Web-based application for online self testing and knowledge evaluation in the field of Microbiology

MIHAELA ELENA IDOMIR ¹, VALENTIN IDOMIR ², ANGELA REPANOVICI ³
¹) Transilvania University of Brașov, Faculty of Medicine
Nicolae Bălcescu Str., No. 56, 500019
BRAȘOV, ROMANIA
²) S.C. Infomad Original S.R.L Brașov
Colinei Str., No. 6, Ap.7, 500084
BRAȘOV, ROMANIA
³) Transilvania University of Brașov, Faculty of Mechanical Engineering
Vlad Tepes Str., No 16, 500092
BRAȘOV, ROMANIA

midomir@yahoo.com, http://www.unitbv.ro/faculties/medicina/
infomad_original@yahoo.com
repa@unitbv.ro

Abstract: - Our Web application has been developed as a Web-based education tool and is addressed to the students and residents in medicine, helping them in understanding and refining the concepts and in easily evaluate their knowledge and needed improvement areas. The described methodology was experimentally tested in the domain of bacteriology, virology and parasitology.

Many studies conducted in the domain of Web-based education tools have showed students and teachers interest in using this kind of applications and its benefits in the professional knowledge development of the students. When using the new instructional technology like online learning and online examination, institutions and teachers have to consider also the professional code and ethical obligations associated with this use like diversity, objectivity, web accessibility, security and copyright.

The aim of our study is to implement a modern solution that will address this issue with a low cost and in the same time to make it available and easy accessible to teachers, students and medical residents. The implementation of this web-based application offers all the advantages provided by the Web technology (interoperability, multiple users, reusability, and extendibility) and will also support the categories mentioned above in evaluating and extending their knowledge in the field of Medical Microbiology. The design and concept of the application allows its extension in any educational field with minimum effort needed.

The innovative aspect consists in a module that will preserve the same set of questions in the examination form for all the tested users, realized by creating an examination template that will arrange the questions in randomized manner, the options for each response being presented to each user in a different order. Our application offers great potential for improving the assessment and self-testing of students and residents in medicine and many advantages over traditional assessment methods.

Key-Words: - Web-based tool, Microbiology, knowledge assessment, online examination system

1 Introduction

Assessment in education is a complex process with deep moral implications having as ethical consequences the achievement of classifications and selections that will affect the professional and personal development. This represents much more than the measurement of acquired knowledge and marking, having effects in social and individual live.[5] In our days, teacher’s interest and attention in following rigorous and high level standards for measuring student achievements has increased. The importance of high-quality Web-based tools for student professional knowledge development is now recognized more than ever in education. [16].

The role of assessment and evaluation is multiple and of high importance in the context of comparisons between what was intended in the learning process and what was obtained. The results can be used to stimulate the students’ interest for study and to evaluate the efficiency of the educational system in order to reach a higher level of performance.[7]

When using the new instructional technology like online learning and online examination,
institutions and teachers have to consider also the professional code and ethical obligations associated with this use. The most important features for an online evaluation tool discussed in the literature are, but not limited to: diversity, equality, Web accessibility, confidentiality, copyright [4].

The classical assessment methods can lead to disturbances due mainly to the subjectivity of the people implied in the process. This can consist in a wrong appreciation by the teacher of an answer due to a pre-existent impression on the evaluated student or lack of communication, low exigency regarding the difficulties of the tests or in attitudes that can discourage the students. These aspects have an unfavorable influence on the quality of the didactical process through the drop of confidence in the examination. [14]

The use of quiz tests allows the removal of the issues due to subjectivity, but has the disadvantage of a longer time needed for the results and of the errors in calculating the score. On the other side, computer-based automation of these tests enables a wider diversity of the question content, increase in results accuracy and significant decrease of the overall examination time, including time spent for the examination, scoring and communication of the results. [8][11]

Researches performed in the field of on-line versus traditional lecture courses have indicated that students are at least as satisfied in on-line courses and examinations compared to face-to-face courses. They have also showed that students benefited most from computer-based courses and assessments. [13][15]

Studies have also indicated that web-based learning environments including support systems for course tests and assessments are considered to have a high degree of necessity and will lead to better student performances. [1][11][15]

Several studies have been conducted in order to define the best assessment methods based on what is intended to measure – knowledge, decision making, practice performance, skills and tasks [8][12]. They indicate that one of the main issues encountered in the assessment process consists in the incapacity of an appropriate management of the time assigned for assessment and maintaining the objectivity of the evaluation. Learning of student can be assessed by diverse types of questions (objective/subjective) [2] and examination formats (easy, single choice, multiple choice, short answer and association questions) [12].

