

Introduction to Mobile Learning Systems and Usability Factors

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Abstract - Number of people using mobile phones has been increased in a tremendous way when compared to personal computers. With advancements in wireless and mobile technologies, learning using mobile phones is a new way of approach towards education. Using this system we can provide the learner's all the probable materials like lectures, videos related to the course work. Mobile learning is unique in its own way offering learning anywhere, anytime. Also mobile learning enables learners reach to the course work and things of their interest just one click away. In this paper, we introduce a new approach towards mobile technology, usability factors that should be considered in detail, the infrastructure to be considered for this type of system, and the prototype for applying this application. The study is mainly related to implementation of mobile learning and usability testing methods for the application developed.

Keywords - Mobile Education, Mobile Learning, Usability Factors, Scalability, Location-Based Services, Regression.

I. INTRODUCTION

The latest technological revolution is the emergence of mobile wireless communication technology. Mobile devices have grown in popularity to become one of the most common consumer devices and cheaper hand held device which we can carry and use whole day everywhere. With different types of technologies in mobile devices such as motion sensors, cameras, global positioning system, infra-red, Bluetooth and others supported by broadband connections, they have revolutionized the way of the mobile devices can be used.

Now they are more flexible to integrate the existing services by employing web based interfaces, so that mobile devices become attractive tools to complete the demand for learning. Mobile technologies have changed the educational landscape in terms of how information is delivered, the speed of access to information, the choice of options for courses, and the programs of colleges and universities since new technologies propose different learning styles.

Most of the students have access to internet on desktops and laptops, which mean that the equipment and technology is used whenever students are studying at home or at work. It should also be noted that content developments consider the environment in which mobile learners would study in the same group as students not having access to mobile technology.

Thus, the design of the learning environment had to cater efficiently for both situations.

In mobile learning, people who have roles in mobile education are students, teacher, designer groups, and directors. Students mainly concern which facilitate active role of communication and teachers play a role to guide students. Designer groups are the real establishers of process as technology facilitators and directors plan and implement education process. For the learners, mobile learning provides more freedom of access and a wider range of opportunities for learning and qualification. For employers, mobile learning offers the possibility of organizing learning and professional development in the workplace itself, which is often more flexible and saves costs of travel, subsistence, and etc. These advantages for learners and employers are also important features in the perspective of governments.

Mobile education is defined as service or facility that supplies a learner with general electronic information and educational content that aids in acquisition of knowledge regardless of location and. Mobile learning or e-learning tool is the result of two converging technologies: computers and mobile. In this paper, we study about the usability factors based on considering the end user and what kind of application interfaces in the mobile devices they anticipate. Smartphone and PDA are most popular amongst those which require the convenience and assistance of a conventional computer. The 3G, 4G and HSPA+ technologies has made mobile devices a lot more popular. For mobile education system, we propose to use the mobile device which has Windows mobile 6.X or Android which is a very new powerful platform for iOS and palm OS.

II. PREVIOUS RESEARCH SURVEY

The mobile learning is based on the use of mobile devices such as cell phones, smart phones and notebooks or Tablet PCs in anywhere at any time. These devices must support wireless technology, have a possibility to present teaching materials, and realize an asynchronous/synchronous communication between learners and teachers. The existing wide range of mobile devices and wireless technologies give an opportunity to realize different systems for mobile education. For example, some of these systems can be used

only in the area of a university or company, as at the same time, the other system ensures a broader usage outside the educational institutions. Some of the systems support user access only to the administrative information, while other systems support an access to educational materials.

In the literature, there are various classifications of mobile learning systems. These classifications concern: support of mobile devices, usage of wireless communication technologies, the possibilities to access the required information and the type of this information. The known classifications often apply one or two indicators, which concern the information, communication or education technologies used in the systems.

The classification regarding educational technologies is made in relation to the supported information and the method to access it. According to this classification the mobile learning systems are divided into several groups. For example, in the literature sources, the systems are classified in respect to the abilities to support on-line and/or off-line access to the learning materials. In the systems are classified according to the user abilities to reach learning materials in the university area (on campus) or outside university (off-campus). In the systems, they are divided regarding the information connected to the educational process they support – learning and/or administrative. However, the existing classifications have big disadvantages since they do not include the whole variety of different systems and do not correspond to their progress. These classifications also do not account for the complexity of modern mobile learning systems and the support of e-learning standards and specifications.

