Adaptive M-learning Application for Driving Licence Candidates Based on UCD for M-learning Framework

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Abstract: This paper reveals the adaptive mobile learning application that we have designed and developed for driving school in Helsinki, Finland. The application development is considered as a case study for User Centred Design (UCD) framework specific for mobile learning. The overall aim of this case study is to assess the UCD framework. The main goal of the proposed UCD method is to ensure that the stakeholders, especially students, recognize the mobile learning application as a learning medium that meets their essential educational demands. The UCD for m-learning application development framework mandates users’ involvement in all stages of product concept development phases. The result of applying UCD for m-learning application framework is an adaptive mobile learning application specific for driving license candidates. This application helps students to study, learn and assess the compulsory driving school theory lessons on their smart devices. Additionally, the application provides mandatory self-evaluation report to instructors after each practical driving session. The application prototype evaluation results indicate that test users are able to carry out the predefined tasks independently. Test users find the application useful and fun to use.

1 INTRODUCTION

Smartphone’s penetration among youth is increasing with a fast pace (Maged et al., 2011) and (Mostakhdem-Hosseini et al., 2006). Youth spend more time with smartphone applications than their PC counterparts. The penetration and the excessive usage is a result of advancement in wireless technologies and smartphones. The numbers of mobile applications such as game, social networking, entertainment, personal and professional are increasing rapidly. These applications are constantly competing for users’ time and attention (Dirin et al., 2013). Mobile learning application development however, requires extensive consideration as the application deals with learning and learners alike. M-learning application must meet students’ essential educational requirements and also encourage students to engage with the application on their smartphones (Keinonen et al., 2003); (Seong et al., 2006); (Zhang and Adipat, 2005) and (Mostakhdem-Hosseini, 2009). Moreover, the m-learning application should follow the pedagogical principles and requirements (Kukulska-Hulme, 2007); (Trinder et al., 2007), (Corlett and Sharples, 2004) and (Mostakhdem-Hosseini, 2008).

The User Centred Design (UCD) for m-learning application (Dirin and Nieminen, 2013) is proven successful framework to design and develop a usable mobile learning application. This framework puts intended users of the target application at the center of its design and development.

The driving licences application development required extensive functional and non-functional considerations. This application enables the driving school candidates to complete the compulsory theory lessons on their smartphones. The application functionality implementation associated with two distinct challenges, 1. the content preperations and 2. the user interface design. The content of driving licenses theory lessons must follow the standard mandates and regulations defined by government organization. Additionally, the content of the theory lessons must be easy to comprehend and simple to use and soft navigate. As a result multi-formated content e.g. audio, video and animations are considered the best approach.

The application follows the user’s learning progress by conducting evaluation test after each
theory lesson. Moreover, the application provides a self-evaluation form after each practical driving session. The application then forwards the completed self-evaluation form to proper instructors at the driving school. Based on submitted self-evaluation form report the application also notifies instructors if immediate attention is required.

The application also recommends the follow-up learning lessons based on user's knowledge and reading history. We refer to this functionality as a part of the application adaptivity. There have already been many initiatives (Vainio and Ahnonen, 2003) and (Jäppinen et al., 2004) to provide adaptive mobile learning applications to improving the usability and learning processes.

In our project we considered the content adaptivity and application usability as major factors for easing the learning process and knowledge creations.

The non-functional requirements of the proposed driving licence application are as important as the functional requirements. The application should be reliable, the user should also feel secure to use and most of all be usable. In this paper however, we focus mainly to the functional requirements and the development steps that are based on the UCD framework for mobile learning application development.

2 APPLIED METHOD

2.1 User-centred Design

The term User Centred design originated by Don Norman during 1980s after publication of book entitled: User-Centred System Design, New Perspective on Human-Computer Interaction (Norman and Proper, 1986) User-Centred Design and development of interactive systems and devices has an increasing importance in product development organizations (Nieminen, 2004). In addition, UCD is the most common method for developing a smart product. Gould (Gould and Lewis, 1985) and (Gould et al., 1997) argued that in a usable system, we need to involve users’ continually, and based on user’s feedback, modify the design. The user-centered design (UCD) cuts both costs (Bosert, 1991) and (Gulliksen et al., 2003) and improves usability, since it continually focuses on the essential needs of the customer as early as possible. The user’s requirements are the focus in all stages of the product development cycle. Human-centric design (ISO 9241-210, 2010) processes for interactive system (Sharp and Rogers, 2006) and (ISO 13407 Model, 1999) defines three different design solutions for UCD as: I. Cooperative design; designers and users involved in all stages II. Participatory design; users’ occasionally participate in the design process, III. Contextual design; design based on the actual context. The UCD phases are as follow, 1. Get to know the users 2. Analyze user tasks and goals 3. Establish usability requirements 4. Prototype and then design concept 5. Usability test of the concept and 6. Repeat the stages as there are more features/services.

