Multimedia Environment for Mobile Learning

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Multimedia Environment for Mobile Learning

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Abstract— **This paper introduces our approach in building multimedia learning environment based on digital library and mobile student services. The learning material can be accessed from standard desktop PCs, but also from wireless PDA or mobile phones. The last two approaches require development of a mobile distance educational system, especially a mobile access to the digital library. We will show the functionalities of the digital library system installed on the technical sub-campus of our University. The functionalities of the virtual table (as one of the student services) and their integration into our multimedia learning environment will be also presented. The evaluation of this learning environment showed that the first experiences by the students are positive, and that both wired and wireless access to this kind of multimedia learning environment is suitable for engineering education.**

Keywords-mobile learning; digital library, student services

I. INTRODUCTION

Engineering education long has relied on methods and information resources that train students to follow directions with little connection to doing real science. Digital libraries (DLs) hold great potential for educational applications, as they provide a new environment for individual and collaborative learning, by providing access to a wide array of information resources that are essential for inquiry. More recent science learning standards [1] promote inquiry teaching as a means to help students develop deeper conceptual understanding of science. When students learn science through inquiry they are imitating practicing scientists [2]. A prerequisite for inquiry learning is to make resources collected by and for researchers available to students.

The ADEPT project [3] has the main goal to make primary sources in geography useful for undergraduate instruction in ways that will promote inquiry learning. The efforts in ADEPT, as a digital library to support teaching undergraduate education in geography, are focused on building tools and services to support instruction rather than on building collections, per se. The lack of generalizability has implications for the technical design of the system, such as the importance of the personal digital library framework, ingest capabilities from personal collections, the ability to manipulate and annotate digital objects, and the need for searching by concept or theme.

Architectures that support the integration of eLearning applications on top of digital libraries are introduced in [4, 5]. The ASIDE architecture [4] supports interoperability between digital libraries and eLearning applications so that eLearning applications can easily use and reuse digital library objects in multiple contexts. The architecture is generic and it provides a framework for integrating in eLearning applications material selection and personalization of the material selected from the digital libraries. The LEBONED approach [5] is to find a general solution for the integration of digital libraries into LMS. Furthermore describes concepts and solutions to identify and physically extract components from monolithic documents.

Digital libraries are used as a source of variety of high quality resources to assemble into courses and training materials anytime/anyplace [6]. A tool, the GROWTutor, is available to allow instructors to develop and manage web-based courses without the need for significant technical knowledge of the web.

Untethered educational digital library and design principles for its design, and the maximization of MLearning potential are emerging from the interactive nature of handheld devices and learning content in the digital library, thus creating the potential to increase engagement level with higher levels of interaction, which has shown to increase knowledge gain and thinking [7, 8]. Perhaps the most fundamental question here is whether the quality of services (QoS) of nomadic computing technologies and wireless networks affect user experiences.

This paper introduces our approach in building learning environment based on digital library and student services which is close in spirit to the last one (as in [7] and [8]). We use the digital content from the digital library as a learning material. It is used from different mobile, wireless devices and services in the process of interactive learning (students) and teaching (professors). Of course the content from the digital library is available on the Web for individual usage by PC or any other handhelds. We will show the functionalities of the digital library system installed on the technical sub-campus of the University Ss. Cyril and Methodious in Skopje, Macedonia. The functionalities of the virtual table (as one of the mobile student services) and their combination into our learning environment will be also presented.

The second section of this paper explains briefly the architecture of the multimedia learning environment based on digital library and student services. In section 3, we are giving some implementation details for the multimedia digital library, while in section 4 some implementation details about our virtual table are given. Section 5 gives some evaluation results from the students, while the section 6 concludes this paper.

II. ARCHITECTURE OF THE MULTIMEDIA LEARNING ENVIRONMENT

The general architecture for the multimedia learning environment based on digital library and different student services is shown on figure 1.