Some authors have also proposed, in order to allow a meaningful computer-based analysis, the “intermediate constraint” questions that fall between the fully constrained responses (i.e. the traditional essay) [8].

Beside the advantages already mentioned, the computer-based automation of these tests enables a wider diversity of questionnaires and of question content, manages the process of scoring and performance reporting, allows randomizing of questionnaires and questions, and offers a real time feedback mechanism. [3][10]

2 Problem formulation

Several modern solutions and technologies are available in order to address some of the described assessment challenges, but often their access is prohibited due to the associated costs.

The aim of our study was to implement a modern solution that will address the issues described above with a low cost and in the same time to make it available and easy accessible to all categories involved in the educational process: teachers, students, nurses, resident doctors. Our application was developed in this respect and is trying to address all these issues.

Our goal was to build a Web-based application that is addressed to three categories of users: administrators, teachers (examiners) and regular users (examined). It offers the possibility of a computer based assessment for a large variety of question models, so that a large area of knowledge can be assessed in a limited timeframe, for a big number of students. It also uses all the possible types of formats that are appropriate in the process of knowledge assessment in the field of Microbiology.

The chosen software and technology: mySql database [9] and a Java-based Web application running on a jBoss application server [6] were also done in this respect, of benefiting from new IT technologies and open platforms with minimal costs.

The system is modular in order to allow the examiners to store question banks, the students to register for self-test and online examinations. It is a multi-task, multi-user application allowing a simultaneous usage for the assessment processes and self-testing by multiple users of different disciplines.

Since computer based assessment can be used at several points in a course depending on the purpose of the assessment, the application should be used for self (assessment during the course to identify learning needs), formative (to measure student performance and teachers course effectiveness) and summative assessment (students have to pass the examination) [11].

The innovative aspect consists in a module that will preserve the same set of questions in the
examination form for all the tested users. This is realized by creating an examination template that will arrange the questions in randomized manner, the options for each response being also presented to each user in a different order. The program allows also the generation of a pre-examination test that can be used for self-testing. The final goal is to use the same questionnaire for each student even if they look to be customized, maintaining this way the objectivity of the assessment process.

The selection of question types should be based on the types of outcomes the teacher is trying to assess and should take into consideration both pros and cons of each question type.[17][18][19]

The results of the assessments should be stored in a database in order to be used later on for the follow up of performance and further analysis. The data will also be used for gathering meaningful information in order to improve the learning process and reach a higher level of performance.

The implementation of the program during the university study year will allow the students to self-test their knowledge in order to improve and optimize the learning process, track down the understanding and learning issues and for acquiring of abilities.

3 Implementation Aspects

3.1 Design considerations

In designing the database we had to take into account following requirements:
- should be used by users of different disciplines;
- should allow the storage of high quality images and efficient data collection;
- should allow examiners and users registration by defining security constrains based on the users role;
- storing of data that allows the management process of the examination (response time per question and/or complete test, scoring, registration);
- storing of question banks that are provided by teachers with multiple types of questions. These are:
  o simple (answer can be yes or no);
  o single choice (only one correct answer from the list)
  o multiple choice (one or more correct answer from the list)
  o associations (association between items contained in two lists)
- should allow CRUD (create, read, update, delete) operations for the stored data;

The database schema is presented in Figure 1.

In designing the application we should take into account the needs of both examiners and examined users, as presented below:
- identifying the main questions that are specific to each section of the exam;
- determining the questions that are required to be answered to, allowing the module to select randomly the other questions up to the total number selected for the questionnaire;
- allowing alerts that will help the user to easily determine the questions he has accidentally skipped;
- providing help tools for time management
- allow temporary savings and easy back and forth navigation between questions;
- allow immediate presentation of test result if option is activated by the examiner.

The proposed implementation is a client-server Web application written in Java as shown in Figure 2 below.
Next we will describe the main design concepts, facilities and advantages offered by our application.

3.2 Data entry process

Each teacher will be granted by the administrator with rights to control all the aspects of his module. He is considered to be the administrator of his discipline.

The data entry (create) process for each discipline is performed by the examiner. He has the option to store in the database any of the six types of questions mentioned earlier.

He is also allowed to read (preview), update and delete the already stored entries.

A screenshot of the user interface used for data storage and data management are presented in Figure 3 and Figure 4.

