Mobilim: Mobile Learning Management Framework System for Engineering Education*

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This paper introduces the implementation of a Mobile Learning Management System (Mobilim) designed for m-learning environments. The Mobilim system has been developed to provide educational contents through the Internet using mobile phones for engineering educators and students. System features have been evaluated by instructors and students. The system evaluation shows that Mobilim is a useful m-learning environment. Initial results of the system are encouraging for the further development of the system. In addition, the use of open software for the development of this system makes it cost-effective. Mobilim pages can be accessed by mobile phones that have the XHTML browser feature.

Keywords: mobile learning; m-learning management system; mLMS; mobile technologies

INTRODUCTION

MOBILE TECHNOLOGY has tremendous potential and presents opportunities for educators to enable and deliver learning in ways that could not previously have been accomplished. Mobile technology that can be or has been used to support education include, but are not limited to, WAP, Wi-Fi Bluetooth and SMS. Mobile Learning is learning through mobile computational devices [1], such as notebook computers, Personal Digital Assistants (PDAs), tablet PCs, smartphones, cellular phones etc. The important features of mobile learning environments are based on wireless connections via these devices, which are bringing about a change of paradigm in the learning model [2].

Educators and students are willing to take advantage of mobile learning and are looking for an opportunity to use a system that provides a mobile learning environment. The most common mobile device is the cellular phone. However, the mobile phone based learning environment is different from that of e-learning. The reason is that a mobile phone has some restrictions compared with other e-learning tools [3]. These restrictions for a learning application on a mobile phone are: the limited processing power and resources, and the variety of screen sizes and relative low resolution of the display, which makes it harder to present learning content in a user friendly way [4]. Because of these restrictions some current e-learning course materials may not be in a format that mobile devices would accept. Thus an instructor needs to prepare course materials in a compact form that can be displayed in a user friendly way on m-learning devices. The objective of this research is therefore to develop a management and presentation system that supports m-learning through mobile phones.

This paper introduces an m-learning platform called Mobilim that meets the requirements of mobile learning management system activities. The core ability of the system is the presentation and management of m-learning courses. The proposed system conforms to the guidelines suggested in Keegan [5] for a good mLMS application in terms of student records, course development tools, communication, and assessment. Mobilim supports the instructor in preparing courses that include appropriate exercises and, announcements. The instructor can model the course content independently from the infrastructure. In the new model, an engineering educator does not need to have specific technical knowledge about the underlying technology. Mobilim provides an efficient learning environment for engineering students, and any student can use the system easily and freely. Mobilim is designed on open source software platforms. The system user interface supports pages both in English and Turkish languages and can be extended to other languages.

The following sections are organized as follows. The next describes the related works, followed by a section explaining the entire learning management system. Mobilim system architecture is next described. The system implementation and user interface on mobile phone and Web management module is then explained. The last section provides conclusions.
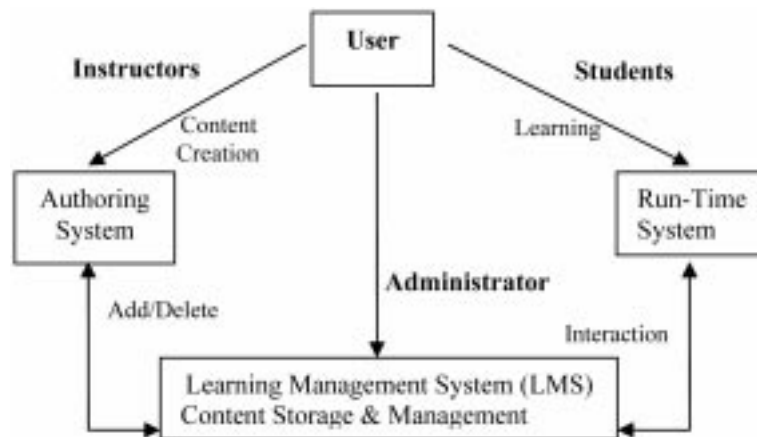
Fig. 1. Generic view of a learning management system [16].

RELATED WORK

M-learning is quite a new domain and there is a lot of work and research currently being undertaken in this area. PDAs have been used in education ranging from kindergartens [6] to medical education [7]. Recently, some education systems that use cellular phone have been proposed. In Europe, the European Commission supports several mobile learning projects [8– 10].