2.2 User Centred Design (UCD) for M-learning Application Framework

This case study is based on the User Centered Design (UCD) method specific for m-learning application development framework (Dirin and Nieminen, 2014). The following diagram reveals the UCD for m-learning application development phases.

![User-centered design process for m-learning application development.](Image)

**User Study Phase (Understanding the User).** The user study phase is the essence of the UCD for mobile learning application development. At this phase target stakeholders are identified and their real needs are investigated by applying various user study methods such as a diary, interview etc. The user study method such as a diary helps the designers to learn about the user and their environment in which they often interact. Standard UCD methodology recommends 3-10 target users’ involvement at various user studies stage (Usability Research Group, 2002).

**Data Analysis Phase (Identifying the Interactions).** The gathered data in the previous phase is raw data, which requires processing for identifying the users’ real needs. There are various data analysis methods such as transcript coding, user task and environment
analysis can help to classify and categories the user requirements. Affinity diagrams are the recommended method for categorizing and prioritizing the requirements.

**Idea Creation Phase (Producing Design Solution),**

At this phase we need to confirm those categorized and prioritized requirements with the potential test users. This confirmation ensures that designers understood the users' needs properly. Additionally, this is yet another opportunity for target users to impact to the proposed requirements. We present the categorized requirements as scenarios. Scenarios are the best approach that we promote in the mobile learning application concept design method. As the scenario speaks user's language and often avoids technical terms and complexities.

**Product Concept (Evaluating the Designs).** In this phase the application concept is modified based on the gathered data in the previous phase. The application concept is now ready to be implemented as a non-functional prototype. The prototype consists of the potential user interface components and the navigations of various screens. In the last stage of users' involvement in the design process, we conduct usability evaluation test for the proposed application prototype. The target application design refinement is based on the usability test results.

The UCD for mobile learning application is an iterative design method. In this method, the concept development mandates the users' involvement at all phases of the mobile learning application development which minimizes the application failure and maximizes the penetration of the application among the target users.

### 3 CASE STUDY “M-LEARNING APPLICATION FOR DRIVING LICENCES”

The mobile learning application for driving school was designed and developed during 2012 at HAAGAHELIA University of Applied Sciences, Helsinki, Finland.

The application is developed based on UCD for m-learning application development framework. The first phase of the framework mandates the direct involvement of the potential application users for understanding users' needs and tasks. In this case study we conducted, our user studies with students and instructors at Haaga driving school in Helsinki. We applied different user study methods such as diary, web questionnaire and semi-structured interview. We asked seven (n=7) driving license candidates to take part in our user study sessions. The age distribution of the users is from 18 to 25 years old. In addition, 5 instructors were also involved as potential users of the mobile learning application and admin tool concept design. The age distribution of the instructors is from 20-55. The user studies are carried out in Helsinki metropolitan area. We utilized the web questionnaire and diary to learn about our users’ daily activities, types of smart gadget they currently use, most frequently used mobile application or most often downloaded, and the level of computer knowledge. After having the basic knowledge on our users through diary and web, we scheduled an individual semi-structured interview. The interview sessions often took 20-30 minutes and all the discussions were recorded with the user’s consent.

After the user study phase, we applied various data analysis methods such as transcript coding and affinity diagram to explore the users' real needs and requirements for the target application. We categorized a list of requirements with the priority level. Based on the list of requirements, we wrote scenarios in which the requirements were presented as the potential function of the target application. We then came up with three different scenarios which the first scenario reflects implementation of the application based on users’ requirements in future technology where technology far more advanced than now. The second scenario reflects the current technology and the third scenario reflect the existing resource to implement the prototypes. In the following figure a sample scenario of the target application is presented.

![Figure 2: Scenario for theory test of driving m-learning application.](image)

The scenarios are then shared with six (n=6) users. Three (n=3) users were selected among those users who have participated already in the first phases of the user studies and the rest were new users. The admin tool scenario for the instructors was also shared with three driving school instructors.
Test users were asked to read the scenarios one by one and then the user study expert conducted an interview about the scenario. Similarly, with user’s consent all the discussions were recorded for further analysis. The collected feedback from all users was analyzed, which helped us to recognize more valuable functional and non-functional requirements. This proceeded with the design of a paper-based prototype of the target application. The paper-based prototype then was consulted again with the test users for final revisions of the concept. We conducted a usability evaluation test for the proposed prototype. The usability test was carried out at the media-lab in Haaga-Helia University of Applied Science. Through usability evaluation we assessed the functionality and the user interface of the target mobile learning application.

