The 8th International Scientific Conference
eLearning and software for Education
Bucharest, April 26-27, 2012
10.5682/2066-026X-12-029

# INNOVATIVE FORMS OF COMPULSORY PRE-EXAM TESTS: STUDY OF STUDENTS' ACCEPTANCE

Corina GROSU, Marta GROSU
*University Politehnica of Bucharest, Faculty of Applied Sciences, Splaiul Independentei 313,Bucharest,Romania*
*E-mail: cgr90@yahoo.com, marta_grosu@yahoo.com*

Brindusa Luciana Grosu
*Clinical psychologiste, Bucharest, Romania*
*E-mail : lacramioara_2006@yahoo.com*

***Abstract****: The present paper introduces a case study concerning the students' self-evaluation of a new form of pre-exam testing. The study is based on: a) the actual test – an interactive pre-exam quiz (with a graphic interface built using a Flash template) and b) an evaluation questionnaire with 10 closed items and an open-ended feedback question. The quiz' questions belong to subjects covered in the first semester course in Mathematics. In this paper we have included a short presentation of the test itself, along with the main findings and conclusions obtained from the application of the feed-back questionnaire.*

***Keywords:*** *flash quiz, self evaluation, standard score*

## I. INTRODUCTION

One of the main challenges the teaching of mathematics faces, especially in the technically-oriented universities, is the right choice of a modern learning/practicing *interface*. This challenge may be considered as a two-sided problem. On one hand the theoretical models built in all the other academic courses rely on the mathematical notions taught during the first university year. But on the other hand, web savvy students are more inclined to get quicker to the applications. Thus they tend to take for granted the models without questioning or understanding the *hidden* mathematics underneath.

It is and has been for some years our goal [1], [2], [3], [4], [5], [6], [7] to attract students towards an active learning of mathematics by presenting them with new forms of self-evaluation. These different approaches are innovative and potentially stronger in both traditional pen and paper tests [1], [2] as well as in e-learning courses [3], [4], [5], [6], [7], especially based on the Moodle platform (1.9 and 2.1) [5], [6]. The present paper is intended to show one of these forms along with some interesting results we have obtained by applying an evaluation questionnaire. Since the self-evaluation form was not applied to a statistically relevant number of students, we cannot conclude that an etalon can be established. Nevertheless, this particular case study offers an insight view concerning the students' interest in learning mathematics connected to the form of presentation of the reviewed knowledge.

Our study relies on two components:

i) a story created by using 3d software [8], [9], [10], [11], [13], [14] and specialized mathematical soft [12] followed by an interactive scored quiz

ii) an evaluation questionnaire with 10 closed items and an open-ended feedback question

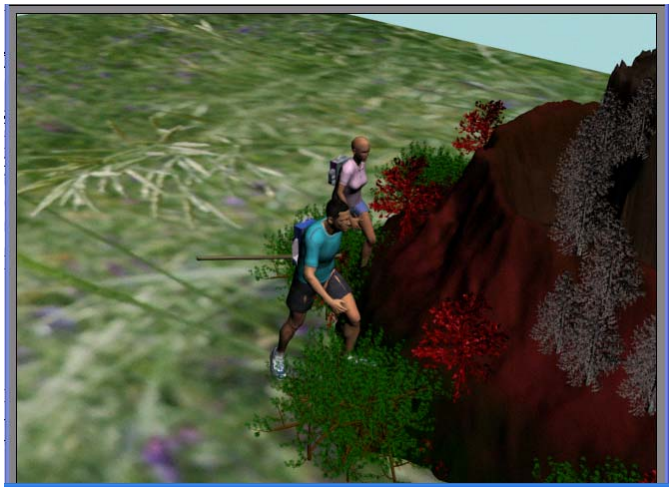
The quiz is intended as a self assessment test and although it is scored, the scores are student' and not teacher' intended. In order to motivate the students and enhance their preparation for the final

