A pilot application of electronic examination applied to students of electronic engineering: Preliminary results.

D. TRIANTIS, I. STAVRAKAS, P. TSIAKAS, C. STERGIOPoulos, D. NINOS
Department of Electronics
Technological Educational Institution of Athens
Athens, 122 10, Tel/Fax: +30-210-5316525
GREECE

Abstract: - A new perception in the field of students’ evaluation is of great interest from both educational and pedagogical point of view. Electronic examination method has been applied and evaluated for one of the core modules of the Department of Electronics of the Technological Educational Institution (T.E.I.) of Athens. Fifty percent of the students, who participated in the module’s final test in June 2004, were examined via the electronic examination, whereas the other fifty percent were examined via the conventional method. The examined topics were of equivalent difficulty and the examinees were distributed in a way that the two groups had the same level of knowledge level. The results indicate that the performance of students who participated in the electronic examination (e-examination) was higher than the performance of students who participated in the conventional method of examination.

Key-Words: - e-examination, electronics engineering education, methodologies in examinations.

1 Introduction
Distance learning has became a very popular way of education during the last years. Thus, ordinary educational methods used for lectures and examinations had be adopted to be applicable to the distance learning model. On this concept, new technologies [1,2] have been used in the frame of improving the quality and the efficiency of the provided education. User friendly and polymorphic educational material based on modern technology is a necessary tool in the teacher’s hands, in order to improve students’ performance. Today education is “studentcenteric” and teaching systems are open to students, offering them many ways of acquiring knowledge [3,4]. This leads also to a variety of ways for performing students’ annual reviews [5]. The usefulness of Electronic examination is still under investigation [6,7,8]. Thus, students’ preparation for the e-examination process has to take into consideration a number of parameters such as the level of the examinees and their familiarization with modern technologies. In order to estimate the level of each student, tests take place prior to the final examination. This tactic can ensure that the results of the e-examination process are reliable and comparable [9]. It is also important to examine the impact of e-examination on three groups:

- Students who have been attending all module lectures, but have not studied any other relevant material such as module notes, exercises and the teacher’s lecture presentations.
- Students who have not been attending any module lectures but have studied the educational material provided.
- Students that have both been attending module lectures and studying the relevant material.

For the students to get familiarized with new technologies, a series of self-evaluation tests are available, giving them the opportunity to check their standard of acquired knowledge. Depending on the score they achieve, they receive the proper stimulation for further study.

The above procedures of self-evaluation were implemented for the first time in the context of the core module “Introduction to Electronics” of the Electronic Engineering Department of the Technological Educational Institution (TEI) of Athens for the academic year 2003-2004. A CD-ROM, containing the proper educational material, was distributed to students. This material was used for self-evaluation purposes after the completion of each module unit. Additional preliminary tests were performed in order to estimate each student’s level. This process set the basis for performing an electronic examination at the end of the semester on a sample of approximately 50% of the examinees in June 2004 for the above-mentioned module. The other 50% was examined via the conventional method.
2 The applied method of Electronic Examination

E-examination was applied for the module “Introduction to Electronics”, the outline of which is: Semiconductors, pn junctions and diode circuits, bipolar, field effect transistors and bias circuits. This module, according to the current curriculum, constitutes one of the basics and is taught during the first semester of studies.

During the semester March-June 2004, 89 students participated in three ordinary written multiple-choice tests of 20 minutes each. The score achieved in these tests had no effect to the students’ final grade of the module. Figure 1 shows the score distribution in a grouped scale of grades of the 89 students. The upper part of the bars, marked in grey, shows the number of students that were chosen to be examined via the conventional method. The lower part of the bars, marked in white, shows the number of students that were to be examined via the e-examination method.

In the T.E.I. of Athens, the range of grades used for marking students is 0-10 (decimal) and successful grades are considered those higher than 5. Students belonging to each of these classes, were randomly and equally divided and created two groups. One of the groups was examined electronically and the rest followed the conventional method.

The educational material, available to every student, was polymorphic. It consisted of a book on Electronics [10] and a CD ROM containing:

- Notes of special chapters.
- Theory questions answered or not.
- Answered multiple-choice questions.
- Problems and exercises with exemplary solutions or just hints.
- A series of questions of past examination periods with its solutions
- Self-evaluation test.

Students, selected to participate in the e-examination, had the opportunity of a briefing in order to familiarize themselves with the system interface. This was considered necessary for the participants in order not to be destructed by handling with the system, but only to cope with the examination subjects. Finally, they took a sample test (e-examination) for better familiarization with the whole procedure, which had no effect to the final assessment.

The context of the final e-examination test consisted of four categories of questions:
- True or false.
- Multiple-choice.
- Questions that demanded short calculations. In this case, students should type the answer in the corresponding field.
- Problems or exercises that required multiple steps for their solution. The presentation of such a problem was made with gradual questions of the above three forms that led to the final result.

The examination contained the above categories of questions for all the topics that are described in the module outline.

A classic case study of such an examination is the analysis of an electronic circuit. The student is asked to calculate the electric current that flows in every branch of the circuit and the voltage in different nodes of it.

3 E-examination platform

The system of the e-examination has been designed to offer the participant a user-friendly environment. It provided online help documentation, including general information about the examination procedure (i.e. how a student can logon to the system and navigate through the questions). Students can control remaining time during the examination process through a digital chronometer displayed on the e-examination platform. On the startup interface of the platform the student is informed about the level of difficulty of the examination and the chapters it refers to. In a
smaller scale this also applies to every question separately. The student can see the weight of each question regarding the total score and the chapter it refers to. The number of questions answered and the number of questions remaining unanswered are also displayed continuously during the examination. Finally, the student can check the answers he provided, before submitting the test. The system provides the ability of navigation through the questions forward or backwards. This can be done not only in sequence but also in an arbitrary way. The student can jump to a question by typing its corresponding number in a text box. This enables students to review their answers and alter them at will or to fill in any unanswered questions.