Holzinger *et al.* (2005) studied a practical approach to m-learning and called it 'Mobile Interactive Learning Objects (MILOs)', which are used within a Mobile Learning Engine (MLE) that runs on a smartphone [3]. MLE was developed with JAVA 2 Micro Edition (J2ME). Chan and et al. [11] investigated a Mobile Learning Platform called MobiLP. MobiLP was developed Java Servlets and JSP as a programming language. Koyama et al. [12] proposed a mobile education system (MES) with learning applications coded using Perl Language 5.0 that could run on a cellular phone in which is implemented with J2ME. Trifonova and Ronchetti [13] presented an architecture where the functionalities of the e-learning platform are presented as Web services and on top of it a mobile LMS. Ally et al. [14] developed an intelligent software agent for m-learning. The agent can search for a conversion tool according to a desired format and convert the course material. Virvou and Alepis [15] developed a mobile authoring tool called 'Mobile Author' for the intelligent tutoring domain. Mobile Author is designed on Microsoft .NET Framework. Mobile Web pages use ASP.NET mobile controls with Visual Basic.NET as the programming language.

LEARNING MANAGEMENT SYSTEM (LMS)

A Learning Management System (LMS) is a collection of e-learning tools that are available through a shared administrative interface. An LMS generally coordinates all learning-related activities. The main players in these systems are the learners and the authors; others include trainers and administrators. Authors (who may be instructors or instructional designers) create content, which is stored under the control of an LMS and is typically in a database [16]. Existing content can be updated, and it can also be exchanged with other systems. The general LMS shown in Fig. 1 is controlled by an administrator, and it interacts with a runtime environment that is addressed by learners, who in turn may be coached by a trainer. Importantly, these three components of an e-learning system can be logically and physically distributed, i.e., installed on distinct machines, and provided by different vendors or content suppliers. E-learning systems and LMS, in particular, are nowadays a key element in the learning processes that take place in universities [17]. There are several such implementations available on the market, such as LearningSpace^{TM}, WebCT^{TM}, Blackboard etc. [18].

MOBILIM—MOBILE LEARNING MANAGEMENT SYSTEM ARCHITECTURE

The overall architecture of Mobilim is shown in Fig. 2. A mobile learning environment requires a wireless Internet environment. The system can run on operating systems that have a Web server and a database installed. The Mobilim is coded with PHP language. The database on the Apache server uses the Data Base Management System (DBMS) attached in the WinMySQL Admin console. Users can communicate with the system through the Apache Web server via GPRS and HTTP protocols. The classifications of users with various access rights have to be established: administrators, tutors and students. The instructor can conduct basic functions on his or her mobile device (check students' progress, check for new announcements etc). The administrator can carry out rudimentary administrative tasks (add a new
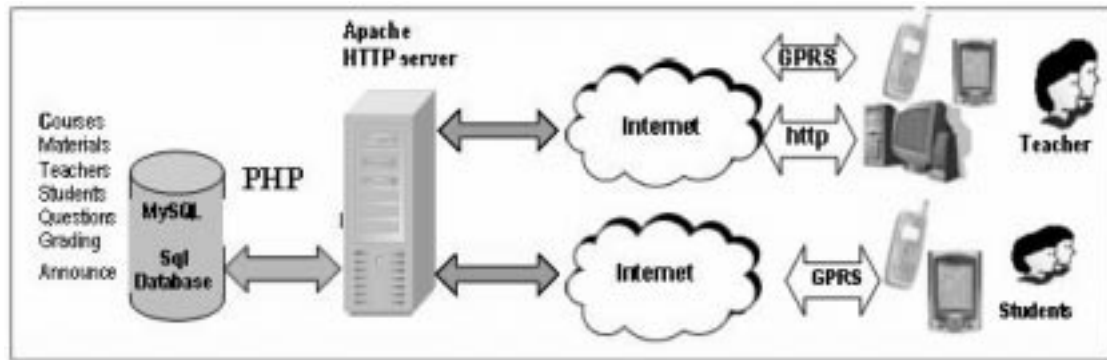
Fig. 2. Mobilim system architecture.

instructor or user, allow users access to new courseware etc.). Mobilim pages can easily be accessed using mobile devices such as mobile phones and PDAs that have the XHTML browser feature. XHTML MP (Mobile Profile) is the widespread standard for WAP development. For that reason, Mobilim is designed to support WAP 2.0.

