

## **An Effective Mobile Learning Model for Learning through Mobile Apps**

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### **ABSTRACT**

With information and communications technology becoming portable and individual-oriented, we are today experiencing the first level of effective mobile learning as it was envisioned decades ago. Mobile technologies have the power to promote and foster collaboration and communication, which are deemed essential for twenty-first century success. Mobile devices allow students to gather, access, and process information outside the classroom. They can encourage learning in a real-world context, and help bridge school, after school, and home environments. This paper discusses a transition between e-learning and m-learning. It also explains the social aspects as one of the context that accounts for mobile learning. Overall it suggests an M-learning framework using different contexts of mobile learning through a RDF data model.

### **Introduction**

Mobile learning is the ability to obtain or provide educational content on personal pocket devices such as PDAs, smart phones and mobile phones. Educational content refers to digital learning assets which includes any form of content or media made available on a personal device. Because of their relatively low cost and accessibility in low-income communities, handheld devices can help the advance digital equity, reaching and inspiring populations at large, children from economically disadvantaged communities and those from developing countries. Not all children are alike; instruction should be adaptable to individual and diverse learners. There are significant opportunities for genuinely supporting differentiated, autonomous, and individualized learning through mobile devices. Mobile devices can help to overcome many of the challenges associated with larger technologies, as they fit more naturally within various learning environments. Mobile learning, or m-learning, can be any educational interaction delivered through mobile technology and accessed at a student's convenience from any location. The software that underlies m-learning includes not only mobile applications designed specifically for learning purposes, but also those designed for other uses - such as geolocation, data access, readers, and maps, that can be adapted for educational purposes. M-learning hardware may include mobile phones, handheld PCs, tablets, the iPad, and netbooks, as well as devices such as the iPod touch that are able to run mobile applications. Because m-learning utilizes a variety of devices, many of which are

ever-present in the lives of students, it can encourage student engagement in learning and offer opportunities to make learning integral to their daily life.

M-learning projects, by contrast, can involve complex tasks that employ multiple applications to track down complex data sets or complete assignments that involve solving multidimensional problems. M-learning accomplishments frequently fall into categories like data collection or application of location-based information, such as checking a map to see whether project team members are nearby. These m-learning activities can be used on a growing list of devices, though the dominance on campus of smart phones with a data plan, which allow users to run applications on the phone's operating system, browse the web, and send and receive e-mail, makes them attractive options for course projects that are supported with mobile technology. That said, the smart phone category represents a range of devices and software, and new classes of mobile tools are emerging, such as HP's Slate and Apple's iPad, that will likely introduce new options and opportunities.

Section 2 discusses the overall work on e-learning and e-learning model. It also explains about the user's transition from e-learning applications to m-learning applications and m-learning model. Section 3 discusses the various contexts in m-learning. Section 4 discusses the proposed m-learning model as an extension of e-learning. Section 5 depicts the findings of the proposed m-learning model in the form of a RDF graph. Discussions about the past, current and future works are given in section 6.

### **Literature review**

#### *A transition from E-learning towards M-learning*

The term e-learning comprises a lot more than online learning, virtual learning, distributed learning, networked or web-based learning. As the letter "e" in e-learning stands for the word electronic[1], e-learning would incorporate all educational activities that are carried out by individuals or groups working online or offline, and synchronously or asynchronously via networked or standalone computers and other electronic devices. The growing interest in e-learning seems to be coming from several directions. These include organizations that have traditionally offered distance education programs either in a single, dual or mixed mode setting. They see the incorporation of online learning in their collection as a logical extension of their distance education activities. The corporate sector, on the other hand, is interested in e-learning as a way of rationalizing the costs of their in-house staff training activities.

E-learning is of interest to residential campus-based educational organizations as well. The growth of e-learning is directly related to the increasing access to information and communications technology, as well it's decreasing cost. The capacity of information and communications technology to support multimedia resource-based learning and teaching is

also relevant to the growing interest in e-learning. Growing numbers of teachers are increasingly using information and communications technology to support their teaching. The contemporary student population often called the Net Generation, who has grown up using information and communications technology, also expect to see it being used in their educational experiences. A key attribute of information and communications technology is its ability to enable flexible access to information and resources. Flexible access refers to access and use of information and resources at a time, place and pace that are suitable and convenient to individual learners rather than the teacher and/or the educational organization.

*Various modalities in E-learning activity*

The various modalities of e-learning activities are discussed as given below (Naidu, 2003)

*Individualized self-paced e-learning online:* refers to situations where an individual learner is accessing learning resources such as a database or course content online via an Intranet or the Internet. A typical example of this is a learner studying alone or conducting some research on the Internet or a local network.

*Individualized self-paced e-learning offline:* refers to situations where an individual learner is using learning resources such as a database or a computer-assisted learning package offline (i.e., while not connected to an Intranet or the Internet). An example of this is a learner working alone off a hard drive, a CD or DVD.

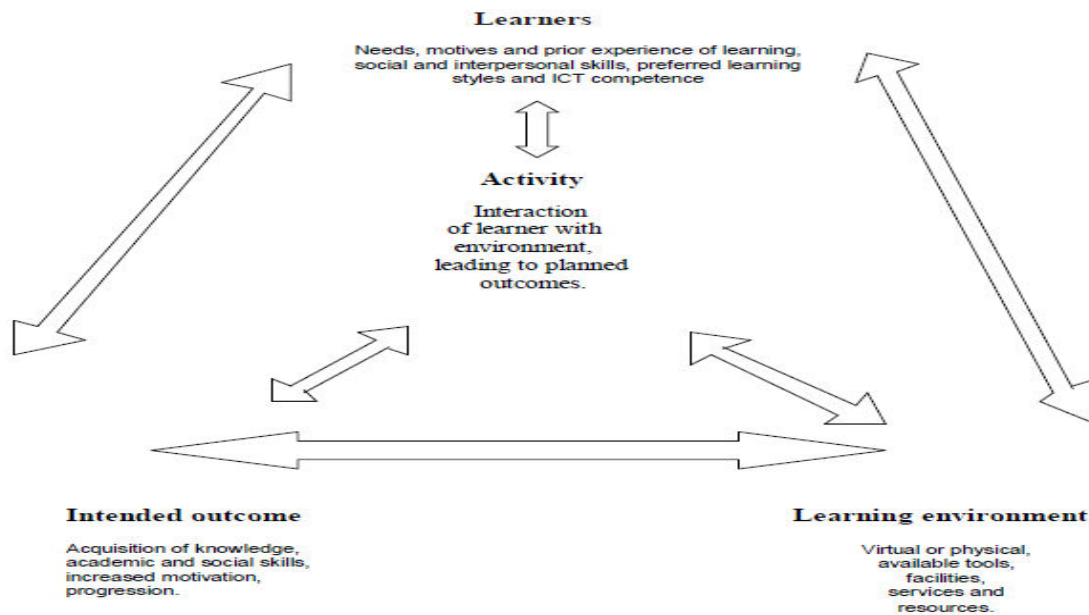
*Group-based e-learning synchronously:* refers to situations where groups of learners are working together in real time via an Intranet or the Internet. It may include text-based conferencing, and one or two-way audio and videoconferencing. Examples of this include learners engaged in a real-time chat or an audio-videoconference.

