ENHANCING STUDYING MATHEMATICS AT FACULTY OF INFORMATION TECHNOLOGIES (FIT), MOSTAR

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ABSTRACT

This paper presents the effects of curriculum changes for course on Mathematics at Faculty of Information Technologies, University "Dzemal Bijedic", Mostar, BIH. Changes were introduced during Fall Semester 2006/7. They are aiming to improve knowledge deliverance and examination process. Effect of changes was measured by comparing actual results with the results of students from previous generations. The results of the study show significant positive effect of the change in examinations (effect size 2.1789), and of overall curriculum changes (effect size 1.1771) justifying the proposed changes.

Keywords: Mathematics, Curriculum improvements, Examinations, Results of changes Effect size

INTRODUCTION

Students traditionally find Mathematics very difficult. These difficulties lead to low motivation to learn mathematics and are often the reason for students to give up studying.

Striving to solve the problem, Faculty of Information Technologies (FIT) of University "Dzemal Bijedic" in Mostar turned to European models and developed new curriculum through Tempus projects, according to Bologna process [1]. Curriculum was developed under the supervision of mathematics department of University of Lleida, Spain, through Tempus project. It meets the standards for faculties of information technologies. The need for foreign help had arisen from the climate of reluctance to changes.

At FIT, we analyzed the problem and decided to act in three directions: to adapt course content, to change knowledge delivery and the examination method.

In order to measure changes' effect, we started a research project to monitor it in three-year period. This project gives answers to several questions:

1. Does the new curriculum meet students' needs? Will the new curriculum improve students' understanding of other subjects, such as statistics, computer networks, software engineering etc?
2. Is the examination process satisfactory for verifying that students gained knowledge of mathematics?
3. Is it more student-friendly [2]?

This project has several phases. The first phase answers the question In this paper, we will focus on answers to the following two questions, as a result of the first phase of the project:

Have we managed to improve the examination process, providing we have the same quality of students passing the exam?

Is there positive effect of overall curriculum changes?

To do this, we accessed data from our Faculty's database (DLWMS), and compared results for previous examination method with those for the newly changed one.

Recognized problems

The problems concerning previous curriculum are the following:

- Mathematics was a two-semester course with 180 hours, predominantly devoted to calculus. One third of the total hours were devoted solely to presentation of theory. This resulted in long and complicated course for students, which became inefficient.
- Knowledge delivery was frontal.
- Students had to pass an eliminatory written test (solving selected mathematical problems), followed by oral exam (students' knowledge of mathematical theory).
- Examination process did not support continuous learning and examinations.

There is one special group of students at FIT: distance-learning students [3]. They represent the majority at FIT, and all teaching staff have to develop e-learning materials, sufficient for successful completion of the course.

- Students rated e-learning materials for mathematical theory among the worse.

- There is a group of students, enrolled before 2006/7, which have not passed the exam.

Changes

We can divide changes in two groups: curriculum changes, concerning course content reduction, methodology of teaching process and examinations, and changes only in examination process.

For course on calculus, now there are 120 hours. The remaining 60 hours are devoted to discrete mathematics (including algebraic structures).

Course content reduction concerning calculus was necessary for achieving recommended international standards for engineering faculties [4]. Theory is delivered in 30 hours (instead of 60), including only necessary concepts and methods. Rather than proving theorems, rules are explained as problem-solving tools. The list of mathematical methods that students have to learn is reduced.

Mathematical problems are methodologically selected, from easier to more complex ones, aiming to develop capabilities for solving problems rather than to force students to memorize as many of them as possible [4].

We developed e-learning materials for the course, with a great number of solved mathematical problems.

Knowledge delivery includes in-class frontal lectures, group and individual exercises and homework There are additional group exercises (at least 30 in-class hours and 15 online) for all students

There is no oral examination; there is only a written test. To show that they have enough knowledge of mathematical concepts, students now have to write down rules they are using while solving the proposed problems and the quality of explanations is included in the score.

In support of continuous learning, we introduced continuous examinations. There are two partial exams, in the form of written tests, per semester. Students who fail them, have a chance to take exam in the regular term, also in form of written test.

The additional informal way of knowledge verification is homework (once per week, weekly checked). Students who complete all of them in due time have 10% extra bonus included into the final score. Homework is a part of pilot experiment, that has to approve (or disapprove) the new examination approach.