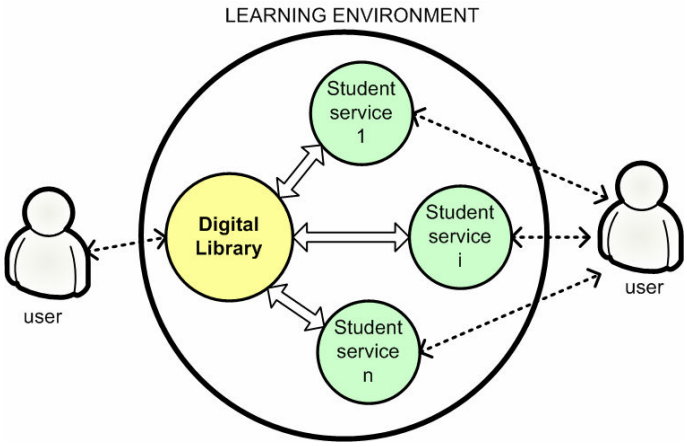

Figure 1. Architecture of the multimedia learning environment.

As can be seen from figure 1, the users can use the learning materials stored into the digital library directly, or they can use the learning objects stored into the digital library by combining them with different student services. In this way, the digital library acts both as storage of different learning materials and as storage of reusable learning objects necessary for more flexible education.

Some of the functionalities of the learning environments are useful for the students and the professors. While using these functionalities from wireless learning environment the students and professors do not have to be in a classroom or a computer room, they could be in the Faculty's buffet, sitting on the lawn or in the Faculty's hallway. As long as they are within the range of the wireless network they can always access the digital library and other student services using a PDA, mobile phone, laptop or a desktop computer.

III. DIGITAL LIBRARY SYSTEM

We developed our digital library system by addressing the following issues: the content of the library (collections), the corresponding annotations and the required searching and manipulation capabilities.

The digital library system has been implemented at the technical sub-campus of our University in both versions for standard PC and for Pocket PC. The most important features of the web-site for Pocket PC are the following:

- Searching of different kinds of data like: books, magazines, CD-s, images, audio, video, electronic materials;
- Enabled reservation of books prior and after the user login;
- Enabled login on the system from pages where the results are presented.

Besides these advantages, the Pocket PC has some disadvantages. It has limitations both in display resolution and the capacity of internal memory. Therefore, the version of the web-site for Pocket PC has the following limitations:

- Unlike the PC version where the number of the results per page can be selected, in Pocket PC version this number is constant and small and it is dependent on the type of data;
- Due to a smaller resolution, the records from database tables are presented vertically in order to avoid the horizontal scroll–bar;
- Some attributes of CSS styles are changed to decrease the size of letters. With small changing of CSS styles this web-site will be adaptable for other handheld devices.

Figure 2 presents the Deployment diagram of the digital library. We use Windows 2000 server that includes Apache web-server which communicates with the Oracle 9.2i database. Client side in this case is a Pocket PC operating on Windows CE platform by using Internet Explorer. The communication between client and server is typically via wireless Internet.

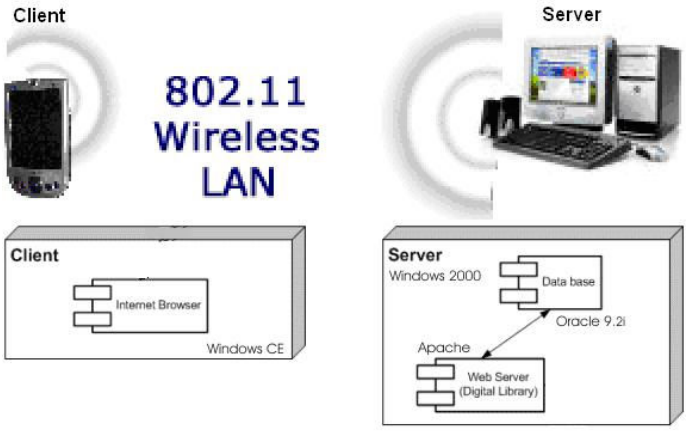

Figure 2. Digital Library deployment diagram.

