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AN INTEGRATABLE ONLINE FULL EXAMINATION MODULE FOR E-LEARNING SYSTEMS: ONEX

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Abstract. The aim of this study is to introduce a module, organizing question banks and producing examination forms using the question banks, which can also be integrated into different e-learning systems. This online examination system, OnEx, creates question banks according to knowledge, comprehension, application, analysis, synthesis, and evaluation taxonomy and it gives the chance to prepare question types which are open-ended, short-answer, multiple-choice, true-false, or matching. OnEx, reports the detailed information about the learning levels and at which learning level the students are successful or not following the examinations. With the help of this reporting system, it is possible that the students will be able to take the proper support from the experts during the learning period.
Keywords: on-line examination module, e-learning systems, e-question bank, e-measurement and e-evaluation, OnEx, UML.

INTRODUCTION

Measurement and Evaluation, being inseparable components of education and teaching, are used to assess whether educational goals are being achieved. Another purpose of using measurement and evaluation is to enhance and support student learning.
Mastery Learning Model was developed by Benjamin S. Bloom (Source). Mastery learning was built up on the assumption that; " if positive learning conditions provided, almost anyone can learn the previously set new behaviours independent from their IQ level" (Source). Mastery learning had been provided for programmed teaching. Programmed teaching, fundamentally brings in two improvements, individualization of learning and minimization of errors. Programmed teaching has been the foundation for using computers in learning, teaching and evaluation processes. Currently, it is very well understood that, tests conducted both on internet and on corporate intranets by using widely accepted e-learning applications can provide an effective and cost efficient way of testing knowledge, competency, and behavioural changes (Hancer, 2009).
When we closely examine the testing modules used in e-learning applications we can see that the existing modules are not able to provide any means for complete measurement and evaluation. This incompleteness of measurement and evaluation further causes a lack of understanding what students really do or do not learn. However, tests composed towards measuring the students' ability of critical thinking are necessary to enable lasting learning to occur, as well as is necessary for measurement and evaluation.
Blackboard, as one of the commonly-used e-learning systems around the globe, lets users conduct online exams through its built-in system of examination forms containing all types of related questions. However, Blackboard does not classify questions according to their cognitive entry levels. Besides, it has been observed that there was not any validity analysis for questions (Meryasoft, 2009).
Moodle, which is developed by Martin Dougiamas as a part of his thesis work, can also compose online examination forms using all types of related questions, however it lets only one type of question to be used. It does not allow for classification of questions according to cognitive levels. Moreover, it has been observed that there was not any validity analysis checks for questions, whereas Moodle does conduct item analysis for questions.

MEASUREMENT AND EVALUATION IN LEARNING

Measurement and evaluation can note two concepts which are closely related. In reality, measurement and evaluation are different concepts. Measurement provides objectivity, but evaluation includes personal conclusions.

Basic Concepts of Measurement and Evaluation In Learning

Basic concepts related to measurement and evaluations in education are:
Measurement: Measurement is a way of observation. It helps us determine a certain quality of a characteristic or a process. We have to look for its certainty, objectivity, credibility, and the ability to provide data in numerical values, to find what makes measurement superior to other observation techniques. Data in numerical form simplifies statistical analysis and interpretation, and further enhances the ability to make more absolute and clear judgments.
Reliability: In educational systems, it is important to be able to measure the activities of teaching and learning. Errorless measurement provides correct and real data to teachers about the subject's or the individual's certain qualities. This is the reason for the need for credible measurement, which is free from constant, biased and random errors as much as possible, in education (İşman, 2006).
Validity: Validity is the degree of contribution of a measurement tool to the purpose (Bahar, 2006). According to Demirel (2007), validity in general, is the degree of ability of a measurement tool or a methodology to assess what it intends to measure accurately, independent on any other characteristic (Kizlik, 2009)
Usability: Usability consists of six main issues (İşman, 2006):

- Examination tool to be used should be economically viable. It shouldn't cause any additional costs neither on teacher nor students.
- Duration of the application should be well adjusted.
- A guideline, depicting all the relevant information needed, should be present in the beginning of each exam.
- Exam papers should be arranged, enabling an easy and orderly way of use for the teacher.
- Exams should be easy to grade, bearing no additional burden for the teacher.

