Universities Go Mobile – Case Study Experiment in Using Mobile Devices

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Abstract. The objective of this research was to investigate the possibilities of using mobile applications and mobile devices in University environment. The research integrates several existing technology adoption models and then for the needs of the research conducted and develop a case study experiment. The objective was to raise the communication level and accessibility, as well as the dissemination of knowledge and learning. The significance of the research is based in the fact that today, almost every student has a mobile device at all times while not everyone has a computer and internet connection at all times. In order to investigate this, a case study experiment was devised. It involved investigation into the factors that influence mobile applications.

Keywords. Mobile application, wireless devices, human-computer interface, usability

1. Introduction

What are the possibilities of improving and increasing accessibility, communication and learning in University environment through mobile usage and wireless applications? Will this have a substantial impact on these factors above mentioned? Will the students find this useful? The research has attempted to answer to these questions primarily above all.

While the opportunities that mobile and wireless devices present us are new, however the challenges are quite old, smaller screen sizes, limited processing power, reduced input capabilities. These challenges mean that adapting existing e-learning services and content to m-learning is not a trivial task.

Because wireless devices are compact and relatively easy to handle, the Information technology focus is quickly shifting from PCs to PDAs, cellular phones and pagers.

The transition to wireless, mobile Internet devices will fundamentally alter the landscape and architecture of communication networks. Especially since wireless devices are becoming more and more customizable.

2. Research Design and Methodology

The research design consisted of three phases. The first phase is explorative and consisted of a literature study of the context of the mobile phone user as well as the factors that influence wireless devices especially mobile phones, mobile computing, and usability issues in mobile wireless devices. The findings from the literature study are our response to the first research sub-question.

In the second phase these findings have been integrated to propose a model of factors that influence mobile wireless devices. This model is a response to the second research sub-question. Then based on our model we have developed and conducted an experiment to see what software development Life Cycle model is most appropriate in the context of mobile environment. Afterwards, the focus have been set on several testing procedures in order to address the identified usability issues and investigate what does and does not work in particular situation and develop guidelines and recommendations for those cases.

- The research is conducted firstly based on fundamental research and grounded theory research and then afterwards action research. For this reason a case study experiment was conducted. Then exploratory research and constructive research to build the solution as well as quantitative research to study the relationships.

- The data collection is realized through surveys focus groups and feasibility study of the realized needs analyses, and then through using the developed software life cycle model.

3. Background Research

Wireless devices and especially mobile phones have been researched from a variety of perspectives, for example, information systems [6] and from Human-Computer Interaction (HCI) [2,3,4]. What is, however, lacking is a model that integrates the factors that influence wireless devices especially mobile phones. Technology
adoption, in general, has been widely studied and several models of technology adoption have been proposed and tested in [9]. Therefore, the research is focusing in investigating mobile software development models as a strategy to match mobile phone design to user’s technological needs and expectations focusing in usability and HCI.

Based on the literature study the research integrates several existing technology adoption models and then for the needs of the research conducted and develop a case study experiment as mobile application.

The research seeks to present usability guidelines by grounding the user interface on usability theoretical framework, possible constraints, and unique properties of mobile computing.

Three categories of usability have been set as the focus:

1) user analysis,
2) interaction and
3) interface design.

Usability guidelines were suggested in aiming for designing highly efficacious, user friendly and usable mobile interface to support dynamicity of mobile and handheld devices.

According to [8] usability means the measure of the quality the users’ experience when interacting interface. Moreover, usability is not a surface gloss which applied at the last minutes or before the releases of the system or product; but it is deeply affected by every stage of the analysis, design, and development [8].

4. Modeling the Factors that influence mobile applications

Improving the knowledge transfer level by improving software processes is a major concern. M-learning is e-learning that uses mobile devices to access learning content and wireless networks. m-learning uses the same technologies as e-learning, where e-learning uses a computer instead. As usual, in a university environment the computer networks are not wireless, that many times depend on the technical equipment. That might cause problems in connectivity. There are no problems of the type in wireless connections that mobile devices use. Although the development of m-learning environments does not differ from development of e-learning environments in the used techniques and technologies, it differs in the user interface design of the application. M-learning differentiates from e-learning, as being ubiquity, convenience, location awareness and personalization [7]. The main differences are categorized as: 1) the mobile phone itself, 2) network accessibility, 3) the end-user, 4) context of usage, 5) usability.

Concerns with the conception, development and verification of a software system have been based on the previous investigation points. Identifying, defining, realizing and verifying the required characteristics of the resultant software. These software characteristics include: functionality, reliability, maintainability, availability, testability, ease-of-use, portability, and other attributes. These characteristics were addressed by preparing design and technical specifications that, if implemented properly, will result in software that can be verified to meet these requirements.