4 The examination process

The e-examination procedure took place in a PC lab equipped with 50 workplaces. All PCs access e-examination platform through a web site (URL). For security reasons, a unique username and a password was assigned to each student just before the initiation of the test. Examination procedure starts concurrently for all students. The end of the examination process is set by the student if this is before the predefined duration of the test which in any case ends examination process. As soon as the examination finishes, the system displays each student’s results. A full report containing information on the time in which the test was completed is also produced and is available to the student. It also includes a list of all the questions ordered by their sequence number with an indication of whether they were answered, which was the student’s answer for each one of them and the correct answer. Finally, on the top of the report, the name of the examinee, the date and time of the test and the total score received, are displayed. There is also a printer friendly edition of this report that can be directly printed by the student.

After the prescribed duration of the test expires, the results are automatically stored in a database of the local server. The collection of the results serves the purpose of further processing by the instructor of the module, or for statistical reasons. The instructor can log-on to the system with extra options i.e. monitoring of the progress. When the examination is finished, the overall view of the results is provided through an administration form that has been created for that purpose. Tests can also be examined separately so as to check analytically all the answers of each student.

5 Results - Discussion

In the whole examination process (electronic and written) conducted in June 2004, 89 students participated. E-examination was applied on 44 of them and the other 45 were examined conventionally. The examination topics in both cases were of the same level of difficulty, they covered the same range of module content and the available time was realistic and adequate.

<table>
<thead>
<tr>
<th>Table 1: The comparative results of students’ performance that participated in both kinds of examination.</th>
</tr>
</thead>
<tbody>
<tr>
<td>e-examination</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>Number of Students</td>
</tr>
<tr>
<td>Succeeded (&gt;5/10)</td>
</tr>
<tr>
<td>% success (&gt;5/10)</td>
</tr>
<tr>
<td>Average score of students who succeeded</td>
</tr>
<tr>
<td>Average score of students who participated</td>
</tr>
<tr>
<td>% Excellent score (&gt;7.5/10)</td>
</tr>
</tbody>
</table>

In table 1 the compared data of the two ways of examination is presented. The overall performance of the students who were assigned to be examined electronically was higher.

In figure 2 the grouped distribution of the grades of students for both ways of examination is shown. The upper part of the bars, marked in grey, shows the grade distribution of the students examined via the conventional method. The lower part of the bars, marked in white, shows the corresponding distribution of students examined via the e-examination method.

The performance of students, electronically examined, indicates that the average score in this case was higher, as well as the percentage of students who succeeded in the test.

This leads to the conclusion that the variety of questions offered by this method helps students to perform better. On the other hand, this method is a more objective way of examination, based on the teacher’s ability to expand in all module subjects covered. Furthermore, according to statements by students who participated in the e-examination, they have studied harder than they would have
done if they were to be examined in the conventional way. They also suggested that this method should be applied in other modules during the next examination period. Generally, most of the students were satisfied with the method, something that is reported in other similar processes [11] as well.

Figure 2: The grouped score distribution of students who participated in both kinds of examination.

Another important outcome of this work is that the instructor of the module can immediately extract statistics like success percentages for every unit taught in the module.

Figure 3 shows these percentages for the current study. In the first unit referring to physics for semiconductors, low success percentage is observed. Accordingly low is the success percentage in the last unit that deals with JFET and MOS transistors and bias circuits.

A first interpretation of the above results is that while the concepts in the unit of physics for semiconductors require more thorough and systematic study, students do not respond to it and they focus their study on the analysis and the design of circuits. Concerning the last unit, the most obvious reason for the low percentage of success is probably that most of the students do not have the time to catch up and complete their study. Another advantage of the system’s design is that it can function as a self-evaluation tool. A student can access the system via the web either from a PC lab located in the campus or from a remote location. Series of questions and questions of past module exams are offered for self-evaluation purposes.

6 Conclusions

A first conclusion is that the students very soon got accustomed to the method of the electronic examination. This is confirmed by the smooth course of the procedure in the PC lab. Therefore this method proved to be simple, easy to use and friendly.

The statistics, concerning the grades, clearly indicate that students who participated in e-examination performed better. The familiarization of the examinees with the new technologies and the informatics make the way of the electronic examination quicker and more functional. Time consuming procedures such as the duplication of exam papers and their correction by the teacher can be avoided, and students can have their results on the spot.

An important parameter, concerning the teacher is that he has the whole image of the students’ progress and performance. The system, by storing user information, can give a variety of statistics either for the class as a whole or for each student individually. The teacher can have statistics even for every single question of the examination, something that is extremely difficult and time consuming to be accomplished via the conventional method.

By considering the final results and the statistics, the teacher can check the percentage of success after the completion of an examination. In this way any failure on behalf of the students, concerning the
understanding of some module points can be spotted. Thus, extra care can be taken during the following semester, for further illustrating the lecture points which the students failed to fully comprehend. Conclusively, every innovation, in the field of education attracts the students’ interest. This results to the accomplishment of higher percentage of knowledge assimilation and better efficiency during the educational process.

Acknowledgments: - Authors would like to thank Mrs. I. Leraki for her contribution to the e-examination procedure. This work has been funded by the EU Operational Programme of Education and Initial Vocational Training.

References: