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Improved Learning Methodology System

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Abstract: Education is one of the systems that have been always upgrading. During past years the teaching process has been always modified and upgraded in order to enable more efficient learning. The use of new ICT technologies enables innovative ideas to make the learning process more efficient. The students gain with better skills and obtained knowledge by these innovations.

We established an e-learning system that supports the education process. This system offers not just content available on-line by using web technologies, but also a wide variety of simulators, animations and films as multimedia approach to the system. In addition to this system we use a system of interactive quizzes and questionnaires as part of the self testing tool that help students understand basic concepts and acquire skills. The system of e-testing helps the professor to assess the knowledge and grade the students. The on-line learning tool is the interactive system that supports the homework assignment and grading tool and helps both the students to learn and the professors to check the knowledge obtained.

In this paper we report the results from using these innovations as improved learning methodology, and how it affects the level and degree of obtained knowledge and skills, students' interest and average score in total knowledge.

We present indicators to measure the results gained by introducing new methodology. These indicators concern quantity and quality measures, obtained by analyzing the pass rate and average scores in the class.

Keywords: E-learning, E-testing, on-line learning, knowledge assessment.

1 Introduction

The instructivism principle is used usually in university and high educational systems as conventional method of teaching. At our institution the lecturing is mainly realized with huge classes that have more then 150 students [1]. There are a lot of

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problems associated with big classes, like no personal contact with the students, no possibility for student's active participation during lectures, no possibility for interactive communication, no efficient way to setup different assignments and projects and check students knowledge. Solution to these problems is usually solved by several teaching assistants, which involves different criteria and similar problems.

2 Methodology

A possible solution to analyzed problems is offered by the usage of challenges of the new emerging ICT technologies. A new e-learning platform is established as complementary process to teaching. We use not only as support to learning, but also as support to the teaching process.

The system is efficiently used in the realization of homework assignments and projects. The new e-testing system enabled a lot of benefits to realize assessment of obtained knowledge each week during the course and enabled conditions for continuous grading and assessment.

The innovations in usage of new ICT technology required a lot of e-Learning content to be available on web. Afterwards it also required development of new tools that support management and administration of users, privileges, access rights, but also a development of new system for realization of quizzes and questionnaires, and interactive communication with students for homework assignment and knowledge assessment. To realize the new technology challenges we had to change the conventional grading and evaluation system and establish new paradigms [2]. These systems are efficiently used for evaluation of students' participation during the complete semester and objective evaluation of obtained knowledge and skills.

These innovations were implemented for several courses and in this article we measure the performance of the following: Computer Architecture, Advanced Computer Architecture, Microprocessors and microcontrollers and Internet programming [3], [4].

3 Evaluation System

The evaluation system was build to enable the following aims: to measure students' participation and assess obtained knowledge and skills. It should enable a new approach in the learning process and motivate the students (1) for studying through the whole year, (2) for active participation and (3) for finalizing the course at the end of the semester. All these problems were the main reason for bad scores and delayed finalization of the courses.

The continuous grading system helps the professor to check the student's ability

of absorbing learning objectives. The feedback part of this system is the student's awareness of his/her weaknesses and knowledge gaps (if any). This system helps the student learn the required course background on time and gain the required skills. It also tracks the student activities and makes easier finishing the obligatory homework and seminar projects on time.

The evaluation system is based 1/3 on coursework and 2/3 on midterm and final exams. The detailed structure is presented on Table 1. Completed homework and the seminar project are obligatory for the course. The homework assignments and projects must be completed in a given time deadline. Late homework submission may be accepted after the deadline only once gaining only half of the proposed credits. Therefore this system motivates the students to do their homework on time enabling the teaching staff to coordinate appropriately for evaluation of the homework.

Table 1. Evaluation system

Assignment	*Credits*	*%*
Homework	50	16.7%
Project 1	20	6.7%
Project 2	30	10.0%
Midterm Exam	100	33.3%
Final Exam	100	33.3%
Total credits	300	*100.0%*

Table 2. Grading system.

Credits	*%*	*Grade*
271 - 300	$>$ 90 %	10
241 - 270	80% - 90%	9
211 - 240	70% - 80%	8
181 - 210	60% - 70%	7
151 - 180	50% - 60%	6
0 - 150	$<$50%	FAILED

Instead of realization of ordinary homework assignments, we use the on-line learning tool described in [5]. It enables the students to evaluate their knowledge using Internet access either at the faculty or in home environment. The seminar projects present practical skills obtained by the knowledge gained in classes. The seminar projects are evaluated in the same way as the homework.

