Mobile Applications and Semantic-Web

A case study on Automated Course Management

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***Abstract*—Different types of e-assessment systems that are recognized at universities and based on the campus wireless have been developed. These systems help the students to use their Mobile Phones as learning media to access the information more easily from anywhere and at any time. Seppala and Alamaki developed a mobile learning project for teacher training. Their study compared the effectiveness of internet, face-to-face and mobile based instructions. Al Masri has proposed a study to compare the effective strategy in paper-based assessment with mobile-based assessment for assessing university students in English literature. It has been found that students gained better scores in mobile phone-based test than in paper-based test. This paper aims to determine and measure the effects of mobile-based assessments on the perception, achievement levels and performance of the students in internet-assisted courses. The main functionalities and features of this paper are: Knowledge evaluation, automatic generation of exams, exam grading, communication, course management, and questions-bank database.**

***Index Terms*—E-Learning; Mobile-based Evaluation Systems; Interactive Educational Applications; Course Management System; M-learning; Semantic Web.**

I. INTRODUCTION

With suitable infrastructure, the notion of "on-line" teaching and "e-learning" could be introduced where no physical contact between students and teachers [13], [23]. Therefore, online course websites must be able to provide students with the high tools quality in order to help them to gathering knowledge, understanding the course contents, interpret the problems, and finding the solutions. The term assessment is used to point on to all activities undertaken by teachers to help their students in assessing themselves, and to measure their success rate in the learning progress [17]. Indeed, In order to insure quality knowledge transmission an assessment process, such as conducting experiments, realizing mini-projects, quizzes, exams…etc., is needed for students and teachers. For students, it helps them to know if they achieve what expected. For teachers, it helps them to adjust their lectures and methodology to a better quality approach [21] [5]. The issue of the web-based system for automatic assessment has been investigated by several researchers. The COMBA system (COMpetence-Based learner knowledge for personalized Assessment) proposed by [16] uses a competency framework to generate automatically a list of questions based on question templates, some criteria, and ability matrix. While EASY system developed by [24] is an automated assessment system whose evaluation focuses on mathematical proofs. Another service oriented approach to present an e-assessment for programming assignments has been discussed by [15].

Other types of the e-assessment systems that are recognized at universities and based on the campus wireless have been developed. These systems help the students to use their Mobile Phones as learning media to access the information more easily at any area of the campus and at any time. Seppala and Alamaki [19] developed a mobile learning project for teacher training. Their study compared the effectiveness of internet, face-to-face and mobile based instructions. Al Masri in [1] has proposed a study to compare the effective strategy in paper-based assessment with mobile-based assessment for assessing university students in English literature. It has been found that students gained better scores in mobile phone-based test than in paper-based test.

In higher education, WAP or SMS based tests via hand held computers (e.g. PDA, mobile phone or PALM) had been encouraged because they provide the possibility for the students to access any posted educational materials on the internet at anytime and anywhere. These types of tests support students' learning process and offer exercise via online learning media. Moreover, they give the students the opportunity to assess the expected learning level achieved [4] and [14].

The focuses of most researches are on the students' achievement level in web-based or paper-based exams in the university level education. This paper aims to determine and measure the effects of mobile-and web-based assessments on the perception, achievement levels and performance of the students in internet-assisted courses. Therefore, we aim to provide a system that contains all the features contained in Course Management Systems (CMS) such as Moodle or Blackboard, but providing the basic support for carrying out the assessment processes. Our system can be used for any courses offered by school/university. It could save hours of preparation and correction in exams/quizzes. It could also save resources such as exams papers, locations of exams, human resources, etc.

The main objectives of the paper are:

1. Design and implementation of Mobile-based assessment system. The system should allow students to download course materials, download online exams/assignments, and benefit from online interactive

materials and tutorials. The system should also allow students to take Mobile-based quizzes and to evaluate their academic program at the end of each semester.
2. Develop new algorithms to improve the assessment process.
3. Assist the educational system for transferring from traditional learning to mobile-based learning. The system should allow instructors and students to participate online from home or at universities in any learning communities via mobiles.

The developed system aims to integrate the semantic web in order to provide a communication between the human and the machine. The use of semantic web will help the system to understand not only the syntax but also the meaning of the content of the courses which will have a promising effect on e-assessment system.

E-learning systems and E-learning research areas can benefit from semantic web technologies. By a set of suitable agents which seem to be powerful enough, the Semantic Web technology is able to satisfy the E-learning requirements: fast, just-in-time and relevant learning. The possible enhancements and uses of the Semantic Web technology for E-learning are:

- **Pull:** Knowledge items (learning materials) are distributing on the web, but they are linked to commonly agreed ontologies. This enables construction of a user-specific course by semantic querying for topics of interest.
- **Interactivity:** Software agents on the Semantic Web may use commonly agreed service language, which enables co-ordination between agents and proactive delivery of learning materials in the context of actual problems. The vision is that each user has its own personalized agent that communicates with other agents.
- **Non-linearity:** A User can describe a situation at hand (goal of learning, previous knowledge) and perform semantic querying for the suitable learning material. The user profile is also accounted for. Access to knowledge can be expanded by semantically defined navigation.
- **Symmetry:** The Semantic Web (semantic intranet) offers the potential to become an integration platform for all business processes in an organization, including learning activities.
- **Continuity:** Active delivery of information (based on personalized agents) creates a dynamic learning environment.
- **Distribution:** The Semantic Web will be as decentralized as possible. This enables effective co-operative content management.
- **Personalization:** A user (using a personalized agent) searches for learning material customized for her/his needs. The ontology is the link between the user needs and the characteristics of the learning material.
- **Dynamism:** The Semantic Web enables the use of provided knowledge in various forms by semantic annotation of content. The Distributed nature of the Semantic Web enables continuous improvement of learning materials [18].

A. Ontologies for E-learning

In a typical E-learning environment authors or trainers produce their learning material in such a way so as to match the E-learning platform's architecture. This leads to situations where authors may use different terminologies, in which case the combining of learning materials becomes difficult. This problem affects the information and knowledge irretrievable problem due to the fact that both instructors and learners have different knowledge backgrounds. Therefore, a mechanism for creating a shared-understanding and terminologies is required. Ontologies are a powerful mechanism for achieving this task.

Ontology provides a critical role for E-learning systems to formally describe a shared meaning of a vocabulary and a set of symbols through a set of possible mapping between symbols and their meanings. In E-learning systems, the shared-understanding problem occurs on many ontological levels in which the description of documents can be mapped in several aspects. The most important issues to be considered when a learner searches for learning materials are:

- **Content ontology** describes the basic concepts of the domain in which learning takes place (*e.g.*, history or computer science). It includes also the relations between these concepts, and some basic properties. For example, the study of Classical Athens is part of the history of Ancient Greece, which in turn is part of Ancient History. The ontology should include the relation "ispartof" and the fact that it is a transitive property of an element. In this way, an automated learning support agent can infer that knowledge on Classical Athens that can be found under Ancient History. The content ontology can also use relations to capture synonyms like 'creator' and 'writer' as well as abbreviations such as 'World Wide Web' and 'WWW'.
- **Contextual** (pedagogical) issues can be addressed in pedagogy *ontology*. Learning material can be presented in the various learning contexts, such as lecture, tutorial, example, figure, walk-through, exercise, solution, and so on. This helps in context-relevant searching for learning material as per user needs. For example, if one is searching for detailed explanation of a topic, it would be appreciated to have material which gives more examples.
- **Structure ontology** is used to define the logical structure of the learning materials. E-learning is often a self-paced environment, so training needs to be broken down into small bits of information, which can be tailored to meet individual needs and skill gaps. But these chunks of knowledge should be well connected to create the whole course. Hence greater attention should be given to design the structure of E-learning materials. Typical knowledge of this kind includes hierarchical and navigational relations like *previous, next, hasPart, isPartOf, requires*, and *isBasedOn*. Relationships between these relations can also be defined; for example, *hasPart* and *isPartOf* are inverse relations. It is natural to develop E-learning systems on the Web; thus a Web ontology language should be used [3] [6].