The research surveys say this can be implemented using the SMS feature of the mobile device. The major advantages of mobile learning include greater access to appropriate and timely information, reduced cognitive load during learning tasks, and increased interaction with other people and systems. It may be argued that networked mobile devices can help shape a culturally sensitive learning experience that can offer more powerful means of encoding, recall, and transfer. In addition, it is very important to consider the development of learning objects as well as the recognition of learning styles, cognitive processing, and motivation of learners.

A current disadvantage is that not all data, which are available on the web, are suitable for some beginning courses. Students may not have acquired sufficient knowledge of a particular field necessary to use available data sets, although these data sets are suitable for many advanced undergraduate courses. Too often, data require professional judgments be made or assume a specialist's knowledge. Desirable attributes when specialists use data, may become a handicap, however, when beginners are exposed to them. Perhaps, data sets that are more appropriate will appear to fill these gaps as more educators recognize needs in their particular area of specialty.

III. MOBILE LEARNING SYSTEM

According to the information and communication technologies (ICT), the systems are classified by the type of mobile devices (notebooks, Tablet PCs, PDAs, cell phones or smart phones) and the type of wireless communication technologies (GSM, IEEE 802.11, Bluetooth, etc.) which they support. One of the technical classifications written in the literature uses two indicators – the portability of the devices and the personal use ability.

- **PDA:** PDA uses GPRS, WAP, video streaming, and office programs.
- **IPOD:** All lessons are taken from system and offline or online service is open.
- **MOBILE PHONES:** Mobile phone uses GPRS, WAP, video streaming, and office programs. These phones have features such as Bluetooth, WIFI which will be very useful in Universities.

The current mobile technologies are mostly based on NFC and Location based services.

A. *M-Learning Materials*

The mobile learning materials depend on the type of course or type of work requested to the service provider. Mainly the mobile learning materials are obtained from their respective service providers. The materials are to be placed on the server which is used to retrieve the data back when requested by the user. The learning materials include class lectures, practice tests, interactive quizzes.

B. *Possible Middleware for Education and Requirements*

The growth of mobile learning has an international dimension as well, since countries around the world are using distance learning technologies to enlarge their own course, program, and degree offerings and to import and export education programs and services. Mobile learning technology can be implemented by using a mobile which can supports applications used to stream both audio and video with support for document viewer to view word, excel, power point, PDF files if a student wants to read instead of viewing the video. Assuming that a university wants these technologies to be used by their students, it has to contact with one of the popular mobile service provider which supports this technology. This can also be used by some institutions which provide online preparation for courses of interest for students.

Apps for the phones makes this possible. The students are required to download the software (Apps) from their university website to access the lectures in their individual mobiles. The university has to ask for authentication, and then it should allow the student to download the software. This way the software release is more secure. After the downloading has been done, the software must be installed in the mobile phone.

After installation, the mobile can display an icon on the screen of the mobile which will be useful to access the app.

When the student clicks or selects the icon, the software should ask for authentication so that the software is avoided to fault use or loose privacy or priority data of the students. Once the authentication is done, the software should forward to a new page containing the courses that particular student has registered for that semester or the institutional courses one might have registered for.

The display should contain titles of the courses the student is registered. The student at any time can access only one course. After the student selects a particular course he/she will be redirected to a new page. This new page will contain tabs that display these optional options:

- Lecture video
- Audio
- Lecture notes
- Grades
- Tests
- Home Works

This flexibility will allow for students to access based on interest. Once an option is selected the screen will display the date and time of all the lectures that have been occurred during that semester or the work he is interested in. The user will have an option to select what kind of lecture she/he is interested in. If she/he intends listen to select the lecture video, first the lecture opens in a player that comes with the application and starts playing the video and he will be able to set the settings in the player such as full screen mode, forward and rewind the lecture video, skip and move to the next part and increase and decrease the volume.

The player will be able to play the audio if the user selects the audio option and the settings and options for the player will same as with the video except the player can be seen in full screen mode. The user can view the lecture notes in the mobile office whichever is supported by the device along with both video and audio. If the user selects lecture notes, she/he will be able to read through the lecture notes along with selected user interface options to listen to audio or video accordingly using the settings provided.