5. Research Instrument Development

Major challenge for mobile researchers is to assess the m-learning effectiveness. In order to do that used is the methodology previously developed for e-learning systems, called ELUAT (E-learning Usability Attributes Testing) described in [2] which combines an inspection
technique with user-testing based on 4 usability attributes previously set.

The usability attributes we have set as the most important factors that influence mobile apps are:
1) Time to learn, 2) Performance speed; 3) Rate of errors; 4) Subjective satisfaction.

This methodology is necessary for presenting the m-learning in an efficient aspect. The theoretical bases are the pedagogical conceptions defined from [3] as following: 1) Learning according to the constructivist perspective, 2) usability of the m-learning environment and 3) research about user opinions.

The measuring instrument is based on the use of predefined evaluation tasks (PET) defined from our previous study [2], which precisely describe the activities to be performed during inspection in the form of predefined tasks, measuring previously assessed usability attributes.

Using this technique evaluated usability attributes using evaluation tasks for a particular scenario. Evaluation tasks in this technique are determined through designing several user scenarios and choosing the scenarios that include the most of the provided options of the software solution.

6. The Experiment

Improving user satisfaction level by improving software processes is a major concern. In the development process guidelines from (Pressman, 2005) regarding the software life-cycle process have been closely followed. We have chosen the spiral software life-cycle as our model for the software development of the solution.

The actuality of mobile learning is based in the fact that almost every user has a mobile device at all times while not everyone has a computer and internet connection at all times. Providing information on real time when needed increases user accessibility and satisfaction of the offered services in real time. Thus based on the student feedback we believe that, developing a mobile accessible learning environment increases the accessibility of the electronic learning content (e-content), user convenience and immediate feedback of the request not depending on the computer equipment, network connections and bandwidth. In order to achieve that, we developed the MobileView application intended for the students of Computer sciences to view the core and elective subjects they can choose, view short lesson description, view the announcements, exam dates and exam results.

The development of the MobileView application is based on students needs, preferences and context.

The software solution was developed in Visual Studio.NET 2003 using ASP (Active Server Pages).

The users are using their mobile devices specifically their mobile browsers using GPRS in order to access the content. The students log on to the web server using their ID number for identification, after which they have three options: To view their exam results; 2) to see the new announcements and news; 3) to see the teaching content for a particular subject.

These options have been derived based on previous student needs analyses that were based on a web survey and a focus group from the Communication Sciences and Computer Technologies Faculty at South East European University. The students have defined these functionalities and options as important for them. The mobile view was compared at all times with the computer (browser) view in order to assess its usability and accessibility.

After logging in the students have been given three options given below.

**Figure 2. Mobile application: Options**

The announcement section was provided as combo box and while being fine in computer (browser view) it was quite not practical and assessed as very bad choice from the testers.

This option has to be addressed in other way and the solution that we have been agreed and preferred from student side is the List form. Also the student were given the opportunity to select and check their exam results without the need to come to the University using their mobiles. The past exams optionality is limited in exams that occurred in the time period of past 2 years.
The option to view the exams was defined by the subject name and date of the exam as well as the type. Three types of exams have been defined: midterm, final, make-up exam. Below is given a visual representation of the views in mobile view and in browser for comparison reasons.

Also the students requested the option to access a short description of their subject topics organised in one semester consisted of 15 weeks.

The week topics consisted of short description of that week lecture in the form of an abstract with goals and objectives and clearly defined outcomes. From the student side it has been evaluated as very informative and just enough information needed since they do not expect to learn the entire lecture using this option. They prefer this option only to be aware of the content of that particular lesson topic. The students still prefer the printed and hard copies of lectures in the learning process and according to them this will hardly change in favor of electronic views.

The usability testing process was divided into three phases and we have followed the guidelines as defined from [5, 10]: planning, acquisition and execution with evaluation. After the usability test collected the data from the 10 participants, age range 20-22 years, all of them students. Experts were 5 of them (Computer Science 3 (third) year students experienced in using mobile software) while the other 5 categorized as novices (Business Administration 3 (third) year students). The mobile devices used by the testers have varied (Nokia, Sony Ericson, HP ipaq). However, they where all the new generation with year of production 2005 to 2007 with GPRS browsing capabilities. In order to handle those data the triangulation technique from [1] was used. There we look at all data at the same time to see how the different data supports each other.
The usability testing metrics is given below in the table devised based on the qualitative method using questionnaire measuring previously defined and described usability attributes with further explanations inside the tables for the both classes of users Experts and novices. The performance measures for expert class compared with novice class, show speed of performance quite higher as well as smaller number of errors and higher subjective satisfaction for expert class compared with the novice class.