*Group-based e-learning asynchronously:* refers to situations where groups of learners are working over an Intranet or the Internet where exchanges among participants occur with a time delay. Typical examples of this kind of activity include on-line discussions via electronic mailing lists and text-based conferencing within learning managements systems.

*Designing a learning activity that incorporate e-learning*

A learning activity represents the means by which the practitioner brings about learning and seeks to influence the development of learners. The fig-1 (Knight, 2004), illustrates fully the art of the practitioner at work in creating and sequencing learning activities, by showing the importance of aligning three essential elements at the heart of learning activity design with the overall pedagogical approach and practice. Each of the three elements brings with it factors which will have some influence on the designing process.

*Learner:* It can be defined as an object with their needs motives for learning, prior experience of learning, social and interpersonal skills, preferred learning styles and expectations of the course and of the practitioner.

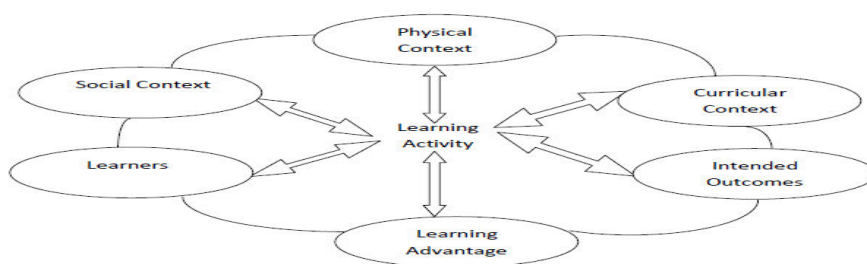


*Learning environment:* It represents available resources, tools, facilities and services and their match with the learners' needs.

*Intended learning outcomes:* It represents the purpose behind the learning activity; internal or external goals and targets. Within the context of any activity, the interaction between these three factors will be dynamic and may influence decisions in an unequal way. The decisions that underpin designing for learning in any particular context, and in any given pedagogical approach, will increasingly involve a selection from both new and established practices, based on perceptions of the learners' needs, the nature of the learning environment and the intended outcomes, as practitioners seek to orchestrate effective learning by seeking out the most appropriate tools.

**Figure 1:** Model of learning Activity Design

*An e-learning model:*



**Figure 2:** An e-learning model

Here the fig-2(Knight, 2004), shows an e-learning model which is associated with various elements such as learning activity, learners, learning advantage, intended outcomes, physical context, social context and curricular context. Social context includes communities of practice, group identification, attitude, values and belief.

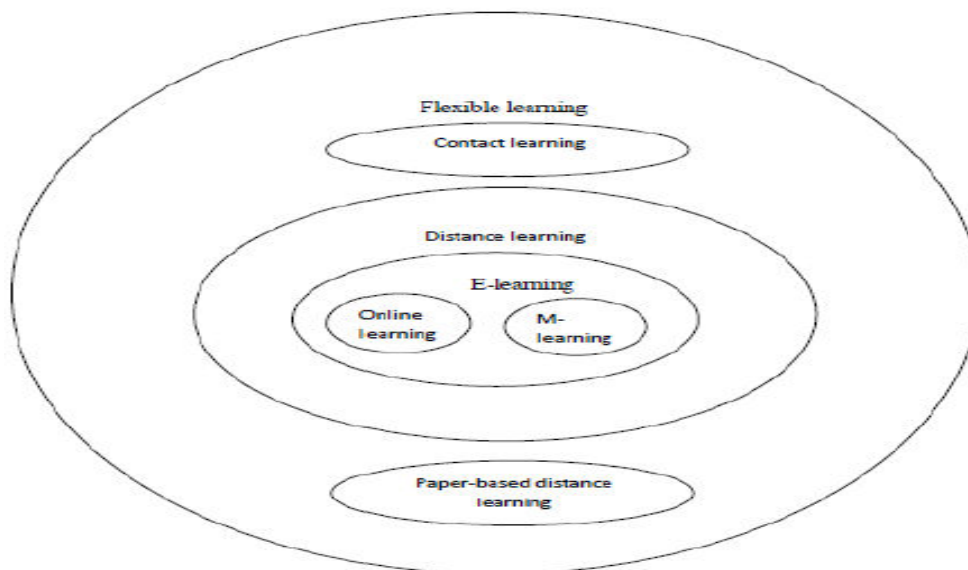
In this context teachers will recognize that when students work collaboratively to assist one another and take on expert roles. Teachers will consider strategies that they can use to build learning communities and to enhance their learning strengthened, reinforced and refined. Collaboration is highly supported for mobile learning. The mobile learning technology (G.Stanton, 2013), removes borders and allows learners to collaborate with peers to peer learning around the world, how and when they want to. Mobile learning environment includes interactions such as learner-to-content, learner-to-teacher, learner-to-learner interactions and learner to interface interaction. These interactions are highly supported by mobile technology and can be utilized quite effectively in a mobile learning environment. Learner-to-Content interaction plays a key role in forming ways of thinking for the learner that will facilitate learning. Learner-to-Teacher interaction is a motivational and facilitation role in learning as well as providing a supporting role. Learner-to-Learner interaction allows for more collaborative to take place. Learner-to-interface interaction is about the learner's experience with the mobile learning and the quality of it. The curricular context [4], associated with the content, teaching/learning methods, assessment and learning resources in e-learning. This context (J. Mckimm, 2007), usually defines the learning that is expected to take place during the programme of study in terms of knowledge, skills and attitudes. It also specifies the main teaching, learning and assessment methods and provides an indication of the learning resources required to support the effective delivery of the course. The physical context in e-learning deals with resources, tools, facilities and services.