II. APPROACH

No previous deep technical skills are needed in order to use the web-based or mobile-based system interface. The system gives the teachers the ability to easily create and add web-based and mobile-based materials. The system is divided into three applications:

- The first one is *Administrator Application* which manages basic information of the system such as courses, programs, sections, classes, students and teachers, activate or inactivate the system, import or export system's database. The *Administrator Application* allows change of users' passwords.
- The second application is the *Teacher Application* which provides the teachers with various tools to manage system services such as quizzes, exam questions, previous exams, model answers and course reviews. Teacher can also change his account's password.
- The third application is the S*tudent Application. It* provides the students with interactive tools to download assignments, previous exams, revision documents and any other files that have been uploaded by the teachers. It also allows the individual student to change account. The students could access their web-based course materials either on or off campus using internet connections.

The software development life cycle (SDLC) covered the following main phases: analysis phase, design phase, implementation phase as well as system testing and evaluation. The system is divided into three applications, namely Administrator, Teacher, and Student. There are different approaches for developing a system life cycle model. Each approach tries to describe differently the tasks or activities that take place during the process of the system life cycle. This process might involve first the translation of users' needs into software requirements. Thereafter, these requirements are transformed into design followed by code implementation. The implemented code should then be tested and installed. Finally, the developed software should be checked out for frictionless operation. The following is a brief explanation of the phases of (SDLC) for this research paper:

- **System Analysis:** The details identification of the system requirements should be done within the analysis phase. The main goal of this phase is to improve the system. A set of artefacts, such as: flowchart, system sequence diagrams, use case diagrams …etc, is used to document the system requirements. A different perspective and distinct requirements are given by the artefact of the system under design in order to accomplish the desired tasks.
- **System Design:** In this section we will cover Design Methodology and Patterns, Database design, Application Logic Design, System Architecture*,* Quiz Generation Algorithm.
- **The Mobile Application and System Architecture:** The web-based M-Learning system consists of 3 components, namely the server, the DBMS, and the client.
- **The Mobile-Based Implementation of the system:** In order to show reliability of the functionality of the wireless evaluation system (i.e. M-learning system), the system was broken into two sub-system components: the student applications and the instructor applications.

This research study used mixed approaches which emphasized on qualitative and quantitative data collections. For the purpose of achievement measurements and feedback about the perception of students towards mobile based exams, repeated measurements have been carried out. Statistical analysis had been performed to evaluate different groups of students. We have evaluated the system according to the following main criteria: Usability, Supportability, Contents and Design, Performance, Flexibility, Security.

III. SEMANTIC-WEB-BASED ANALYSIS, DESIGN, IMPLEMENTATION, TESTING AND EVALUATION

A. System Analysis and Design of the Web-Based application

1) Adopted System Life Cycle Model

There are different approaches for developing a system life cycle model. Each approach tries to describe differently the tasks or activities that take place during the process of the system life cycle.

This process might involve first the translation of users' needs into software requirements. Thereafter, these requirements are transformed into design followed by code implementation. The implemented code should then be tested and installed. Finally, the developed software should be checked out for frictionless operation. Some of these activities may be performed iteratively or may be overlapped [2].

The problem of defining the different activities and associating them soundly together had been studied extensively. Many models have been proposed to handle this problem. The V-model has been chosen for the system life cycle development process (see Figure 1). The V-model could be presumed as an extension of the Waterfall model [20].

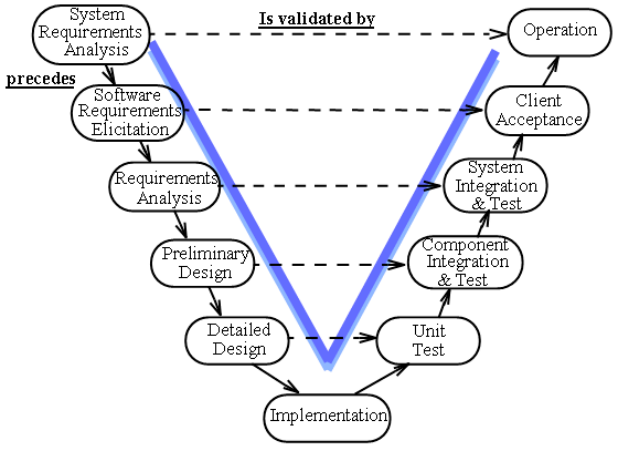


Figure 1. The V-model system's life cycle development process.

2) System Analysis

The details identification of the system requirements should be done within the *analysis phase.* The main goal of this phase is to improve the system. A set of artifacts, such as: flowchart, system sequence diagrams, use case diagrams …etc., is used to document the system

requirements. A different perspective and distinct requirements are given by the artifact of the system under design in order to accomplish the desired tasks.

3) System Requirements

Based on actual universities needs in teaching, the requirements of our web-based e-assessment system are classified in two types, namely *functional* and *non-functional* requirements.

a) Functional requirements

Functional requirements are the description of the systems' interactions with its environment (i.e. end user and other external system), without taking implementation into consideration. As shown in Figure 2, web-based evaluation system has different type of users (i.e. *administrator*, *teacher*, and *student*) that interact with different privileges. The different services provided by our system for each user are:

- The *administrator can*: Log-in (as administrator), change PW, get a new PW instead of eventually lost one, activate or inactivate the system, renew data (e.g. delete data from a given table, import data from an Excel file to the SQL server database…etc), send instantly an e-mail that contains the new password whenever the user has changed the old password and manage the basic information of the system such as adding, updating, deleting and/or displaying.
- The *teacher* can: Log-in (as teacher), change PW, manage all the system services such as adding, updating, deleting and displaying of reviews, exam questions, quizzes, previous exams, model answers…etc.
- The *student* can: Log-in (as student), change PW, obtain new PW instead of eventually lost one, download course materials, assignments, revision documents, tutorials, previous exams...etc., and take online exams, online quizzes, online assignments, and online interactive tutorials.

b) Hardware and Software Resource

The software that has been used during the system development includes: Windows XP professional, Windows Server O/S, Microsoft office Excel, Microsoft Word, MS SQL Server database system, MS Visual Studio.Net, and Photo Shop.

4) System Design

The design goal of the system is to make it easy to be used (i.e. easy to access and to customize) by the user. The system should be web-based application, so it could be accessed through internet. All other related issues should be resolved.

a) Design Methodology and Patterns

The process of software development (*methodologies*) is decomposed into activities and methods (see Figure 3). Design pattern has been used to describe the interactions and relationships among objects and/or classes. This pattern is not a finished design that can be transformed directly into code. It is a re-usable solution and not a finished design.

b) Database design

Database is considered as a fundamental component in our system. It is implemented using Microsoft SQL Server database. It is the database management system (DBMS)

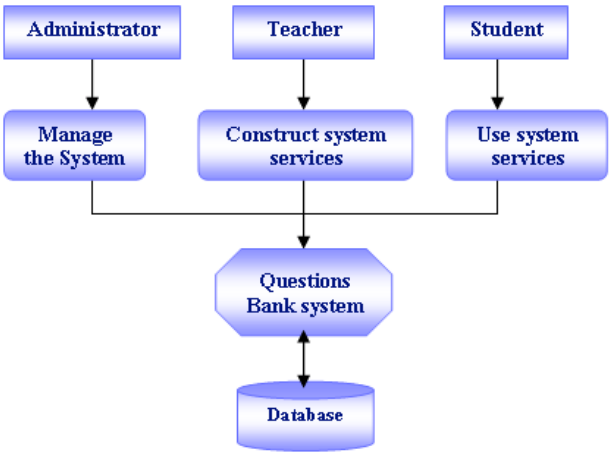


Figure 2. The three main users of the system.