USER INTERFACE WITH MOBILE PHONES

The user features that are available for students are rearranged for mobile device access. Using these features students can: see the content of the subject, select courses, answer the tests given at the end of each subject, read the announcements issued by the instructors, and send e-mails to other students (individuals or groups) that are taking the same course, and to the instructor of the course. Students can access the education module of Mobilim by means of a mobile phone, PDA or pocket PC.

Login procedure
As seen in Fig. 3(a), the user accessing the Mobilim Webpage for the first time selects the language. Currently only Turkish and English are

available. Language support can, however, be extended to other languages. At the first level of authentication, the application determines whether the user name and password are valid. Students need to register in order to use the Mobilim system. This is necessary in order at allow individual students to follow their progress. For registration, personal information about the student (name, surname, e-mail address etc.) is required (Fig. 3(b)). After entering the user details, the student is informed that the registration must be approved by the system administrator.

If the user's registration is completed, they can directly go to the login page (Fig. 3(c)). After the user enters the user name and password, (s)he selects 'student', 'instructor' or 'admin' category and then logs on to the system. The user name and password is always required to access the mobile pages. When a student logs on to the system, they encounter three options (Fig. 3(d)): 'Announcements', 'Your lessons' and 'Register lesson'.

Registering for courses
As seen in Fig. 3(d), 'Register lesson' is clicked; the courses available are listed with their codes and names (Fig. 4(a)). When a student selects a course from the list (Fig. 4(b)), the course-related subjects can be seen (Fig. 4(c)). By clicking on a subject, the

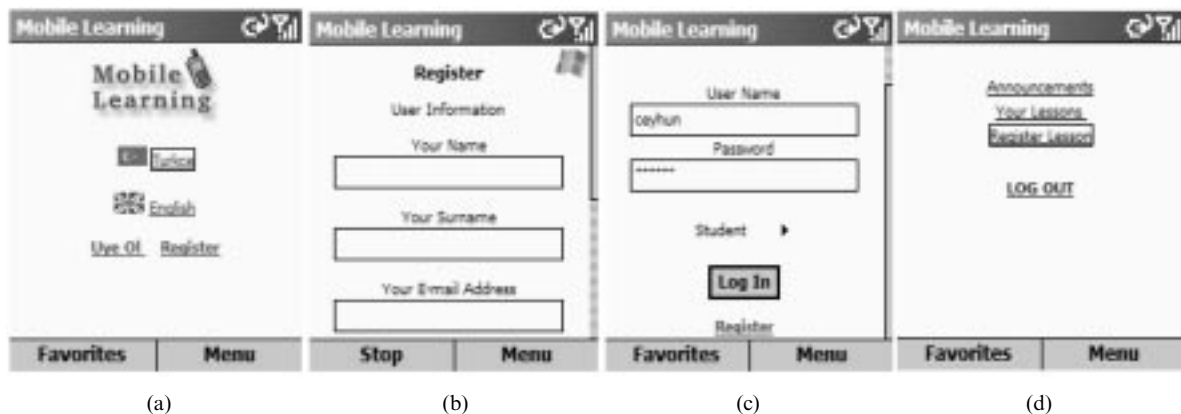|			
(a)	(b)	(c)	(d)

