A New Mobile Learning Adaptation Model

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Abstract—This paper introduces a new model for m- Learning context adaptation due to the need of utilizing mobile technology in education. Mobile learning; m-Learning for short; in considered to be one of the hottest topics in the educational community, many researches had been done to conceptualize this new form of learning. We are presenting a promising design for a model to adapt the learning content in mobile learning applications in order to match the learner context, preferences and the educational objectives. Moreover, the proposed model will support the student learning context which is a result of the mobility of m-learning scenarios such as user location, movement, duration of stay, noise level and availability of resources. Our model covers mainly context dimension, user dimension, device dimension, and connectivity dimension.

Index terms—m-Learning, Mobile learning content, Adaptation, computer based training (CBT).

I. INTRODUCTION

The last four decades added a great enhancement to the learning process through introducing a new medium to interact and communicate between the learners and the tutors. In the seventies, distance learning (d-learning) began to include audio and video [16]. In the late eighties computer based training (CBT) came out to support the learning process by using computers and some special designed programs that use video, audio, and computer graphics[16]. In the late nineties, where the new technology of the internet started to be used worldwide, there was emergence of the e-learning to describe a new way of managing the learning process and delivering the learning materials via Internet. In the past few years e-learning has grown very fast, and many universities and organizations adopted such form of learning [19]. Now, with the speedy of mobile technology it seems e-learning is getting ready to make another shift to the era of mobile learning [4]. Many mobile devices combine telephone, wireless internet connection and many of the personal computer capabilities. These devices can enhance the teaching technique and help the educational community to achieve the idea of learning anytime and anywhere [5].

E-Learning can be defined as the utilization of internet, intranet, software, and any other e-media to combine the power of all the new technologies in order to enhance the learning process. E-Learning introduces a different way of learning that can help students in many ways[19]. Students can access a large amount of information, study in their self-base, be more confident, communicate with fellow classmates, and they will be released from the traditional classrooms' stress. However, e-learning is not intended to replace the class room learning.It could be used alone or in conjunction with more than one traditional learning methods; in this case the term blended learning is used[14].

E-Learning platform provides several services. Some of these services are common and have grown since computers were first used in education, the other services can vary from one platform to another. One of the most important services for any e-learning platform is the learning content and content presentation.

e-Learning content is a digital content that is used by tutors to present the teaching materials to students. Much effort has been devoted for the reuse of the teaching material, and the result was introducing the term Learning Objects (LO)[15], which are defined as "Any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning."[17].E-learning content has a lifecycle which include a number of phases. The content pass through these phases before the learner can interact with it. Each phase has a specific purpose that enhances the leaning content in some way. e-Larning lifecycle content includes analysis, design, authoring, assembly, transport, storage, delivery, interaction and monitoring [13].

Mobile learning; m- learning for short; has many definitions revolve in how people can learn or stay connected with their learning environments that include their classmates, instructors and instructional resources through mobile devices [18]. m-Learning had been added to the online learning category, which mean a new supporting technique for the education. "Formal Learning now can be broadly divided into three categories based on the context of occurrence-Regular Class room learning, distance learning and online learning [16]. Distance learning can be within a class room environment or with online access and it can be a combination of both. On the other hand, online learning can include e-learning and mobile learning as shown in figure 1" [6].

The significant developments in mobile technology and the new mobile devices that can deliver web or internet-based learning materials led to a natural flowering of e-learning to mobile learning [6]. There is a large similarity between e-learning and mobile learning. e-Learning can be defined as learning supported by digital "electronic" tools and media. Milrad defined m-Learning as 'e-Learning that uses mobile devices and wireless transmission [5]. It's clear that mobile learning is a subset of e-learning [16]. M-learning extends the benefits of e-learning (e.g. access to information, learning anytime anywhere) to a much wider range of teaching and learning contexts. With mobile learning, students get a new degree of freedom; they can choose when and how they want to consume learning contents [7]. However, just as the relationship between e-Learning and the traditional learning methods, mobile learning can not replace the traditional
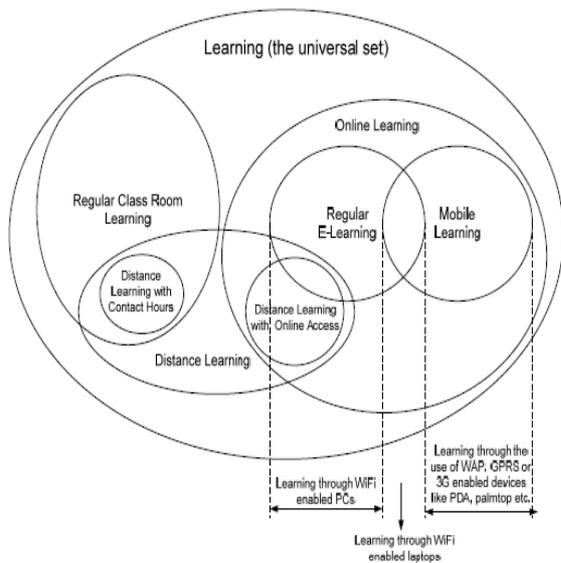
Figure 1. The relationship diagram that shows different learning approaches