#### *Why M-learning?*

The mobile devices is the handheld technology not only accompany the learner almost anywhere but also provide a platform that is rapidly evolving and always connected to data sources. Learning management systems adapt mobile apps which are always on and anyplace technologies, that crosses the physical boundaries and extends classrooms. Ease of use offered by mobile devices supports lifelong learning and the devices themselves are integrated into everyday life to facilitate authentic learning. Ultimately, it might be the ubiquity of these student-owned devices that ensures their use as teaching and learning tools. Where wireless networks are available, or where smart phones with data plans have access to cell networks, mobile lessons and exercises can leverage the ability to gather information from a variety of interdisciplinary sources in a wide array of formats while exploiting the

value of location-based learning. While some m-learning applications may be provided by colleges and universities, mobile technology in the main provides an inexpensive layer of functionality to the institution, capitalizing on an infrastructure that is increasingly supported by cloud services and by the technology that students bring to campus.

Mobile learning is the ability to obtain or provide educational content on personal pocket devices such as PDAs, smart phones and mobile phones. Educational content refers to digital learning assets which includes any form of content or media made available on a personal device. Mobile learning (T. Brown, 2003), can be a natural evolution of e-learning, which completes a missing component such as the wireless feature or as a new stage of distance and e-learning. M-learning is often described as occupying a sub-space within the e-learning space, which is in turn a sub-part of digital learning. E-learning is a subset of technology-based training. It also incorporates a number of learning activities conducted on the Internet, of which mobile learning is one part. E-learning can be real-time or self-paced, also known as synchronous or asynchronous learning. Additionally, e-learning is considered to be tethered and presented in a formal and structured manner. In contrast, mobile learning is often self-paced, un-tethered and informal in its presentation. Because mobile devices have the power to make learning even more widely available and accessible, mobile devices are considered by many to be a natural extension of e-learning. More ever E-learning is the macro concept that includes online and mobile learning environments. E-learning is in turn a subset of distance learning, which is in turn a subset of flexible learning. M-learning is e-learning through mobile computational devices. The fig-3 shows e-learning vs. m-learning [6]. A comparative analysis between e-learning and m-learning is given in table 1.



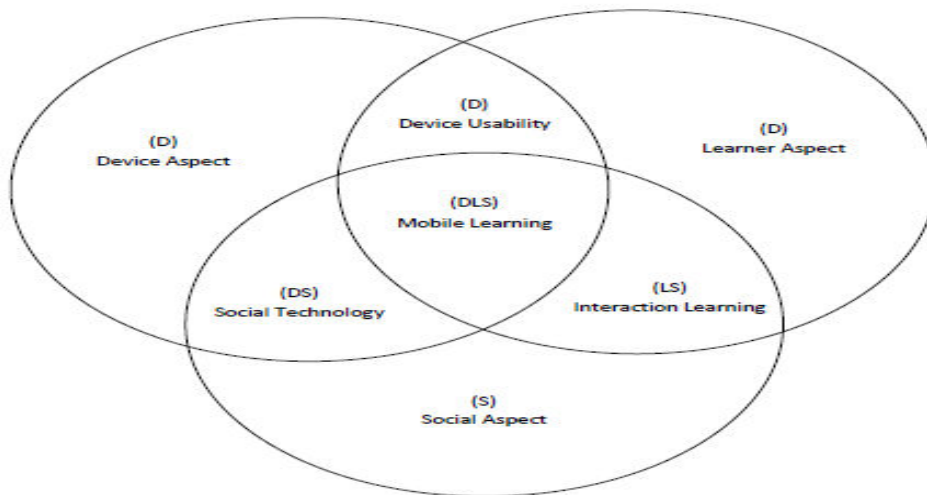
**Figure 3:** E-learning vs. M-learning

**Table 1:** Comparison between E-learning and M-learning

E-learning	M-learning
Lecture in classroom or internet labs	Learning anywhere, anytime
E-mail-to-e-mail	Instantaneous messaging
Location specific	No geographic boundaries
Travel time to reach to internet site	No travel time with wireless internet connectivity
E-learning involves the use of some technologies like desktop and laptop computers, software, digital camera, video conferencing tool and mobile wireless tool.	M-learning involves only wireless tool as mobile platforms.

Source: Secondary Data

*M-learning model:* The Venn diagram (M. L. Koole, 2009), aptly represents the three aspects of mobile learning, Device, Learner and Social. The Device aspect refers to the various capabilities of the mobile device that includes its specifications, physical and functional characteristics. These characteristics have a significant impact on the usage habits of the learner and therefore require a comprehensive investigation before being implemented. Acting as a bridge between human being and technology, devices should be designed for maximum comfort.



