Design and Realization of Multimedia-Examinations for large Numbers of Participants in University Education

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Abstract—We report on Multimedia Examinations successfully accomplished in a physics lecture for engineering freshmen. The use of New Media enables us to create new types of questions, including Java-based applets or those requiring internet-based research. The new forms are presented in detail. Economically priced hardware solutions and user-friendly software for both teachers and students are realized in collaboration with Promethean Corporation. A first evaluation - which is very countenancing - is presented, our eAssessment finds general approval in the participants' opinion.

***Index Terms* — Electronic Examinations, Multimedia Examinations, University Education**

I. INTRODUCTION

Multimedia has become more and more important for our daily life in recent years. Internet applications and the knowledge of how to use them effectively is a key qualification of almost all professions and should therefore be part of university education. The use of multimedia while teaching classes gives an opportunity to improve the learning success and accelerate the students' individual progress considerably. At an early time of the eLearning development, education experts have pointed out the fundamental changes in learning processes due to the New Media [1]. In the meantime discussions have given way to something different: how to establish the new techniques to everyday business [2, 3]. To meet these new demands it has become increasingly important to include new media not only in classes, but also in the examinations of the traditional subjects.

From the examinees' point of view there are some remarkable advantages of eXaminations in general:

1) They provide the opportunity for instant feedback to the examinees,
2) They form a very objective assessment,
3) They may reduce the exam nervousness as compared to oral examinations.

From the teaching point of view, multimedia offers the chance to diversify the assessment and include interactive elements. Furthermore, the planning, realisation and especially correction of written exams are very time-consuming and labour intensive.

The assistance of electronic innovations reviewing and storing the participants' answers helps to free resources in the teaching staff. This is so in particular because of the possibility of collecting questions in a sufficiently large database so one can just choose a set and shuffle them for a new test.

II. Realization

The exam we report about here is part of a set of physics lectures for engineering freshmen. Three passes were made until now under different conditions:

The first pass substituted an oral review following the written exam. Traditionally, after the classes the students take part in a written exam. Those failing the exam twice have the chance to successfully finish the course by passing an oral exam. This final review was transferred into the multimedia-examination, no marks were given (pass/fail only). The exam took place in October 2005, with nine participants, and the exam consisted of 12 questions. The time given to pass the exam was about 35 minutes. The second time the multimedia exam substituted the written exam and marks were given. In January 2006 this exam was conducted with six students where 27 questions had to be solved in about 75 minutes. In April 2006 a third run was accomplished, where 29 students participated in the exam, 25 of them as oral review and four of them as a substitute for the written exam.

The exam takes place in the following way: the students workplace (see Fig. 1) contains a computer (tablet PCs running Windows XP), a calculator, sheets of

Figure 1. Participants workplace

Figure 2. Voting kit

paper, a pencil, and the most important tool, a voting kit (Fig. 2).

The PC is necessary to solve questions involving Java applets and accordingly virtual experiments.

For solving mathematical problems the calculator respectively the sheets of paper can be used. The questions are shown one after another by a video projector on an interactive whiteboard. For each question up to six possible answers were displayed on the screen, each answer having a unique letter corresponding (from a – f). The students make their choice by pressing buttons from a to f. This choice is transmitted by the kits via radio transmission and analyzed automatically by a mobile PC connected to the whiteboard. The time for each question can be controlled manually or by a timer; every question is worth one point. After the exam the results are evaluated automatically and displayed on the server PC. In the end the results can easily be exported into any spreadsheet analysis software. The students mobile PCs are connected to the internet via wireless lan to share the applets etc.

On the software side, a PROMETHEAN [4] built question master with integrated database (to store the designed questions) is used. A distribution into different subtopics is implemented into the program and the handling is quite straightforward. Up to now, the database consists of 120 questions in six subcategories. Our revision of the software only supported single-choice-mode, further revisions may also contain multiple-choice-mode, which is a more powerful tool to check the participants' knowledge.

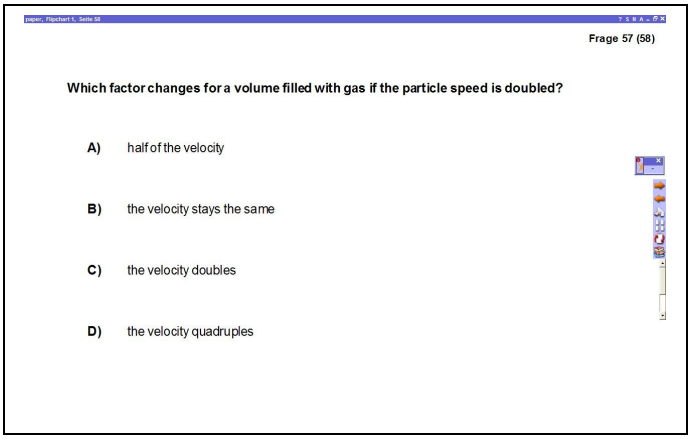

Figure 3. Screenshot of a typical question used during examination

We distinguish four different types of questions:

- The *first* one contains comprehension questions assessing the general physical knowledge of the participants (e.g. questions about physical phenomena, see Fig. 3).
- The *second* type consists of arithmetic problems. These two types are traditional and were also used in previous written and oral exams.
- The *third* type uses multimedia elements like Java-applets or virtual experiments. The participants interact with the applets and have to answer questions about their physics background. Using those types of questions one can better examine the participants' skills than traditional questions can. Virtual experiments like the determination of the angle of total reflectance (cf. Fig. 4) cannot be realized during a traditional exam. With help of virtual experiments it is possible to examine the skill of extracting information from an experiment.