Each student can achieve a maximum of 300 credits. The grading system is presented on Table 2. The student can pass the course only if he achieves more than 50% the credits. Midterm and final exams (first and second colloquiums) test the students' knowledge, by two different ways as two sets of questions which include: (1) theoretical part, performed on the online learning system and (2) practical exercises, as written part of the exam. At least 30% of the midterm and final exams are required for the student to pass. In order to pass with the lowest grade the student must complete the homework and pass both colloquiums, i.e. midterm and final tests. The student can get the highest grade only if he/she completes both the homework and the projects and achieves outstanding results on both colloquiums. Those that fail have a chance to take an exam at the end of the semester provided that they have submitted the homework assignments and projects.

The automated electronic testing system includes concepts of random question

generation and random position of available option answers. This type of computer-based testing has property to mislead the student of learning position numbers of possible answers for a given question. Thus, instead of memorization of the questions and line numbers of the offered answer options, the students were forced to learn the relations between questions and answers, i.e. the concepts and other knowledge skills.

The assessment measures specific knowledge skill in given time constraint. Negative grading for wrong answers is used as a system of punishment. This is a discipline measure to prevent from cheating and guessing possible answer where the student can win a positive assessment based on lottery or good luck. That's why the student is motivated to click only on answer options he/she is very sure that they represent the right answer instead of guessing. He/she usually avoids clicking if he is not sure about the answer since he will score negative points. This is another motivation for students to learn real concepts and relations.

4 Achieved Results for Computer Architecture Course

The basic Computer Architecture course is placed in the second semester of Informatics studies at University of Cyril and Methodius, Faculty of Science and Mathematics, Institute of Informatics [1] in Skopje, Macedonia. During the last several years the course has been reorganized to meet the challenges and needs of modern teaching and grading. The course information and statistics are accessible over the Internet on [3].

In this course we implemented on-line accessible e-Learning course material, covering all lectures and tutorials. All lecture slides, textbook and supporting materials, like animations and films were set on web. In addition to this, we created a lot of simulators that helped students understand concepts. These simulators had either web interface and run on our engines or were small programs easy for download and usage on personal computers. For first time we invented VHDL and used simulators in logic design.

Two projects were assigned, the first requiring programming tasks with implementation of computer arithmetic and the second with VHDL design of simple logic circuits. We were very glad to realize a great students' interest in the second project introduced with simple logic design and VHDL. The students were happy and found a lot of fun realizing the project.

The homework assignments were realized by the on-line testing tool. A set of 1850 questions formed the question database.

Table 3 presents the pass rate of the students in June sessions. In academic 2001/2002 year we used conventional teaching system. There were 180 full time

students graded by the traditional system with written and oral exams. Only 43 students completed the exam successfully in the first exam session in June 2002. The next academic year the results improved to 84 students finished in June session out of 195 that enrolled. In the third analyzed academic 2003/2004 year there were 169 enrolled students and 80 of them passed. This situation is presented on Figure 1.

Table 3. Pass rate for Computer Architecture course in june sessions

academic year	*enrolled*	*passed*	*%*
2001/2002	180	43	23.9%
2002/2003	195	84	43,1%
2003/2004	169	80	47,3%

The quantity of students that passed the exam was increased from 23.9% to 43.1% and reached 47.3% in final year as shown on Figure 2. The rest of the students took the exam in some later examination sessions. These numbers show great improvement analyzing that it the pass rate reaches the rate of students that actually continues studying.

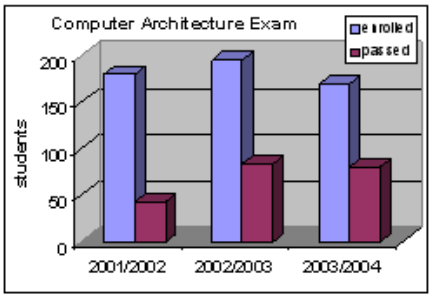

Fig. 1. Exam Statistics in June Sessions for Computer Architecture

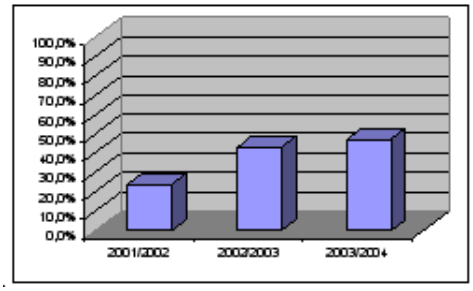

Fig. 2. Comparison of pass rate for Computer Architecture course

In previous years the students used to pass the exam in later sessions and not in the first (normal) June exam session. By inventing the new learning method the students were motivated to pass the exam with continuous learning and use the benefits of the new grading system. This is not due to lowering the quality of the course materials, but due to the new methodology and motivation to keep tense on the students to finish their obligations on time. Actually this is the greatest achievement by invention of the new methodology in learning.

