blocks of time dedicated for learning.

Mobility of technology: Tools & Resources are portable & can be easily carried on mobile devices. Seamless transfer of these resources is also possible between mobile devices.

Mobility in conceptual space: A person can capture any information or learning topic around the year. Tough [7] describes that an adult can take eight learning projects in a year. So, M-Learning enables one to switch between learning topics based on their personal curiosity, commitment, or curiosity.

Mobility in social space: A person switch between various social groups like family, office, classroom or peer groups.

Learning dispersed over time: learning can spread over time to aggregate connections & reinforcement amongst various learning experience (formal or informal)

This study provides the readers with two objectives: first the literature review of the current state of M-Learning, second, explore the emerging trends in M-Learning research by systematically analysing the past studies in M-Learning.

II. FOURTH GENERATION CELLULAR NETWORKS (4G)

4G Cellular networks was conceptualized back in 2004 by *The 3rd Generation Partnership Project* (3GPP) [8] and commercially started in 2009. It was started as the *Long-Term Evolution* (LTE) project or the 4G wireless network which was the enhancement over the *Universal Terrestrial Radio Access Network* (UTRAN) and provides optimization to *Radio Access Network* (RAN) architecture. A report by Deloitte named Global Mobile Consumer Survey points out that by the end of 2013, two billion smartphones, Three Hundred million tablets and one billion portable computers will be used by people worldwide. These huge number of mobile devices will require ubiquitous connectivity which 4G networks can easily deliver. 4G networks not only provides 100Mbps for downlink and 50Mbps for uplink but it also improves upon the existing 3G network which provides speed upto 42Mbps which are rarely achieved. Increased penetration of 4G can also be shown by the same survey by Deloitte that shows by the end of October 2013, it is assumed that some 22 wireless carriers had launched 4G networks with 18 4G service launch in the last two months only & 38 more will launch by the end of the year.

III. LITERATURE REVIEW

Wong & Looi [9] in their study of Mobile Assisted Language Learning (MALL) designs argues that MALL paradigm can create creative output-centric and seamless learning. To support the argument, authors present two case studies. In the first case study, a two-year study on students was conducted where the focus was on transforming the believes of students from being passive learners getting knowledge from formal lessons to become active learners who are capable to learn anytime, anywhere & can synthesize both formal & informal learning. In the second case study, authors created a one-and-a-half-year study where learners were instructed to undergo continuous learning by making use of handhelds to take photos, to always create phrases/sentences in time between their study, contributing on wikis etc. Author predicts that although much work needs to be done in MALL paradigm, if it is designed with right design & seamless language learning is successfully inserted in learner's learning environment, mobile based learning can help students in any formal or informal setting.

Hashim et al [10] in their paper proposed a general purpose Customized Mobile Learning Management System (CMLMS) framework which will allow its user to customize the framework as per their requirement. The framework is developed to mitigate these research problems: absence of standard Mobile Learning Management System (MLMS) for secondary schools, low parent's participation in their children's learning and limitations in learning activities. The framework will be tested in various secondary schools in Malaysia and the requirements will be gathered from those tests which will then be compiled to create a set of standard set of functions for the framework. The framework uses following three parameters:

- Approach: it is the mechanism to use and develop the default system. The developed system will have these four approaches: transactional design theory, instructional design (ID) model, learning theories and Unified Modelling Language (UML) model.

- Technology: In designing the framework, these technological considerations needs to be taken prior: mobile usability guidelines, device technology, mobile technology, and mobile operating systems before the actual development of system is begun to ensure the compatibility of the developed system with the technological capabilities used.

- Requirement: Framework will be developed according to the requirements identified during the testing phase before its development. Requirements for the framework will be divided in to following four parts: system functions, data management, user requirements and collaboration requirements.

Initial concept of framework is derived from identifying problems in previous research works in the similar area and especially focussing problems from the selected six frameworks.