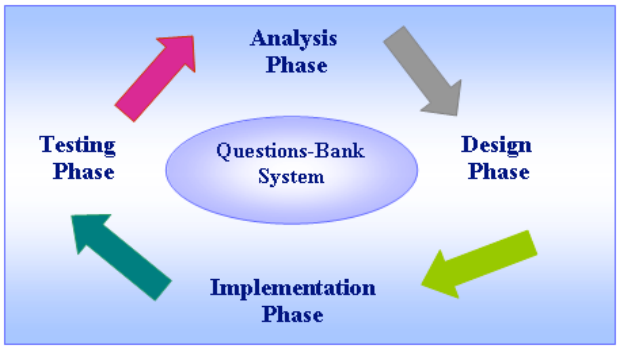


Figure 3. Software development methodologies.

needed for applying all requirements of the system. The DBMS stores all data needed for the we-based evaluation and management system including; course materials, course assignments, tutorials, exams questions, previous exams, quizzes, students' grades, basic information of the administrator, teachers, and students. Figure 5, shows the basic ER diagram (ERD) of the system.

c) Application Logic Design

This part deals mainly with 3 subparts of system design:

- The architecture design (i.e. tiers and layers of the system).
- The upper level design (i.e. identify the different subsystems and their functionality).
- The detailed design (i.e. sequence diagram and class diagram).

5) System Architecture.

Our web-based evaluation system consists mainly of three components, namely, the *client*, the *server*, and the DBMS (see Figure 4). On one hand, Web-based programming languages such as XHTML, ASP.NET, Macromedia Flash and Java script have been used to develop the client side application. On the other hand, Microsoft Visual Studio (ASP.NET, C#.NET, and VB.NET) have been used to develop the server application. The server application is also acted as a gateway between the client and the database. Microsoft SQL Server database stores and manages the school information and courses materials. Microsoft Windows Server is the tools will be used to run the database and the server applications.

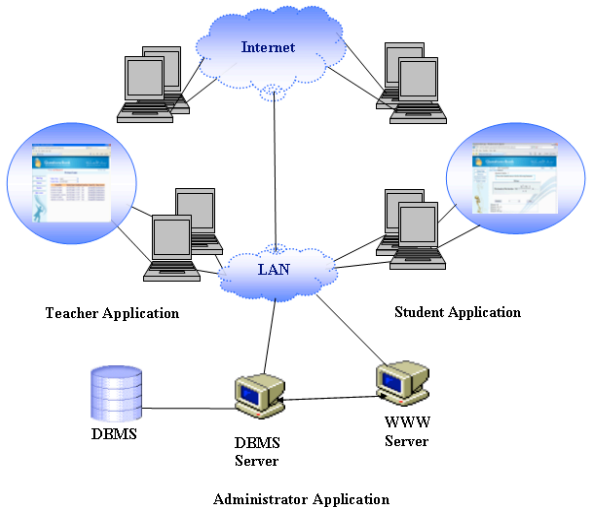


Figure 4. System overview

a) Quiz Generation Algorithm

In the paper published by [7], an intelligent and innovative algorithm for managing the *difficulty* of the quiz questions using DBMS of the system has been introduced. The difficulty attribute set by the user is used as an input parameter. Using a numbering system the *difficulty levels* will be set by the teachers during the creation phase. At the numbering system, the value assigned to a given question should identify how difficult or easy the question would be? The proposed algorithm can generate automatically quizzes with different levels of difficulties. The developed algorithm can adjust and update the difficulty value of the questions based on the students' responses. The different methods of the proposed algorithm might be summarized as:

- Get_Difficulty (): This method determines the difficulty level of a given question.
- Calc_Margn ( ): This method calculates the upper and lower bounds of error percentage in the students' responses.
- Calc_Error ( ): This method calculates the wrong percentage in the students' responses to questions. The wrong percentage is calculated as a ratio between errors and a constant value named Max_Num_Access. After each evaluation, all involved variables will be reset.
- Mark_Ques( ): This method activates a Boolean field in the register of a question if the difficulty level reaches the thresholds.

The difficulty degrees are ranging from level one to level four. Level zero means that the question is too obvious, while level higher than four considered ambiguous. This type of out of bound questions is marked so they will not be used for any quiz and updating them is the responsibility of the teacher. The upper and lower bounds for determining the difficulty of the questions are depicted in Table 1 below.