**Figure 4:** M-learning model

Generally mobile device aspects consist of its visualizing characteristics since it plays a relevant role in every domain of mobile applications. Compared to the desktop computers, the mobile devices have downside such as less CPU capacity, small screen size, and low level graphics. Now new mobile applications are developed to provide context-aware service to the user. Context-awareness gives considerable added value to mobile visualizations for example the system can be aware of the lighting conditions by adapting brightness and contrast of the visualization. The mobile system can be aware of the geographic location by drawing the appropriate map. The mobile apps can be aware of user's interests by highlighting personalized points of interest in the visualization. The small screens of mobile devices allow only for a very small quantity of text to be shown on a single screen with an adequate font. This seriously affects readability and a number of important tasks. Dynamic text presentations [8], are being tested in the mobility context because they require very limited screen space. For example, Leading Presentation scrolls the text horizontally on one line, while Rapid Serial Visual Presentation (RSVP) displays text as small chunks appearing in sequence at a single location. Leading presentation is more familiar and thus initially more acceptable to users. It is possible to effectively read long texts with RSVP. It is as efficient as reading from a book or on a large screen, but is cognitively more demanding. RSVP appears to be faster than MS Explorer on a PDA for text presentation of short texts, and just as fast for long texts. RSVP can cycle among a sequence of regions of a picture. The selection of the regions can be based on the automatic identification of likely user's regions of visual attention. The RSVP browser works well with photographs of groups of people, but tends to be less effective with generic photographs taken from the news. The abstract data that includes calendar applications, medical records and stock market records, are visualized on mobile apps in many ways. For example the user can start from a calendar overview of a large time period, and then specify a focus by tapping on a day and expanding its details without losing the global context. Drawing bar charts (L. Chittaro, 2006), on small screens of mobile phones have been tested by visually encoding the sign so that positive and negative bars can grow in the same direction and more screen resolution becomes available for discriminating the relative size of bars. The Social aspect takes into account the various interactions between two learners with their mobile devices while following the rules of cooperation to communicate. However, what we are really concerned about is the area where all these three aspects intersect each other. Web 2.0 provides the user with more user-interface, software and storage facilities, all through their browser. This has been (K.G.Jayade, 2013), called network as platform computing. Web 2.0 applications are those that make the most of the intrinsic advantages of that platform: delivering software as a



continually-updated service that gets better the more people uses it. Web 2.0 apps are consuming and remixing data from multiple sources, which includes individual users. These web apps are providing their own data and services in a form that allows remixing by others and creating network effects through architecture of participation and going beyond the page metaphor of Web 1.0 to deliver rich user experiences. Major features of Web 2.0 include social networking sites, user created web sites, self-publishing platforms, tagging, and social bookmarking. Users can provide the data that is on a Web 2.0 site and exercise some control over that data. These sites may have an "architecture of participation" that encourages users to add value to the application as they use it. Social networks (M.Giles, 2010), are being used to break down internal barriers in the corporate world too. Social networks deserve applause for developing this fine -grained controls, and for their efforts to educate youngsters in the appropriate use of social networking sites. But their desire for profit can put them on a collision course with privacy activists, regulators and their users. Face book also has a plethora of controls that can be adjusted to create different levels of confidentiality. Default settings for younger people on social networking sites are often more restrictive than those for adults to ensure they are protected from unwanted attention. There are networks such as Face book and MySpace that are mainly for socializing with friends, and there are others such as LinkedIn aimed at professionals. Face book can do well using a variety of different ad formats rather than a single. The social networks has attracted companies is their ability to target ads with laser like precision and the data they hold on company's user's ages, gender, interests and so forth. The rise of mobile phone based networking will have an impact on rich world markets too. Face book, which has some 65m mobile users, says they are almost half as active again on the site as other folk.

The Learner aspect focuses on the cognitive abilities of the learner such as context and transfer, memory, prior knowledge, emotions and motivations and discovery learning. Mobile learning helps the learner access content in various formats and these factors have a vital role to play in the encoding, recalling and transfer of information. Mobile learning can in fact help students to be more motivated and therefore improve their overall performance. M-learning introduces a whole new type of learning, different from the typical tasks such as making notes, reading from a textbook, etc. This variety within a learning course is sure to increase levels of interest among learners. M-learning is very accessible. Students are able to complete homework tasks wherever they are. If students know that they can complete their homework without being glued to a desk, they would be more likely to do so. The intersection of all the three aspects in the m-learning model facilitates mobile learning in mobile apps. The interaction of device, learner and social is what defines mobile learning, which itself is an

ever-evolving process. As the amount of knowledge increases, it is necessary to rapidly evaluate it for worthiness and that's where mobile learning comes into help. Governed by flexible social, technological and cognitive factors, mobile learning helps users get immediate access to knowledge and experts, who help in determining the relevance and importance of the information found on the Internet.

*Enhancement of Social Apps through M-learning in Mobile Devices*

In today's classroom, the reality is that laptops have started to take the second row to allow space for smart phones, tablets, and other mobile devices. Most of the new applications which are created for mobile devices include social media or web 2.0 tools and these apps are accessed easily from mobile devices. A social media application through mobile devices improves student engagement and interactivity in the classroom. Using tablets in the classroom, shows an increase in student's active participation during lectures and evaluates student's learning by enhancing their ability in the learning process. Social media fosters communication (A. L.Harris, 2009), engagement, and collaboration.

A community can be created locally beyond the boundary of a single classroom for a particular class and even beyond the campus for a university using a virtual world which can be referred as second Life. The second life allows students to communicate with each other and the instructor through a three dimensional simulator which comes complete with a variety of audio and visual objects (C.Wankel, 2009). The rapid advance of technology and increasing student use [13], were driving faculty to implement technology within the classroom and the faculty who participated in this study were self-motivated to use social media for teaching. The advantage of using social media tools in classroom includes student feedback from multiple sources and engages students. It also provides information sharing, stronger classroom community and higher quality student collaborative work.

Class management and discipline problems are hardly new phenomena in higher education [14]. It is quite reasonable that college students might experience learning at times as compulsory, frustrating, boring, or irrelevant and behave accordingly. In the past, probably most students would believe that reading the newspaper or listening to a walkman during a lecture is rude and illegitimate. Moreover, while most instructors would ban newspaper reading or walkman listening during lectures. However, it seems that the mobile culture has changed students and instructors expectations (R.Hammer, 2010). According to this social conventions are rapidly changing today. The mobile culture has heavily invaded college classrooms. More and more young students might feel it is their right to be multi-taskers during lectures.

### *Usage of Mobile Technologies in Education*

In the context of distance education, mobile learning is classified into four types [16]. It includes,

1. High transactional distance socialized m-learning.
2. High transactional distance individualized m-learning.
3. Low transactional distance socialized m-learning.
4. Low transactional distance individualized m-learning.