classrooms. Mobile learning is a supported teaching technique that can be presented with conjunction of other teaching methods.

Generally, mobile learning should include tools that enable learners to access the learning content that can be stored on mobile device or can be accessed via internet [1]. Learning materials were developed in large sections which may not be appropriate for m-learning. Many guidelines have been proposed to help in reorganizing learning content to fit the limitation of the small devices [4]. There is a common agreement that mobile content must be designed in the form of learning objects or granules to allow for the reusability and flexibility in learning materials development and delivery [13]. m-Learning content must contain visually information and effective graphical strategies that can help the student in learning via small screens by reducing the amount of reading required. Moreover, the mobility of m-learning scenarios defines a new relation between the learning and the student context [12]. This relationship should be taken into consideration when designing the mobile learning content. Mobile learning content must be developed to support the students in any context [2]. Also, mobile learning must be able to support different learning styles in different ways and motivate the students who may lose their motivation because of being far from the traditional class rooms.

A. Statement of Problem

There are many problems and issues should be taken in the consideration when we want to relocate services that are provided by an e-learning platform into services provided in a mobile learning platform. One of the most important issues is the content design. Most of today's e-learning content has been designed for larger screens, 15 inch or more, how could this content be squeezed in a way that fit the mobile devices screen and doesn't limit the student interaction with the content. Moreover, the mobile learning has its interesting aspect from the idea of learning any time anywhere, and in the own student base. But on the other hand this aspect inherits a problem that was descried in [8] and to recognize the essential role of mobility and communication in the process of learning. In this re-

search paper we introduce a model to design the mobile learning content in a way that match the user's preferences and context.

B. Related Work

Many researchers [9, 10] introduced new approaches for adapting content in a mobile environment. One approach suggested adapting the delivery of small chunks of complementary learning content to mobile devices using Bayesian belief networks as shown in figure 2. The authors categorize these variables into four main categories: device limitations, connectivity, learner's profile, and content types [3].

A tree organization for the learning objects has been presented in [10], where each object in the tree have a certain goal (level) and specific features which are compared with the learner' contexts and preference. The sequence of objects is dynamically changed according to the learner contexts and preference. This model enables the learner to participate in customizing his own course.

TABLE I.
DEVICE SPECIFICATIONS

Device	Resolution and screen size	Operating System	Data entry	Browser	Wireless capabilities
Palm Tungsten T	320 x 380 resolution 2.5" display	Palm OS 5.0.	Touch-sensitive Graffiti writing area Soft on screen keyboard	Blazer	Bluetooth
HP iPaq hx4700	640 x 480 resolution 4" display	Windows Mobile 2003	Soft on screen keyboard, track pad	Pocket Internet Explorer	Wi-Fi, Bluetooth
I-mate PDA2k	240x320 resolution 3.5" display	Windows Mobile 2003	Full slide-out QWERTY keyboard	Mobile Opera	Wi-Fi, Bluetooth, GRPS
Sony Ericsson V630i	176x220 resolution 1.9" display	Sony Ericsson	Multi tap keyboard	Opera Mini	GPRS, Bluetooth
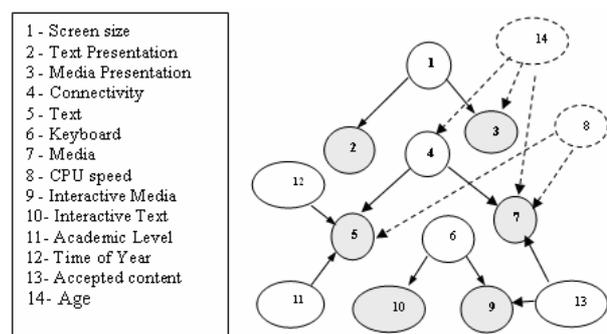
Figure 2. A potential model showing dependences among adaptation attributes. Shaded nodes are decision nodes and un shaded ones are evidence nodes. Dotted lines represent possible variations.