Figure 4. Screenshot of a virtual experiment used during exam, showing critical angle phenomena

- The *fourth* type of questions includes the internet; as mentioned before, their importance has grown tremendously in recent years. To solve these questions, the participants have to search the internet and look for specific information (e.g. the band gap energy of some semiconducting element).

All questions belong to the content used in the lectures and the corresponding book [5].

III. RESULTS

In all tests the participants needed 50% of the obtainable points to pass the exam. One exception concerning this rule was made in an oral review in April 2006: One question was not formulated correctly and therefore taken out of the appraisal. Participants passed this test with five instead of six right answered questions (eleven instead of twelve questions overall).

During the first run in October 2005 four out of nine participants failed the exam (44.4%), which is a typical value for a physics examination. Before the exam the participants were told, that they would have the chance to be examined orally, should they fail the eXam. This had to be done in four cases, and all four failed the oral exam too, verifying the validity of the test. The average percentage was 50% of all obtainable points. The second time all participants passed the exam with an average percentage of 66%. This time the multimedia exam substituted the written exam, which means we did not examine students who failed the written exam before, explaining the better grades. This impression is enhanced by the fact that for all participants this exam was their last chance to pass the course, which implies a better preparation of the students. Furthermore it was again a small group, so the statistics are not very significant. Thanks to the third run we now have more significant statistics concerning the oral review of 25 participants. Seven participants failed the exam (28%), so for all oral reviews we have a failing quota of 32%. The distribution of points is depicted in Figs. 5 and 6. Four of the eight participants passed the exam with five points because of the one invalid question as mentioned above. Overall we get an average of 5.9 points per participant, which indicates that the level of difficulty in the multimedia exam is appropriate.

For the written exam substitute no specific conclusions can be made due to the small number of participants we had up to now. Looking at the existing results we get an average of 16.1 points per participant, which also indicates an appropriate level of the exam. Further examinations are planned, and a comparison between the multimedia examination and an oral examination is scheduled.

IV. Evaluation, Conclusions

After the exam, an anonymous evaluation by the students - accomplished in form of either interviews or questionnaire (free choice) – was performed. In a first category the students were asked to comment on the commonness of using new media. It turns out to be well-established to use the internet for the purpose of studying (85%), and even Java applets are quite common (37.5% of the students mentioned not having used applets). A further category deals with the difficulty of certain types of questions mentioned above. 32.5% of the participants found the examination easier than the written exam, 62.5% said it was equal and 5% found it harder than the written exam. In the students´ perceptions the overall degree of difficulty is thus slightly easier compared to the written exam. One participant mentioned that arithmetic problems and comprehension questions were too easy. 82.5% found the degree of difficulty appropriate.

Concerning the internet research there are different views. About half of the participants did not find the connection between physics and the requirement to use internet research obvious. Thus it appears that accentuating the need for training in new-media skills is at issue now.

A criticism by the students was a lack of a watch showing the remaining time per question. Another remark concerned the display of exponents. Up to now the software is not able to show exponents in the common way [10^(-17) instead of 10^{-17}]. This problem can only be solved with a software update. One participant mentioned the somewhat impersonal character of this type of examination compared to an oral exam. The time the students had to answer the questions were assessed as good, and just two out of 40 participants mentioned problems with handling the hardware.

From the examinees' point of view there were no problems with the hardware, the system was very stable during the examination.

As far as the size of the groups is concerned, we would like to point out that the hardware is designed for up to 64 participants. Our small groups were pilot schemes. We are going to compare the system to others, like completely PC based server-client-solutions, which promise to be useful for larger groups. Nevertheless the system we ran here is very comfortable and fits the use we intended it for.

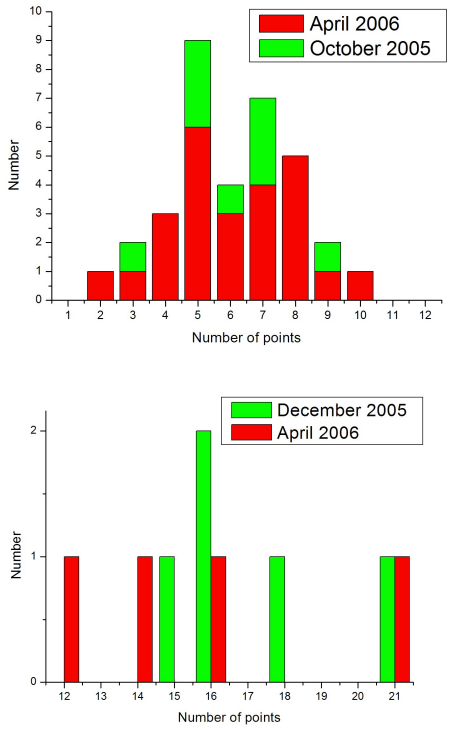

Figure 5 Distribution of points for the oral reviews (upper sketch) and the written exam substitute (lower sketch)

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