C. Proposed Infrastructure

The Mobile learning system should be designed such that the application would be compatible with most of the mobile devices and technologies. The application shall provide the default player and office to play audio and video and to open the lecture documents. The mobile technologies that can be used to use this application are 3G or any latest technologies. PDAs, smart phones and any other device which has access to data i.e. any mobile with advanced technologies will be used now. The application shall be designed such a way that it can be used in mobile devices in congruence with the computers and laptops.

D. Other Factors

Other factors include the type of software used by the mobile devices. In the mobile education system, the application designed should be software compatible i.e. the application should be compatible with all the different types of phones. There are other security related issues that needs to be considered. We should even check that CPU usage should be nominal even after loading the application. The OS should not slowdown using this application. The battery life shall remain same with and without application. The application installed should not much affect the battery life.

IV. IMPLEMENTATION METHODOLOGY

A. Prototype

The mobile learning system application includes an icon in the startup programs. When the icon is clicked, the application is launched in an explorer kind of display which has options to select the different kind of options associated with the application. The menu included in the application provides access to different application in the device.

The prototype is used to demonstrate, test, and verify concept technology at an early stage. This calls for over dimensioned but not fully optimized hardware. Prototyping facilitates the testing and analysis of different implementations at an early stage. Flexible designs make it possible to add and modify hardware according to needs.

However, this is not possible in commercial product development cycles. Although ideal for proof-of-concept applications, prototype terminals are typically too expensive for high-volume production and also cannot be optimized for other features soon, such as low power consumption and small size. For this reason, they cannot be turned into a commercial market solution even when they excel at demonstrating functionality.

B. General Architecture

There are two classes of users namely web users and mobile users as shown in Fig.1. The web user will connect to the system traditionally on a desktop computer via their browsers and by using the HTTP protocol while the mobile user will likely be connecting with a smart phone or PDA device via a wireless network such as WIFI or Data.

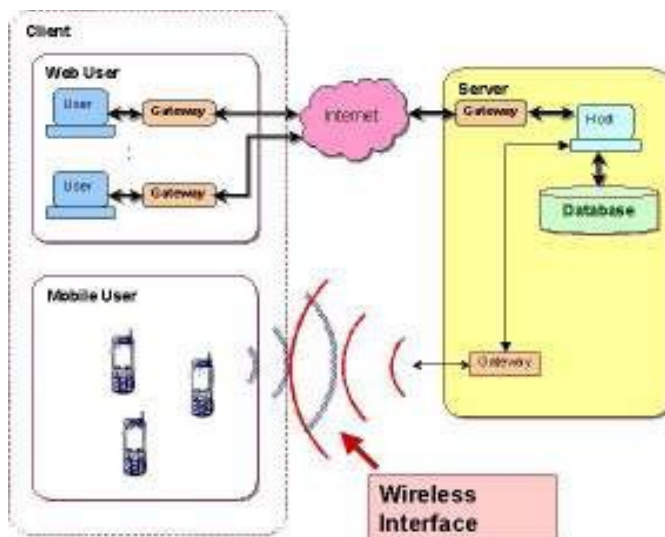


Figure.1. The adaptive system architecture

On the server-side, the database contains information on courses, activities, exam question banks and student profiles that will be retrieved and used in the adaptation process as previously described.



Figure.2. The Web interface for lecturer

The lecturer uses the web interface similar to Fig.2 to author assessment instruments that will be hosted by the University secure web server. She/he also obtains access to a range of tools such as monitoring students' progress on the tests to determine the effectiveness of instruction.

C. Usage Criteria

On the other hand, the student can have a variety of options to take a test. The first option is that she/he takes it online on a desktop computer. The second option is that she/he takes it

online in synchronous mode through his portable device while in the third option he may download the test application, takes the test in offline mode and synchronizes her/his performance afterwards with the server.

Concerning the adaptation feature, when the students register in the system, they will be invited to take a learning style test that will help build a student profile in the system. Each question in the question bank is also rated with a 'learning style weight' that categorizes the question according to the learning style in use. When a student decides to take a test, the system generates a questionnaire of 20 questions based on the current performance level of the student and his preferred learning styles. The questions are proportionally generated with his strengths (learning preferences) by following the capitalization phase. The assumption when the student first takes a test is that the data about his learning preferences are accurate.