High transactional distance socialized m-learning activity or process occurs, when the learners have more psychological and communication space with their instructor or institutional support. Here the learners are involved in group learning or projects where they communicate, negotiate and collaborate with each other. In this type of m-learning process learning materials or the rules of activity are delivered from the pre-determined programme through mobile devices and communications mainly occur among learners and the instructor or teacher where they have minimal involvement in facilitating the group activity. For example, the Math MCSCL project uses activity theory as a conceptual framework (G. Zurita, 2007). In this framework an activity was developed to enable grade 2 students to practice addition, subtraction and multiplication in a group. In this activity, students with a certain number of objects have to reach the target quantity for each object by exchanging them with other students on their mobile device. Individual students keep track of the quantities of each object by performing arithmetic operations and search for other students to exchange objects with. They have to talk, negotiate and collaborate to achieve the goal of the game. Although the content area in the example is mathematics, but these activities require building social interaction, negotiation, and collaboration skills among group members. In developing this type of activity, instructors and instructional designers need to give special attention and effort to the design of the mobile application and the set-up of social interaction by defining the rules of the game and the roles of players.

The high transactional distance individualized mobile learning activities occurs, when the individual learners have more psychological and communication space with the instructor or instructional support. In this process the individual learners receive tightly structured and well-organized content and resources through mobile devices. The individual learners receive the content and control their learning process. This type of learning activity provides the interactions between the individual learner and the content. This learning process demonstrates an extension of e-learning that allows greater flexibility and portability. Individual learners fit this flexible learning into their mobile lifestyle. This type is mostly influenced by the context regarding when and where to learn. This type of learning process

also includes m-learning for students in rural areas. The off-campus postgraduate development programme of the Australian national university is an example of this m-learning activity which is implemented both online and on mobile modes of distance learning (E. A. Beckmann, 2010). The low transactional distance socialized m-learning process provides individual learners to interact both with the instructor and other learners as they use mobile devices. They have less psychological and communication space with the instructor and loosely structured instruction, but they work together in a group as they solve the given problem and trying to achieve a common goal. This m-learning activity engages learners in social interaction, negotiation and frequent communication. This learning type also demonstrates the most advanced forms in terms of the versatility of mobile devices and learners social interactions. For example, the mobile device can be used as simulation and game tool where students play the role of environmental engineers and are given a scenario in which the spread of a toxin is simulated on a location-aware pocket PC equipped with a GPS [19]. The pocket PC allowed students to investigate a toxic spill by collecting samples to test for chemicals in the groundwater and required them to respond to different variables programmed by the teacher. Many students indicated that these types of collaborative activities helped them to evaluate their choices, motivated them and transformed their perceptions of learning. Developing this type of learning requires instructional designers and instructors to promote their active participation and to allow students to have many social experiences. This last type of mobile learning activity refers to less psychological and communication space between instructor and learner. It provides loosely structured and undefined learning content. This kind of learning process allows individual learners to interact directly with the instructor. It also allows the instructor for leading and controlling the learning in an effort to meet individual learner's needs. This type also shows characteristics unique to m-learning that support blended or hybrid learning.

### **Categorization of Contexts in M-learning**

#### *General contexts*

Context is any information that can be used to characterize the situation of entities, i.e., whether a person, place or object that are considered relevant to the interaction between a user and an application, including the user and the application themselves. Context (M. Baldauf, 2007), can be classified into different dimensions such as external context and internal context or physical context and logical context. Context can (G. Chen, 2000), also be divided into four categories such as computing context, physical context, user context and time context. It is a fact that context has no uniform or standard definition. So everyone can give his understanding about context and it can be classified into any dimension. However in

mobile computing area, the target of using context is to enable the device to better serve for people, either human computer interaction or context-aware mobile application/service.

Classifying of context should embody human-centric essence. It includes classification of context [22], into three dimensions such as physical context, internal context and social context. Physical context refers to real world nearby user, making up of physical things. Internal context is composed by abstract things inside people, such as feeling, thought, task, action, interest, goal etc., which is very related to people. Social context means user's social surrounding, that is social relationship of user. This social context consists of persons related to user.

#### *Contexts in mobile learning or m-learning*

Mobile learning is the ability to learn different contexts. Mobile learning is unique by nature which is the combination of mobile technology and its affordances that create a unique learning environment and opportunities that can span across time and place. Delivering content, to the user should be based on their current context. Context plays an important role while designing the m-learning environment. The mobile learning context is where the situational and learning context meets in a learning environment. Contexts are created through mobile learning and classified as (G.Stanton, 2013), learning context, social or situational context and learning environment context. The learning context is mainly focused on three entities such as learner context, learning components and learning contents through mobile device or apps. It also accounts for learner's aspects such as profile, preference, physiological and cognitive ability. Profile is used to handle the learner's personal information such as name, address etc. The Preference context contains information about the learner's preferences including learning style and learner's intention. Physiological and Cognitive states are related to the learner's physical and cognitive characteristics. This learning context also considers the learner's memory, prior knowledge, emotions and possible motivations. These states have significant impact upon encoding, retaining, and transferring information. Mobile learning may help to enhance encoding, recall, and transfer of information by allowing learners to access content in multiple formats and highlighting the contexts and uses of the information.

The social or situational context is the actual context in which the learner currently exists as they access or receive learning from a mobile device. The social aspect takes into account the processes of social interaction and cooperation. Individuals must follow the rules of cooperation to communicate by enabling them to exchange information, acquire knowledge, and sustain cultural practices. Rules of cooperation are determined by a learner's culture or the culture in which an interaction take place. In mobile learning, this culture may be physical

or virtual. It is important to realize that there may be constraints upon participants in a conversation. Such constraints provide guidelines and predictability for behavior that enable effective communication.

Cooperative communication requires that contributions are as informative as necessary, accurate, relevant, and sufficiently clear. When a participant neglects to follow one or more of the rules, miscommunication occurs. This context will involve any distractions or interruptions to the learning environment context. Using mobile technology can often be a secondary task within our social context, mobile phones have introduced unpredictability. When one person calls another they are not sure what situation that person is in and cannot know whether they are interrupting that person. It is also a common expectation that someone can answer a call at any time as they will always have access to their phone. The mobile device is then an extension of that person's situation, so while a user is interacting with the mobile technology they are also involved with the world as negotiated and enacted in the moment.