### Table 1. Results - Measurements for Class Expert

<table>
<thead>
<tr>
<th>Usability Attribute</th>
<th>Value to be measured</th>
<th>Current Level average</th>
<th>Worst acceptable</th>
<th>Planned target level</th>
<th>Best possible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to learn to use</td>
<td>Time to learn to use</td>
<td>8</td>
<td>20</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Speed of performance</td>
<td>Time to complete all tasks (seconds)</td>
<td>17</td>
<td>40</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Rate of errors</td>
<td>Number of errors</td>
<td>2.37</td>
<td>4</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Subjective satisfaction</td>
<td>Satisfaction degree of users</td>
<td>4.03</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

* legend: very high, high, average, low, very low

| Time to learn to use | Time to learn to use the app (seconds) | 14 | 30 | 15 | 5 |
| Speed of performance | Time to complete all tasks (seconds) | 37 | 60 | 30 | 10 |
| Rate of errors | Number of errors | 4.53 | 5 | 3 | 0 |
| Subjective satisfaction | Satisfaction degree of users | 3.06 | 1 | 3 | 5 |

### Table 2. Results - Measurements for Class Novice

<table>
<thead>
<tr>
<th>Usability Attribute</th>
<th>Value to be measured</th>
<th>Current Level average</th>
<th>Worst acceptable</th>
<th>Planned target level</th>
<th>Best possible</th>
</tr>
</thead>
<tbody>
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<td>1</td>
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</tr>
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</table>

* legend: very high, high, average, low, very low

8. Conclusion

Analysis led to a series of recommendations for changes to methods and procedures currently employed in developing mobile software solutions that are to be used in learning and offer learning services.

Nowadays mobile phones are rapidly becoming increasingly powerful (both from hardware and software point of view) however their screens remain comparatively small. Often also the navigation is hard. Equipped with a small phone-style keyboard or a touch-screen the users lose more time in searching where on the page the information they need is than also in reading it and manipulating to view it. The student feedback on the developed mobile application is that it offers quite important options and increases accessibility on real time and when needed however usability of the presented information and e-content remains still a challenge and an issue to be addressed.

8.1 Positive Outcomes

It was found that mobile access of the e-content and provided services at real time is far more effective vehicle in dissemination of knowledge and knowledge transfer primarily based on the user motivation and recent popularity the mobile and wireless devices are gaining in general.

Students generally agree that this approach with mobile devices is more intrinsically motivating, it encourages collaboration, is more challenging; focused on higher-order skills and reflective learning. Generally the mobile software is very much appreciated and well welcomed specially from the more experienced expert group of users. Based on the problems identified by the students the appearance of the interface is changed and is made more usable according to the usability test and users comments and that is believed to increase the learning outcome specifically knowledge and understanding.

Those involved in executing and managing the process gained a substantial increase in understanding the overall learning process using mobile devices and attitudinal changes occurred and the role each group played in its successful completion lead to increased goal congruence.

8.2 Negative Outcomes

It was found that graphical representations in mobile applications are not preferable at all and should be avoided as much as possible. Use of computers and mobile devices and applications to teach theoretical Computer Science is dangerous as students may think they don’t have to learn how to solve problems, but just how to
use computer packages to solve them. What
effected substantially their motivation in using
the system because of the amount of work
additionally added to maintain courses? We are
in an opinion that this could prove also very
successful for different institutions/departments
since it does not require any particular effort to
set it up, almost no need for maintenance and
training.

Organized and analyzed the problems
appeared from the testing in two dimensions:

1) Scope (how widespread is the problem)
and 2) Severity (how critical is the problem)

Global problems by scope: The mobile
screens had different resolutions and screen
dimensions and generally not all provided the
same view of the application especially those
with smaller screens. For example some of the
used mobile devices for testing purposes had the
following characteristics and not all of them
provided the same view.
Nokia 8800: 208x208 pixels, 31x31 mm
Sony Ericsson P990: 240x320 pixels, 41x56 mm
Sony Ericsson P900: 208x320 pixels, 40x62 mm
Nokia e61i: 320x240 pixels, 2.8 inches
Motorola w380: 128x160 pixels

Recommendation is to accept and develop for
resolution which is in the middle 208x208 since
the resolutions constantly are being upgraded.
However there is still no standard resolution that
all of the mobile manufacturers would support
which is a consideration to be raised from the
developer community.

Global problems by severity: Several objects
like combo box option that works well in
computers has not been proven as accessible and
usable from the mobile user’s perspective.
Having several screens should be also avoided
because of the time it takes for the content to
load and the expenses that users have in such
cases. The content should be organized in as few
as possible screens and should be provided as
hyperlinks in order to interconnect and be more
usable and in this manner to increase the
navigation.

As conclusion in general mobile applications
and mobile devices offer very important increase
in accessibility and communication level at real
time when needed. However, usability still
represents a major concern and primarily
depends in the need to define standardization in
screen resolution and screen dimensions among
the mobile manufacturers that at the moment is
left without addressing in order for the developer
community to be able to offer more usable
interfaces.

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