Mobile Learning: An Application Prototype for AVL Tree Learning Object

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Abstract: - The rapid growth of mobile phone technologies encourages many researchers to explore, design and develop mobile learning applications for tertiary students. In computer science related disciplines, students always find computer science concepts as complex, abstract, and esoteric subject. Hence, we have seen the number of students enrolled for computer science related programs has decreased lately. Current delivery methods of computer science concepts are also not so interesting to the students. This project focuses on the design and development of an AVL tree learning object for tertiary students by utilizing current mobile phone’s features such as mobility, multimedia capability and connectivity. Our approach is to incorporate video clips that presenting the algorithm systematically. With this mobile learning application, student could learn at his or her own pace, anywhere at anytime. This application intends to complement current learning systems that are traditional classroom and e-learning systems. We applied prototype methodology in designing and developing this mobile learning application prototype and considered several mobile application design principles. Initial testing has shown that a well-presented video clip of AVL tree concept that delivered through mobile phone has a great potential to promote and enhance learning process.

Key-Words: - Mobile learning, Mobile application, e-learning, Multimedia, Video, Animation, AVL tree, Computer science

1 Introduction

Mobile learning is as a subset of e-learning and distance learning [1]. O'Malley et al [2] describes mobile learning as "any sort of learning that happens when the learner is not in a fixed, pre-determined location, or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies". Among several strengths of mobile learning are its mobility, connectivity and multimedia capability. With these great features, mobile learning has a big potential to extend our current learning systems.

Recently, we have seen a reducing number of students enrolled for Computer Science (CS) related programs. One of the reasons is the potential CS students see the computer science subjects as complex, abstract and esoteric. More surprisingly, current CS students are also facing the same problems and decided not to involve in programming during their internship and working lives. In current practice, most lecture notes are prepared in powerpoint slides. The lecturer presents the slides during lecture hours and disseminates it through e-learning system. Due to a bad design of powerpoint slides, it does not significantly help the students in understanding the basic concepts.

Therefore, we try to explore mobile learning by utilizing mobile phone’s features that the students are familiar with to support their learning process.

Mobile phone is becoming a powerful computing device with some appealing multimedia features and connectivity. The device is able to connect to the Internet through built-in WiFi, 3G, GPRS and Bluetooth. Among multimedia features that current mobile phones support are record, edit and play back video, sound as well as static photo [3]. These features promote the implementation of rich networked multimedia mobile learning applications.

This paper presents the design and development of an AVL (which is named after two inventors G.M. Adelson-Velskii and E.M. Landis) learning object to be delivered via mobile phones. In CS curricula, AVL is a self-balancing binary search tree and usually is taught in a subject called data structures. This subject is one of the core subjects in CS syllabus. According to Del Vado Vírseda [4], this subject is essential for CS students. However, the students find it as a complex subject since it requires a deep understanding of the algorithm. Hence, we propose a mobile learning application prototype to help the students grasp the basic concepts of AVL tree by utilizing the existing
features of their mobile phones. Our approach is to use multimedia features especially video and animation to deliver an effective learning object to the students.

2 Motivation
In this mobile age, mobile phone is a common tool for the adolescent and teenagers worldwide. Mobile phone is a personal device that every student carries everywhere he or she goes. Results from two separated surveys done at a private university in Malaysia proved that current CS related program students are ready to use mobile learning applications [5, 6]. Therefore, there is a high potential for us to implement mobile learning that could complement existing teaching and learning practices i.e. traditional classroom and e-learning.

Like e-learning, mobile learning should be treated as a tool that complements conventional learning. It has some advantages that students cannot get it through traditional learning systems. Agnes Kulkulska-Hulme et al [7] reported that “mobile learning can work, reaching places that other learning systems cannot, it is best provided as part of a blend of learning activities, it offers a collection of pieces to be fitted to a learning need rather than a single solution, it is not simply a tool for delivering teaching material but can be used for learning through creativity, collaboration and communication”. More studies on the effectiveness of teaching and learning through mobile learning system should be carried out.

Many researchers have explored research in mobile learning since the last decade. This leads to the development of some mobile learning applications. Among mobile learning projects that have been established by researchers worldwide are ‘bubble sort’ and ‘binary search’ applications [8], the mobileDNA [9], AMULETS [10], MUSIS [11] and MobileMath [12].

Judith O’Rouke et al [8] have developed two iPhone applications for students namely ‘bubble sort’ and ‘binary search’ applications. The main objective of both applications is to attract potential CS students at the middle and high school levels. The target group of users is becoming familiar and comfortable with iPhone applications. In the future, they also plan to develop more applications related to computer science concepts such as sorting algorithms, search algorithms, greedy algorithms, probability, and binomial expansion. Besides that, they also would like to consider Java based development tools in order to make the applications supported by other devices than iPhone.

3 Methodology
Since the target user never experience mobile learning before, it is quite difficult to get a complete set of user requirements at once. They do not know what to expect as well as what design would suit them most. This also brings our concern to design the best layout of the system that is most conducive to the students. Having not known the best design as of the planning phase, the best way to overcome this uncertainty is by developing prototypes so that students as our users would be able to test the application and comment on ways to improve the current functionality, usability, ease of use, layout and navigation. With these comments, the development process would reiterate through the analysis, design and implementation phases until the target users accept it. Figure 1 shows three main stages in the system design and development.

In stage 2, testing was done after every function was created. Every function has gone through both functional testing and ad-hoc testing. Functional testing tested the desired output and functionality while ad-hoc testing tested the unfinished product of the function being developed. Therefore, as the function is being developed, ad-hoc testing was done on the function. Every function has gone through the planning, analysis, design, implementation, and testing process.

After each individual functional testing, the system will be integrated. This is to ensure the correct function flow from one function to another with ease and smoothly. To add on, when integrating, every function should work as it should and to work with other functions as well.
4 The Design Prototype

Based on user requirement analysis gathered from the potential users, below are six functions that we have implemented in this first prototype:

User login: Students are required to login into the system for security and personalization purposes. With this personal login, once a user has successfully login, he or she will be redirected to his or her respective page based on his or her learning progress. This helps the student from leaping from one screen to another.

Video clip function: The lesson was designed in the form of short video clips. Student has a full control of the video clips and able to replay and pause it at anytime. Therefore, each student is able to learn at his or her own pace.

Recap function: This function provides more interactivity between the user and the system. Student is able to drag the nodes and drop it at the appropriate area. This function will definitely reinforce learning.

Exercise function: Student will be given several MCQ questions at the end of each lesson. Marks will be recorded in the database. Thereafter, both the student and teacher can monitor the progress of learning process.

Homework function: Student should be able to get his or her list of homework of the week. They will request the homework list from the web server where their lecturer has placed the homework list.

Write Comment. Student will be provided with a form to fill in their comments. The comments will be sent to their lecturer’s email and will also be stored in the database.

Two important principles in designing a mobile learning application are user analysis and usable interface due to its small screen size. This application prototype applied guidelines for designing contents for mobile learning as described by Grasso and Roselli in [13].

- Correspondence to hardware characteristics. In this stage of prototype development, we designed this application for smart phones that support flash player, i.e. HTC Touch Pro.
- Rationalized contents. We have to ensure that the content for this application small in size because of limited capacity of the device.
- Simple, handy usage. The user interface of this application was designed carefully in order to make it simple yet useful for the students to concentrate on the learning tasks.

5 The Application Prototype

The overall system architecture comprises four main components as depicted in figure 2: (1) user terminal e.g. desktop or mobile phones, (2) Internet Service Provider either fixed or wireless network, (3) main servers i.e. web server and mail server, and (4) database server. Users can access the system through either mobile phones or desktop terminals as long as the users have the Internet connection. The web server serves all the services provided by the application. Mail server is required in this system to send email notification to users. The database server is responsible to keep all the learning materials, user profiles as well as the video files.

