Online assessment and self-assessment with iTest: experiences in higher education Mathematics

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RESUMEN

iTest es una herramienta de evaluación online diseñada y desarrollada por el grupo de investigación HEOL (Herramientas de Evaluación On Line) compuesto por profesores de la Escuela en Ingeniería Técnica en Informática de Sistemas del CES Felipe II de la Universidad Complutense de Madrid y por profesores de la Facultad de Informática de la citada universidad. En este artículo, se describen y analizan los resultados de las pruebas preparadas y llevadas a cabo por miembros de este grupo en todas las asignaturas de matemáticas de nuestra escuela, muchas de ellas como grupos piloto siguiendo las directrices del nuevo Espacio Europeo de Educación Superior.

Palabras claves: Didáctica de las Matemáticas; herramientas de evaluación online; Espacio Europeo de Educación Superior: evaluación continua y auto-evaluación en Matemáticas; integración de nuevas tecnologías en el aula.

ABSTRACT

In this paper we describe the experiences designed and conducted with Mathematics Computer Science major students to study the integration of alternative assessment and self-assessment online tools at higher education. We have used the educational software iTest, developed by a group of professors at the Computer Science departments in the CES Felipe II and at Universidad Complutense de Madrid. Special efforts have been made to use iTest as part of the continuous evaluation methodology promoted by the European Space for Higher Education.

Key words: Math education; online evaluation tools; European Space for Higher Education: self-assessment and assessment in Mathematics; technology in the classroom.
1. INTRODUCTION

The traditional classrooms have been around for centuries and still continue to exist in a relatively high amount of institutions despite all the advances in the technology and its implications on education. Technologies complement traditional education with new possibilities, such as automatically graded quizzes or e-questionnaires, not only as a technology for assessment but also for self-assessment. This aspect is extremely important at higher education nowadays since we all have to work with new methods for teaching and learning focused on the students [1], [2].

There are tools that deal with graded quizzes, such as Hot Potatoes and MegaTest (Zipposoft), and there are complete e-learning platforms used in academia such as Moodle [3] and Sakai [4], that also have modules to generate tests for the students. In these systems mathematical formulas and graphs cannot be easily integrated, accessed, visualized or stored in databases, therefore reuse and portability are limited in general. Moreover, the tests modules in these platforms do not in general provide features such as complete statistics about the results or controlled random generation (see Section 2 above). For these reasons, among other, we decided to create iTest, a new more specialized noncommercial online evaluation tool compatible with existing Learning Management Systems such as the ones mentioned above. In a few words, iTest is a web application that allows instructors to configure multiple choice exams and students to take them getting their grades automatically. Through an intuitive interface, iTest allows professors to easily include mathematical formulas and (plane) graphs of functions in the body of questions and answers through a math editor that supports LaTeX type code. It is also possible to insert multimedia files (images, audios, animations and GeoGebra files among others) in the question body. This versatility makes iTest a very suitable tool to design multiple choice tests and to administer them to the students just using an Internet browser.

Fortunately, iTest automatically generates statistics about the results of each examination for the instructor, and this is a great source of feedback that normally is difficult to obtain when paper-and-pencil exams are administered. It also allows
students to revise their graded exams being therefore extremely useful as a self-assessment program [2].

Our research group HEOL [5], composed of professors from the Computer Science Departments at the UCM campus in Madrid, as well as the UCM campus in Aranjuez, has designed, developed and implemented iTest. Some members of the group, assisted with interns, are continuously in charge of the maintenance of the tool and they also develop new features as demanded by the users. Other members of the research group prepare and give in-service training courses for teachers in Aranjuez and also coordinate workshops with non-university students (from preschool through high-school). To help and to encourage instructors to use iTest, we offer continuous support through our web page ([http://www.itest.es/]) and our email account ([itest@cesfelipesegundo.com]). Our website also provides access to a forum, a link to a demo of iTest for student users and also a video where the professor interface is shown.

The paper is organized as follows: first we include a short technical description of iTest. Then we describe all the activities that have been designed and implemented with university students at our department using iTest as an online evaluation or self-evaluation tool. We also include some statements about the results although this paper does not pretend to give a rigorous analysis of the results of the integration of alternative assessment approaches using online learning environments in college Mathematics classrooms. We finish this article including some of our conclusions.