3.3 Building a questionnaire template

Another module of our application offers the options for managing the template creation process. By selecting to display the questions stored in the database, administrator have the option to click and select that question to be added to the template. They can also select the number of questions of each type to be included in the template.

Based on the number of questions of each type, the template generation module will be responsible to pick the teachers selections and randomly select the other, up to the number of questions that were selected.

At any time, the template can be previewed, transformed into a pdf document and printed. The response keys are also listed at the end of this generated document.

3.4 Assessment management process

The system has an assessment module allowing the arrangement of the question included in the template in randomized manner, for the order of questions within a questionnaire and answers within a question. Administrators can provide the list of users and decide the way the results are calculated and displayed. This is very important since multiple choice questions and associations can be rated in different ways. The module offers also some help tools for time management and validation that can be made available to the users based on teacher’s selection. This include the ability to select a convenient time for taking the test, save the partial results and continue after a short brake, opportunities to reset some answers, information about the tasks to perform based on question type and opportunity for feedback.

Once this last step is completed, the application generates (as simple as a button click) the
questionnaires of each user. This is done in the form of an xml document that is transformed in html by the display module. An important aspect of having this in xml format is that we could, in the future, extend the possibility of allowing the students to take the examination from any client application other than web browsers, like PDA’s or mobile devices.

All the configuration files used in our application are designed so that the user interface can be displayed in several user languages based on the computer locale settings.

3.5 Assessment form

Figure 5 below shows a section from the Web-based examination form.

![Assessment form](image)

The main advantage of this questionnaire, compared to other examination forms consists in the objectivity of the examination (same questions and answers in the form even if they look to be different because of the random arrangement) and selectivity since the most important questions have been selected to be included in the form. The full support of the application for examiners and users offered by a simple user friendly user interface is also an important feature.

Once the assessment process was completed, the display module of our application has the ability to online preview the results (by examiner and student) and also to generate a pdf document with the examination form, answers and score. This is very useful for students in case of self evaluation tests and for teachers to track the progress and review how students have performed.

4 Results

The described methodology was experimentally tested in the domain of bacteriology, virusology, parasitology in the “Department of Fundamental and Prophylactic Disciplines” from the Faculty of Medicine of the “Transilvania University of Brasov”.

The use of this application in the examination sessions allows the evaluation of the acquired level of knowledge as well as of some abilities regarding the reaction speed and use of information, synthesis capacity and links between theory and clinical practice.

In the domain of Microbiology – Virusology – Parasitology, the program enables the achievement and assay of both theoretical and practical knowledge, by offering the possibility of understanding and refining the concepts of microbial and parasitical morphology through the use of image representations of microscopic prepares.

Putting in practice this methodology has leaded to a larger diversity of tests and of their content, significant decrease of the time spent for the examination and communication of results and in better results in the process of evaluation and scoring.

5 Conclusion

Web-based assessment tools are in our days complex and rapidly emerging, involving many considerations like interactivity, performance and feedback, offering great potential for improving the assessment and self-testing of students and residents in medicine and many advantages over traditional assessment methods.

Computer based assessment in medicine has become much more important in our days as information technology has become a key factor in the educational process.

Our Web-based application has been tested with success in the field of Microbiology and provides a set of advantages over other assessment tools. These are:

- preserve the same set of questions in the examination form for all the tested users by arranging the questions and answers in randomized manner, maintaining this way the objectivity of the assessment process;
- wider diversity of questionnaires and of question content, easy managed by a friendly user interface;
- ability to manage the process of scoring and performance reporting;
- low cost solution benefiting from the new IT open source technologies;
- easy to extend in any educational field related, but not limited, to medical disciplines;
- easy to adapt to any client application like PDA’s and mobile devices due to the xml format used;
- decrease of the overall examination time being a multi-task, multi-user application;
- increase in results accuracy due to the scoring module;
- allows self-testing during the university study year and so improves and refines the studied concepts;
- offers several help tools for time management and validation
- offers feedback options
- ability to follow up students performance and further analysis

The obtained assessment results have demonstrated the need of the application and lead to the necessity of extending it by adding more question types (like multimedia-support questions) and allowing adaptive testing, in which questions can be picked at the level of expertise of each candidate (more easy or increasing in difficulty based on student answers).

References:
[16] Steve Whitaker, Mable Kinzie, et al., Use and evaluation of Web-based professional development services across participant levels of support. Early Childhood education Journal, Vol.34, Nr.6, 2006; pp. 379-386