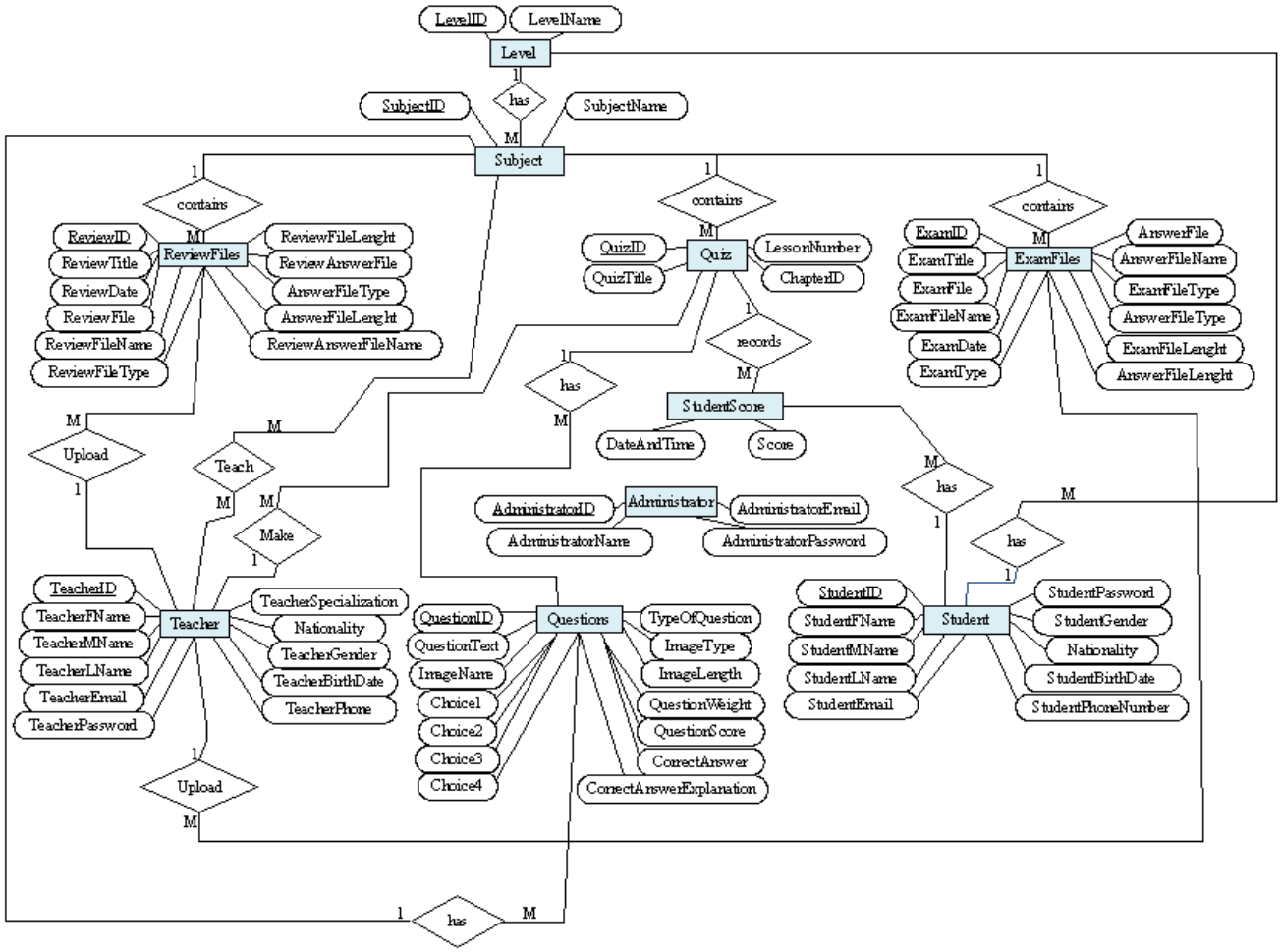


Figure 5. The basic ER diagram of the system

TABLE I.
QUESTIONS LEVELS

Difficulty	Lower bound (%)	Upper Bound (%)
1	10	30
2	30	50
3	50	70
4	70	90

B. The Web-based Implementation of the System

The web based evaluation system is an ASP.NET web application that was written using C# programming language on the Microsoft's Visual Studio .NET development environment. On the server side, the event handlers processing was written in C#. All database operations were handled by Microsoft's SQL Server 2008.An action page that represents options to users based on their privileges will appear to the user after successfully logging into the system.

1) Database Implementation

The following main tables exist in the database: courses, sections, ReviewFile, Quiz, ExamFiles, Questions, StudentScore, Student, Teacher, and Administrator.

Testing of different functionalities for the tables was happened either by importing the testing data from a Microsoft Excel sheet using the database of the school or during the runtime of the system.

2) System Requirements Implementation

In order to show reliability of the functionality of the web-based evaluation system, the system was broken into three sub-system components: the *administrator*, the *teacher,* and the *student* sub-system:

a) The administrator sub-system:

Provides the administrator with necessary tools to manage the system. The administrator provides some of the following services:

- Login: The most common authentication method to access the system is *Username* and *Password*. The authentication program match between *username* and *password* stored in the database and between the given ones. If a mismatch found, then an *invalid login* message is displayed, and the login page is displayed again. Different levels of privileges are associated to the user account:
  - System management: That service can add, update, or delete the data needed for the other two sub-systems.
  - Change password: That service provides a mechanism to allow users to change his/her account password.

b) The teacher sub-system:

Provides the teacher with tools, in addition to the login, and change password, to manage the information on the system, such as:

- Reviews/Tutorials: That service helps the teacher to upload/delete/display materials of the reviews/tutorials of each course. The teacher can store level name, subject name, review title, review date, review file, and the review answer file (if exist).
- Previous exams administration: That service used to upload/delete/display previous exams. The teacher can store the level name, subject name, exam type (midterm, final), exam title, exam date, exam file, and the exam answer file (if exist).
- Exam administration: That on-line service used by teachers to ass/update/delete questions/ answers for exams/quizzes. The teacher can store for each exam/quiz the level name, subject name, chapter number, lesson number, quiz title, quiz type (multiple choices, true or false or fill in the blank), question text, question image file, choice1, choice2, choice3, choice4, correct answer, question weight, question score, and question explanation.
- Print students' scores: That service is used to print the web-based quizzes/exam grade reports for every student.

c) The student sub-system:

Provides the student with tools, in addition to the login, and change password, to manage the information on the system, such as:

- Download reviews: That service used to download the reviews files for student's subjects.
- Download previous exams: That service used to download the previous exams and their model answers for student's subjects.
- On-Line Quiz: That service used to allow the student to choose the quiz where the questions (multiple choices, True/False, and fill in the blank) will be selected randomly by the proposed algorithm from the available database. The quiz will be finished either by finishes it by the student or by the termination of the pre-allocated time. The quiz score will be saved in the *StudentScore* table at the database, so the teacher can monitor the student performance.

C. Web-Based Testing And Evaluation

In analog study [25], we have used 2*3 factorial design methods in this study to test and to evaluate the assessment system on school site and to get the feedback of students, teachers and parents who are the potential users of the system. Dependent variable of the study is the scores obtain from the students who take the web-based quizzes, exams, tutorials, and free exercises by the system in different months. The students are divided into two groups, including *experimental group* and *control group*.

- **Participants:** In the initial test of this study we selected 30 students from preparatory-three level (class 9-A) to form experimental group and 30 students (class 9-B) to form control group. Experimental group took paper based exam and web-based exam respectively for 3 weeks. Control group took only paper based exam for 3 weeks. Each exam consisted of 10 true-and-false questions and is scored by 10 points.
- **Survey:** The survey will gather the perceptions of the experimental group of students who took paper based and web-based exams. There exist 13 questions in the survey which divide into 11 questions and 2 questions. The 11 questions answered using 5-points likert (i.e. 1 is strongly disagree and 5 is strongly agree). The 2 questions are open ended questions that ask the

students to explain about which exam they preferred the most/least.

- **Procedure:**The study conducted on the student from 2 classrooms, for the duration of 3 weeks. All exams included true/false questions. The first week, paper based exam was applied to both groups; the scores were announced one week later. The second week, experimental group took web-based exam, it consists of 10 true/false questions broadcasted together on one screen and the feedback and the score were given on the next screens (i.e. numbers of correct answers are the achievement score), the exam was taken only once with no time limits, while control group took paper based exam. The third week, control group was informed about the scores they received from paper based exam and they were given another paper based exam, while experimental group received web based exam, it consists of 10 true/false questions displayed sequentially with the ability to go forward/backward and changing their answers, at the end of the web based exam, a feedback and the score were given (i.e. numbers of correct answers are the achievement score), the exam was taken only once with no time limits.
- **Results: Students' perceptions in paper-based and web-based:**Two-factor ANOVA (Analysis of Variance) for repeated measurements had been applied to measure the achievement and the student perceptions of paper based and web-based exams. The ANOVA test will show if there is a significant difference between the scores of the students, see figure 6. The means and the standard deviations of the answers are shown at figure 7.

The p-value and F-value had been used. The p-value, see figure 6(b), is a probability statement that is concerned about finding the probability of observing test statistics at least as extreme as the one observed, assuming that the Null Hypothesis is true. Generally, a p-value of 0.05 (i.e. at the 5% level) or less rejects the Null hypothesis, the statistical assumptions used imply that only 5% of the time (i.e. 5% and 10% are common significance levels) would the supposed statistical process produce a finding this extreme if the Null hypothesis were true.