examination, the level of difficulty of the quiz is medium towards high. The reason is that the pre-exam quiz' questions are usually more complex than regular exercise tests, since a question relies on several notions from the course. Consequently, the quiz is a good start for the students' preparation, since in the final examination we verify the acquired knowledge through a similar format. In order to make this new form of pre-examination attractive for students, a short story was included in the beginning of the quiz allowing an interesting approach to the pre-exam questions. By answering the questions, the students get an insight view of possible applications of the mathematical notions they have learnt about and they are encouraged to search for and provide some more applications. Following the completion of the quiz, the students were given the evaluation form, with clear instructions for completing it anonymously.

In this paper we have included the main findings and conclusions obtained from the application of the feed-back questionnaire. The questionnaire's score indicates results that justify this new pedagogical approach in the actual learning environment. We also discuss some of the drawbacks of this form of testing as they have appeared from the students' answers to the feedback.

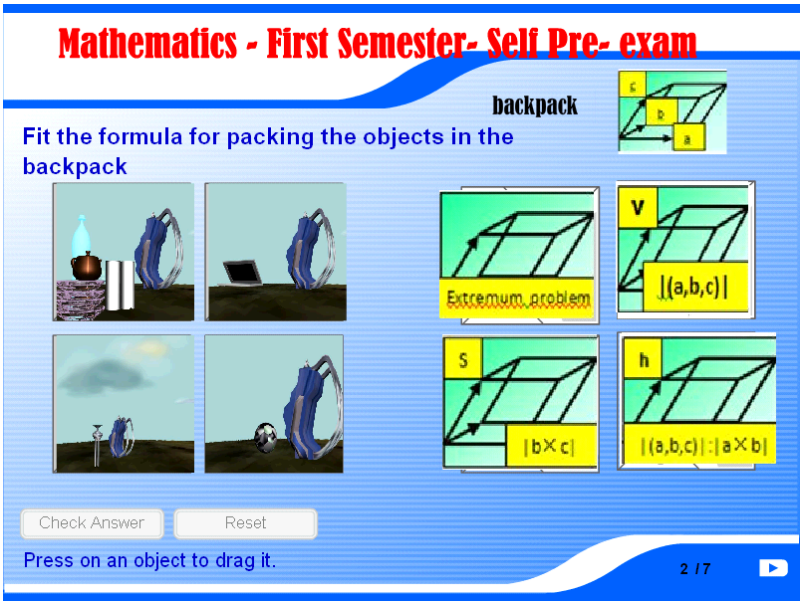
## II. STRATEGY: MEET MATHEMATICS IN YOUR SPARE TIME

The self-evaluation form starts with a short story, which we created and adapted by using 3d software [8], [9], [10], [11] along with dedicated mathematical work and visualization programs [12]. A mountain trip for photo capturing of a rare roof view on top of the mountain is the pretext for meeting mathematics. The students are welcomed to participate to the trip, starting of course with packing everything needed. The quiz focuses on the encounter between mathematical notions and the different stages of the mountain trip. We have to mention here the following aspect: the testing of the mathematical notions does not follow the time order in which they were taught through the academic semester. Actually, we think this is a better preview of the exam test, since in the final evaluation subjects are neither proposed, nor tested in the order they were taught during the university year.