Fig. 3. Student view of features of Mobilim: (a) language selection, (b) registration to the system, (c) system login, (d) registration to a course.
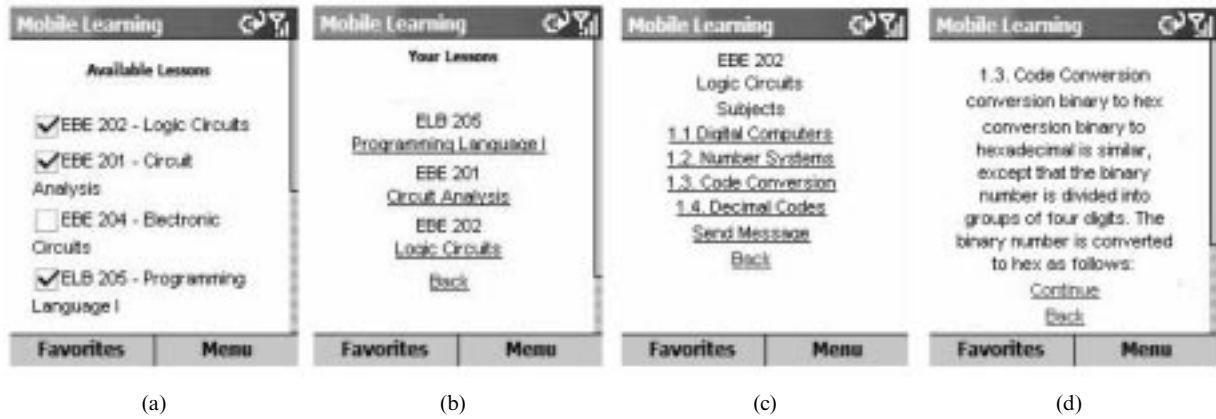
Fig. 4. Student course selection procedure: (a) course selection, (b) selected lesson, (c) subjects of lesson, (d) content of subject.
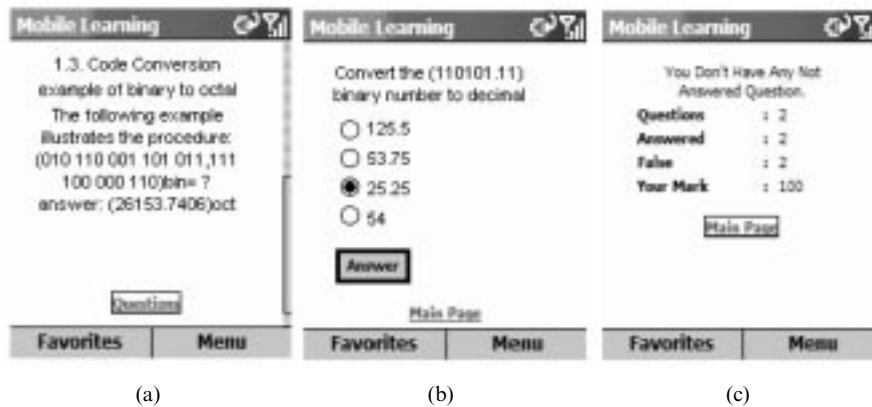

Fig. 5. Student self-assessment: (a) selecting 'Questions', (b) answering checkbox questions, (c) viewing results.

content of the subject appears (Fig. 4(d)). Throughout the subject presentation, there are 'previous' and 'next' links under each screen for student to navigate in the page.

Student self-assessment

After studying all the pages related to the subject, on the bottom of the last page, the student clicks on the 'Questions' link to access subject related exercises (Fig 5(a)). When this link is selected, the multiple choice questions prepared by the course instructor appear (Fig 5(b)). When a question is answered, the next question appears and, at the end of the exercise, the performance results of the student is shown on a separate page. On the 'result' screen, a summary is given of the total number of questions, the number of questions answered and the number correctly answered (see Fig 5(c)). These performance results are stored in the database, and the instructor monitors the students' performances through this information.

Communications

The system provides a communication environment for students and instructors. Students are able to send an e-mail directly through their mobile phones via Internet services. For this facility to work, the SMTP server should be running on the Web server. The body of this e-mail will be the body of the short message and the subject of the e-mail will specify the receiver using his/her name. Messages (if send from the instructor) can contain information about which test the student should attempt next or about anything that the instructor thinks that the student should pay attention to. Students are able to send e-mails containing remarks (Fig. 6(a)) and additional information to other students or instructors as seen in Fig. 6(b). The student enters the subject in a text field and the message is entered in a different text field as seen in Fig. 6(c). Finally, the message is sent by pressing the 'Send' button as seen in Fig. 6(c).

Instructor interface on mobile phone

Mobilim can be used by instructors from either a computer or a mobile phone in order to manage their own lesson and to distribute the lessons to their students. Some of the instructor functions can be accessed by either mobile or non-mobile devices. When an instructor logs on to Mobilim, the list of the course they are teaching appears (Figs 7(a), (b)). When any course is selected, a menu related to this course appears. On the menu, there are links for students taking the course, the subjects of the course, questions added to the course, previous announcements, and new
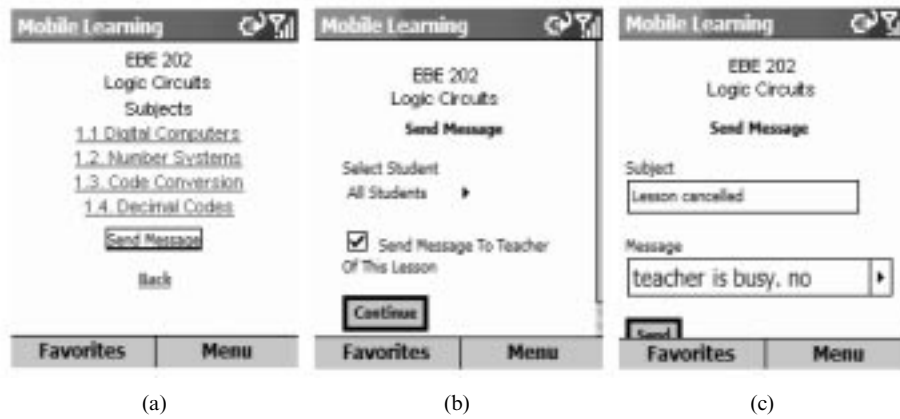
Fig. 6. Communication features of Mobilim: (a) selecting a message, (b) recipient, (c) message text.
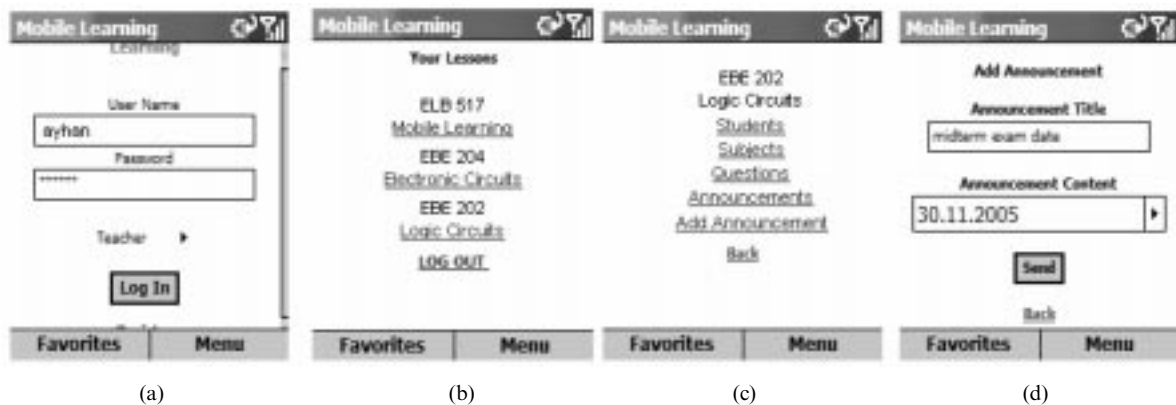

Fig. 7. Instructor's view of Mobilim features: (a) system login, (b) course selection, (c) monitoring course selection, (d) adding an announcement.

announcements as seen Fig. 7(c). Students, subjects, and questions cannot be changed on WAP, currently they can only be viewed. These operations can be done by using the Web management panel. The communication between instructors and students can be achieved in a number of ways. By using a mobile phone (connecting to the Mobilim's pages), instructors can 'Add announcement' to the Mobilim's database. This makes the system flexible for instructors. Figure 7(d) shows the title and content sections used to add an announcement.

Instructor interface on the Web management module

Mobilim allows instructors to create their course in the domain in which they are interested. The system will endeavour to produce m-learning courses that students can take on their own mobile devices when and where it suits them. For this, instructors can upload course materials through a user friendly Web interface from any computer. All lessons, questions, and announcements that are inserted by instructors are kept in a database. Mobilim Web management module allows the creation of a whole course. The teaching materials are usually text. To make multiple choice questions, the instructor needs to prepare the

following items for each question: the question text, the answer options and the correct answer. The instructor can prepare about 5–10 questions on a topic.

When logged into the Web management module, instructors can see the course lists and can edit them as seen Fig. 8. In the 'Lessons' section the instructors can create lecture documents. Course topic editing can be seen in Fig. 9. After creating a course, the instructor edits a subtopic entitled 'example of binary to octal' as illustrated in Fig. 10(a). The instructor can add or edit questions at the end of each chapter as shown in Fig. 10(b). Questions may be of the following types: multiple choice questions or true/false questions. Mobilim also manages the students' grades. As illustrated in Fig. 11, an instructor monitors the progress of students and sends an e-mail.

Administrator features on the Web management module

The administrator features in Mobilim Web module are as follows: adding courses, listing the courses, organizing the courses, adding students, listing students, organizing student information, adding instructors, listing the instructors, organizing the instructor information and related menus. Admin creates entries for each of the instructors
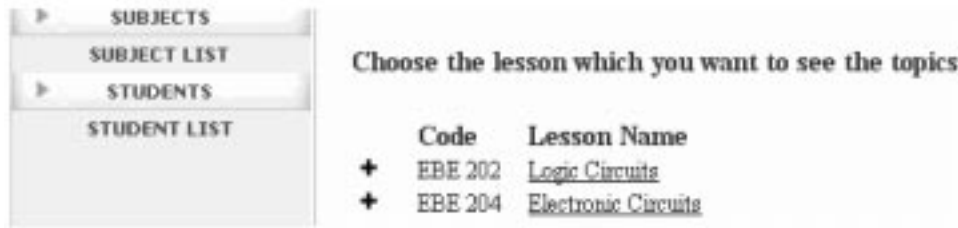
SUBJECTS
SUBJECT LIST
STUDENTS
STUDENT LIST

Choose the lesson which you want to see the topics

	Code	Lesson Name
+	EBE 202	Logic Circuits
+	EBE 204	Electronic Circuits

Fig. 8. Course management module for instructors.

Topic List

Add Subtopic — Add Questions — Delete subtopic — Topic

Add Subtopic	Add Questions	Delete subtopic	Edit Subtopic	Topic
+	Q	🗑	📝	1.1 Digital Computers
+	Q	🗑	📝	1.2. Number Systems
+	Q	🗑	📝	1.3. Code Conversion
+	Q	🗑	📝	1.4. Decimal Codes
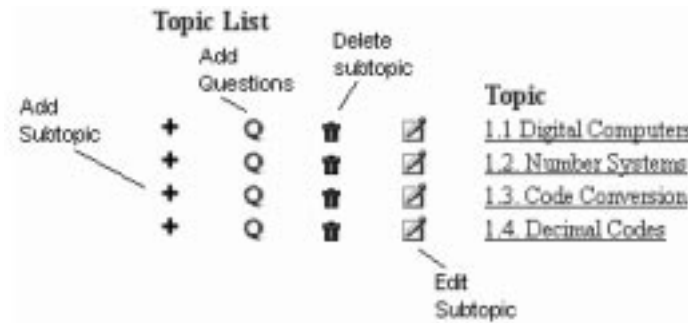
Fig. 9. Topic list editing of a sample course (Logic circuits).

Edit Content

Title : example of binary to octal

Content :
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The following example
illustrates the procedure:
(010 110 001 101 011,111 100
000 110)bin= ?

answer: (26153.7406)oct
```

Submit

(a)

Edit Question

Question : Convert the (110101.11) binary number to decimal

Option 1: 125.5
Option 2: 53.75
Option 3: 25.25
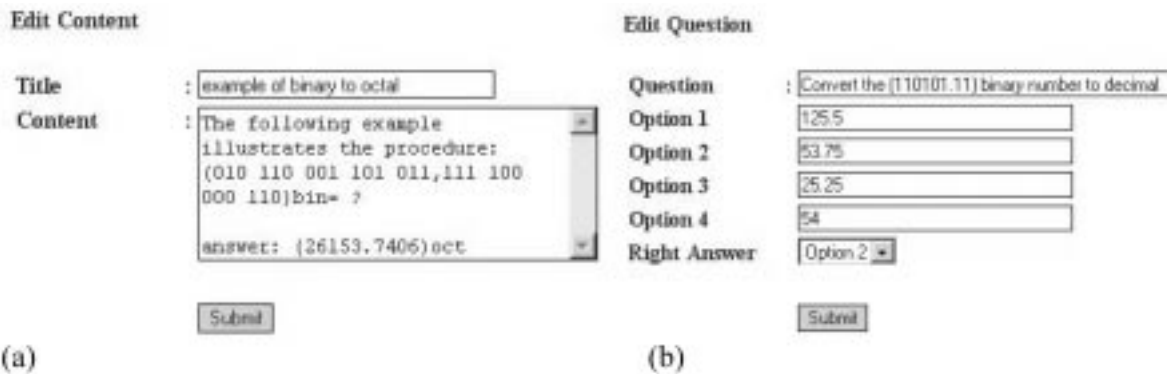Option 4: 54
Right Answer: Option 2

Submit

(b)

Fig. 10. Editing modules: (a) content editing module for subtopics, (b) question editing module

Student List (EBE 202 - Logic Circuits)

Name	Surname	Number Of Questions	Answered	Right	Percent
Hakkı	YILMAZ	5	5	2	40
Faysal	Kelleci	5	5	4	80
servet	sancili	5	5	2	40
Ahmet	Gacar	5	5	0	0
ali	bahadir	5	5	1	20

Print This Page

Send This Page As E-Mail

Fig. 11. An instructor monitors the progress of a student.

Fig. 12. Administrator management module.

who will be teaching a course that is on the system. After creating teaching entries, admin creates the courses and assigns an instructor to a course. Admin also approves the registration requests of the students. After the administrator has prepared all the necessary courses and the instructor entries, students and instructors can log on to the system and use whatever the functionality they need.

Figure 12 shows an administrator management module. When the admin clicks on the 'Add new teacher' link, a page to enter new teacher information appears. The name and surname of the teacher, the user name and password to be used by the teacher when accessing the system over a mobile or Web module, and the teacher's e-mail address are entered.

Evaluation

The system has been tested in Mugla University in the department of electronics and computer science education with sophomore students, who were taking the author's Logic Circuits course in spring 2006. For evaluation, 9 instructors and 45 students were interviewed. Five of the instructors were from the electronics and computer education department and four of them were from the wood technology education department. Naturally, instructors from the wood technology department are not well equipped in terms of a technical background. Seven of the instructors thought that the system was effective. Five of them were satisfied that teaching materials could be prepared easily and Mobilim could support students efficiently. Four of the seven instructors thought that the presentation quality of the system is unsatisfactory as the system currently supports only text, and five of them thought that mobile quizzes are useful for effective learning.

Forty-five out of fifty-two students were able to use the system. Unfortunately, other students were unable to use the system because their mobile phones did not support the WAP 2.0 standard used on the system. The students who were able to use the system were interviewed. Thirty two of the forty-five students found the system to be effective. Thirteen of them said that the system was not effective. Among those who stated that the system was not effective, five found the texts were hard to read, two said that navigating through the system was not easy, and six stated that the cost of access might be too high when the system is used continuously. Seventeen of the thirty-two students who found the system to be effective stated that they liked the use of cell phones as an education tool. Eight of the thirty-two found the system useful because of the quizzes. Four of the thirty-two said that announcements were useful and effective. Being able to access course material exercises by mobile phone also motivated those students who were unable to attend classes for some reason.

Looking at the students' negative responses, since the display of the cell phone is small and resolution is not that good, hardness of reading texts from cell phone is an inherent difficulty. The reason for not including multimedia content is that it increases the cost and decreases the speed of students' access to the system, and this might be discouraging for them. Although some of the students stated that access cost is high, GSM operators charge the users by per KB and the cost of data per KB is reasonable and getting lower day by day.

Some instructors have found the Web management module easy to use. However, they have found one shortcoming: not all management and presentation functions can be accessed on the mobile phone. This will be taken in consideration when developing the next version. Some students suggested that the system should include SMS, but the system is not designed to support SMS to keep down the costs for students. Students with mobile phones that do not support XHTML could not access the system but this is not a major shortcoming as all new generation mobile phones do support XHTML.

The system can be used by students at any level (from freshman to graduate) because the system is designed so that anyone can use the system, even if they have no technical knowledge about the system they can use a cell phone to access a Web page.

CONCLUSIONS

This paper describes a mobile learning management system for engineering educators. A mobile learning environment of activities has been devel-

oped in order to provide services for flexible teaching and study. The main contributions of this paper are in the creation of an m-learning environment for non-technical instructors and a highly flexible m-learning environment for students. The system, which we call Mobilim, is designed on open source software platforms (Apache, PHP and MySQL). Use of the system is open to the public free of charge. It can be used by instructors, accessing it either from a computer or from a mobile phone, to manage their lessons and to distribute them to their students.

We interviewed the students and the instructors who tested the system and the feedback is encouraging that the system is helpful and convenient for both students and instructors in engineering education. It also motivates the instructors to provide more services for the students. The author also observed a noticeable improvement in the students' knowledge and success index compared with previous years.

The system is still under development and the results provided in this paper are based on the current evaluation version of the system; they provide encouragement to develop the system further. Since wireless technologies are developing rapidly, the spreading of 3G technology will add much more functionalities to m-learning. Mobilim Web pages [19] can be accessed at http://www.mobilegit.net.

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