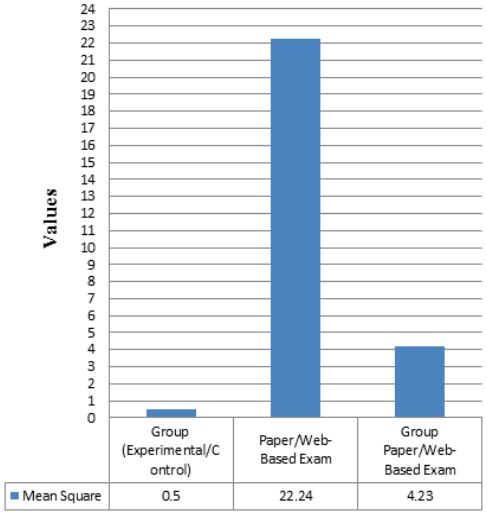
In order to emphasize that our test is significant, we might use also the F statistic, see figure 6(b). F is a test statistic and is equal to: F=variance of the group means / mean of the within group variances. The F value is defined as a ratio of two mean squares, see figure 6(a). The numerator is the treatment mean square; the denominator is the experimental error mean square. If the F value exceeds the critical value, we reject the Null hypothesis and conclude that there is a significant effect due to the treatments. P-value and F-value are two different values; p value is a probability, while F is a value of a test.

Figure 6 show that students at experimental group and those of the control group had no significant difference between them ($F=0.13$, $p > 0.05$, see figure 6(b)). The scores of the students who have been in different groups and the students who have been undertaking different delivery mode of tests had no significant difference between them ($F=2.4$, $p> 0.05$, see figure 6(b)). The scores of the tests in 3 weeks had a significant difference between them ($F=12.4$, $p < 0.05$, see figure 6(b)).

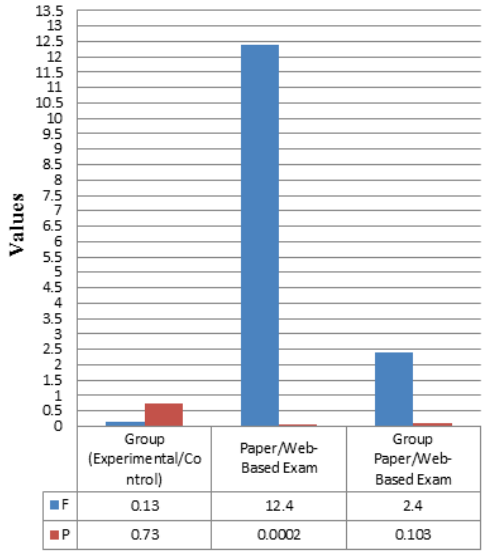
The survey (number of students N=30) was conducted on the students who were in the experimental group in order to obtain their perceptions on paper based and web-based test. Below are the 7 questions used to test the students' perceptions.

Questionnaire given to measure perceptions on paper-based and web-based exams look to Figure 7

1. I prefer the paper based Exam.
2. I liked the web based Exam.
3. Use of different media, such as internet and WAP increased my attention to the course.
4. If I am to undertake Exam in other courses, I would prefer web based Exam.
5. It was easy to use web based Exam.
6. Paper based Exam was the best in offering feedback on my answers to the questions and my scores.
7. Web based Exam was the best in offering feedback on my answers to the questions and my scores.



(a) Mean Squares of the students' scores.



(b) F- and p- values

Figure 6. The two way ANOVA results for repeated measures of students' scores in paper-, and web-, based test shown in (a) and (b)

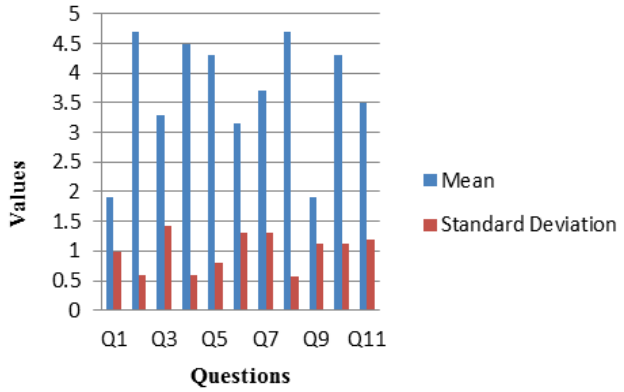


Figure 7. Students' perceptions on paper-, and web based exams.

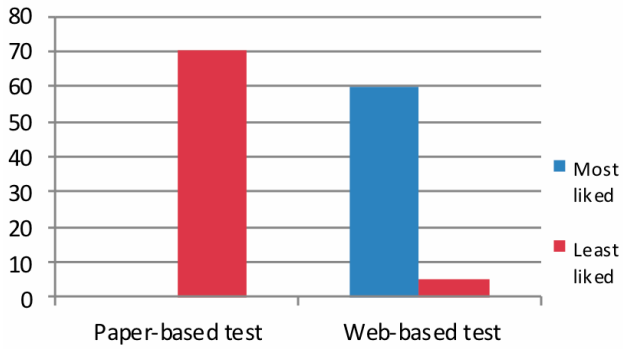


Figure 8. Comparison between percentage (%) of paper- and web-based tests.

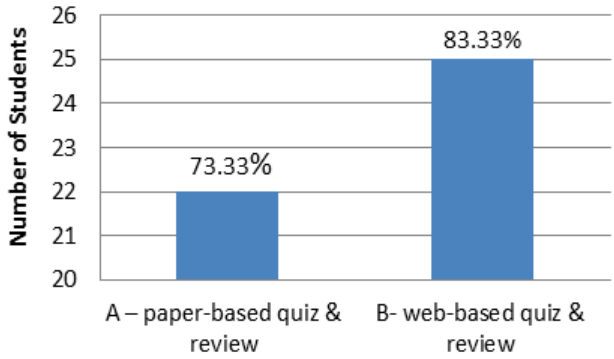


Figure 9. Quiz results of the two groups of students.

The means and standard deviations of the answers had been summarizes at figure 7. The results show that students did not prefer paper based exam (i.e. means of the items which related to paper based test are lower than 2.00), and students strongly liked and preferred web-based exam (i.e. means of the items which related to web-based test are above 4.00). Students stated that use of internet and WAP (i.e. media) had increased their attention to the course.

Finally, Figure 8 represents that the majority of students trust more a web-based evaluation system than classical methods. They also think that taking web-based test is easier than taking paper-based tests.

In a similar experiment, Sirin Karadeniz at [25] applied two-factor ANOVA (Analysis of Variance) for repeated measurements to find out whether there is significant difference between the scores of the students. The results obtained were approximately similar but not typical to this chapter results. That is not surprising due to the fact of close culture background between Middle Eastern countries. That will lead to close results for students' perceptions in similar situations.

1) The Evaluation Of Question-Bank-System

The Questions-Bank system, needed to be evaluated. Students registered in the system had been asked to answer a questionnaire that evaluates the Questions-Bank system [10].

Randomly, 60 students have been selected to be used as a testing pool. Two groups, each has 30 students, had been formed, one group have used a paper based quiz (and review); the second group used the web-based system. Students had to obtain a grade of 60% to pass the quiz. Both groups had approximately similar results, see figure 9. After taking the quiz, all the students had to fill in a questionnaire with questions related to the method of testing. Figure 10 shows the most significant questions reflecting student opinion with the relevant group responses. The questionnaire (i.e. Question 2 results) shows that a vast majority of students want to know their grade as soon as possible as well as the correct answers, a large percentage of students who did not use the computer-based system felt that their marks would have been worse if a computer had been used (i.e. Question 5 results), and a percentage of student using computers felt that they might have done better using traditional methods (i.e. Question 4 results). Notably, the majority of the students trust more a computer-based evaluation system than classical methods, some students did comment on the absence of printed copies of their answers and the fact that they could not compare their answers with the correct results after the quiz.