To avoid component of subjective selection we turned to random selection of problems for the written test. For that, we use DLWMS test module. In that module, there are now around 200 mathematical problems divided into sections, and for each examination, we select equal number of them. Some sections are obligatory for each exam (problems are randomly selected), while others we chose on random. All of the proposed problems come from obligatory literature.

Students are strongly recommended to use mathematical software (i.e. Maxima) to help them exercise and to meet their needs to deepen knowledge beyond the proposed curriculum [5]. Basics Maxima manual is a part of e-learning materials, but there is no examination of their skills.
For students from enrolled before 2006/7 that have not passed the exam till the end of 2005/6 academic year, there are modified examinations. They have to pass written test, including theoretical questions from the list of obligatory items (instead of oral examinations). Problems and questions are randomly selected.

Effect measuring

The effect of changes both for the previous generations compared to freshmen knowledge is measured.

Therefore, we are measuring the following effects:

- The effect of changes in the examination process (students enrolled before 2006/7 written test with theoretical questions included compared to students enrolled before 2006/7 that passed the written test + oral examinations);
- The effect of overall curriculum changes (reduction of number of hours, the new approach to teaching theory together with introduction of written test as the only examination method).

Purpose of the study

The purpose of this research is to quantify the effect of changes we introduced at FIT. In this first phase, we answer the following questions:

Will modified examination method result in higher number of students passing the exam?

Will overall curriculum changes introduced in Fall Semester 2006/7 result in higher number of students passing the exam?

METHODS

This study has been carried out at FIT, Mostar, during the 2006/7 Fall Semester (examination period included). The students attended lectures and took exams after the newly changed curriculum, predominantly calculus with reduced course content. Students from previous generations had to complete thematically the same course in two semesters.

Subjects

We measure the effect of changes on three separate groups of FIT students:

- G1: Students who successfully passed the exam on mathematics before 1.10.2006 (total of 1638 students enrolled at FIT since 1999/0, total of 345 passed the exam). Those students had to pass the oral examinations.
- G2: Students that passed the exam after 1.10.2006 (enrolled before 2006/7, total of 62 students passed the exam in three examination terms). Modified examinations: have to pass written test; instead of oral examination, they have to answer one theoretical question from the list of obligatory items.
- G3: Students attending the course according the new curriculum (255 students enrolled at FIT in 2006/7, 42 passed both of the partial exams).

From one of our previous studies, we concluded that there is no need to stratify sample into DL and in-class students [6].

Data preparation

We accessed data from our Faculty's database (DLWMS), and exported them to MS Excel. For each student we have his unique ID number, academic year when they enrolled at FIT, score if they passed the exam, date of the score, indicator for type of studying (DL or in-class). We than had to calculate the distance between the ending of lectures and the date student passed the exam (in further text the distance). That variable is essential for measuring the difficulties students have in successful completion of course on mathematics. We also derived an indicator based on the score date to distinguish students from G1 and G2. After cleansing the missing data and those students that already passed mathematics before they enrolled at FIT, we started our data analysis.

Data analysis

All the statistical analysis was performed in MS Excel [6]. We first wanted to have better insight into our data and therefore employed descriptive statistics for both the distance and the student’s score. We also searched for correlations, among enrolment year and the distance, the distance and type of studying, and the distance and student’s score. The next step was grouping data and determining frequencies, which are numbers of students passing the exam with regard to the distance. At the end, we had enough summaries to calculate the effect size and odds ratios.