The reusability of existing learning content has been proved to be an efficient way for universities to provide students with mobile learning services. An example on how we can get benefit from an existing e-learning content is presented in [7]. It proposed a practicable and easy to use procedure to facilitate traditional e-learning content to users of mobile. Callum and Kinshuk [11] presented a case study on the functionalities and capabilities of different devices as shown in Table 1. It aims to create an awareness of the actual difficulties that are inherited when

interacting via mobile devices with discussion forums and other utilities due to technological functionality limitations.

II.   THE PROPOSED MODEL

The evolution of information and communication technologies in the last three decades has had an impact in all aspects of human activities. Learning has also been subject of these changes. Current research efforts in the field of mobile learning have been in many cases guided by a learner-centered approach. Context and content adaptivity are crucial components in mobile learning environments. One important challenge is how to design and implement technological tools and methods to support them. In order to tackle this challenge, learners' context should be defined. In this paper, we describe our current efforts regarding how to model context in mobile learning activities. We introduce an environment dependent context model based on four dimensions context that can be used to design and support context in mobile learning environments.

The model will reallocate the e-learning content into wide range of mobile devices; also it will support the mobility of the learner by taking into consideration the learner's context. Our model will base on the guidelines that were introduced in [10]. As shown in figure 3, the author organized the course as a sequence of objects in a tree form. Each object in the tree has a certain goal (level) and specific features.

The learner will sit his contexts as well as his preference. The sequence of objects is determined based on the object's attributes and the learner' contexts. The sequence of objects can be changed dynamically, according to the changes in the user context

The user context and preferences are not the only issues that should be taken into consideration when designing mobile learning content. The device limitation and the connectivity also play major role in designing mobile learning content. In addition, it is not enough to only change the sequence of objects to fit the different scenarios of mobile learning.