Evaluation: Evaluation is indispensable for education. Evaluation in education shows whether the goals have been reached and in what degree (Yıldırım, 1983). Evaluation is an act of judgement unlike measurement. The basic principal of measurement is to convey the results in numerical values, whereas in evaluation it is all about judgements made by interpretation of numerical values based on certain criteria.

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Tools And Methods In Measurement

Exams are the leading tools for educational measurement tools. Other tools aside from exams are homework, laboratory work, projects, portfolio building, articles, field studies, surveys, observation etc. As mentioned above, selection of measurement tools should be chosen, in general, based on the subject, education model, measurement goals, and evaluation model (Kabacı ve Karakaya, 2003).
Exam types aiming to measure cognitive adequacies, which are amongst educational goals, can be: long answer exams, short answer exams, multiple choice, true/false, matching questions exams, and oral exams.

E-Test Plan Steps

Computers offer great ease in the application of the test plan. The eleven-step test plan as a tool for classic tests are adopted for online tests. Eleven steps for an E-test plan should be as follows:

1. Setting up the start and end dates
2. Assessment of the test goals
3. Preparation of table of specification
4. Setting the number of questions
5. Selection of test items
6. Scoring the test items
7. Setting the test duration
8. Implementation of the test
9. Evaluation of the test
10. Sending feedback to the student
11. Item analysis studies

Step 1 defines the period that the students can take the test. Students cannot take the test before or after this pre-defined period. The test stays active only between start and end dates and will be shut down by the system automatically after the end date.
The steps 2-5 include of assessment of the test goals, preparation of table of specification, and setting the amount of questions are similar to a classic test plan. The teacher defines the number of questions, how many questions from which category, and which subjects to be included in the test. Instead of writing down test items, as it is done in the classic test plan, the system automatically provides the related questions from already developed question banks, after the teacher prepares the table of specification. The teacher does not spend time writing test items, instead she uses test items already present in the system.
Step 6, scoring the test items, each test, automatically created in the system, will receive their relevant scorings. Setting the test duration, defines the duration of the test as it does in the classic test plan. It is important to mention the duration, since the test will be online, there will be a countdown after the test starts. Steps of both implementation and evaluation of the test are different from the case of the classic test plan, as both will be conducted by a computer. Sending feedback to the student is an important step; including showing the test results to the student, and stating the point grade, along with data for right and wrong answers and blanks. There is no additional burden on the teacher since the item analysis is conducted again by a computer. Question cards are also prepared by the computer, and the teacher does not need to prepare score cards for grading. All in all, since all of these steps mentioned are handled by a computer, it saves time and effort for the teacher.

ONEX ONLINE EXAMINATION SYSTEM

This section talks about tools and methods used in developing the system, as well as process analysis of measurement and evaluation, analysis, design and development of the OnEx System, followed by an evaluation of the system.

Tools

OnEx, which is an online test system was developed as a master's thesis ,and it was coded in PHP language and using MySQL databases. The resulting original software is hosted in an Apache Web server bought by Istanbul University Scientific Research Projects Secretariat under the project scope no. 3246.
Adobe Dreamweaver CS3 is used to developed the visual interface for the system. JavaScript is used to control data entry, to assess the number of choices in a question dependent on the subject, and to bring up a question entry screen according to the preferred question type.