Sha eta al [11] in their paper explore how Self-Regulated Learning (SRL) is highly fit to solve the issues related to mobile learning like creating student-centred, personal, and ubiquitous learning. Authors used a three-year research project in which a mobile learning environment was created for elementary science classes in Singapore to determine the effectiveness of SRL theories to understand & analyse mobile learning. SRL has its roots from Bandura's social cognitive theory which states that personal cognition is multiplicative inverse to the behavioural and environmental factors. Another view of the social cognitive theory is that human beings are proactive, self-regulating and self-organizing organisms instead of a reactive being to the external environmental

factors or to the genetic impulses. All SRL theories share the same common assumptions that are:

- Learners are able to personally improve their own abilities by learning to selectively use meta-cognitive and motivational techniques
- Learners can proactively create, select and organize advantageous learning environment
- Learners themselves involves significantly in selecting the form and number of instructions they need.

The SRL model for mobile learning will constitute of three dimensions, first SRL theories will help in analysing & comprehension of learning exercises of learners undergoing mobile learning. Second, Mobile technologies & devices are supposedly act as social, cognitive & metacognitive tools. Learners' conception of scientific concepts can be extracted in the form of visualizations of concept maps & animations in a mobilized learning. Third, providing some degree of freedom to learners in selecting goals, monitoring & controlling learning processes, assessing & evaluating learning activities is the key to the pedagogical design of the model.

Liu et al [12] in their paper explore the design of an open multimedia based mobile learning framework for university graduates. The framework constitutes of a mobile leaning application & a custom-built learning device. The proposed framework's architecture is depicted in fig 1.

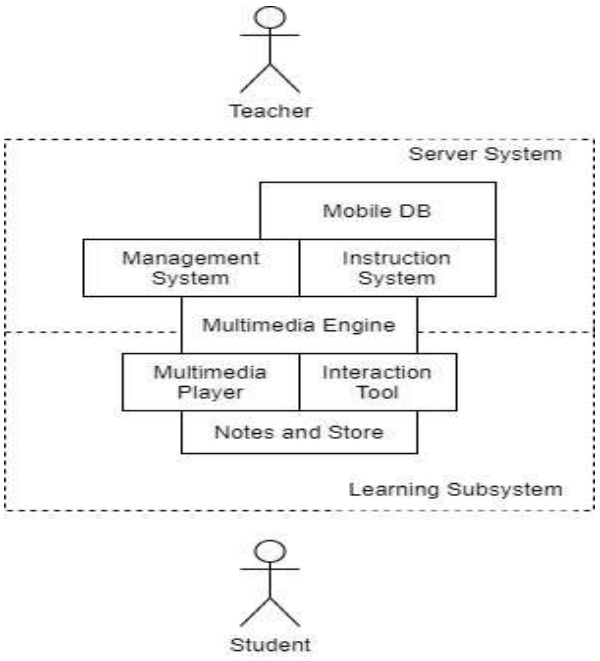

Figure 1 System Architecture of MMLF [12]

Often mobile phones contain small screen, inadequate input methods & small battery life which makes mobile learning difficult to use. Authors create their own learning device for mobile learning. The custom-built device uses a PXA255 processor. PXA255 is a 32-bit RISC (Reduced Instruction Set Computer) based SoC (System on a Chip) which includes the low-power high-performance Intel® XScale™ core-based CPU fabricated with Intel® 0.18µ process for wireless handheld multimedia technologies. The software part of the framework is responsible for efficient video coded & transferring control for mobile learning. MPEG-4 is the video codec used to provide real time learning media delivery due to the bottlenecks created by the bandwidth and the embedded processor speed. RTP (Real-time Transport Protocol) is the underlying network protocol for multimedia transmission in IP networks which uses UDP transport layer protocol for multicasting. The wireless adapter in the custom-built hardware uses the 802.11b standard for wireless network transmission. The framework tries to support at least 40 devices at a single 802.11b Wireless Access point where each custom mobile device requires 200kbps network bandwidth.