Not only the quantity indicators were improved, but also the quality indicators show this tendency. The course statistics are presented in 4. The course average was 63% for June sessions in academic year 2002/2003 and improved to 71.3% one

year later. These averages are higher then averages obtained by first year students' grades.

One very obvious fact is that there was a high interest to complete the homework and the seminar projects in time, since the students completed approximately 67.8% of the homework assignments and 94% of the seminar projects. About 29% of the students did not finish the obligatory homework and were not allowed for exam. Additional 16.9% of the students did not finish at least one project. Averages obtained on midterm and final exams are 54.2% for academic year 2002/2003 and 68.1% in academic year 2003/2004.

Averages on homework assignments and projects show slight negligible changes. However the highest improvement is in averages of midterm and final exams.

Table 4. Average credits gained per assignment for Computer Architecture course.

Type of assignment	2002/2003	2003/2004
Homework (maximum 5×10)	33,9	34,9
Project 1 (maximum 20)	18,2	15,7
Project 2 (maximum 30)	28,7	27,0
Midterm and final (maximum 2×100)	108,3	136,2
Course average (maximum 300)	**189,1**	**213,8**
Course average (%)	**63,0%**	**71,3%**

5 Achieved Results for Advanced Computer Architecture Course

Advanced Computer architecture course started in academic 2002/2003 year. The course statistics are presented in [4] along with definition of projects and curricula.

Similar issues about advanced computer systems existed in the old curriculum in the course with the title "Microprocessors and microcomputers". It covered ILP concepts and topics but lacked VLIW organization and compiler techniques. All the students had to make only one project given at the end of the course, without time limit. However, there were no deadlines, so it took the students almost a year to complete the project, i.e. they finished the project before taking the exam. This was the reason to set a real deadline for the project. This resulted in extremely low interest in passing the course through active participation and colloquiums, i.e. midterm and final tests.

The statistics about pass rate is shown on Table 5 and Figure 3. We can observe that after introducing the new methodology the number of students that have successfully passed in June sessions is increasing and approaching 100%.

One very obvious fact is that there was an extremely high interest to complete homework assignments and projects on time. The students complain to the timing

Table 5. Pass rate for Advanced Computer Systems course in june sessions.

academic year	*enrolled*	*passed*	*%*
2001/2002	42	24	57.1%
2002/2003	51	39	76.5%
2003/2004	66	63	95.5%

requirements, they had more time to complete the first project then the second, which resulted in approx 90% for the first project and 84% for the second project. The quality indicators of colloquia, i.e. midterm and final exam tests show a good performance of 75.5%. All relevant data is shown on 6. Course average of 81% is more then typical achievement of students, representing a good knowledge and obtained skills for the course.

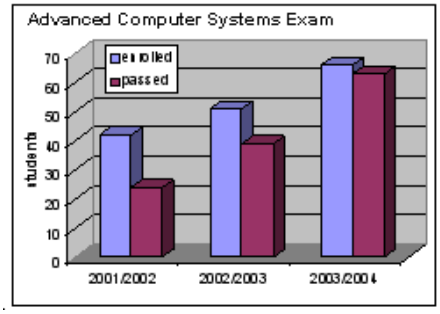

Fig. 3. Exam statistics in june sessions for advanced computer systems course.

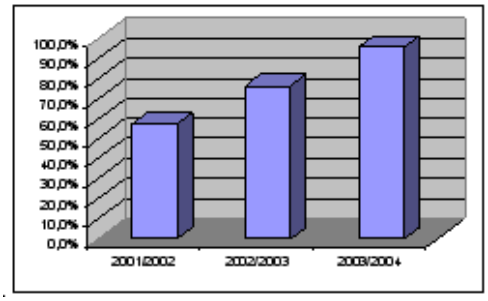

Fig. 4. Comparison of pass rate for advanced computer systems course.

Only 29% and 37% of the students passed the course through colloquiums in the academic years 2001/2002 and 2002/2003 correspondingly. However, since there was no deadline on the seminar project it took some of the students almost a year after the end of the semester to complete the course. The other reason for such late submission of the seminar project is that it had little influence on the grading (only half grade up or down). There was no grading scale of the seminar projects given to the students in advance.

Six months after the end of the semester in the academic year 2002/2003, only 10 students had finished their seminar work. Their average course grade was 8.4. Under similar circumstances in the academic 2001/2002 year only 12 students finished the course with average grade of 8.4. This comparison is presented on Figure 2.

There is no significant difference in the average grade of the courses: (1) 8.7 for “Advanced Computer Systems” and (2) 8.4 for the old “Microprocessors and microcomputers” course. However, there is significant improvement of the throughput

Table 6. Average credits gained per assignment for advanced computer systems course.