Method

Two separate system analyses were conducted in the development of OnEx system. First is the process analysis of measurement and evaluation; second is aimed at coding for the development of OnEx system. Analysis and design details for coding purposes were not mentioned in this study.
Process Analysis of Measurement and Evaluation: In this phase, all the measurement and evaluation criteria, which ensure the measurement of achievement in education and teaching were considered to develop a test module aiming for total measurement of achievement in an e-learning system.
OnEx automatically applies and ensures the rule for picking three, four, and five multiple choices for first to third grade, fourth to eighth grade, and nineth to twelveth grade respectively taking measurement rules also into consideration. An example would be the system bringing up four choices if the teacher is preparing a test for seventh grade. Additionally, the system does not allow for creation of questions having choices of "all of the above" and/or "none of the above". Even if the teacher misses these rules, the system will not allow these types of errors to occur.
Answer choices can range from six to a maximum of fifteen, for matching questions exams. Even if the teacher picks less than six answer choices, the system will automatically enlists up to six sub-questions. Furthermore, the answer list needs to contain three more choices than sub-questions. The system automatically ensures the proper application of this rule. All of the sub questions and answer choices are properly numbered or contain symbols. The system again will make sure that all the sub-questions and answer choices are numbered or contain a symbol, providing a consistent test format.

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The teacher should not use more than one blank in the sentence and must not start the sentence with a blank, for fill-in-the-blanks questions. The teacher will get an error message if this rule is not followed.
The teacher can compile examination forms. The teacher needs to enter the information to relevant areas on the screen, including the number of questions from each question type, and the number of questions from which question category. The system will not allow more than three question types, as well as the combined use of matching questions and true/false questions at the same time.
The steps from UML methodology was applied in analysis, design and documentation of the OnEx project. The reason for UML methodology to be used is that OnEx is an integratable examination module for e-learning systems. As is known, data in e-learning systems are subject-oriented, therefore it is reasonable to use a subject-oriented software development methodology. When subject-oriented methodologies were examined, it can be seen that UML methodology is the right one for this project, which contains all the strengths of other methodologies in itself (Ayvaz, 1999). Ayvaz states UML process steps as follows; 1.Use case Modelling, 2.Use case Verification, 3.Category Modelling, 4.State transition diagrams, 5.Component Modelling, 6.Development Model, 7.General Concepts. UML steps are modelled using Visual Paradigm CASE.

Development of OnEx System

There are five distinct user types and a guest user for observation purposes. Each user type has different tasks and authorization in the system. Fig.1 shows users in the OnEx system.