Yeonjeong Park [13] compares the mobile learning with the e-learning (electronic learning) & u-learning (ubiquitous learning) and reviews the technological and pedagogical contributions made in previous literatures. Also, the author tries to categorise previous literatures into these four types:

- *high transactional distance socialized m-learning*: This learning is characterised by these activity: a) learners have deeper communication and psychological space with their instructor or institution b) learners perform group learning activity where they actively communicate, negotiate and collaborate with each other c) Mobile devices have prebuilt software on them which dictates the learning materials or activity rules d) Main transactions to perform group learning happens among the learners and the teachers have minimal involvement. This learning is most suitable to replace technology-based classroom group activity where groups or pair of students are assigned a task.
- *high transactional distance individualized m-learning*: M-Learning activities in this learning are characterised as: a) learners have deeper communication and psychological space with their instructor or institution b) An individual learner receives a well-organized and comprehensive learning materials with the use of mobile devices c) An individual learner controls the pace to learn by itself with the learning material provided d) Major interactions happens between the individual and the content. This learning provides greater portability and flexibility and easy for learners to fit the learning in their mobile lifestyle.

- *low transactional distance socialized m-learning*: Learners have more interactions both with their instructors and other learners while using the mobile device. This learning constitutes the following activities a) Learners have low communication and psychological space with the instructor b) Learning instructions are loosely structured c) Learners work together in a group to solve a problem or to achieve a common goal d) frequent engaging in social interaction, negotiation and communication naturally. This learning activity is very advanced in terms of flexibility in leaners' social interactions and mobile devices.

- *low transactional distance individualized m-learning*: This learning is characterised by following activities a) Learners have low communication and psychological space with the instructor b) Learning instructions are loosely structured and not clearly defined c) Individual learners can directly interact with their instructors d) Instructors dictates and controls the learning to match the individual learning needs while also providing sufficient independence. This learning supports hybrid or blended learning.

Kumar et al [14] have performed a 26-week long study in their paper to support their argument that cell phones are the best way for providing educational opportunities to rural children which is accessible anywhere and anytime as per their convenience. Authors argue that about 43% of school-age children are not able to regularly attend school in rural India since they have to work to earn livelihoods. The study spans between two time periods a) summer 2008 b) spring and summer 2009. The study spans over 28 weeks in field and done in neighbouring two mango growing northern districts of Uttar Pradesh state. Phase 1 of the study performed observation of the participants to determine the social dynamics around cell phone use and adoption in rural children. It spanned over two weeks in June-July 2008 with 45 children form 20 households. In this phase, the first week was observation of daily lives of these children. Total 9 different scenarios were identified where m-learning can happen in a typical day of these children. The second week was observation of the ways these children can use cell phones for m-learning during leisure times in their day. Children were encouraged to come up with their own ways of using the cell phones. Phase 2 spans over 26 weeks in January-July 2009 with 18 children from 15 households. Children were not re-enrolled due to the long duration of the phase and the need of someone to take responsibility of cell phones. Researchers loaned Motorola Razr V3m cell phones to the participants with guarantees from their parents and were loaded with pre-built m-learning apps for entire duration of the study. Cell phones were loaned to ensure the uniform platform support of m-learning app and that results do not ger skewed. In first 10 weeks, researchers visited the village regularly twice per week to train the participants and to inform them how to troubleshoot common problems. Researchers also hold semi-structured, short interviews with the participants on their usage of the cell phones. After 10 weeks researchers stop their visit to the village to ensure the transition of the study from semi-supervised setting to unsupervised. The m-learning app also creates logs of user actions to collect even more data about app usage.

Luvai F. Motiwalla [15] studies the ways in which e-learning can be extended to handheld/palmtop devices with the help of m-learning. For this research project, requirements were ascertained to create m-learning application which can complement classroom or distance learning. A custom prototype application was developed which links the wireless handheld devices to three course sites. The built app was tested over two semesters by 63 students in graduate and undergraduate programmes. Framework implements customized commercial software which are specialised for business application but are tailored for the framework requirements. Site can be accessed by any WAP (Wireless Application Protocol) supported mobile device.