The student then takes the test and answers the questions. When she/he submits the questionnaire, the number of correct and bad answers is computed and classified as per learning style category. If for any particular learning style, the number of correct answers is zero, then that component's complement is incremented by one unit. This step ensures that the system recognizes that this component needs to be taken into account when regenerating questions to ensure the student's preferences is taken into account. At the same time, a flag is used to ensure that in the compensation phase of the adaptation process, the student's weakness is accounted for. By incrementing this component, the next questions that will be generated will take into account the student performance in the different learning style components and the number of questions per component will be adjusted accordingly. In case the student does not perform as per expectations, that is achieves a score below the pass rate, or successively achieves a borderline score, then the system initiates the remediation phase where the student is given academic support and tutorials that are related to the content of the tests.

V. USABILITY FACTORS AND TESTING OF MOBILE LEARNING SYSTEM

Usability factors should include social factors and mobile interactions that are closely affiliated with the mobile community and human interaction background. On the other hand, those usability factors are focused on system design and development because interaction techniques in which hardware shape, size, and media type are correlated with each others. Some of the usability factors that are needed to be considered in mobile education are:

- Location and sociability
- Mobility and privacy
- User interfaces and user-friendness (easy-to-use)
- Regression
- Stress related usage

A. Location and Sociability

Mobile applications has emerged such a way that they can intelligently interact with users based on type of commands given by users. The mobile learning should be location independent i.e. the information should be available at any place. A service enabled phone with 3G, 4G, GPRS, WIFI, or EVDO should be needed to use the mobile learning system application. The information is downloaded to the mobile device and can be used effectively just as streaming audio/video using RTSP (Real Time Streaming Protocol) links.

Sociability refers to the user's perspective of interaction with the application. For example, individuals can prefer to watch the lectures rather than to read or listen. The application designed be in such a way that it can be used for both computers and mobile devices. When we refer to sociability we check how familiar users are with learning using mobile. Does the device allow the user to actively interact with the application when needed? For example, after every lecture or chapter, there can be some tests or assignments which need to be answered online like multiple choices or to write some text, upload into the server. We should check if the application is appealing and does not create noise or distractions when using the application. We should check how much power the application uses and shall make sure that the battery usage for this application should be minimal. How convenient are the application and its settings and if using the smart phones or PDAs, we should check how well is the device or user interacting with each other using voice commands.

The mobile learning system is a software application designed which binds the relationship between user and mobile technology. Designing the mobile learning application interfaces, which are based on above location and sociability constraints will be useful and successful. These kinds of challenges creating a totally different kind of application defined for a purpose using mobile applications will be useful to users.

B. Mobility and Privacy

We introduce the following problems, when conducting a usability testing for mobile devices. First, privacy must be considered, because mobile learning system providers wants their application to be used by a specific area of users because the amount of data used is private and some of the data is not for sharing. It also includes the users privacy when it comes to their work, the data which they do not want share and their grades. Second, the mobility is that generally users should be working under physically mobile environments, so the users want to use them in any place and any time. To construct the usability testing of mobile learning system applications, we need to understand what problems the applications have in terms of privacy and mobility. Thus, privacy and mobility will be strong points of consideration when we build and design usability testing for mobile learning system applications. Furthermore, mobile devices have several hardware

constraints, such as low CPU speed, low resolution, low capacity and a small screen size which differs from device to device. These constraints also might restrict selecting and using a proper testing method. We should consider these hardware constraints, because they can limit the testing scope, which is in the selection of a useful method. Therefore, when conducting usability testing for mobile devices to develop new interfaces or applications, we should consider the following two factors in terms of mobility and privacy.

The mobile learning application we thought should be installed in the mobile device. The file that should be installed in the device is obtained either from the universities or from the service provider with whom the user would have registered with. In order to avoid the piracy downloads of the software, the privacy should be maintained by the service providers. So after installing the software the user is requested to enter the credentials obtained from their respective sources in order to use the software. These are some of the usability factors needed to be handled when testing the application.

The mobility includes testing of features, such as if the application can be installed at any place or any time with and without the service enabled on the device. For example, if we consider mobile devices which has options of using WIFI we need to check if the application can be downloaded and installed in the device without service. We even need to check if this can be used with mobile based gadgets such as Apple I-touch which has only EVDO i.e. with only data working. The other things we need to consider are the other applications and life of the battery which are affected by using the application and how well this application can work in congruence with other applications. For example, this application needs to play video and audio and should use the mobile office in order to open lectures and other docs.

C. User Interfaces and User-Friendness (Easy-to-Use)

The user interface (UI) is one of the most important usability factors which have to be tested in all different ways possible because the applications ease to use depends on this. The usability testing of the UI includes testing of the application software from installation steps to using the application.

- 1) First we need the usability test of UI during the software installation and how ease is the steps to install for the common users.
- 2) We need to test each and every UI after installation of the application such as login screen, what happens if the user has entered incorrect credentials, how to regain the password if the application is locked.
- 3) The application should block user if user enters wrong credentials multiple times or requested by the service providers in order to protect the privacy, so as to make the application more secured.

- 4) After the user logged in into the application, the user is provided with different options as indicated by their respective service provider.
- 5) The setting option for UI and others should be included in the application in order to support the user's preference.
- 6) The UI of the player should be installed or the one which comes along with the application.
- 7) All audio and video codec information and types of documents should be supported by the application.

We even need to test the ease-to-use the application based on heuristic research or by setting up a test place or by preparing some presentations and explaining it to the most common users student and takes their responses on the project.

D. Regression

Regression testing is a type of software testing which seeks to uncover the software regressions. Here we test the application when it is in process of the development. Software regressions occur when the applications stops to work as intended or when there are changes made to the application in order to improve the UI or increase the ease of application to be used. Regression testing of application is also used to track the quality of mobile learning system applications output. Regression testing includes testing of applications correctness of working such as opening of the documents and playing files and interaction of user with the application. It also includes testing of application and its working when there are feature interactions. For example, if we receive an email, SMS or call...etc while the application is running and verifying if the application does not lock up or end or if it does not return back to the previous screen after the interaction.

E. Stress Related Usage

We even need to do stress testing of the application in order to determine the stability of the application and the mobile device when using the application vigorously. It involves testing of the application beyond the break points in order to get the results to determine the stability of application. Stress testing often refers to tests that put a greater emphasis on robustness, availability, and error handling under a heavy load, rather than on what would be considered correct behaviour under normal circumstances. In particular, the goals of such tests may be to ensure the software doesn't crash in conditions of insufficient computational resources (such as memory or disk space), unusually high concurrency, or denial of service attacks.

VI. CONCLUSION AND FUTURE WORK

With the advancements in the wireless and mobile technology, easy-for-creating our own apps for mobile phones makes mobile learning a convenient, interesting, and useful

way of learning for students. Using new operating systems such as Android, iOS and Windows makes us to think about more advanced and improved way of mobile learning.

The main objective of the paper is to provide the conceptual knowledge about mobile learning systems and introduce usability factors which will be considered for designing and developing procedures. The usability and regression tests suggested to perform on the mobile learning systems makes the mobile learning application more reliable and efficient.

The major advantages of mobile learning include greater access to appropriate and timely information, reduced cognitive load during learning tasks, and increased interaction with other people and systems. It may be argued that networked mobile devices can help shape a culturally sensitive learning experience that can offer additional and, possibly, more powerful means of encoding, recall, and transfer. In addition, it is very important to consider the development of learning objects as well as the recognition of learning styles, cognitive processing, and motivation of learners.

A current disadvantage is that not all data, which are available on the web, are suitable for some beginning courses. Students may not have acquired sufficient knowledge of a particular field necessary to use available data sets, although these data sets are suitable for many advanced undergraduate courses. Too often, data require professional judgments be made or assume a specialist's knowledge. Desirable attributes when specialists use data, may become a handicap, however, when beginners are exposed to them. Perhaps, data sets that are more appropriate will appear to fill these gaps as more educators recognize needs in their particular area of specialty.

Therefore, the biggest contribution of the paper is to provide a small step for how to design and implement mobile learning system order to meet the user needs.

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