Mobile learning has the ability to cross the boundary of a learner's context and facilitate sense making activities. The learner is now able to move beyond the classroom, both taking the classroom with them while being removed from that context. The mobile learning environment is able to create its own environment within any situational context and engage the learner. The learning environment context takes into accounts for context elements as device contexts and network contexts. The device context refers to the physical, technical, and functional characteristics of a mobile device. The physical characteristics include input and output capabilities as well as processes internal to the machine such as storage capabilities, power, processor speed, compatibility, and expandability. These characteristics result from the hardware and software design of the devices and have a significant impact on the physical and psychological comfort levels of the users. It is important to assess these characteristics because mobile learning devices provide the interface between the mobile learner and the learning task. In other words, the device characteristics have a significant impact upon usability. In order for a device to be portable, for example, the size, weight, structure, and composition must match the physical and psychological capacities of the individual users. In particular, input and output capabilities must be suited to human perception. Similarly, the capacity and speed of the device memory, processor, file storage, and file exchange require error-free response rates appropriately timed to the human user's needs and expectations. Learners equipped with well designed mobile devices should be able to focus on cognitive tasks rather than on the devices themselves. Device portability is dependent upon the physical attributes of the device such as size and weight, the number of

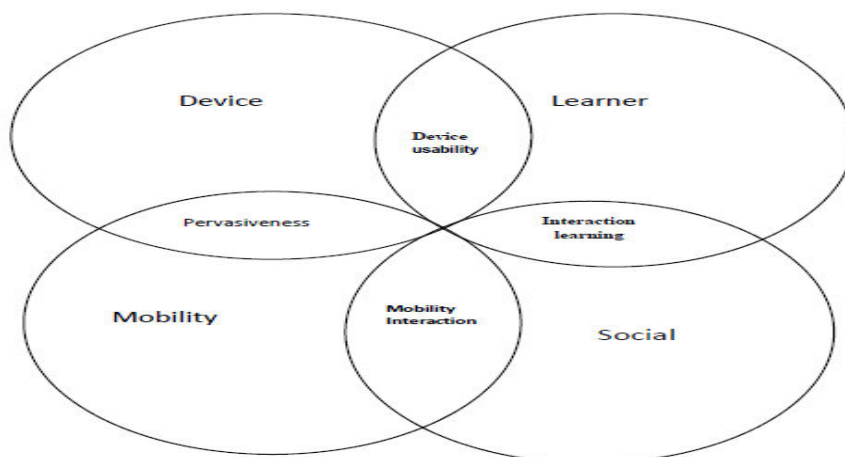
peripherals, and the materials used in the construction of the device. Highly portable devices must resist humidity, dust, and shock. Information access complements portability, and it enables information to travel with the user rather than the user moving to the information. Psychological comfort in learning refers to how intuitive the device is or how quickly a learner can understand and begin using the device. Users should be able to learn the main functions quickly so they can accomplish desired tasks as soon as possible.

The network context includes minimum speed and maximum speed exchange of information in a network. The learner is now able to move beyond the classroom, both taking the classroom with them while being removed from that context. The mobile learning environment is able to create its own environment within any situational context and engage the learner through its device and network contexts.

### Research Methodology

There have been many mobile learning models developed, but those are context specific and are using pedagogical approaches and techniques. The model we propose here is based on mobile learning contexts and RDF technology. Here we have taken four aspects of mobile learning such as device aspect or context, learner context/aspect, social aspect/context and mobility context or aspect. The device aspect and mobility context may be included in mobile learning environment context. The learner aspect is included in learner context and social aspect included in the social context of mobile learning or m-learning.

*Proposed model for mobile learning*



**Figure 5:** Proposed Model for Mobile Learning

Here the figure 5 shows a proposed model for mobile learning. This proposed model focuses various aspects in mobile learning, which is based on various contexts of mobile learning as described above. This model includes aspects device aspect, learner aspect, social aspect and mobility aspect.

*Contexts or aspects*

1. Device aspects include mobile devices or learning component in which m-learning occurs. Mobile learning is impossible without learning components or mobile devices. These devices vary in features, size, ability and price. These learning components include mobile phones, PDA and tablets. The physical characteristics of these devices include size, weight, configured technology and one hand or two hand operability. These physical characteristics enable the user, how it can manipulate the device and move around while using the device. The input mechanisms includes using of keypad, touch screen, pen/stylus, swipe types that allows to position and selection of objects and data on the mobile device. The output mechanisms include using of screen, speakers and other audio/visual methods to allow the human body to sense changes in the device and also allow the user to interact with the device. The device aspect also includes memory, processor speed to provide support to learners for learning activities in m-learning.

2. The learner context or aspect consists of the following element such as learner profile, cognitive, physiological and preferences. The learner profile includes learner's personal information such as name, age, address, goal and profession. The preference context contains information about the learner's preferences including learning style and learner's intention. Physiological and Cognitive states are related to the learner's physical and cognitive characteristics or abilities. A learning style is a particular method of learning to an individual that is presumed to allow that individual to learn best. Learning styles can be defined as characteristics which are cognitive, affective, physiological behavior that serves as relatively stable indicators of how learners perceive, interact with and respond to learning environment. Each learner has its own learning style and preferences that can help him/her to accelerate his/her learning process. Learning styles can be classified into some dimensions such as active, reflective, sensing, Intuitive, visual, verbal, sequential and global. Active learning style refers to the learner preference on actively processing information on the learning content. In reflective learning style, the learner has the preference to read and think about the learning content. Sensing learning style refers to the learner preference in reading concrete material such as facts and data. Intuitive learning style refers to the learner preference in reading abstract material such as theories and concepts on the learning content. Visual and verbal learning styles refer to the learner preference in reading pictures, images and texts on the learning content. Sequential learning style also called as bottom-up style where the learner focuses on the narrow details first and brings them together to form the larger picture. Global learning style also called as top down style where the learner finds easier to learn by having the overall picture and getting the details. The learning content is the central element



in the success of any mobile learning application because it determines whether the learner fully engage in the learning experience. The mobile learning application must be able to support all relevant file formats and content types so that learner could access all required content seamlessly. The learning content delivered to the learner is of any format that includes text, audio, video, animation or slide show. The determination of format of learning contents is made by sets of constraints such as display, screen size, processing power, memory and location of the mobile device or learning components.