The digital library works with collections that contain books, magazines, CD-s, multimedia data like images, video, audio and electronic materials. Electronic materials can be searched by title, author, type (doc, pdf, txt, htm) and description. Besides learning materials which are part of learning courses, our multimedia DL system supports different multimedia data (images, audio, video, animations, 3D objects) which are stored separately in the DL and they are treated as additional learning objects. By using the corresponding presentation methods these data will be easily displayable on various devices. For an example when displaying the learning material on Pocket PC, some of the images will be displayed in very low resolution and can be found not very usable for the reader. Therefore we have provided a full screen option for

displaying the images. Figure 3 gives an example of displaying an image in full screen.

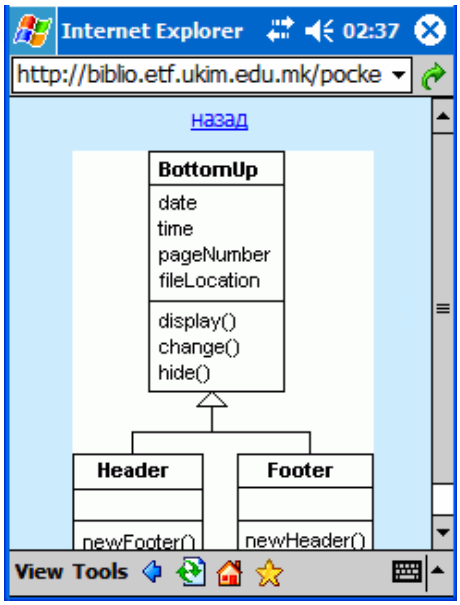

Figure 3. Example of UML class diagram stored in digital library system.

In order to support data like MP3, MID, WAV, AVI, MPEG etc, it is necessary for the Pocket PC to have installed a player for such kind of data. The Windows CE Operating System has a player which supports MP3 and WMV files, but it is not enough to play other kinds of data.

The 3D multimedia data can be attached to different learning materials. When the student retrieves a material that contains 3D objects, the list of 3D objects will be displayed on the screen together with some annotations. When the user selects one of the 3D objects, the ActiveX component based on Microsoft's DirectX technology will be activated and the corresponding 3D object will be displayed (see figure 4).

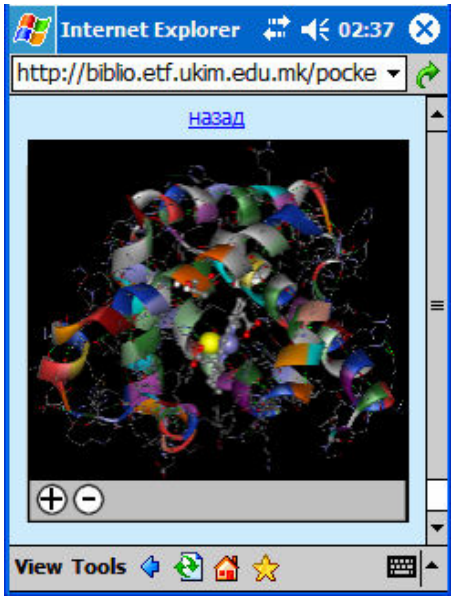

Figure 4. ActiveX control for displaying 3D objects (bio-molecular chains).

By using the mouse or tapping pencil for Pocket PCs, the students can rotate, zoom in, zoom out or pan the presented 3D object. In this way, the students can access different types of materials, which are necessary for their studying. The 3D objects can be found very useful when explaining some lessons in engineering education because they are very rich in visual information, and by given the possibility of user interaction the student can found these data very suitable for learning and studying.

IV. Virtual Table Student Service

Synchronous communication within mobile learning community can be provided with chat service. The simplest one simulates "face to face" communication of traditional educational systems. Obvious improvement of that communication can be done by providing means for: free hand drawing capability in order to reproduce the blackboard and taking the track of the communication (history log). The service should also support authority control (with the instructor), which is used to manage the consultation group and set permissions to the users of the system. These findings are basis for the next mobile services we have implemented into our DES: virtual table with integrated chat service.

The users of the virtual table student service (both students and instructor) log on to the service and start the consultation process. The list of the logged students is visible for the instructor as a dropdown list. Users are connected to the system as clients served by the server applications, which enable identification, customization and different means of communication (like multicast, multiple multicast, etc.) The system supports one instructor and any number of students to be logged on at the same time. The service consists of virtual table, chat and VoIP based audio conferencing tool (in the process of implementation). Virtual table is used as a document-sharing tool where instructor can draw additional explanations on blackboard directly as on a blank page or on a certain preloaded learning object from the digital library.

The user interface of the wireless virtual table is presented on figure 5. On the upper part of the figure 5 two screens from the emulator representing one example of E-R diagram is presented. On the lower part of the figure 5 the same diagram on the HP iPAQ handheld computer is shown.

The student's user interface is very similar to the instructor's except that it has a button to send a drawing request. The instructor can choose the needed functionality for the student interface. The interface for virtual table has a chat part that is consisted of the input text box and the display text box (on the top of the application interface), where all chat' messages are written. The rest of the interface is the drawing area, with the ability of drawing, erasing, changing pen colour and size etc. The learning objects (for example images) stored in the digital library can be imported into this area in order to draw additional information over these images. When a student wants to use the drawing area, he sends the drawing request to the instructor. When the request is received by the instructor's interface, the corresponding alert button blinks so that instructor can notice the request. After that, the professor can allow the student to use the table or ignore the request. Multiple

requests can be received and allowed, so that more than one student can use the drawing area at the same time.

Figure 5. Wireless Virtual Table on a wireless device display.

V. EVALUATION

On Table 1, survey results from 40 students on the last year of study are presented. It is obvious from the table that the students prefer usage of learning materials in electronic format with multimedia data, but they still need hard copy of the learning materials. Wireless and mobile technology was very exciting for students that have a chance to provide wireless and mobile devices. For this survey most of them had the opportunity to use such devices.

The most important conclusion from this survey is that students strongly approve the mobile learning approach and the possibility of displaying learning courses on various devices especially handhelds. They also showed great interest in enriching the learning process with additional multimedia data that will ease their studying. For example, by using our application in signal processing (voice signal together with its FFT and DFT on the screen on the handheld divice), we found an improved understanding of related topics.

TABLE 1. STUDENT SURVEY RESULTS

Features of multimedia learning environment for mobile learning (ML)	**percentage of student that approve the feature**
ML and content in electronic format	87,5
ML and Multimedia content	80
ML and images	78
ML and 3D content	78
Mobile access to learning electronic content in the Library	75
Easy use of mobile devices for education	67
Availability of Learning materials in hard copy	65
ML and more frequent reservation of books	63
Learning material in pdf	62,5
Other electronic formats	57,5
Access to IEEE and ACM Digital Library	50
Access to other Digital Library	25
Mobile access to Library administration services in connection with ML	25

VI. CONCLUSION

This paper introduced multimedia learning environment based on digital library system and mobile student services. It was shown that these services reuse mobile learning objects from the digital library. The learning environment provides all the multimedia and communication functionalities either on a desktop PC or on any portable device (for example, HP iPAQ handheld computer). This allows the students and professors to move freely anywhere in the wireless campus. All these findings can lead to learning environment that enables extension of traditional classrooms to other environments (homes, parks, trains, laboratories). This will enable the students to "learn whenever and wherever" they need in the real meaning of that concept. We consider this as a basic improvement of the flexibility and efficiency of learning.

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