RESULTS

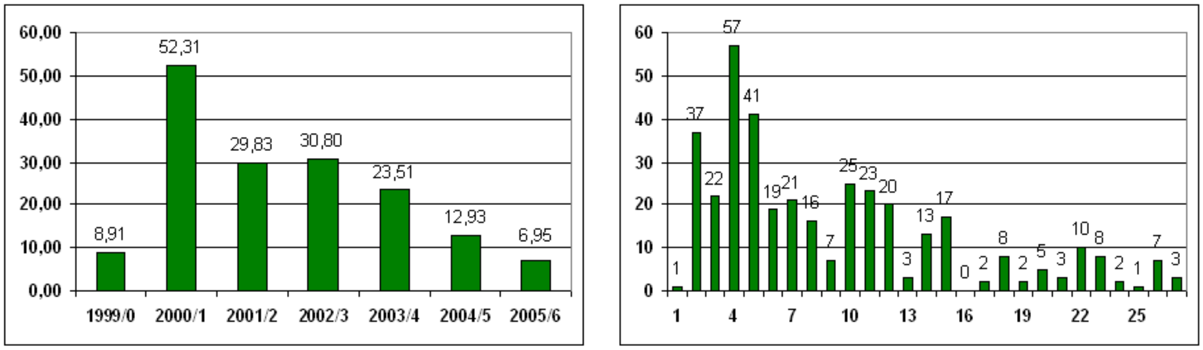
The first part of analysis is only for the G1 students. The descriptive analysis for the distance resulted in mean 1.7187, with standard deviation 0.9091. The distance of 1.7187 corresponds to the fact that it took a whole year for an average student to pass the exam, after the ending of lectures. For student’s score we obtained mean 6.7306 with standard deviation 1.0090. We obtained the following correlations: between enrolment year and the distance, -0.0260, between the distance and type of studying, -0.0236, and between the distance and student’s score, -0.1791.

Average number of students per examination term is as following:

- For G1 students, mean 7.8775, standard deviation 6.9691;
- For G2 students, mean 20.6667, standard deviation 4.5092;
- For G3 students, mean 21, standard deviation 14.1421.

The results for frequency analysis for G1 students are presented in Figure 1. For G2 students the frequencies are the following: 3 students from 2002/3, 14 students from 2003/4, 15 students from 2004/5, 30 students from 2005/6 have passed the exam since 1.10.2006.

Figure 1: Frequency analysis for G1; percentage of students who passed mathematics by year of enrolment (left), and number of students who passed mathematics by examination term expressed as the distance (right).



We obtained the following values for odds ratio:

- G2 vs. G3 for average number of students passing the exam per examination term: 2.7081
- G1 vs. G3 for average number of students passing the exam in first two examination terms: 1.4954
- G1+G2 vs. G3 for average student's score: 0.9982

To measure effect size, we calculated Cohen's d and obtained:

- The effect due solely to change in examinations, d=2.1789 (G2 vs. G3);
- The overall curriculum changes, d=1.1771 (G1 vs. G3).

DISCUSSION

Preliminary analysis concerned G1 students, and served as basis for further comparison. The result for the distance mean corresponding to the fact that it took a year for the average student to pass the exam, verifies the need for changes. Relatively small standard deviation also favors the assumption that mathematics is very difficult to pass. The mean obtained for student's score is rather low, and favors previous findings.

More unusual are correlations we obtained. As expected, all students are equally unsuccessful, regardless the enrolment year or type of studying [3]. The result that student's score is not significantly correlated to the number of unsuccessful trials is unexpected. That result favors the idea that oral examinations might be biased.

From the insight into average number of students per examination term, we can conclude that oral examinations indeed were the problem for students. Comparing the average of 7.88 for G1 with 20.67 for G2, clearly confirms that written examinations are more student-friendly. We can also see that the trend tends to continue even for G3 students, even though there is considerably large standard deviation. In our opinion that deviation comes from small size of the sample, but it can also represent the pilot study uncertainty.

The results for frequency analysis for G1 students presented in Figure 1, give the overall impression of mathematics as one of the main problems for students.

Odds ratio for average student's score close to one means that students generally have no motivation to score higher, which is probably a consequence of mathematics' bad reputation. For the effect of oral examination's exclusion, we can say that odds for students with no oral examinations increased 2.71 times. From comparison of students from G3 with G1, it is clear that overall curriculum changes increased odds for students to pass the exam 1.49 times.

Finally, the overall effect size also confirms the previous findings. The effect of oral examination's exclusion is very large, and we accept H1. The effect size of overall curriculum changes is smaller, but still significantly large, so we also accept H2.

CONCLUSION

The results of this study verify both of the hypotheses we tested. Therefore, they justify the proposed mathematics curriculum changes.

It turned out that exclusion of oral examination is a significant part of the changes. The other improvements were due to restriction and methodological selection of methods, partial written examinations, problems proposed for homework, free additional instructions, and the improvement of e- learning materials. The newly developed e-learning materials are sufficient for successful completion of the course. We also strongly believe that homework and instructions were very helpful to students.

The only thing we recognized as a problem, but were unable to treat is motivation. Students are still reluctant to learn mathematics, let alone to strive for higher scores. Our hope is that motivation will rise due to the changes we presented in this paper.

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