**Location Based Context-Aware Mobile Learning Framework**

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**ABSTRACT**

This research is a part of an ongoing research about personalization in mobile learning which aims to introduce and develop a personalized location based mobile learning framework. Mobile Learning (m-Learning) - which refers to the use of mobile devices for educational purposes. Mobile learning is gaining more importance over other learning platforms such as e-learning or online learning. While most of the learning content existing today is designed for high resolution screen, only a fraction of contents can be utilized on a mobile device. And almost all current mobile learning content are just shifted from e-learning systems to mobile learning ones which may be not appropriate or suitable to be viewed or studied using mobile devices also maybe not suitable to different locations. Although there are some efforts to deal with this issue, these efforts need consider more attributes and specification of the learner's location. In this paper, we introduced a location based context-aware mobile learning framework (LBML), which provides contents based on the characteristics of the learner's location. After the framework was developed based on the previous studies, a prototype was developed based on the proposed framework and validated by a ten items questionnaire developed for this purpose to measure students' satisfaction about the prototype system. 30 undergraduate students participated in the experiment over a six week period, during that period the students were requested to study one course (Basic computing skills), after that the questionnaires were distributed to the participants. The results showed a high satisfaction about the delivered materials and their suitability to the student's location, which mean that the framework is capable of delivering suitable learning materials for the students anywhere and anytime. In conclusion the students support the use of the system and they were satisfied by its overall functionalities. But there is a need to enhance its performance in relation to two aspects, namely, messaging and interaction between the students which will be taken into consideration in future research.

**KEYWORDS:** Location Based, context-aware, mobile learning framework, personalized mobile learning

**INTRODUCTION**

The growing interests on adaptive and personalized mobile learning by many researchers had led to several research initiatives world-wide that aims to investigate the potential of the shift from the traditional teaching approaches to an adaptive and personalized learning. The key benefits of this approach are that learners are provided with customized and personalized learning experiences that are tailored to their particular educational...
needs and personal characteristics toward maximizing their satisfaction, learning effectiveness and performance [1].

The widespread ownership of mobile devices and the growth of mobile communications industry had led to a variety of platforms and specifications of mobile devices used by the learners. This in turn led to an increased interest on context-aware adaptive and personalized mobile learning systems, who aim to provide learning experiences delivered according to the principle of anywhere/anytime learning [2]. The key benefits of these systems that can detect the learners’ location and provide them with personalized learning experiences suitable for their locations to maximize the ability of concentration according their study sessions.

Mobile Technology concept includes a huge range of mobile devices. This research predominantly focuses on handheld devices such as cell phones, smart phones, PDAs, mobile Internet devices, Internet tablets.

**Background:**

Mobile technology allows people remotely access to services such as voice, messaging, controlling, Internet etc. and in some cases mobile embedded systems make user accessibility easier. Today’s youth welcome technology with enthusiasm and they are motivated to use it. Elliot Soloway says [3]:  

“The kids these days are not digital kids. The digital kids were in the ’90s. The kids today are mobile, and there’s a difference. Digital is the old way of thinking, mobile is the new way.”

**From E-Learning to Mobile Learning:**

In fact mobile learning inherits many features of e-learning although they have many differences such as knowledge input, output, memory capacity, application types etc. This overlap brings the basis of technical shifting from e-learning to mobile learning, Ally points to mobile learning as a delivery of electronic context-based learning content on mobile devices [4]; however in e-learning solutions, content delivery is via personal computers.

After the era of e-learning, we are converting to mobility, so is the need of the education process. Such a shift offers the opportunity of ubiquitous learning anytime, anywhere, so that learners do not need to wait for a fixed time and place for learning to take place. Kevin Walker says [5]: “Mobile learning is not something that people do; learning is what people do. With technology getting smaller, more personal, ubiquitous, and powerful, it better supports a mobile society. Mobile learning is not just about learning using portable devices, but learning across contexts” [5].

The vision of mobile learning presented by the majority of authors currently searching in the field is that it seeks to enable portable and personalized learning; it will facilitate communication, collaboration, and creativity among participants in authentic and appropriate contexts of use. In some respects, this is perceived as a revolution of ‘just-in-time’ and ‘just-form’ information delivery; however, the employment of mobile devices will be far from a panacea for the problems currently faced in education unless implementations of mobile learning take heed of lessons ‘e-learned’ [6].

As with the implementation of any innovative scheme, significant technical and administrative challenges will be encountered. These will be met along with a more ill-defined challenge: ‘How can the use of mobile technologies help today’s educators to embrace a truly learner-centered approach to learning?’ [7].