IV. RESEARCH METHODOLOGY

To obtain the best quality research papers, SCOPUS database was used. SCOPUS is one of the world's largest abstract & citation database provided by the company Elsevier which consists of scientific research works in form of any type namely original research, review articles, conference proceedings, book chapters etc. SCOPUS was started back in 2004 to ease the researchers in finding relevant materials, research insights, detailed paper analytics & suitable collaborators for research projects. SCOPUS database also allows to search patents on their service. To efficiently query this large database, following search query was passed to retrieve only relevant materials for this paper:

(mlearning OR "mobile learning") AND framework

Total 1160 results were returned by the database of which only 269 journal research articles were selected. It is also worth mentioning that only research articles published between years 2009 to 2013 was selected to keep up with the latest trends in the M-Learning research and to explore the effect of new wireless technology over M-Learning development.

V. RESULTS & DISCUSSIONS

With the advent of high-speed wireless interest access either through WLAN service provided by educational institutions or universities or 3G/4G cellular technologies, M-Learning is finding new grounds where it can help learners in achieving knowledge beyond the boundaries of a confined classroom or formal learning. Last five years shows the rise in

interest of researchers in M-Learning as depicted in following fig 2.

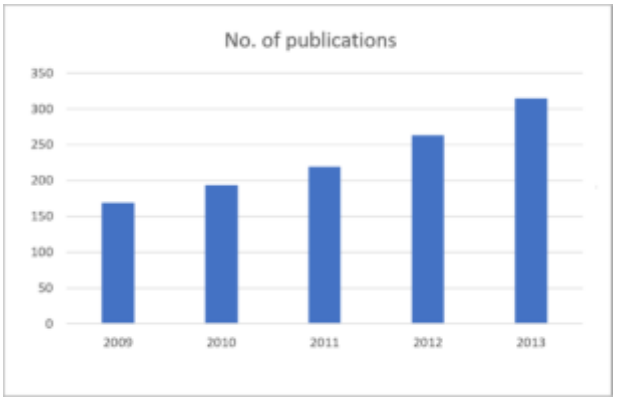

Figure 2 Line chart showing number of publications each year

Total 50 countries participated in the M-Learning research. The contribution in the M-Learning research by each country is shown in figure 3.The major contributing country in M-Learning research was United States with 37 publications, followed by United Kingdom Australia, Taiwan, Spain, China, New Zealand with 30, 19, 16, 15, 15, 12 publications each. Rest of the 43 countries have publications below ten.

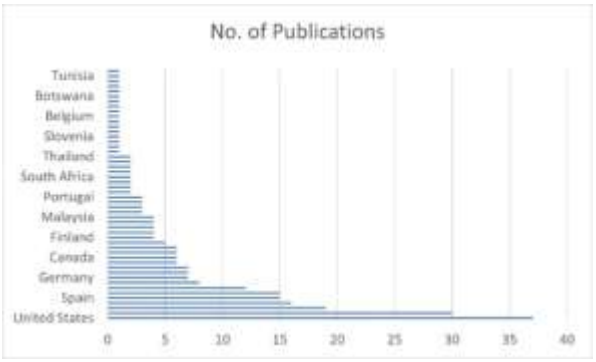

Figure 3 Number of Publications by country

Figure 4 shows the journals which publishes most research articles in M-Learning. "*International Journal of Mobile Learning and Organisation*" has published most publications with 15 articles followed by *Computers and Education*, Inter*national Journal of Mobile and Blended Learning*, *Journal of Computer Assisted Learning*, *Studies in Computational Intelligence* with seven, seven, six and five publications respectively. Rest of the 181 journals have publications below five.