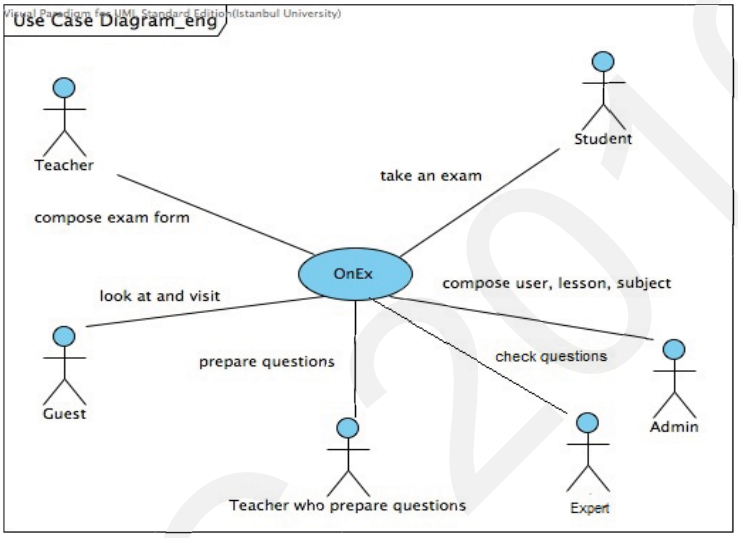

Fig. 1 visualizes the Use Case Diagram of OnEx System

Admin (System Administrator): Administrative tasks for the system as a whole are conducted in this entry level. The system administrator sets up users, assesses authorizations and subjects, and develops classes and class related subjects. He can create new subjects, as well as edit and delete existing ones. He also determines languages in the system. Besides viewing questions, he cannot prepare, control, edit or delete them.
Expert: Expert controls the questions prepared by the teacher. He decides whether questions are aligned with relevant categories. If necessary, the expert can send a message to the teacher by using the message panel. Expert can also prepare questions. Any questions prepared by an expert are sent to other experts to ensure control.
Teacher Preparing Question: Teacher Preparing Questions (TPQ) can enter questions to be used in an online exam. S/he can edit or delete her questions. S/he can reply to any message from the expert. She can view the test statistics and question cards. She can review questions prepared by the computer according to item analyses. If any corrections by the teacher made to questions prepared by the computer, questions will automatically be sent for the expert's attention.
Teacher Using Questions: Teacher Using Questions (TUQ) can prepare examination forms for her class using question banks. She can assess the test takers for her test. She can view the test statistics and question cards. She can send test-related messages to students.
Student: Student takes the tests using the system in a certain time period. Student will see the results immediately after taking the test.
Guest: Guest can navigate through the system for observational purposes.

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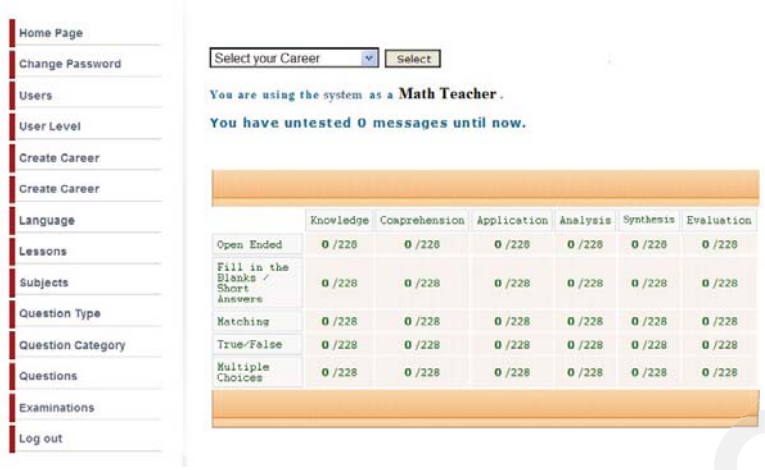

Fig. 2 Home Page Screen of OnEx System

Fig. 2 is the screen shot of the screen when the user enters the system for the first time. User (teacher) needs to use her own username and password. In this screen, the teacher can see the number of questions from which category. Furthermore, since there is a possibility that the teacher may have more than one teaching field, the system allows her to switch between subjects. For example, suppose a math teacher also wants to prepare questions for her science class, she can do it by simply changing her subject as science teacher

EVALUATION OF SYSTEMS

Online examination modules of Blackboard and Moodle are evaluated since they are widely used e-learning systems. WebCT is not examined due to Blackboard's acquisition of the software. This evaluation is done according to the criteria from Table 1. Complete set of features are not included.

Table 1 : Comparison Of Systems For Measurement And Evaluation

Criteria	Blackboard	Moodle	OnEx
All types of questions can be used	+	+	+
Number of answers in multiple choice tests according to class grade	-	-	+
Limits the number of sub-questions in matching questions between 6 to 15	-	-	+
Ensures three more answers than sub-questions in matching questions	-	-	+
Excludes "all or none of the above" as answers in multiple choice tests	-	-	+
Categorizes questions according to the question level	+	+	+
Expert control on questions submitted by teachers	-	-	+

OnEx automatically applies the rule of three, four and five choices in multiple choice questions for the grades first to three, fourth to eighth, and nineth to twelveth consecutively. Even if the teacher did not know about this rule, the system will not allow the teacher to proceed preventing any errors. However, there is no limit for the teacher about the number of multiple choice answers, which reduces the validity of the question. Another point to consider while preparing multiple choice questions is the exclusion of "all of the above" or "none of the above" answers. Current online examination modules do not control this, but OnEx does. OnEx further presents any numbers or dates in the choices in an ascending order.

In matching questions the number of sub questions are limited to a minimum of six and a maximum fifteen. The system will enlist six sub-questions even if the teacher did not list six of them. Also there should be at least three more answers than sub-questions. If teacher misses this rule, the system automatically ensures that there are at least three more answers than sub-questions.