It is important to highlight that there still a lack of complete and well-defined set of requirements for mobile learning environment, despite the efforts of some authors in this regard [8] [9], such as, Nemesio Filuo and Ellen Barabosa, who tried to establish a requirement catalogue for mobile learning environment using systematic analysis of the existing literature in mobile learning, even they didn’t validate or prioritize the requirements, it is a good start for more generalization of mobile learning [10] [11].

Moreover, mobile learning can provide learners with characterized learning services according to their needs [1]. But it require more concentration on GUI, which need to be user friendly and easy to use [12]. Also, assessment or testing learners’ abilities or achievement is a key element of the educational process, which should be included in a mobile learning system. That can be utilized to enhance more traditional learning practices, or for sure provide an important tool to support distance learning [13] [14].

Location awareness or detection is an important feature that mobile learning systems should include, according to Cho (2014) and Lee and his colleagues [15] a new type of agents is needed to reason on streams of data, agents that make use of the rich and collective knowledge obtained by continually analyze media and location specific information [15]. Moreover, Cho (2014) assure the importance of location estimation in the mobile computing environment to achieve the intended outcomes of a mobile application, through the use of existing technology used in mobile devices. Also Kim [16] argue that the mobility is the most distinguishing characteristic of mobile learning environment, there for mobility (location) should be taken into consideration in the design of mobile learning system, so all information delivered to the learners are suitable for their locations. The advancement of mobile learning in 2007 was the main focal point of many researches; one of them was conducted by Luvai Motiwalla on a new framework for mobile learning, her study results showed that
mobile learning system is useful and good complementary tools for the classroom, providing flexible access from anywhere and anytime. Also, students perceive an important supplementary role for wireless handheld devices in e-learning, and are effective in delivering personalized content [17]. In 2015 Morales and his colleagues introduced a context-aware mobile language learning, that focus on providing language support to users living in foreign countries. It incorporates users’ location, gender and native language to supply the user with the relative vocabulary suitable to these contexts. Thus, in the main objective of this paper is to introduced a location based context-aware mobile learning framework (LBML), which provides contents based on the characteristics of the learner's location

3. Materials and Methods:
To acheive the research objective (Location Based Mobile Learning Framework (LBML)), the research methodology consist of three main phases, and within each phase there are some activities as follow:

First Phase: Literature review:

In this phase a clear concise about the problem is obtained with research questions are addressed before project started to solve the problem. It starts with a question such as, 1) What are the current frameworks for mobile learning? 2) What are the limitations of those frameworks? 3) How did they deal with the same problem in the previous studies?

This literature review conducted based on Levy and Ellis [18] about how to conduct a systematic literature review in information systems research with some adaptation from [19] that contains some activities that should be followed to produce a good review of the literature. The three stages of effective literature review process [18] [19]. It involves reviewing the current state of the art in the related issue of location based mobile learning. The purpose of this phase is to understand the issues and problems of the subject under study.

Second Phase: Methods, Frameworks, and Framework Development:

In this phase, the historical development of location based mobile learning systems, and different approaches of the existing research efforts, and methods in the related area are reviewed. This phase involves identification of a specific design, methods, and approaches of improving the limitations of the previous researches.

Also, in this phase a LBML framework was developed, the conceptual development was illustrated and evaluated to identify the suitability and capability of performing the idea, it is then to be implemented as a system to demonstrate its concept and act as an alternative illustration of the solution of the research problem. And before proceeding to the next phase this framework was reviewed and discussed with experts.

Third Phase: Implementation and Evaluation:
The implementation of the proposed framework and evaluation process as follow:

Implementation:
The proposed framework was implemented as a working prototype system to be used in an experiment; this system is implemented as a tool to demonstrate the applicability for intended roles which acts as an alternative solution to the research problems established.

The development tool (Programming Language) chosen is ASP.net 2013 and C#. Since they include a built in configurations functions and tools that enable the researcher in the development of the prototype system.

Participants:
According to Neal [20], 15 participants for usability testing is sufficient for collecting feedback that covers various user groups. McLefferty [21] also pinned that post evaluation can vary from 4 to 20 participants [21]. Thelin et al. [22] in his experiment evaluation has used 23 participants to evaluate his techniques [22]. Thus 30 participants from General Foundation Program students were invited (One Class) to join in this experiment. Before the experiment started, participants attended a briefing workshop, about the reason of this experiment and the activities needed during the experiment. Surveys (Questionnaire) were distributed to each of the participant individually. During the experiment participants were guided and observed.