Based on the above statement, content presentation should be changed as well as the sequence of objects. Several dimensions of adaptations need to be considered as shown in Fig. 4. In this new model, we are building a flow diagram to produce a mobile learning context based on a set of dimensions, each dimension has several factors. Our model will consider each factor in order to make the context adequate to the limitations of mobile functionalities and also to present the content in the adapted m-learning platform. We introduce a multidimensional model that consists of the context dimension, the user
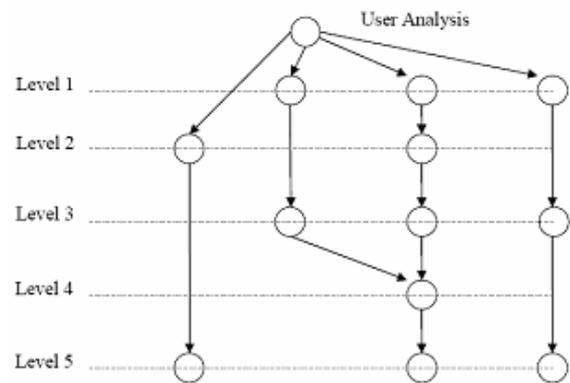
Figure 3.   Objects structure
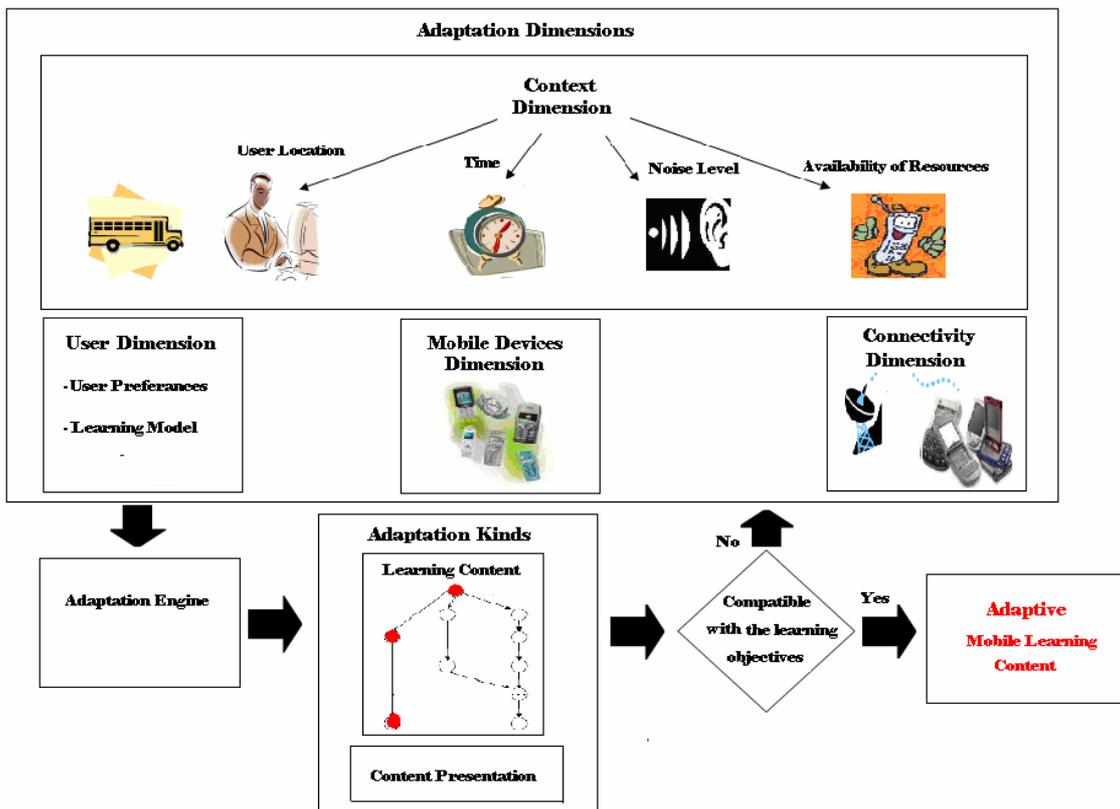
Figure 4.   The model of M-learning

dimension, the mobile device dimension and the connectivity dimension. According to these dimensions the sequence of objects and the presentation of the content may be changed dynamically.

Context Dimension: Under this dimension, all of the possible context scenarios are taken into consideration such as user location, noise level and availability of resources.

User Dimension: This dimension defines two basic categories of attributes. The first category includes the learning model.

Attributes such as module completed, weight, score, time taken, date of last access and so on. The second category is about the user preferences and contains attributes such as preferred difficulty level and learning style.

Device Dimension: Device dimension include attributes such as the device types and its capabilities, limitations, display capability, memory, and so on.

Connectivity Dimension: In this dimension there is more than one possible scenario.

The transformation of the learning content will be in respect of four types of adaptation which are: adaptation on the content presentation, entire order, level of detail, and finally on the learning object flow. The adaptation engine will be used to conceptualize the different relationships between the context factors and the available types of adaptation and it will define the appropriate content that should be presented to the learner. However, this content must be compatible with the learning objectives as well as with the learner context and preferences.

For example the user can operate in a real-time online. In this aspect, the operating connecting speed and throughput determine some of the adaptation capability such a multimedia representation or text-based representation. Here device capability and network reliability and connecting type are the main consideration for adaptation.

To adapt content we can adapt the selection of adequate learning object or their assembly. For adaptive presentation, the visualization and animation of content, combination of text, sound, video and images are heavily influenced by the type of users' learning modalities.

According to the adaptation's features, the adaptation engine determines how the sequence and the presentation of object can be adapted using a set of adaptation rules with respect to the learning objectives aspects.

III. CONCLUSION

We have introduced a new model for m-learning context adaptation. This model is intended to adapt the learning content in mobile learning applications in order to match the learner context, preferences and the educational objectives. Furthermore, our model will support the student learning mobility and the change in the user context. The presented m-learning model describes several dimensions where each dimension contains several context related to specific specialization. These contexts reflect specific factors in each dimension. Our future work will investigate more in the role and specification of each factor and its effect of the flow process of our model. Also we will compare our model with other comparative research work to produce statistical result.

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