In the case of fill-in-the-blanks questions:

- The system will not let the teacher use more than one blank in each sentence.
- The system will not allow the teacher to leave the bank at the beginning of the sentence.

OnEx groups the questions under categories and saves them therefore the teacher can reach all types of questions while preparing an examination form, enhancing her ability to conduct a real measurement and evaluation.

OnEx, unlike other e-learning systems, aims to ensure the compatibility of any question under relevant category submitted by the teacher, by employing at least three experts to control the question. Questions need to have at least two thirds of confirmation from the experts to be counted as compatible.

It will take a substantial amount of time for the teacher to prepare an examination form with questions from different categories which also meets the criteria, therefore OnEx can prepare examination forms according to the criteria and category preference of the teacher, since the questions are already in the system.

Questions are only categorized at the cognitive level in the system, excluding affective and psychomotor levels. There are not any categories in the question bank related to affective and psychomotor levels since these are not measurable only by questions. Measurement of affective behaviour is only possible through observation of students and helping them to explain their thoughts clearly. In the psychomotor level, the methods of exercising the target skill, producing a skill product by exercising the target skill, or producing a product by exercising target skill can be used for measurement. These types of measurement are not included in thesis study. However, the dynamic structure of the system allows addition of different question categories. An exam can only contain three types of questions, and cannot contain matching, true/false, and fill-in-the-blanks questions at the same time. OnEx also takes this rule into account.

By using OnEx to prepare the examination form, the teacher can choose which students can take the test. This directly correlates with students whom are enrolled in the course in the e-learning system that OnEx will be integrated to. Following the test, students can see the

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results on screen, and print the result screen with the help of the web browser. The system, on the other hand, presents details about the test including, questions answered, how many right and wrong answers, and questions not answered.
OnEx also sends student test results to the teacher via a report titled "Test Results Report". This interface also enables sending feedback to students via e-mail. The report also gives information about how many questions from which category were asked by this particular student, and the number of right or wrong answers to questions according to the category. This way, teacher can see the deficiencies of the student on each different category and therefore better assess in which areas the student needs help and help them to improve by targeting these deficiencies. There is a negative correlation between the level of difficulty for each question and the rate that it has been answered correctly. Therefore, in order to assess the difficulties of questions the system simply stores the information about the rates of right and wrong answers for the questions. After the system assesses the difficulty level of the questions, questions will be automatically sorted from difficult to easy. Additionally, after the preparation of each examination form points from each question should be determined by the teacher. Since OnEx is still developing its question bank, and the difficulties of questions are undetermined, all questions have same points.
The system security was examined by an expert and they found 90% secure for modules of submitting questions to the system, preparation of tests, and student examination. While OnEx deals with the tasks of users on the surface, at the back end, authorizations for the users are being defined according to their usage areas by the system administrator.

CONCLUSION

Mastery learning is important because of many aspects in education and teaching. Mastery learning is vital for development of skills, providing systematic education, quality of education, and cultivation of student abilities. It is important to assess, in which circumstances students can learn more or less. And since learning continues during the examination, if measurement and evaluation is done properly, student achievements can be presented completely, and the results form measurement and evaluation may reduce negative factors affecting student achievement.
In order to make OnEx compatible with any platform flawlessly, open source PHP and MySQL database are used. Any user can reach the system through any web browser problem-free, because the system is designed to be internet based.
We can conclude by stating some points which can be helpful to the further development OnEx:

1. Teachers or Teacher candidates can use the system, providing feedback about the usability of the system. Because measurement and evaluation knowledge of the teacher candidates are more up to date, they can provide valuable feedback.
2. OnEx, not only as measurement and evaluation tool, can also be used as a supplementary tool in teaching. By adding areas for teachers to send the students a feedback to reinforce relevant knowledge, OnEx can help enhance learning.
3. OnEx can be developed towards the needs of different countries and languages, through the use of multi-language support and developments depending on feedback and needs of users from those countries.

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