Experiment Design:
Before the experiment start, the system was uploaded and hosted on the internet, and internet connection was configured on students’ mobile phones. The participants need to use the system for a period of six weeks in which observation and technical help was provided by the researcher.

Experiment Evaluations:
The surveys (Questionnaires) consisted of two parts: The first part of the questionnaire was to identify the
overall system satisfaction about the system. The second part of evaluation aimed to evaluate and determine students’ opinions on the role and values of the suitability of delivered learning materials for their locations.

**Lbml Framework:**

Based on the literature analysis and finding on existing mobile learning frameworks, framework to support any location based context-aware was proposed as shown in figure1. This framework is designed on agent technology and includes two agents one to detect student’s location (Location Agent) and the other one (Resources Agent) to select the suitable materials for the current location of the student from the learning resources database. Figure 1 show the architecture of the framework and the interaction between agents.

**Location Agent:**

The location agent in LBML will capture the location of the student automatically through the GPS sensor, if the access point is defined in the system database, it will send the location to the resources agent accordingly with the specified materials types allowed in that location, else it will suppose that the student is outside the campus and allow him to view all types of learning materials as shown in figure 2. Noting that, the system administrators is responsible of assigning the locations name, coordinates and the allowed materials for each location, and store them in the location database.

**Resources Agent:**

This agent will accept all the outcomes from the location detection agent, and choose the most suitable resources, according to that location, then deliver them to the student.

**Location Database:**

Location database is the repository that store information about each location, and what are the suitable types of materials for each location, these specifications are managed and assigned by the course instructor.
Resources Database:
A database that contain the learning resources that can be accessed and used in the learning process, organized in course bases.

Students Database:
A database containing the students records and information, including user name and password used to login to the system.

Prototype System And Evaluation:

Prototype Implementation:
This section presents some aspects from the implementation of the system. To develop the prototype, ASP.net with C# were used to develop a web portal (PMLS) according to the framework, and then tested to make sure it is working effectively, some screen shots of the system are shown in figure 3.

![Login Screen](image1)

![Location Settings](image2)

Fig. 3: Sample screen shots from the system

Prototype Evaluation:
The two major goals for evaluating the application were to:
- Observe the usage of this application in a classroom setting with students and obtain student feedback on our mobile learning application, and
- Determine the student opinions on the role and value of the suitability of the delivered learning materials, according to the access location, after participating in this study and their satisfaction about the overall system.

Therefore, the evaluation process was broken into two phases. Before they start using the system, a workshop has been conducted to train the students on how to access the system and register/login, browse and navigate the system. And students were shown how to access and use our application during a class session and were instructed to use the application for next few weeks of the semester (six weeks), also user’s name, password, and student’s data were prepared. This was followed by a survey (as a second phase) containing 10 questions, the first section of the survey emphasis was only on student satisfaction regarding the system (5) questions, while in the second section the emphasis was on student satisfaction and their general opinions about the delivered materials and their suitability to the location (5) questions.

Total of 30 undergraduate students from an introductory course in computer (Computer Skills I) were involved. All the students in this sample have a wireless (Wi-Fi) enabled phone or Internet data (mobile data) services to access our application and a wireless internet connection provided by the university.

The students task was to login from their mobile devices to the prototype web portal to access the materials and interact with their peers and instructor. The system logged the usage of the students and also whether they accessed it from a smartphone or a laptop, and of what type. Students were informed about this and were specifically instructed that to get their participation grade for this assignment they were required to access the
system at least seven hours during that period. We felt the students should have some repetitive experience before making a judgment on our system. A review of the system log revealed that all the students in our sample had accessed the system for seven or even more times, during the testing period.

An empirically validated survey instrument developed by Zhao [2] for measuring learner satisfaction for mobile learning systems was edited and customized for this study. Questions focusing on both usefulness of the location based mobile learning system (LBML) as well as student satisfaction with the LBML were asked using a 5-point Likert scale with strongly agree as 5, neutral as 3 and strongly disagree as 1 on the Likert scale.