Questionnaire given to both groups to measure students' perceptions on web-based and paper-based quiz, look to Figure 10

1. Do you trust the on-line evaluation system?
2. When do you prefer to be told your quiz score?
3. How would you describe the process of entering answers in the computer?
4. How do you feel your result would have been, if the quiz had been on paper as the traditional way?
5. How do you feel your result would have been, if the quiz had been by the on-line system (i.e., computer-based)?

a) Anticipated Results and Evaluation Criteria

This research study used mixed approaches that emphasized on qualitative data collection [1]. The project data is collected from the following specific resources:

- Primary data will be collected from the first prototype of Questions-Bank project. That project implemented in three Qatari schools, and presented in the international conferences IMCL'09 and ICL2009. This includes the articles by [8] [9] [10] [11] [12] and the article by [22].
- Qualitative data is collected from Alwakra Qatari School (as a performance site) through the project documents, system testing and implementation, scheduled interviews with involved project participants, and analysis of open (free-response) questions from two questionnaires. Moreover, we used external material such as books and research articles covering relevant topics for this study [9] [11].

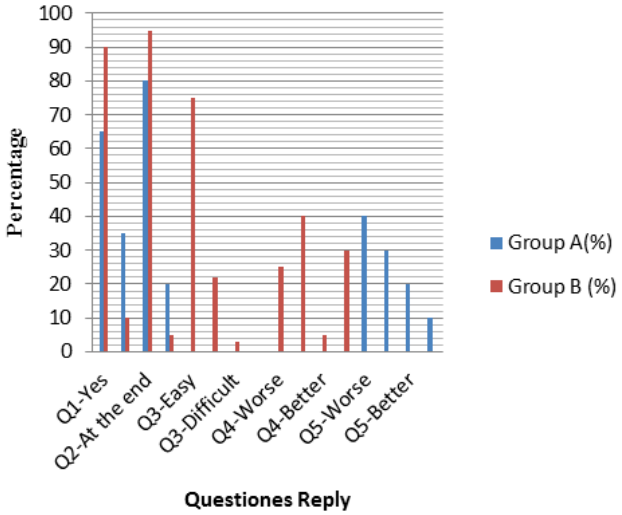


Figure 10. Results of the questionnaires given to both groups to measure students' perceptions on web-based and paper based quiz.

- Secondary data source collected from the E-learning literature (i.e. research literature on E-learning, available school education, customization for corporations, relevant elements…etc.). The strategy of searching is also included electronic databases (i.e. ACM Digital Library, IEEE Xplore, ISI Web of Science and CiteSeerX), Google Scholar that provided a simple way to broadly search for scholarly literature across many disciplines and sources and published books on E-learning [14].
- Supplementary data is taken from the Princess Sumaya University for Technology (PSUT-Jordan), as a collaborative academic institution in this study

2) The Quantitative Research Approach

The students who follow the two classes of (9-A and 9-B), each class contains 30 students, were given one electronic questionnaires each to get an indication of how the students perceived the overall quality in the courses. The questionnaire (designed based on Cooper & Schindler (chapters 12-13) [4]) contains free-response questions, dichotomous questions, multiple-choice questions, checklists and rating questions. The questionnaires are distributed to the students as part of the mandatory exercise program. At the end of the semester the two groups are taken the final exam in three subjects (Mathematic, Science, and English language) using the project.

IV. MOBILE-BASED ANALYSIS, DESIGN, IMPLEMENTATION, TESTING AND EVALUATION

A. System Architecture

As depicted in figure 11, the web-based M-Learning system consists of 3 components, namely the server, the DBMS, and the client. The environment of the system can be divided into two major blocks. The first block is the server application. It is developed by ASP.NET, and C#.NET. It acts as a gateway between the clients and the database. While dealing with different screen sizes, orientations and device capabilities, the ASP.NET controls render the appropriate markup (HTML, WML, cHTML, XHTML). The second block is the database management system (DBMS) which is a collection of computer programs that controls databases in every way of creation, maintenance and use of the database.

One of the most important aspects of a DBMS is the end user. A DBMS ensures that information is presented to the client from the database in a logical fashion. The course information content is stored and managed using Microsoft SQL Server database. The database and the server applications will run on Microsoft Windows 2008 Server. The third block is the client side application. It can be used as web application opened from the browser, or a native application developed with eclipse which loads *mobile-aspx pages* and displays other customized pages.

B. The Wi-Fi Network Technology

Wi-Fi is a popular technology and widely used in comparison to others wireless networks. It uses radio waves and allows an electronic device such as a PC to exchange data wirelessly over a computer network. The PC can be connected to a network resource such as the Internet via a wireless network access point. A centralized network with access point that uses radio waves to communicate is called infrastructure network. Therefore, we will focus in this research paper on infrastructure WiFi network. The radio transmission takes place at frequencies of 2.4 GHz or 5GHz. Such frequencies are considerably higher than the frequencies used for televisions, cell phones… etc. The higher frequency allows the signal to carry more data [4].

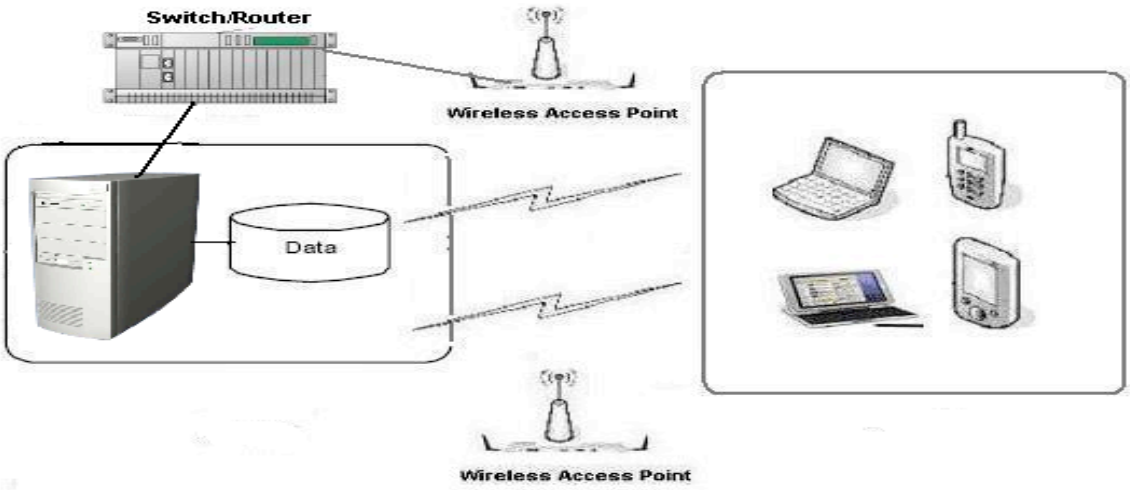


Figure 11. Mobile system architecture.

C. System Architecture Scenario

First, we will need a Windows Server that runs Internet Information Services (IIS), the .Net Framework in order to start the proposed applications of the Web-based M-learning system.

The Microsoft Mobile Internet Toolkit (MMIT) extends the functionality of the ASP.NET to easily target mobile devices using mobile Web Forms technology. For data Access and the Common Language Runtime, we can use .NET framework services like XML Web Services, ADO.NET.

Once the mobile Web application and the Web server are adopted on the Internet, the wireless device that wants to access the mobile Web application will initiate to send an HTTP request to the Web server.

The HTTP request will be processed on the web server in 3 main stages, namely *Device capabilities, Mobile.aspx pages and Mobile controls and device adapters generate display*. The first process is to identify the requested device, which is occasionally in this step, "a wireless device". This process also identifies the capabilities of the web device (e.g. *browser*, *image capabilities, and mark-up language)*.