3. The social aspect or context includes web server and mobile browser by which learning process happens through mobile device. The web server refers to either the hardware or the software that helps to deliver web content that can be accessed through the Internet. The most common use of web servers is to host websites, but there are other uses such as gaming, data storage, running enterprise applications, handling email etc. The mobile web server application allows mobile devices a means for hosting personal web applications including web pages and server side control. The most commonly used HTTP servers and servlet containers currently available are jetty, tomcat, glassfish and resin. A mobile browser also called a micro browser or wireless Internet browser is a web browser designed for use on a mobile device such as a mobile phone or PDA. Mobile browsers are optimized so as to display web content most effectively for small screens on portable devices. Mobile browser software must be small and efficient to accommodate the low memory capacity and low-bandwidth of wireless handheld devices. The mobile browser usually connects via cellular network or wireless LAN using standard HTTP over TCP/IP and displays web contents in mobile devices. Through web server and mobile browser, learner can obtain their learning process in the form of learning module. The learning module is a packet of learning objects consisting of learning activities and contents. Learning objects is defined as an entity that may be digital or non-digital, which is used for learning, education or training. A learning object [26], is any digital resource that can be reused to support learning. In mobile learning, learning object refers to any digital resource. These objects are digital self-contained and reusable entities, with a clear educational purpose, with at least three internal and editable components such as content, learning activities and elements of context. The learning objects must have an external structure of information to facilitate their identification, storage and retrieval of metadata. Learning objects are a new way of thinking about learning content. Learning objects are much smaller units of learning, typically ranging from 2 minutes to 15 minutes. Each learning object can be taken independently. A single learning object may be used in multiple contexts for multiple purposes. Learning objects can be grouped into larger collections of content including traditional course structures. They are tagged with metadata

having descriptive information and allowing it to be easily found by a search. Learners are able to enable their learning process from learning modules consisting of learning objects in mobile learning application.

4. Mobility aspect allows the mobile users to sense and react in everyday situations in the world with simple system architecture. The mobility of the mobile device is the key to the idea of mobile context awareness where sensing and reacting is done by the mobile device itself. To achieve mobile context awareness, mobile device should be equipped with various sensors. For example location of a user as well as mobile phone is determined through GPS sensor in an outdoor application. To identify the location of any user or location of any place that is nearer to that user, GSM and WLAN is used in a mobile apps, in an indoor application such as within a building. User and its activity are captured by monitoring user interactions such as the user's goals, tasks, work context, business processes. They are captured by physical sensors. For example user's activity on mobile screen either touch or swipe can be captured by touch sensors which are implemented in mobile devices.

#### *Interactions*

*Pervasiveness:* The interaction between mobility aspects with the mobile device provides pervasiveness. Pervasiveness or ubiquity allows time and location access every individual user everywhere irrespective of device capabilities such as screen size, resolution, display properties and computational properties. Pervasiveness feature in mobile apps enables the applications to be device aware, time aware and location aware and make them personalized. Pervasiveness or context aware mobility in mobile devices allows the user to go anywhere and to access the device for getting context aware application in any environment. Pervasiveness allows the user to learn in any environment through mobile apps.

*Device Usability:* Device usability contains the affect of the device characteristics on learner's physiological comfort in learning. Device portability allows the learner's learning ability in all the environments with respect to device location. Availability of information or stored information on the device enables the learner to access them anywhere anytime and provides just-in-time learning. The physiological comfort allows the learner to understand and begin the device easily. For example learnability, memorability, intuitiveness affects the cognitive load and speed with which learner perform learning in devices.

*Social interaction:* Social interaction allows by how the mobile device provides communication and collaboration among individual user and systems. The mobile device hardware and software provides communications such as WLAN and GPS services through which m-learning applications happens. It also provides social interactions through different web servers and mobile browsers in m-learning. Social interaction allows the wireless

network which is a most significant feature in mobile apps, that assist mobile learners to communicate among themselves and provides exchange of information even though they are spatially and temporally separated.