2. DESCRIPTION OF iTEST

In brief, iTest may be described as an online evaluation tool that allows two different types of users: teachers and students. Teachers may create a syllabus for each course they manage with iTest, they may also add questions to the database (each of them is attached to a topic in the syllabus and to a degree of difficulty) and configure exams. The questions for each student exam are then randomly selected by the tool from the ones in the database according to the configuration parameters predefined by the teacher who in this way can control the randomness. If several questions are included in a given topic with a given degree of difficulty, it is easy for
any given couple of students to obtain different exams with the same configuration parameters so cheating is very hard. Once the student has completed an exam, her/his score is immediately shown on the screen. Afterwards, the student is also able to revise his/her graded exam if the instructor activates the revision. As mentioned above in the introduction, iTest automatically generates statistics about the results of each examination for the instructor too.

2.1 Mathematical formulas and multimedia support

Any new tool in online evaluation should provide some added value to the current state of the art. In this way, iTest contributes in two different aspects. On one hand, iTest offers capabilities to create and to edit mathematical formulas, graphs of functions and Venn diagrams (Figure [1]) in LaTeX-style format in order to include mathematical expressions in questions and answers. This feature is particularly useful because the use of images representing formulas is not mandatory. Figure [2] shows an example of a question with formulas and another with a graph typed directly through the editor.

On the other hand, it is also possible for the instructor, through a very intuitive interface, to attach multimedia contents such as Flash animation files, image files, GeoGebra (Figure [1]) or audio files in the question space, and also image or audio files in the answer space.

*Figure 1: Questions with GeoGebra files including Venn Diagrams.*
2.2 Teacher interface

As explained before, iTest distinguishes between teacher and student users. Therefore, each one of those classes of users works on its own interface.

A teacher user may define a syllabus of the course, work with questions, manage exams, register his students, view the grade of any student, and analyze statistics. Regarding more specifically to questions management, iTest allows a complete set of operations for questions. (1) It is possible to add questions and answers, (2) Store data related to a question (subject, difficulty level, visibility, question text, comments for each question to appear in the revision of the graded exams by students, identification name and number of correct answers), (3) Upload multimedia files, (4) Edit a multimedia file (file name and ordering number for visualization), (5) Add or edit answers: each answer is associated to one question, and establish the correct answers for every question (the user may define more than one correct answer), and (6) List the questions with the possibility of filter, edit, modify, activate or delete them. As an example, Figure [3] shows the interface for adding and editing a question.
Teacher users may apply public visibility to the questions they include. When this option is selected, the question is available to all the other teachers registered in iTest. This is a very innovative and important factor that allows instructors to collaborate and then to create bigger and complete question banks.

In addition, the teacher may obtain for each exam the following statistic information: attendance, passing grades, minimum and maximum grades obtained on a given exam and average time employed to solve a given exam. The tool also provides percentages of correct, incorrect and non-answered questions.

**2.3 Student interfaces**

A student user can take exams previously configured by the teacher of the course, and afterwards he also review his results online. Comments about the answer included by the teacher in each question are shown in the revision, which is crucial for self-assessment.

iTest implements a special interface for pre-school students, called kid interface. The necessity of a special interface for pre-schoolers was detected when a Mathematics pilot workshop was carried out with 4-year-old kids in May 2007. Student users denoted as “kids” receive the exams in a different way as the rest of student users. Kids receive one question at a time and it is individually graded using visual and auditive signals to tell the student if her/his answer to that particular
question was correct before passing to the next question. In addition, a special final screen is displayed with a cartoon character showing a happy or sad face depending on the final total score. A kid user only needs to use the click of the mouse to make any test. Screen colours and sizes of the buttons have also been adapted ([5] and [6]).

2.4 iTest technology

Through an innovative application and combination of web technologies such as AJAX and MathML (W3C, 2003), server-side Java technology (J2EE under a Spring framework) and database access (Ibatis on MySQL), iTest offers a web tool for online exams where contents and support services are interoperable. In order to obtain a more dynamic application, we also use technologies compatible with the so-called web 2.0.

3. EXPERIENCES WITH UNIVERSITY STUDENTS

iTest has been used with Mathematics students from pre-school through college in Aranjuez since the academic year 2006-2007 [6]. In this section, we enumerate and briefly describe all the online evaluation activities we have been conducting in Mathematics university courses until February 2009. In all of them questions from 3 levels of difficulty were considered. All scores in this section are calculated over a 10 point scale and the frequencies are normalized as percentages.