Type of assignment	2002/2003	2003/2004
Homework (maximum 5 × 10)	46,7	49,2
Project 1 (maximum 20)	18,8	17,5
Project 2 (maximum 30)	24,4	25,2
Midterm and final (maximum 2 × 100)	150,2	151,0
Course average (maximum 300)	**240,1**	**242,9**
Course average (%)	**80,0**	**81,4**

of students that finish the course by the end of the semester. This is obvious if we compare the results as presented on Figure 4.

6 Achieved Results for Internet programming Course

The Internet Programming course is placed in the fifth semester of Informatics studies at University of Cyril and Methodius, Faculty of Science and Mathematics, Institute of Informatics [1] in Skopje, Macedonia. This course started in 2002/2003 and it was offered to two generations, so the number of students that attended the course was a lot more then the following 2003/2004 year.

In this course we implemented on-line accessible e-Learning course material, covering all lectures and tutorials. All lecture slides, textbook and supporting materials, like animations and films were set on web. In addition to this, we set a lot of exercise that helped students practice skills.

The homework assignments were realized by the on-line testing tool. A set of 1403 questions formed the question database.

Table 7 presents the pass rate of the students in June sessions. The pass rate was increased and in both cases s very high, meaning that the students were highly motivated to finish the course on time and that the system offered them a goof learning and motivation platform. This is also presented on Figure 5.

Table 7. Pass rate for internet programming course in june sessions.

academic year	enrolled	passed	%
2002/2003	142	129	90,8%
2003/2004	46	46	100,0%

The quantity of students that passed the exam was increased from 23.9% to 43.1% and reached 47.3% in final year. The rest of the students took the exam in some later examination sessions. These numbers show great improvement analyzing that it the pass rate reaches the rate of students that actually continues studying.

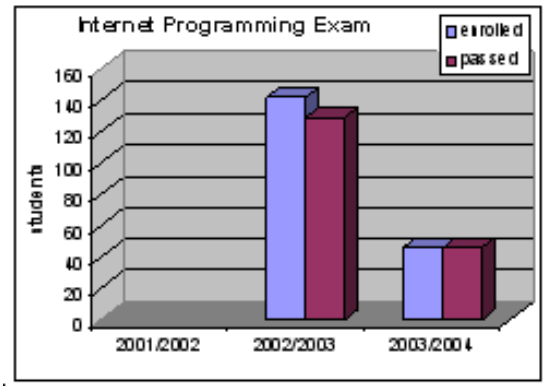

Fig. 5. Exam statistics in june sessions for Internet programming course.

Not only the quantity indicators were improved, but also the quality indicators show this tendency. The course statistics are presented in Table 8. The course average was 82,9% for June sessions in academic year 2002/2003 and improved to 88,6% one year later. These averages are higher then averages obtained by usual students' grades.

Table 8. Average credits gained per assignment for internet programming course.

Type of assignment	2002/2003	2003/2004
Homework (maximum 5×10)	45.0	48.8
Project 1 (maximum 20)	19,0	18,8
Project 2 (maximum 30)	25,7	27,9
Midterm and final (maximum 2×100)	159,0	170,3
Course average (maximum 300)	**248,7**	**265,8**
Course average (%)	**82,9%**	**88,6%**

One very obvious fact is that there was a high interest to complete the homework and the seminar projects in time, since all the students completed assignments.

7 Conclusion

Better education is not gained only by improving the curricula only. Usually better quality means improvement of teaching process and establishing new environments for better education. This means usage of new ICT technologies, but also a great move towards establishing content for learning materials, creation of simulators that improve skills and creation of knowledge concepts. The grading system must

also be reviewed and upgraded in order to facilitate new methods and continuous learning.

We used quantity criteria based on pass rate to measure and compare conventional system and new methodology. The quality indicator is the average obtained in the first exam (June) session for the course. By analyzing these criteria we obtained higher averages of grades and higher pass rates of the course.

The students accepted the new way of teaching and grading better than expected, which resulted in 38% more students passing an advanced computer systems course with more requirements than before and with comparable average mark.

In the advanced computer systems course we introduced a lot of innovation in homework assignments and projects realized with ILP simulators as tool to obtain knowledge and specially to make further research on ILP processor behavior [6]. These tools helped them not just understand main concepts and topics, but deeply get into computer architecture and analyze reasons for deadlocks and stalls due to data dependencies in conditions of high parallelism on instruction level.

The methodology described in this paper aims to motivate the students to study through the whole year, with active class participation. These innovations motivated new curricula in current courses. Introducing indicators for development we can observer that students benefit with more knowledge and skills obtained.

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