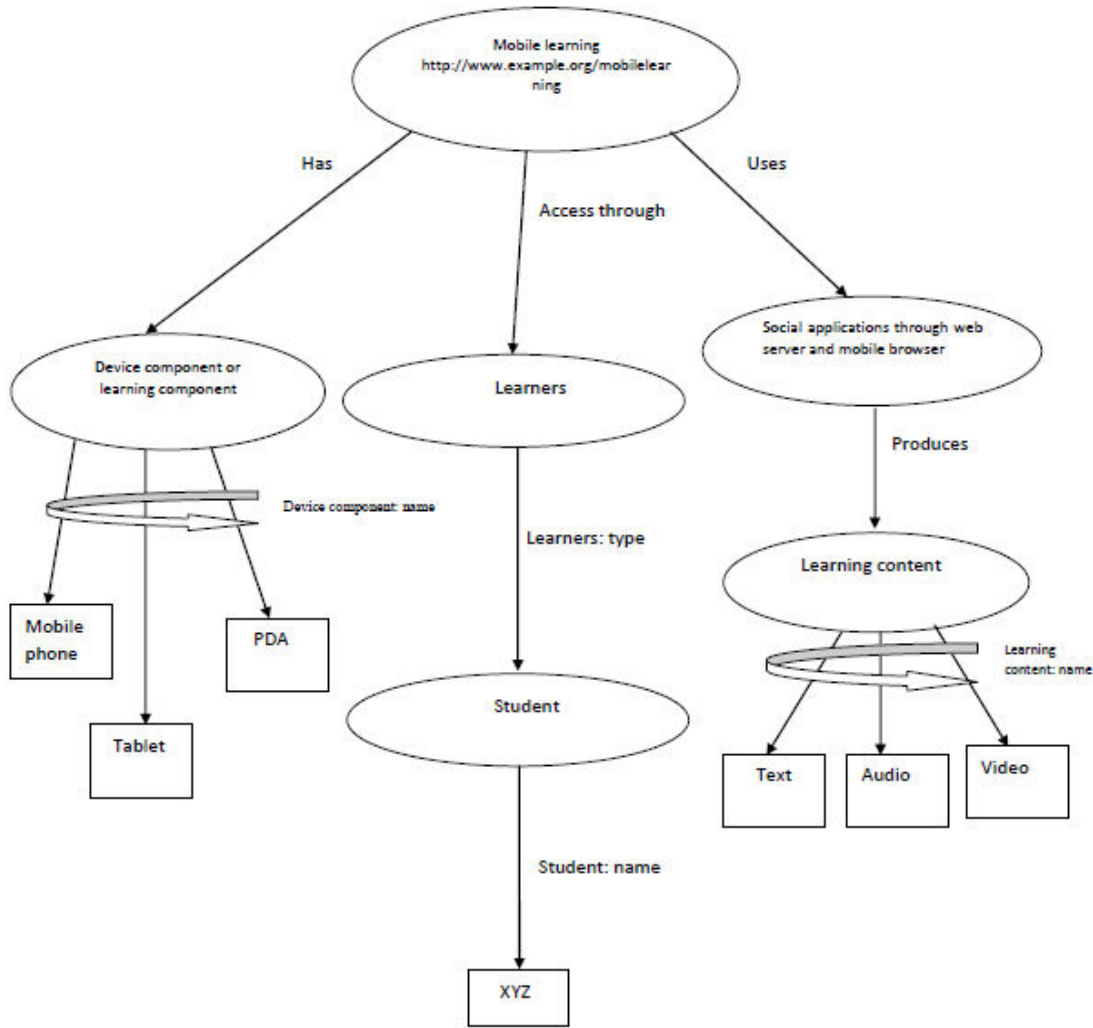
*Mobility interaction:* The interaction of mobility context with the social context or aspect provides social application or any business application by enabling communication tools such as WLAN and GPS services in a mobile device. The context aware mobility captures context data such as location of the device as well as user and provides mobile learning application to the individual user any where any time.

#### *Building RDF in m-learning application*

Resource Description Framework (RDF) is a framework for representing information about resources in a graph form and recommended by W3C. Since it was primarily intended for representing metadata about WWW resources and it is built around resources with URI. RDF is designed to represent information in a minimally constraining, flexible way. It can be used in isolated applications, where individually designed formats may be more perspicuous, but RDF's generality offers greater value from sharing. The value of information thus increases as it becomes accessible to more applications across the entire Internet. RDF is a common acronym within the semantic web community because it forms one of the basic building blocks for forming the web of semantic data. By including more expressive constructors to describe the semantics of the elements, RDF provides mechanism to achieve the balance between expressiveness and computability, consequently enables a formal knowledge representation that enhances the capabilities of model computational processing and its adaptability.

#### *Representation of RDF graph data model in m-learning apps*

In resource description frame work (RDF), data is stored in a graph model for semantic data. Also, in RDF information is represented by triples that are in a subject-predicate-object form. The RDF graph has nodes and labeled directed *arcs* that link pairs of nodes and this is represented as a set of RDF triples where each triple contains a subject node, predicate *and* object node. Predicates refer to the relationship among the nodes or the property of the nodes. In RDF, the statements are built by taking subject, predicate and objects. RDF statements describe the characteristics of their subjects using properties, or predicates in RDF terminology.



**Figure 6:** RDF Graph Data Model

*Building RDF in M-learning Application*

*Building the first document in RDF:*

```
<rdf: RDF
xmlns : rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#">
xmlns : ex="http://www.example.org/">
<rdf: Description
rdf : about="http://www.example.org/mobilelearning"/>
<ex: has rdf : resource="http://www.example.org/#devicecomponent">
<ex:name> Mobile phone</ex:name>
<ex:name> Tablet</ex:name>
<ex:name> PDA</ex:name>
</ex:has>
</rdf:Description>
</rdf:RDF>
```

*Building the second document in RDF:*

```
<rdf: RDF
xmlns : rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#">
xmlns : ex="http://www.example.org/">
<rdf: Description
rdf : about=="http://www.example.org/mobilelearning"/>
<ex:accessthrough rdf:resource= "http://www.example.org/learner">
<ex:student rdf:parsetype="Resource">
<ex:name> XYZ</ex:name>
</ex:student>
</ex:accessthrough>
</rdf:Description>
</rdf:RDF>
```

**Findings**

RDF provides a general, flexible method to decompose any knowledge into small pieces, called triples, with some rules about the semantics of those pieces. The foundation is breaking knowledge down into basically is called a labeled directed graph and also called as terminology. By putting a lot of facts together, one can arrives at some form of knowledge. From figure-6, it can be seen that mobile learning has learning or device components. The learning components include various mobile devices. The mobile learning has access through the learners. Learners are students. This fact or knowledge can be represented in RDF in a tabular notation by taking start node, edge level and end node. This fact also can be represented as RDF triples as given below,

**Table 2: RDF Triples**

Start node	Edge level	End node
Mobile Learning	Has	Learning Component
Learning Component	Name	Mobile phone
MobileLlearning	Access through	Learners
Learners	Type	Student

Source: Secondary Data

**Conclusion**

This paper aims in building a framework for mobile learning in mobile apps by including m-learning contexts. These learning contexts are then represented or stored in the form of entities and relations in ontology at a conceptual level to obtain semantics in data. This paper also comprises RDF tool for representing data in terms of knowledge and facts.

## Discussion

Here we have proposed a model which describes different contexts of mobile learning by means of device, learner, social and mobility. This model proposed here uses RDF or resource description framework technology. In the past learning process in education is based on knowledge adoption and production. The behavior of the education has objectives, and is cognitive and constructive with no navigation. But now the education has changed and is based on knowledge navigation through wireless devices like mobile devices and laptops. Now the learning is the combination of study, research, evaluation and navigation. The mobile device plays the primary source of knowledge instead of teacher in the learning process. In mobile learning application, the focus of learning is to navigate in the ocean of knowledge.

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