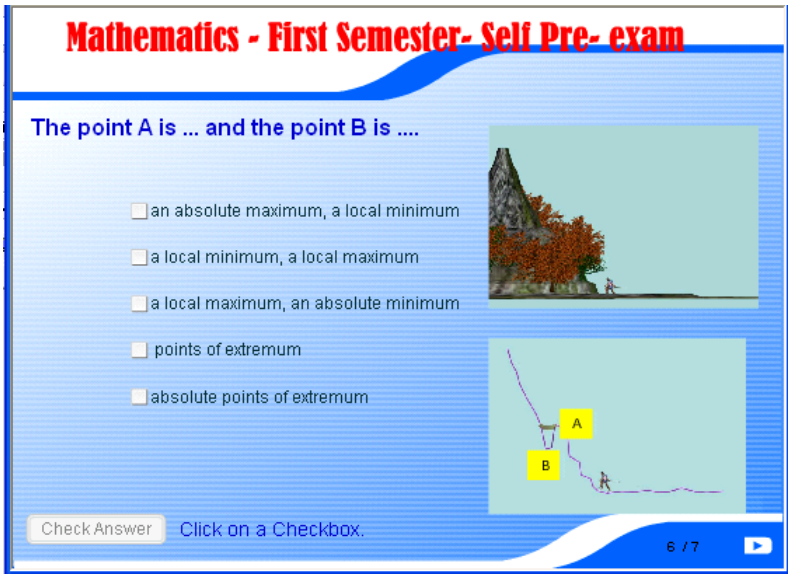


Planning and preparing the trip means using analytical geometry sometimes combined with analysis. Thus, students are required to recognize certain formulae they have learnt in order to be able to crowd in their backpacks (assimilated to oblique parallelepipeds) various objects: household items, a special tripod for the camera, a laptop and … a soccer ball. In this pre-exam test the formulae are already associated to their corresponding geometrics notions (volume, area and height) which makes in easier task for students to solve the given items. We have to mention here that in the actual examination, students do have to remember the corresponding formulae, not just to match them! Moreover, at that point they are supposed to recognize the geometrical figures and supply data for them using vector calculus. Specialized soft (Maple) may help offering the needed visual support for representing plane and tridimensional figures specified by equations. A reference should be made here

in connection to the strategy used for testing notions of analytical geometry. First of all, the principal geometrical shapes introduced during the first semester course are intended to be applied for the integral calculus on plane and tridimensional bodies (a major part of the second semester course) and therefore the test should stress those properties which are invariant under certain deformations – translations, rotations- like area or volume. And secondly, analytical geometry is a good starting point for getting acquainted with mathematical modeling: reducing real world models to appropriate recognizable shapes followed by their characterization in terms of systems of equations.

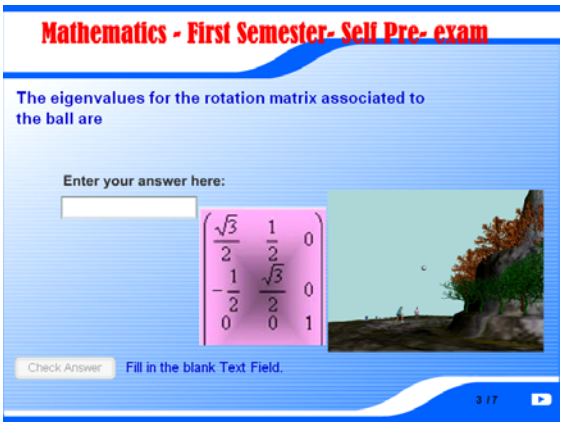



Another chapter of mathematics – analysis- is addressed when the students are asked to characterize the principal points of their mountain trip. Again, modeling here stresses the extraction from a real world element (the mountain) of a certain characteristic (shape) which is then used to obtain the required information. A particular mention has to be made here concerning the images appearing in this part of the quiz: the mountain was 3d created exactly from the shape represented for the analysis.

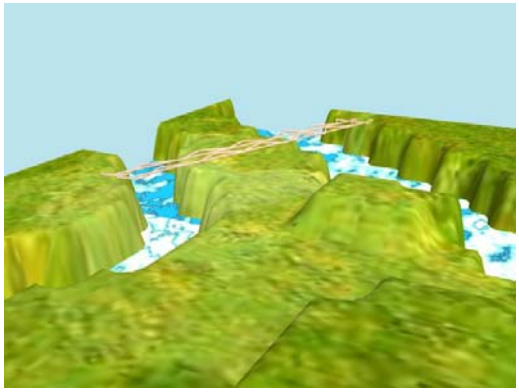



Thus, an intuitive approach to one of the main notions from the first semester course is used to stress that passing from functions of one variable to functions of three variables is nearer to our representation of the world.

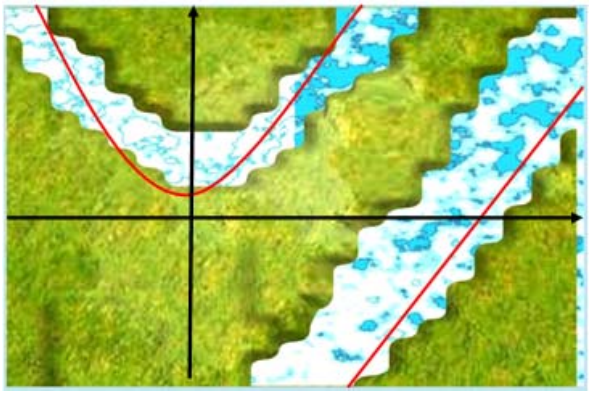
Additionally, students are welcomed to test their knowledge on another important key-notion of the first semester course , namely linear algebra, and more specifically the notion of eigenvalues and eigenvectors. Therefore, after their trip mission was successfully completed, the game's characters from the interactive test start 3D animated (trip) football game. This game serves as a pretext to ask students about the eigenvalues characterizing a certain rotation of the matrix (one question of the quiz) and about the corresponding eigenvectors (directions of rotation).




The level of difficulty for this task is higher than in the preceding cases since this time students are not offered any choices (hints), so they have to effectively use the already known algorithm. A similar approach is considered when students are asked to solve the following problem: build a rope and planks bridge of minimal length for the crossing a river passing through well shaped terrain forms.



Thus, the knowledge of finding constrained extrema is the mathematical knowledge required in overcoming the obstacle. Since this subject is covered towards the last part of the semester, students are given a hint concerning the geometrical part of the problem. They still have to bring their contribution in choosing the correct form of the problem.



## III. ARE WE READY FOR A NEW FORM OF EXAM? LET'S TEST AND IMPROVE

As we have already mentioned in the introduction, the completion of the quiz was followed by an evaluation form. The students were required to complete it, under complete anonymity.

**QUESTIONNAIRE**

| Nr. | Question | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 1 | How helpful was the quiz in helping you review your knowledge? | ☐ very helpful | ☐ helpful | ☐ somewhat helpful | ☐ not helpful | ☐ can't decide |
| 2 | How did the quiz help you in fixing the notions? | ☐ very well | ☐ well | ☐ poorly | ☐ very poorly | ☐ can't decide |
| 3 | How would the quiz help you in solving more complicated problems? | ☐ very well | ☐ well | ☐ poorly | ☐ very poorly | ☐ can't decide |
| 4 | How would you characterize the role of the quiz' pictures in helping you better understand the Math course? | ☐ very important | ☐ important | ☐ not so important | ☐ no influence | ☐ can't decide |
| 5 | How do you appreciate the interface? | ☐ very well | ☐ well | ☐ poorly | ☐ very poorly | ☐ can't decide |
| 6 | How interactive did you evaluate the quiz to be? | ☐ very interactive | ☐ quite interactive | ☐ some interactivity | ☐ very little interactivity | ☐ can't decide |
| 7 | On a scale from 1 to 5 how would you rate the impact of this experiment? | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| 8 | How would you evaluate the level of difficulty associated with the quiz' tasks? | ☐ very easy | ☐ easy | ☐ hard | ☐ very hard | ☐ can't decide |
| 9 | Would you favor this form of test over the traditional pen and paper test? | ☐ absolutely | ☐ yes | ☐ maybe | ☐ no | ☐ can't decide |
| 10 | What do you think about the moment of the academic year chosen for presenting the test? | ☐ very well chosen | ☐ well chosen | ☐ quite badly chosen | ☐ very badly chosen | ☐ can't decide |
| | **TOTAL** | | | | | |
| 11. | Give your opinion in introducing or removing items from the test (notions and corresponding examples) | | | | | |

