Delivering Moodle CMS to Mobile Devices

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Abstract — We presented development of a Moodle Web Service and a client application for a Windows Mobile platform. We decided to develop a Web Service as a more universal data source for access to Moodle from different kind of devices and platforms. We also aimed to enable students to access Moodle CMS on the go, via mobile devices (PDAs and smart phones). Finaly, we presented our findings on a usability study conducted among University students.

***Ključne reči* — eLearning, Mobile devices, Moodle, Usability.**

I. INTRODUCTION

EDUCATION is organized process of knowledge, skills, values and beliefs transfer. Prerequisite for any improvement at individual or social level is education process. Due to technological advances new opportunities emerge to fulfill the process of education amongst which the strongest representative -universal educational tool- the computer. With its abilities it added a whole new dimension to the education process.[1]

Mobile devices provide an ever-growing industry that promises new foundation for expanding educational influence. When learning is distributed to mobile devices such as cell phones or PDAs, it is called M-learning. The basic presumption of M-learning is that a user would like to interact with educational resources whilst away from their normal place of learning -classroom or computer. Mobile devices weren't the first occurrence of M-Learning. It is well known that M-Learning has been around for longer than e-learning, with the paperback book and other portable resources. However, technology is what shapes today's usage of M-learning. Technology now allows us to carry vast resources in our pockets and access these wherever we find convenient. Technology also allows us to interact with our peers instantaneously and work together remotely in ways never before possible.

The prime assumption of this work is that it is possible to bring process of learning and exchanging of knowledge to mobile devices, while saving or even improving the usability of such systems in compare to standard use via desktop computer. The challenges of proving such assumptions lie in limited performances regarding mobile devices such as small screen size, limited processing power, reduced input capabilities. Overcoming those limitations is intended by developing software, for use on mobile devices, that provides users with a quality way of exchanging knowledge and learning. Adaptation of existing e-learning services and content to m-learning is by no mean a trivial task.

This paper describes a process of developing such software able to support M-learning. In the second part, we give brief explanation of terms e-Learning and CMS. Third part is examining the existing solutions for the identified problems. Fourth part presents our solution as a proposition on solving identified problems and a short comparison with existing solutions. As a form of evaluating our proposed solution we conducted usability study described in part five. Conclusion is given at the end of the paper.

II. E-LEARNING AND CMS

E-learning is every aspect of learning using electronic media. This type of learning uses network for interaction. This network can be Internet, university network or any other computer network. E-learning, therefore, is an approach to facilitate and enhance learning through both computer and communications technology. Such devices can include personal computers, CDROMs, Television, PDAs, MP3 Players, and Mobile Phones. Communications technology enables the use of the Internet, email, discussion forums, WIKIs, collaborative software, classroom management software and team learning systems.

E-learning is based on course management systems CMS. CMS is software for different types of direct and indirect interaction between professors and students, and exchange of different type of electronic learning material. Most used systems are Blackboard, WebCT and Moodle. WebCt and Blackboard are commercial software, and Moodle is open source free software.

Moodle is a software package designed to help educators create quality online courses. Such e-learning systems are sometimes also called a Learning Management System (LMS), Course Management System (CMS), Virtual Learning Environments (VLE), education via computer-mediated communication (CMC) or just Online Education (e-learning).[1]

III. EXISTING PROBLEM SOLUTIONS

Research area targeting access to Moodle via mobile devices is not adequately addressed to, only few solutions

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for mobile access to Moodle content was proposed [2,3,4,5], and few researches were conducted concerning usability of Moodle via mobile devices.[6,7] On the other hand there were several projects not specifically targeting Moodle, but offering custom made m-learning solutions.[8,9,10,11]

Most of them rely simply on mobile web access, e.g. Mobile browsers, which provide access to standard Moodle web pages. However, this approach has few drawbacks:

- Limited screen size
- Limited input methods
- Limited network bandwidth

Solution that is more adequate to mobile devices is writing Moodle modules using WML (Wireless Markup Language) instead of HTML, which is targeted to be used with WAP browsers, on limited mobile devices (mobile phones). However, this is still web request/response application model, and even more adequate for limited devices, still suffer from similar problems as standard web applications. Unfortunately there are still no realized solutions that are utilizing these abilities.

IV. Our Solution

We decided to develop Moodle extension for PocketPC devices, which will enable the use of core Moodle functions for mobile users.

In order to satisfy these requirements, we decided to develop a rich client application for PocketPC, and a Web service as standard middleware interface between Moodle database and a client application. System architecture is shown below (Fig. 1).

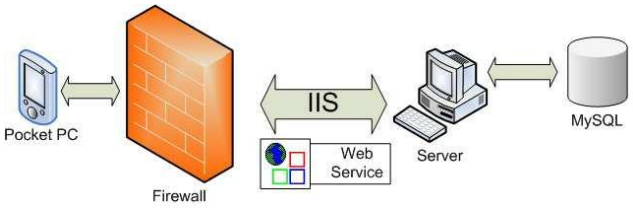

Fig. 1. Mobile Moodle architecture

We utilized Larman methodology for application development, which includes main phases: gathering requirements, system analysis, design, implementation and testing, each covered by adequate UML diagrams.