The MMIT extends the .NET Framework Machine.config schema with the capabilities of the target mobile device and pre-populates the device data. The Machine.config file applies to all applications on the web server while the web.config file applies to specific application.

The HTTP request from the wireless device contains the User Agent string, Header information and the requested URL. The User Agent string should be matched against entries in the Machine.config file.

The mobile Web page that contains the .aspx file extension will be located via the URL obtained from the requested HTTP.

As soon as ASPX page is accessed for the first time, it will be sent to the parser. Once the paper has been parsed it will then be processed by the compiler. The compiled page is then stored in the Assemble Cache. The server then creates a new instance of the compiled page, and uses it to process the request.

There is no need to repeat the process of parsing and compiling steps for each request after the page has been compiled for the first time. The class of compiled page can be reused to improve the performance result.

The proper *mark-up language* will be generated via the *device adapters* associated with the requesting device and controls used on the page. For the wireless devices in our case, the proper *mark-up language* is the HTML.

The *mark-up language* is then encapsulated in an HTTP response and will be returned to the requesting wireless device. When a WML browser accesses the same mobile web application as the wireless device, it goes through the following steps. The WAP browser makes a WAP request to a WAP Gateway. Usually, these gateways are a service provided by wireless carriers. The WAP Gateway translates the WAP request to an HTTP request and passes it to the web server over the internet [2] [14] [20].

D. Contents Of Wireless Course

The contents of the *wireless course* used for interaction between students and instructor could be categorized into two groups:

- **The contents of wireless information:** The content will mainly follow the traditional online course. However, course documents and materials will be designed via wireless infrastructure and will be delivered via wireless devices. Following contents of wireless information should be identified and included: wireless syllabus, wireless schedule, wireless assignments, wireless labs, wireless course resources, and wireless tutorials.
- **The contents of wireless interaction:** These types of wireless interactions are highly depend on the type of the wireless device and the micro browsers installed on these wireless devices. Following contents of wireless interactions should be identified and allowed: wireless testing, wireless e-mail, SMS, wireless grades, useful links.

Both of the contents of the *wireless information and* wireless *interaction* will be dynamically generated the course database. Different levels of wireless quizzes and test items have been uploaded to assess the student knowledge and learning outcomes. Based on a grade database, a wireless grade application has been designed. Based on application capabilities, the instructor is allowed to specify the grading methods, procedures, and grading formulas as well as to enter and update grades. Through a WAP phone or a PDA, students have instant access to their grades. The wireless testing automatically saves the student test grades in the grades database table.

All items of the contents of wireless information have been designed as tree data structures. The nodes of such tree data structures contain separate sections from the information item. For example the wireless syllabus is designed with such sections (nodes) as instructor information, course description, Lab. session information, textbook, course topics, and grades distribution.

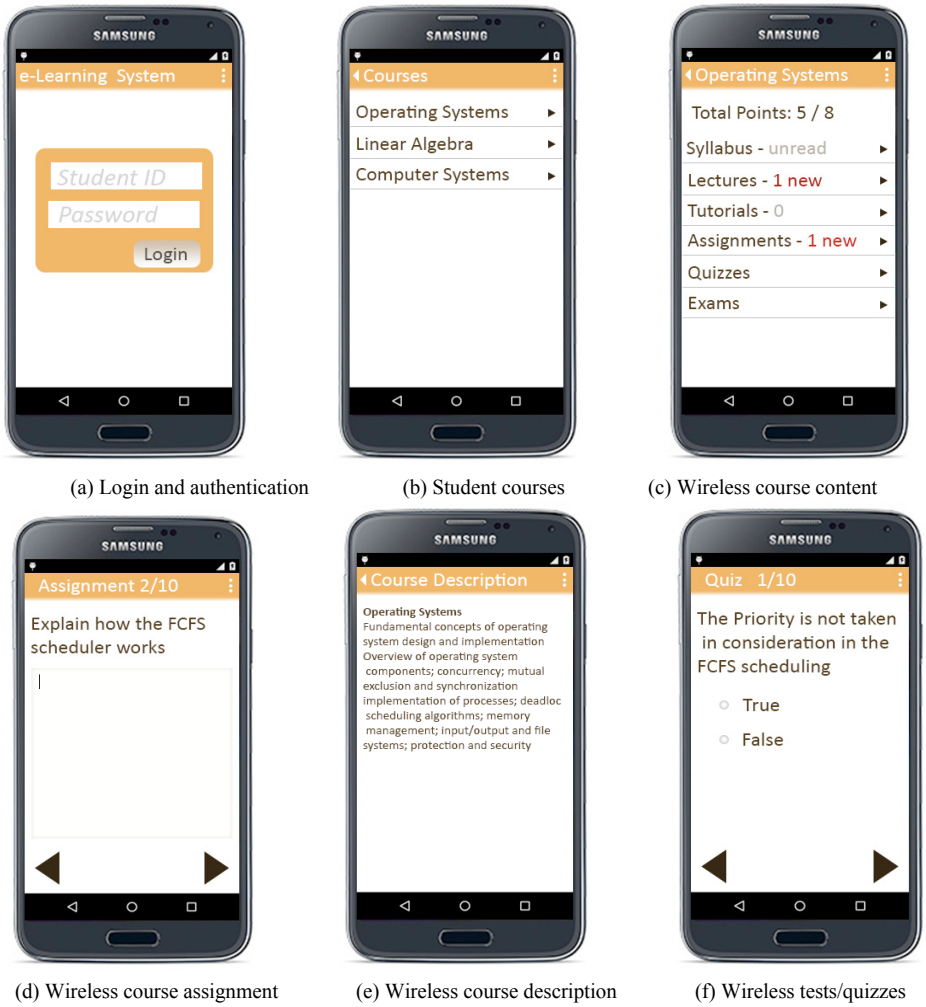
The node course content is a parent node for syllabus, course lectures, course tutorial, course assignments, test/quiz, Lab assignments, SMS, and useful link nodes. The tree data structure has been chosen because it provides an easy mechanism for the implementation of the contents of wireless information and makes it possible to implement its delivery on wireless devices through menus, small size windows and basic navigation.

E. The Mobile-Based Implementation Of The System

In order to show reliability of the functionality of the wireless evaluation system (i.e. M-learning system), the system was broken into two sub-system components: *the student applications* and *the instructor applications*.

1) The Student Applications

- Student Login: The student will login to the M-learning system using student ID and password, see figure 12(a). Once logged in, the student can choose a course from a list of courses, see figure 12(b).
- Wireless Course Content: Several course contents had been implemented in the M-learning system, see figure 12(c).



(a) Login and authentication (b) Student courses (c) Wireless course content

(d) Wireless course assignment (e) Wireless course description (f) Wireless tests/quizzes

Figure 12.

- Wireless Course Assignments: The student can solve and submit the assignment, see figure 12(d).
- Wireless Course Description: The student can read the course description, see figure 12(e).
- Wireless Tests/Quizzes: M-learning system allows the test/quizzes to be taken anytime/anywhere by the student through a wireless mobile device, see figure 12(f).

2) The Instructor Applications

- **Instructor Login:** The instructor must login successfully to the WCMS using a *user name* and a *password*. If the web server authenticated the *user name* and a *password*, then the list of courses related to the instructors will be displayed with necessary privileges, else an *invalid login* message is displayed, and the login page is displayed again.
- **Wireless Course Management:** The instructor can login successfully to the WCMS wirelessly, and create/update/maintain/ upgrade/monitor the courses related to him/her, using a *user name* and a *password*. If the web server authenticated the *user name* and a *password*, then the list of courses related to the instructors will be displayed with necessary privileges, else an *invalid login* message is displayed, and the login page is displayed again. The system administrator of WCMS has similar duties as the systems administrator of traditional Course Management System (CMS) (i.e. use/course management, open/close accounts, add/delete students…etc.).

V. CONCLUSION

In this paper, an e-assessment system based on using web- paper and mobile-based technologies had been presented. The proposed system can be used with any educational facility, allowing them to create their Questions-Bank database and may save resources substantially. The V-model had been used to develop the system. The V-model started by specifying the system requirements, then constructed the UML use cases and domain model, next is the system design, and finally, the implementation phase. The proposed system was used successfully in distance learning/self-training. A test had been conducted to the system with different type of courses. The feedbacks of both teachers and students were highly promising.

Further future work is needed on mobile- and paper-based testing and comparison with web- and paper-based.

A bigger number of students in control and experimental groups should be used. Upscale the experiment to have more representative results. Describe the use of the system for a specific discipline. Know more information about the attitude towards the system for age, gender and other differences among the groups.

REFERENCES

[1] A. Al Masri,"Using mobile phone for assessing university students in English literature in Jordan", European Scientific Journal, Vol.8, No. 24, ISSN: 1857 - 7881 (Print), ISSN: 1857 - 7431 (Online), 2012.

[2] B. Bruegge, and A.H. Dutoit, Object-Oriented Software Engineering using UML, Patterns and Java. Prentice Hall, 2nd ed., United States, ISBN: 10: 0130471100, 2004.

[3] B. Dutta, "Semantic Web Based E-learning", DRTC Conference on ICT for Digital Learning Environment, 11th – 13th January, DRTC, Bangalore, 2006.

[4] E. Scornavacca, and S. Marshall, "TXT-2-LRN: Improving students' learning experience in the classroom through interactive SMS", Proceedings of the 40th Hawaii International Conference on System Sciences, ISSN: 1530-1605, 2007, http://dx.doi.org/10.1109/HICSS.2007.579

[5] F. Bota, L. Farinnetti, and A. Rarau," An educational-oriented framework for building online courses using XML", Proceeding of the IEEE International Conference on Multimedia and Expo, ISBN: 0-7803-6536-4, Vol 1, pp: 19-22, 2000, http://dx.doi.org/10.1109/ICME.2000.869536

[6] G. Antoniou and F.V. Harmelen, A semantic web primer, MIT Press, London, 2004.

[7] H.F. El-Sofany, A. Hasna, J. Ja'am, F. Ghaleb, and S.A. El-Seoud, "A web-based e-learning system experiment", Int. J. Comput. Inform. Sci., Vol 4, No. 1, pp. 22-29, 2006.

[8] H.F. El-Sofany, N. Al-Jaidah, S. Ibrahim, and S. Al-kubaisi, "Web-based Questions-Bank System to Improve E-Learning Education in Qatari School", Journal of Computer Science, vol. 5, issue 2, pp. 79-108, 2009, ISSN 1549-3636, Science Publications, U.S.A.

[9] H.F. El-Sofany, and S.A. El-Seoud , "Towards Development of Web-based Assessment System Based on Semantic Web Technology", International Journal of Advanced Mobile Technologies (iJIM), vol 5, issue 1, 2011.

[10] H.F. El-Sofany, and S.A. El-Seoud, "Towards the Development of an M-Learning System: A New Stage to Enhance Higher Education", International Journal of Advanced Mobile Technologies (iJIM), vol. 3, issue 3, 2009, DOI:10.3991/ ijim.v3i3.719.

[11] H. El-Sofany, S.A. El-Seoud, A.M. Sadek, D.S. Hadded, A.N. Elashi, and A.G. Ismail, "Web-based Course Management and Evaluation System", Proceedings of the IEEE International Conference on Interactive Collaborative Learning (ICL2011). Piestany, Slovakia, 2011.

[12] H.F. El-Sofany, S.A. El-Seoud, F.F.M. Ghaleb, S. Ibrahim, and N. Al-Jaidah, "Questions-Bank System to Enhance E-Learning in School Education", International Journal of Emerging Technologies in Learning (iJET), vol. 4, issue 3, 2009, http://dx.doi.org/10.3991/ijet.v4i3.978

[13] H.F. El-Sofany, S.A. El-Seoud, F.F.M. Ghaleb, S.S. Daoud, J.M. AL Ja'am, and A.M. Hasna, "XML and databases for e-learning applications", International Journal of Emerging Technologies in Learning (iJET), Vol 2, pp. 6-12, 2007.

[14] L. Wentling, J. Park, and C. Peiper , "Learning gains associated with annotation and communication software designed for large undergraduate classes", J. Comp. Assist. Learn, Vol. 23, No.1, pp.36-46, 2007. http://dx.doi.org/10.1111/j.1365-2729.2007.00197.x

[15] M. Amelung, K. Krieger, and D. Rosner,"E-Assessment as a Service", IEEE Proc. Transactions on Learning Technologies, Vol. 4, No. 2, pp. 162-174, 2011. http://dx.doi.org/10.1109/tlt.2010.24

[16] O. Sitthisak, L. Gilbert, and H.C. Davis, "Towards a competency model for adaptive assessment to support lifelong learning [online]", TENCompetence Workshop on Service Oriented Approaches and Lifelong Competence Development Infrastructures, Manchester, UK, 2007. Available from: http://eprints.soton.ac.uk/263859/ [accessed 2013]

[17] P. Black, and D. Wiliam, "Inside the Black Box: Raising Standards Through Classroom Assessment", Phi Delta Kappan, Vol. 80, issue 2, pp.139-148, 1998.

[18] P. Drucker, Need to Know: Integrating e-Learning with High Velocity Value Chains, A Delphi Group White Paper, 2000. Retreived from: http://www.delphigroup.com/pubs/whitepapers/20001213-elearning- wp.pdf.

[19] P. Seppala, and H. Alamaki,"Mobile learning in teacher training", Journal of Computer Assisted Learning, Vol 19, issue 3, pp. 330-335, 2003, http://dx.doi.org/10.1046/j.0266-4909.2003.00034.x

[20] R. Elmasri, and S.B. Navathe, Fundamentals of Database System. Addison-Wesley, 5th ed., USA, ISBN: 0-321-41506-X, 2007.

[21] R. Lister, and P. Jerram , "Design for web-based on-demand multiple choice exams using XML", Proceeding of the IEEE International Conference on Advanced Learning Technologies, ISBN: 0-7695-1013-2/01, pp: 383-384,2001. http://dx.doi.org/10.1109/ICALT.2001.943952

[22] S.A. El-Seoud, H.F. El-Sofany, and Y. Al-Halabi, "Wireless "Questions-Bank" System to enhance M-learning in School Education", International Journal of Advanced Mobile Technologies (iJIM), 2010, http://dx.doi.org/10.3991/ijim.v4i1.1129

[23] S. Badariah, and S. Rosnafisah, "Rapid e-learning content management system", Int. J. Comput. Inform. Sci, Vol. 4, pp. 1-9, 2006.

[24] S. Gruttmann, D. Böhm, and H. Kuchen," E-Assessment of Mathematical Proofs:Chances and Challenges for Students and Tutors",IEEE Proceedings of the International Conference on Computer Science and Software Engineering, ISBN: 978-0-7695-3336-0, 2008, pp. 612-615. http://dx.doi.org/10.1109/CSSE.2008.95

[25] S. Karadeniz, "The impacts of paper, web and mobile based assessment on students' achievement and perceptions", Scientific Research and Essay,Vol.4, issue 10, pp. 984-991, 2009, ISSN 1992-2248.

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