There was a strong need in our Mathematics department of a tool like iTest to call students attention towards the study of abstract topics such as Calculus, Discrete Mathematics, Mathematical Logic, Linear Algebra or Statistics [7]. Statistics is a 2nd year course, and the rest are all 1st year college mandatory courses at our institution. This need becomes even stronger with the arrival of the European Space for Higher Education (ESHE) in 2010. In the ESHE the assessment methodology has to change since the learning process is centered now in the students: they have to be continuously evaluated by the instructors and by themselves. iTest provides a perfect complementary tool for the assessment and self-assessment of students in the ESHE environment. Questionnaires have been administered in some of the courses just mentioned since the academic year 2006-2007. We summarize in Table [1] and Figure [4] the main characteristics and the results of these first tests.
Table 1: College tests (2006-2008): characteristics

We will give some details about the experiences of the current academic year 2008-2009 at the end of this section.

In the “Test configuration” column we include the number of questions in every test of each course, the number of answers shown for each question of the given test and the maximum time length (in minutes) allowed for the corresponding students to take their tests. For most of the questions, only one answer was correct, but there were a few questions with 2, or even 3, correct answers. In those cases, partial grades were assigned automatically. In these first experiences, it was not mandatory for the students to take the tests and some partial extra credit was assigned to the ones who took them. Most of the tests were taken by the students at our computer laboratories. In some cases during the academic year 2007-2008 (Discrete Mathematics and Linear Algebra), instructors allowed students to take the online tests from their personal computers at home.
The instructor activated the tests at night, after 10 pm, and he was available via email to the students through the duration of the test. As it can be seen in Figure 4 no significant differences are appreciated in the results when the tests are taken without supervision. The average duration of the Discrete Mathematics test 1 is very low because this particular exam was configured only to have the students checked that all the plugins worked correctly in their PCs and it only represented 1% of the final course grade. When two tests were administered, the percentage of passing students and the average scores were always lower in the second test. This might be because the second tests covered the whole syllabus of the course.

Figure 5: Calculus results with iTest (2006-2009)
During the academic year 2008-2009, iTest is being used by all the professors at our Mathematics department as a support tool for the continuous evaluation methodology adapting to the ESHE as pilot study groups. In all the Mathematics courses taught in the first semester, 1 or 2 midterm exams were configured with iTest for the students, and the performances on these tests represented between 20% and 40% of the students final grade. Regular paper-and-pencil examinations, as well as group presentations and homework assignments (with or without iTest) were also considered. It is worth mentioning that in the Calculus course, every student who passed the online exams, passed the course, and only 3 (12% of the students attending the course) students passed the course having failed the exams with iTest.

In the percentage chart of Figure [5] it can be seen that the average score in the Calculus online tests is slightly decreasing with time. The percentage of students taking the online exams is also decreasing slowly with time. As it was the case with the 2007-2008 results, when two tests where administered, the average score and the percentage of passing students were lower in the second. To finish this section, we would like to express our worries concerning the decreasing of the percentage of passing students in the Calculus online tests with time. In the academic years 2007-08 y 2008-09 the bank of questions used in the online tests was very similar, only more questions of low difficulty level were added to the database based on last year of high-school Mathematics books. It is our impression that students training in Mathematics is falling in high-schools year after year and also students’ interest to learn complex concepts investing a lot of time is disappearing. These aspects have motivated a more intense use of iTest as a self-assessment tool in our courses so that students can detect since the first week of the semester the situation and be still on time to remedy it.

4. CONCLUSIONS

The use of new technologies can be a profitable supplement for the traditional classrooms. iTest supplies automatically graded quizzes, which provides teachers and students a good tool for assessment and self-assessment. This is especially important in the new European Space for Higher Education where new evaluation strategies have to be implemented in order to accompany the new teaching and learning methodology. In this direction, our experiences make us find
this type of software very helpful, but we still believe that extra efforts need to be done by students and professors to adapt better to the new requirements of the ESHE in order to fully benefit from all the advantages of this new system.

The use of iTest has shown that it also helps to motivate the students, especially in complex learning domains like Mathematics. It is important that students get used to different evaluation systems to awake their critical thinking as well as to the progressive integration of new technologies in the classroom.

The use of mathematical formulas and graphs, multimedia objects and the direct way of obtaining results, grades and statistics of each examination with our tool have been very helpful to Mathematics instructors from all levels of education.

We find extremely important to make connections between the different levels in education to soften the various existing gaps. The collaboration with so many instructors (and students) in the past two years has given us valuable information about the performance of our system in real environments, about the satisfaction of their users and its usability. This information will be very useful not only for the future development of the tool helping us to adapt iTest to the real demands of its potential users, but also for the design of massive testing experiences in the next academic years in our education community.

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5. REFERENCES

[1] The Bologna Declaration. (Consulted on February 2009.)