All the user requirements for this cycle of prototypes have been successfully developed and tested. This mobile learning application prototype has been developed by using several development tools primarily JavaFX SDK and PHP MySQL. JavaFX provides a unified development and deployment model for building rich client applications. It is able to integrate rich immersive media, graphics, rich text and web services. Therefore, all animations and multimedia presentations in this application have been developed using JavaFX SDK. We used PHP MySQL to develop some functions such as quizzes and comments that requires some communication with MySQL database server.

The fundamental approach of this project is to utilize the video feature in mobile phones where the algorithm is presented through animations and video presentations as depicted in figure 3a and figure 3b. It helps students to see the movement of the data step by step and predict the outcome of the algorithm easily. Another advantage of applying
video in this context is the student could learn at his or her own pace since they have freedom to pause and rewind the video. At every step, the commentator would explain why each step is taken that way and how a new result is derived. This would help students understand the reasons and thoughts behind every step of the algorithm. This is very important for the students in designing the solution to the problem that they were assigned to solve later on.

After the student gone through a lesson with video, the student can proceed to recap section. In this section, the student will be given several sets of problems to be solved. The problems are designed in the form of animation where the students are required to drag the nodes and drop it into the correct positions. If the student drags a node and drops it into a wrong position, the note will move back to its original position with a buzz. We hope that this approach will make the student realize his or her mistake and try again. The expectation is that the algorithm and basic concept are reinforced.

Figure 4 shows the last page of a sample exercise question. All the questions are generated randomly from a question bank based on the level of difficulty. Therefore, each student can retake the same set of questions multiple times. In case of multiple attempts, the average score will be taken as the final score for the exercise section. Final score from this exercise function will be stored in a database server for reviewing purposes.

6 Discussion

Ten students were randomly picked to test this first application prototype. All of the students have taken all the prerequisite subjects for data structures & algorithm and will enroll for this subject in the next semester. We have selected a group of students without any background in AVL tree because we would like to see first hand experience learning the AVL concepts through mobile phones. First, introduction to the subject was given to them verbally. Then, we let them test the mobile application prototype and watch the video clip which shows the how an AVL tree is formed. After watching the video, they recap their lesson by dragging and dropping nodes into a specified area. Following that, they answered a few exercise questions to test how much they have understood the lesson.

Based on this user testing, all the students found the mobile learning application as a useful and convenient tool and happy with the functions provided. Users found the systematic explanation of the AVL concept through video is effective. Two students complained that they hardly to see the numbers on the AVL nodes from the mobile phone screen because of small font size and the screen is a bit glaring when they were testing it outdoor.

A mobile learning system makes it possible for students to study anywhere and anytime. They can do revision when they are waiting for a bus or when they are on the move from one lecture hall to another. Students can also send email messages to their lecturer via their mobile phones through a
simple form. This is made possible with the availability of wireless Internet connection.

The Recap and exercise functions are essential for students. From the results gathered, all of the students found the recap lesson useful because it helps students to reinforce their understanding of the video clip that they have watched before. The exercise section tests the students understanding on the lesson that they have just learned.

7 Conclusion & Future Works
This paper has presented the design and development of a mobile learning system for university students. Our focus in this project was utilizing multimedia elements on mobile phone especially video and animation. We can conclude that it is possible to incorporate video in a mobile learning system. In this mobile learning application prototype, a complex concept such as AVL tree was presented effectively through a video clip running on mobile phones.

In the future, we will continue to improve and develop more learning modules for the subject. One of the issues here is how the small and limited screen size could handle a video clip that explains more complex algorithm. Besides that, students should be allowed to interact with each other through the system. This will enable them to share knowledge with greater ease. We suggest mobile forum should also be incorporated into this system. Considering some mobile phones with poor quality of audio, each video clip should come with explanation in text at the bottom screen.

References