Finally m-learning application for driving school is designed and proposed for implementation. In all processes of the application design and development the user experience factors such entertainment; delightful and adjustability of the learning application were in the center of the design theme (Dirin and Nieminen, 2013)

3.1 Prototype Implementation

Selecting the right smartphones’ platform for implementing the prototype was the first challenges that we encountered. There are many smartphones in the market and each of which has a unique development and usability requirements. We came to the conclusion that we develop a cross platform application as it is not possible to anticipate the potential users’ smart devices. We select HTML5 and JQuery as the most appropriate technology for developing the application for all the latest smartphones (Dirin et al., 2013). HTML5 is considered as cross platform that provides a consistent UI across the latest smart devices. We however ensured that the selected HTML5 API’s support the latest smartphones. For the server and backend implementation, we have utilized Microsoft Technologies such as MS MVC4, MS SQL Server 2012 and MS Server management Studio.

With the help of this application the driving license candidates are able to study, complete and pass the compulsory driving school theory test. Additionally, with the help of this application, the instructors at the driving school are able to receive instance reports about students’ practical driving performance. The report consist of students’ self-evaluations on the driving experience besides other data such as GPS data, durations of the driving practice and the route that the students has taken during the practicing driving session. The following diagram presents the application self-evaluation concept.

Figure 3: Sequence diagram of m-learning driving application, Self-evaluation concept.

The actual content of the learning materials are provided from the server by application query. Students are able to make a query for a particular content or a topic at their convenience. The application assesses the users’ knowledge based on the previous learning activities. The content is then provided to students in three different circumstances. I. User may select an active topic from table of content in the theory section of the application II. The application may propose content to user after random theory test. III. The application may propose content immediately after reporting the self-assessment form to instructors.

Figure 4: Self-evaluation screen shot.
The application UI is consistent, interactive and supports touch and non-touch smart devices. The application provides the content to the user in various formats which depends on the context of the query. Nonetheless, the application supports video, audio, animation and text-based formats.

Each theory sessions consist of an evaluation test. Passing the evaluation test is prerequisite for starting the next topic. The new topics are dimmed and the user is not able to select. In case the number of failed answers exceed to certain percentage. The application discards the lesson and recommends user to re-take the lesson. The users also can suspend the reading or the self-evaluation test at any time. The application however keeps track of the user’s readings and self-evaluation activities. As a result users may continue the reading tasks or self-evaluation test in their convenient time.

After each practical driving session, students must submit a report to the instructors. The content of the report form and the questions are customized by the driving school instructors. The content of the report form personalize by instructors based on students’ theory achievements and previous driving experience reports. The application react instantly on the reported form after driving session. If severe errors occur during driving sessions the application warn the student about the seriousness and prompt a proper content for further studies.

The following screen shot shows the driving session self-evaluations application form. The application UI is customized both for touch and n-touch devices.

The administrative tool is the most important part of the driving licence application. With the help of this tool the instructors define the application content, self-evaluation test content and criteria for passing the theory lessons. Additionally, the administrative tool provides a unique report to the instructors about the students’ performance on the theory part and in the practical driving sessions. The administrative tool is compatible with mobile and PCs, we have considered both pc and mobile versions as the instructors often on the move or in office. Similar to the self-evaluation question UI, we have used colour coding for instructions to check the report of each student instantly. The instructors are able to print out the students details learning history and driving session progress summary reports. The following screen shot presents the instructors’ admin tool.

4 CONCLUSIONS

In this case study we utilized a User Centred Design (UCD) framework specific for m-learning application development. This case study strives to assess the UCD framework by developing the mobile learning application for driving schools and driving licenses’ candidates. The UCD for m-learning application development framework ensures that the users of the application are directly involved in the application of the concept design. The framework results in an application that meets all the usability criteria. The prototype evaluation report indicates that the application is easy to use and provides the essential learning materials for driving school candidates. Users are specially satisfied that the driving theory lessons are accessible at anytime and anyplace. Additionally, the UCD framework for mobile learning application helps to develop a mobile learning application that is adaptive, interactive and easy to use. The usability
reports show that these features in mobile learning application provide positive user experience for our test users. The UCD framework results in this case study and application that is dynamic. The application content and UI is customizable based on students’ performance on theory lessons evaluation and practical driving session reports. Moreover, the application supports multi-formatted content. Students may select one or combinations of many formats based on the context and the content of the learning materials. The main focus in this case study is to assess the UCD application development frameworks’ efficiency. The pedagogical considerations or evaluations are out of the scope of this study.

5 FUTURE WORK

This case study is designed, developed and evaluated with the help of one driving school in Helsinki. As future work, we plan to test the application in different driving schools in Helsinki and possibility in different cities. The results will help us to compare the application performance and users satisfaction more accurately.

We have not assessed the pedagogical perspective of the application. It is important to study the learning efficiency of the proposed mobile learning application. And to assess how the proposed mobile learning application helps students to learn more efficiently? And to find out whether students comprehend the mobile-learning materials as easier than the traditional approach.

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