RESULTS AND DISCUSSION

As stated earlier to measure the overall satisfaction about the system five questions were asked and the results of students’ responses are summarized in table 1.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Strongly disagree</th>
<th>Strongly Agree</th>
<th>Mean</th>
<th>St. Deviation</th>
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<tbody>
<tr>
<td>OA1: The operations of the systems were clear and easy to use.</td>
<td>0%</td>
<td>0%</td>
<td>3.3%</td>
<td>63.3%</td>
</tr>
<tr>
<td>OA2: The learning content provided by the system were appropriate me.</td>
<td>0%</td>
<td>0%</td>
<td>6.7%</td>
<td>43.3%</td>
</tr>
<tr>
<td>OA3: The system helped me to learn anytime/anywhere I want.</td>
<td>0%</td>
<td>0%</td>
<td>3.3%</td>
<td>53.3%</td>
</tr>
<tr>
<td>OA4: I would be happy to recommend this system to other students.</td>
<td>0%</td>
<td>0%</td>
<td>6.7%</td>
<td>46.7%</td>
</tr>
<tr>
<td>OA5: This system was very helpful in my learning process.</td>
<td>0%</td>
<td>0%</td>
<td>40.0%</td>
<td>6.7%</td>
</tr>
<tr>
<td>Totals of Overall Satisfaction</td>
<td>0%</td>
<td>0%</td>
<td>3.3%</td>
<td>80.0%</td>
</tr>
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</table>

From table 1 we can see that 80% of the students agree that they fell satisfied when dealing with the system and with its delivered materials by the system, and 16.7% fell very satisfied about the system, totaling of 96.7% system satisfaction. Moreover, about 63.3% of the students see that the system was very clear and easy to use, and 33.3% agree that the system is clear and easy to use totaling 96.7% of them fell that the system is clear and easy to use.

Also, 53.3% strongly agree that the system helped them to learn anytime/anywhere, and 43.3% agreed on that. Totaling 96.6% of the student sees that the system helped them in this content. Moreover, 46.7% said that they encourage other student to use the system, and 46.7% said that they will strongly encourage other students to use it, totaling 93.4%, which mean that they felt satisfied about the system and its functions. The item that has the lowest standard deviation (St. D.=0.563) is OA1, “The operations of the systems were clear and easy to use”, indicating that most of the responses are very close to the mean value of 4.6. In the other hand, the standard deviation of the statement “The learning content provided by the system were appropriate me” (OA2) is the highest (St.d=0.626), indicating that the data is well dispersed.

Finally, despite 40% felt neutrals about the help that the system can be helpful in their learning process, 53.3% agreed that the system was helpful and 6.7% strongly agreed it was.

The following figures summarize the results of Overall System Satisfaction.

![Fig. 4: Means for students responses on the overall satisfaction](image)

The items in figure 4 are presented with mean scores. The statement (item OA1) “The operations of the systems were clear and easy to use” (mean = 4.6) scored the highest mean among other items. While the statement OA5 “This system was very helpful in my learning process” (mean=3.67) scored the lowest score.
among other items in the Overall System Satisfaction construct.

The overall average mean scores of all the five items measuring the construct Overall System Satisfaction are all above 4 indicating that most of the respondent agreed that they are satisfied with the Overall System.

**Student Location Results:**

Table 2 represents the percentage of student responses related to the suitability of the delivered learning materials according to the students’ current location. From the table we can see that the overall evaluation for students’ location agent has 93.4% agreement percentage, 56.7% of the students agreed on the suitability of the delivered learning materials, while 36.7% strongly agree that the delivered learning materials were suitable for their location.

Also, 73.3% of the students strongly agree on the statement (STL1) “I was able to view the materials on-campus”, and 20% of responses agree on that, totaling 93.3% of the responses. In addition, the responses on the statement (STL2) “I was able to view the materials off-campus” has 30% percentage of agreement, 63.3% strong agreement and a total of 93.3% agreement.

In their responses on the statement (STL3) “In general, the delivered materials were suitable to the access location” 53.3% of the students feel that they strongly agree with this statement and 43.3% agree that the delivered learning materials were suitable for the access location totaling of 96.7% of the responses.

Moreover, 90% of the students feel that their current access location didn’t affect their learning process and advancement (STL4). On the other hand, related to statement (STL5) “I feel that the system is reliable in any location”, it scored the lowest agreement level average than the four other statements (60%) agree and strongly agree, and 40% of the students feel neutral about this statement.

In conclusion from table 2 we can say that the students agree that the students’ location agent perform well, and deliver suitable learning materials according to the student location.

**CONCLUSIONS**

In summary, the evaluation was successful because it gave us some feedback on what the students think about our LBML, helped us to find that the students support the use of the system and they were satisfied by its overall functionalities. But there is a need to enhance its performance in relation to two aspects, namely, messaging and interaction between the students. It should be pointed out that the small sample size of this study limits generalization (or external validity) of the results; nonetheless, it does give a first glimpse on
understanding the role of mobile learning applications in higher education. This feedback helps us move forward to the next phase of this research project, namely, enhance the performance of the system by adding new functionalities to enhance its performance and deliver more personalized learning materials.

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