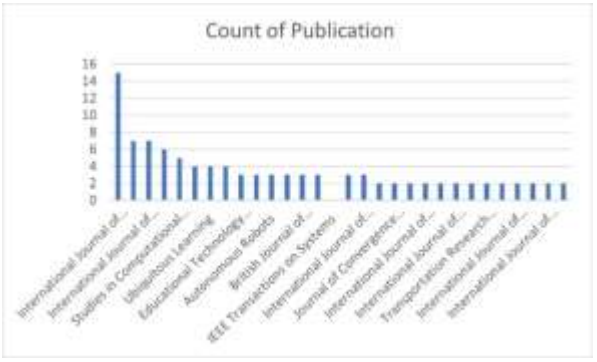

Figure 4 Major Journal publishing M-Learning research

After analysing the filtered literatures, this author found out five most impactful research in M-Learning which provides the emerging directions or comprehensive review of M-Leaning research and is shown in figure 5 below. *Park* [13] in her paper tries to categories existing literatures in M-Learning into her own classification system which is a modification of Transactional Distance (TD) theory. *Wong et al* [16] in their paper try to ascertain the meaning and ten dimensions that classify Mobile-Assisted Seamless Learning (MSL). *Kearney et al* [17] in their paper present a pedagogical aspect of M-learning which sets three main features deeply embedded in M-Learning context: personalisation, collaboration and authenticity. *Frohberg et al* [18] in their paper review 102 M-Learning projects that were published before the end of year 2007 with the parameters: control, communication, tools, objective, subject and context. *Peng et al* [19] try to find a new definition of M-Learning and to construct a new theoretical framework for ubiquitous knowledge construction. The framework contains component in hierarchical fashion with M-Learning Infrastructure at the bottom of the triangle, next is pedagogical methods such as constructivism & LLL theories (Lifelong Learning) and finally at the top is the vision with ubiquitous knowledge construction as the end goal.

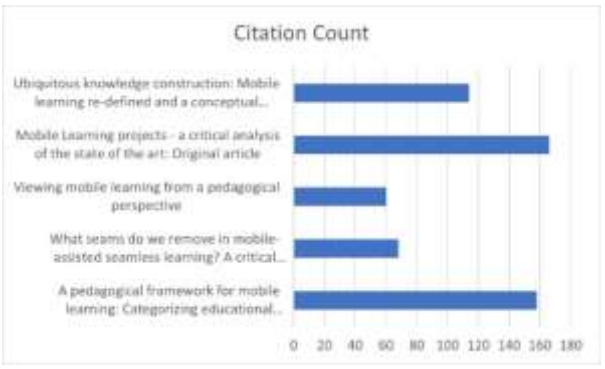

Figure 5 Five most impactful research papers in M-Learning

VI. FUTURE RESEARCH DIRECTIONS

Mobile learning has found greater acceptance as the cost to access high speed internet has brought down to affordable levels and smartphones are getting better performance and high-definition screen for viewing. Some of the areas where the future direction of research should be taken to enhance m-learning and its adoption are:

- More studies need to be done to ascertain the various ways M-Learning can be used as a complement to formal learning especially in the poor, technology backward, low literacy countries such as African countries like Nigeria, Kenya, Uganda etc.
- Learners performing real-world tasks under M-learning can face high cognitive load especially in the case of a novice or a beginner learner [20]–[23]. Further research is required to create a well-designed instruction guidelines or manuals which will be used to avoid this issue.
- Major number of researches in ascertaining the role of mobile technology as a learning tool mainly focus on using technology to only deliver the learning content whereas there is very little focus on providing guided reflection, reflective data collection and content construction. Hence future research should discover ways to shift from teacher-controlled learning to learner-controlled learning so that learners can make their own reflections, knowledge discovery or problem solving.
- Further research needs to be done in promoting m-learning contents in NFC (Near-Field Communication) and RFID (Radio-frequency identification) technologies [24]–[26]. These technologies can be used to create rich, interactive, playful M-Learning contents which can assist from kids to adults in learning beyond formal learning setting.

VII. CONCLUSION

Through this study, it is found that there are numerous new and exciting fields where M-Learning can help to provide learning in a funny, balanced cognitive load way. Learners can have greater control over their learning, hence find it more motivating, engaging and takes an active role in learning. M-Learning can even help the disadvantageous people in finishing their education when they were somehow devoid from getting formal education in their earlier life. M-Learning is also one of the best ways to provide learning content to this modern generation who is always on phone and always accessing contents. M-Learning will allow group activities that need not be done in a classroom setting but at a time and a place of their own choosing. M-Learning can not only provide education for rich internet savvy kids but also to poor kids who are not able to afford or attend primary schools and hence are prevented from getting any primary education. NFC & RFID are some nascent fields which will make learning from M-Learning even more easy and interactive.

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Corresponding Author

Arman Rasool Faridi*

Aligarh Muslim University, Aligarh, India

arman.faridi@gmail.com