Since Moodle was developed using PHP/MySQL platform, we decided to develop a Web Service as more universal data source to access Moodle from different kinds of devices and platforms. Because Web Service implements standard interface described by WSDL (Web Service Description Language), accessible via SOAP (Simple Object Access Protocol) based on XML (eXtensible Markup Language) it's very well suited as a universal data source, much better than just MySQL database. It also supports additional features such as using a firewall for extensive security without additional reconfiguring. In our architecture, Web Service is very important, in order to develop clients and support broad range of mobile devices (PDAs, mobile phones, smart phones, etc.).

Rich client application is a better solution than standard or WAP Moodle pages, because it targets main drawbacks (listed in previous section) of these solutions. However there are downsides to using rich client (fat client) where most significant is forking (Certain changes to Moodle will require updates of client as well as server).

The ways of overcoming the disadvantages of mobile devices using our solution are listed below.

A. *Limited screen size*

Standard PocketPC screen has QVGA resolution, which is 320x240 pixels. To efficiently utilize this space, rich client application is a better solution, because it uses controls designed for this screen size, which are layered on the screen in a way which is more productive and easier to use for end users. We use Tab control, to split content related to the different Moodle modules which makes navigation very easy, only one 'tap' (touch screen with stylus pen) is required. (See Fig. 2.). When we need

to show list, we use list box control, which enable users to scroll only that area, not the entire screen.

B. *Limited input methods*

Standard PocketPC devices support three ways to input characters: write recognition, letter recognition and virtual keyboard. No one of them can compare with productivity of standard full-size keyboard, with keys. Fastest way to get user action is by tap, and this should be used as much as possible. We should always offer predefined data for user to choose, rather than to enter them. Utilizing mobile controls, rich Moodle client requires less user interaction in order to reach wanted content and information.

C. *Limited network bandwidth*

Most users use GPRS connection, which has limited bandwidth, and is also expensive when compared to standard home or broadband Internet connections. However, it's well suited for mobile Internet access, but needs to be utilized carefully. Only necessary data should be transferred. Our client application transfers only required data (for example, only activities between chosen date interval are transferred; only details for chosen news;), and performs cashing of such data locally, where any repeated request for the same data will just check for new or modified data to be retrieved via Web Service (already opened news does not require network access, can be viewed off-line).

In order to make better conclusion, we conducted more detail research which included quantitative comparison of network consumption and usability of applications. Usability study includes examination of different usability aspects such as: stability, response and feedback, consistency, control and screen design.

Fig. 2. News module (list and detail) and activity module (list of activities between chosen dates)

V. USABILITY

Usability often refers as the question of how well users can use system functionality [12]. Usability is not one-dimensional property of user interface. It's associated with five attributes: learnability, efficiency, memorability, errors and satisfaction. In order to measure usability we conducted a study among University students.

Due to a limited amount of space that this paper provides, we will shortly describe our study and present and analyze only the essential results of this usability study. The goal of the study was to compare the quality of our PDA solution with other available technologies for using Moodle via mobile devices and also compare the results to standard desktop approach using internet browser. For the alternative technology we have chosen the Google Proxy for mobile devices that provides the service of reformatting the requested content to be more suitable for mobile devices. We used Google Proxy for mobile and PDA as well.

Subjects in our research were undergraduate senior year students from different classes at University of Belgrade Faculty of organizational sciences. A total of 12 students participated in study and all of them completed the end survey. Students first performed a predefined set of tasks on desktop computer using internet browser. Then they performed the same predefined set of tasks firstly on PDA using our custom application, following on PDA using internet browser through Google Proxy, and at the end on mobile device using internet browser through Google Proxy. After the participants performed a set of tasks on different platforms, they were asked to fill out questionnaire. Questionnaire included a few demographic questions about respondents and their computer skills. Then questionnaire included questions about subjective satisfaction on every platform and questions that required them to rate the platforms and to explain their rating. Questions about subjective satisfaction were presented using seven points semantic differential rating scale from positive impression to negative impression (for example 1 = complicated 7= simple).

During the task completion we measured efficiency of use by measuring number of clicks/taps and the times necessary to complete the task. Besides efficiency we measured errors by number and type (simple and catastrophic), and subjective satisfaction.

Respondents were 8 men and 4 women. All respondents were experienced users of computer, PDA and mobile phone. The mean knowledge about CMS systems was 4.92, on the seven point scale, where 1 = no knowledge about CMS systems, and 7 = sufficient knowledge about CMS systems. On the scale ranging from 1 = little experience with e-learning to 7 = experienced user of e-learning systems, our participants mean was 4.58, with no answer under 3.