The following table shows the results we have obtained (in percentages):

**RESULTS OF THE EVALUATION FORM**

| Nr. | Question | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 1 | How helpful was the quiz in helping you review your knowledge? | 30% very helpful | 40% helpful | 10% somewhat helpful | 10% not helpful | 10% can't decide |
| 2 | How did the quiz help you in fixing the notions? | 10% very well | 40% well | 20% poorly | 20% very poorly | 10% can't decide |
| 3 | How would the quiz help you in solving more complicated problems? | 15% very well | 20% well | 30% poorly | 15% very poorly | 10% can't decide |
| 4 | How would you characterize the role of the quiz' graphic and animations in helping you better understand the Math course? | 40% very important | 30% important | 10% not so important | 10% no influence | 10% can't decide |
| 5 | How do you appreciate the interface? | 40% very well | 40% well | 20% poorly | 0% very poorly | 0% can't decide |
| 6 | How interactive did you evaluate the quiz to be? | 40% very interactive | 40% quite interactive | 20% some interactivity | 0% very little interactivity | 0% can't decide |
| 7 | On a scale from 1(=meaning no impact) to 5 (= meaning very high impact) how would you rate the impact of this experiment? | 0% 1 | 0% 2 | 10% 3 | 40% 4 | 50% 5 |
| 8 | How would you evaluate the level of difficulty associated with the quiz' tasks? | 15% very easy | 20% easy | 35% hard | 20% very hard | 10% can't decide |
| 9 | Would you favor this form of test over the traditional pen and paper test? | 40% absolutely | 30% yes | 10% maybe | 10% no | 10% can't decide |
| 10 | What do you think about the moment of the academic year chosen for presenting the test? | 20% very well chosen | 40% well chosen | 20% quite badly chosen | 10% very badly chosen | 10% can't decide |

## IV. CONCLUSIONS

We can group the conclusions we have drawn from applying the evaluation form in three main categories of remarks:

1. The quiz's level of acceptance: the majority of students found the quiz to be high-impact (60%) and very useful (70%). Students were enthusiast about the innovative e-learning aspects of it such as the test's interactivity (80%), the visual impact (70%), and the attractive interface (80%). 70% said they would favor this form of testing over the traditional pen-paper one, which is an overall positive response and a grounded reason for us to continue our research.
2. The quiz's efficiency. Regarding the test's relationship to the actual testing of Math knowledge, those students who had no previous understanding of the scientific notions, said the test was not so efficient in helping them fix the acquired information (40%). However, our quiz's mission is not to teach, but to encourage students to practice what they already know, assuming they know it. This is the reason why the feed-back of the students who previously had had poor results in Match, apparently diminished the test's perceived efficiency in helping students solve more complicated problems (only 35% "pro"), and artificially raised the test's perceived difficulty ( 55% students thought the test was hard and very hard). Nevertheless, we consider our quiz initiative to be successful since the students who previously "had a good relationship with Math" responded positively.
3. The quiz's relevance to students' self-evaluation and academic progress. Most of the students thought the quiz was an useful pre-exam review tool (60% said the moment of the academic years when the test was administered was well chosen) , which leads us to the conclusion that interactive methods are best to use whenever students are confronted with preparing exams that involve complex scientific knowledge.

All in all, we have enough proof to consider the great majority of the students appreciated our innovative approach. Furthermore, our quiz is potentially useful in different contexts, as it may be adapted to test other parts of the course or another course all together. Although we have to agree this form of evaluation is a great time consumer, especially in building the interface, we believe e-learning models are a viable solution to enhance students' learning and awake their interest for science.

Finally, we couldn't have ended this paper without a humoristic quote, part of the students' feedback: "I may trick the test by guessing the right answer, but I certainly won't pass the exam! "

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