First table (Table 2.) provides the results of measuring the amount of click/tap actions to complete the given operation with results of measured amount of data transfer in Kb per operation. Operations are processed for each device/technology. The results provided indicate that PDA Application has the lowest amount of click/tap actions comparing to other technologies. The only exception is Read Activities. The reason for that is poorly developed input control for specifying the date interval for searching the activities. It does not provide the ability of choosing the date from calendar but requires manual input. Another indicative that this is a good place of improving the interface came from our test subject that commented on this feature as inadequate during our Talk a loud study. Some of these comments were: "The date input is too complicated!" or "It is too difficult to enter the date, and I am repeatedly making a mistake!".

TABLE 2. CLICK OR TAP NUMBERS/ MEASURED DATA TRANSFER (KB)

	Desktop		**PDA Application**		**PDA Browser**		**Mobile Browser**	
	No	Kb	No	Kb	No	Kb	No	Kb
Login	15	166	15	1	16	37	24	37
Read News	2	17	1	4	7	13	12	13
Read Activities	2	30	22	1.5	9	16	12	16
Send Message	17	7	16	1	22	9	29	9
Receive Message	2	6	1	2	5	7	8	7
Check Grades	3	5	1	1.5	6	4	9	4

The given data for data transfer clearly states the obvious advantage for PDA Application comparing to other technologies. Interaction between PDA Application and a Web Service provides impressive amount of savings in data transfer due to the ability to return only the data relevant for the given operation.

Second table (Table 3.) is a summary of results acquired by measuring time efficiency of each operation executed by our test subjects. The data shown in table are average times per operation for given devices/technologies. Revision of data leads us to a conclusion that PDA Application is more time efficient than other two mobile technologies for each operation performed. Interesting fact is that it also proven to be more efficient than standard Desktop use of Moodle except in two cases Login and

Read Activities. Average time for Read Activities can be explained by poor method of date input mentioned earlier while the reason of longer lasting Login operation could be blamed on lack of keyboard on PDAs part. Also several of our test subjects positively commented on ease of use of PDA Application as opposed of Desktop internet browser. Some of these comments were: "It is a bit confusing to navigate to the wanted section, and it is hard to immediately find a way to perform the given operation", this regarding the Desktop internet browser, and also "It is much simpler to find my way around on this than on Desktop", regarding the PDA Application.

TABLE 3. AVERAGE USER TIME PER OPERATION (SECOND), FOR EACH OF DEVICES

Time (second)	Desktop	PDA Application	PDA Browser	Mobile Browser
Login	27.8	34.7	39	54.3
Read News	58.2	23.2	80.6	87.4
Read Activities	82.6	98.5	121.5	139.9
Send Message	74.8	39	181.6	209
Receive Message	55	27	65.9	57.2
Check Grades	45	18.8	59.6	65.6

As we described subjective satisfaction was measured by seven point's semantic differential rating scale. Questions included in measurement were: System is pleasant to use; Interface is complete; Interface is simple for use; System is fast for use; System is cooperative in completing the tasks. Results are shown on the chart (Fig. 3).

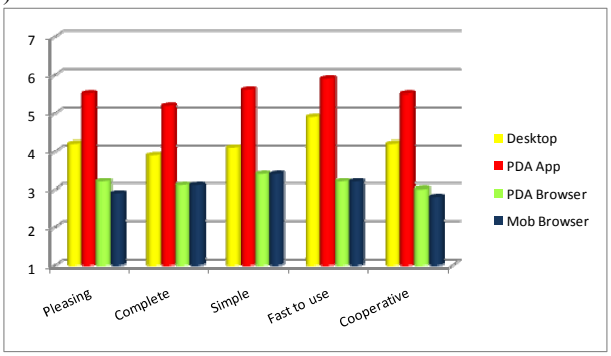

Fig. 3. Results describing subjective satisfaction for each platform

Rankin results were similar as results from satisfaction measurement. Almost all respondents (9 of them) said that the most preferred platform is PDA application. Second preferred was desktop, third PDA browser and forth Mobile browser. Some comments about PDA platform were "PDA application is very easy for use, and almost all poor implementations from desktop are corrected." or "PDA application is almost perfect!" or "Definitely, PDA application is my the most preferred solution".

During the test there were no catastrophic errors, but there were few occurrences of simple errors such as accidental closing of mobile browser (two times) and one network error during the call to a Web service. The test resumed after the second try.

VI. CONCLUSION

We demonstrated how existing Moodle CMS can be expanded for use on PocketPC devices. Our usability study has shown clear advantage of our solution comparing to other alternatives of using core Moodle functionalities via mobile device. Further development may include implementation of other popular Moodle modules (like blog, wikis, quiz, hot potatoes quiz, lessons, assignments...). However, we should carefully weight benefits before deciding to implement support for other Moodle modules in rich client application, because of mobile device limitations (e.g. screen size, memory, keyboard). Not all of them are well suited to be used from mobile device.

Due to extensive data that usability study has provided us, we have the ability to develop the same functionalities for other popular mobile platforms (Windows Mobile, SymbianOS, and J2ME) based on the conclusions from the above mentioned study.

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