THE RELATIONSHIP BETWEEN THE SUCCESS OF STUDENT IN CALCULUS COURSE AND MATHEMATICS EDUCATION OF HIGH SCHOOL

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Abstract

This study aims at exploring whether there is a relationship between the success of students taking Calculus Course given in Science and Engineering Faculties at Turkish universities and the mathematics education these students receive in Turkish high schools. The data for this study was collected through questionnaires administered to 245 freshman students of the Faculty of Science and the Faculty of Engineering at Anadolu University. The statistical analysis of the data obtained from this questionnaire revealed a significant relationship between the success of students and the mathematics education these students receive in Turkish high schools.

Sommario

L'obiettivo di questo studio cerca di esplorare l'esistenza di una relazione tra il successo degli studenti che frequentano un Corso di Analisi Matematica nelle Facoltà di Scienze ed Ingegneria nelle università turche e l'istruzione matematica che questi studenti ricevono nelle scuole secondarie superiori turche. l dati per questo studio sono stati raccolti attraverso questionari somministrati a 245 studenti universitari della Facoltà di Scienze e della Facoltà di Ingegneria all'Università di Anadolu. L'analisi statistica dei dati ottenuta da questo questionario ha rilevato una relazione significativa tra il successo degli studenti e l'istruzione matematica che questi studenti ricevono nelle scuole secondarie turche.

Key words: Calculus, Mathematics Education of High School, Success of Students.

1. INTRODUCTION

Many universities in Turkey and in the world have Calculus course in their programs, even for the social sciences-based departments. The aim of this course is to provide students with mathematical thinking skills and to teach them some basic mathematical terms and concepts to be used in departmental courses in the following years. However, desired success level cannot be achieved in this course in almost all universities, which is a problem observed for a long time in higher education. This failure is more important if the students are attending a department of Science or Engineering Faculties. Since this problem is observed in all over the world, there are many studies conducted on this issue (Ferini-Mundy & Graham, 1994; Gray & Tall, 1992; Selden et.all., 1989) and are still being conducted. The first step to find an effective solution to this problem is to identify the underlying reasons correctly. Among the possible reasons of this problem are the mathematics education the students receive in previous educational

institutions before they take this course at universities, teaching methods and the qualifications of instructors, gender of the students, and finally the coursebooks used. There are many studies conducted on these variables. For example, Meece, in one of his studies, states that failure and success of a student in mathematics cannot be accounted for only by a single variable such as gender (Meece 1996). In fact, there are some studies which reveal that there is not a significant difference between girls and boys in terms of success in mathematics (Hall et.all., 1999). Some similar studies also show that students' attitudes towards mathematics play an important role in success in mathematics (Hare, 1999; Mpntgomery, 1987; Papanastasiou, 2002).

The goal a high school student in Turkey is to have a job after taking a university education. One of the requirements to achieve this goal is to enter ÖSS (Student Selection Examination) and to obtain a certain score in this exam so as to obtain the right to attend to a department he aspires. This placement exam has mainly three types of scores; namely qualitative, verbal and equal weight, where mathematics questions influence all these three groups of scores. Recent ÖSS exams include mathematics questions based on the topics covered throughout primary, secondary education and in the first year of high school education. Although this application is based on logical reasons, it has had deep effects on high school education. These effects can be listed as follows:

i) Since no questions are asked from the topics included in the syllabi of second and third years of high school education, these topics are not given importance by high school students, teachers working in high schools and private courses. For instance, although the topics such as limit, continuity, derivation and integral are included in the syllabi, they are not covered in the lesson or covered very superficially in Turkish high schools. These terms and concepts are the basic components of Calculus course, which is a main course for the curricula of Science and Engineering Faculties. Not being able to develop background for these terms affects the success of students taking Calculus course at the university to a great extent.

ii) The aim of ÖSS is to select students who are more likely to be successful than others and to place them in certain programs at universities (ÖSYM) (The Student Selection and Placement Center). The fact that approximately 1.5 million students take this exam makes it compulsory to administer this test in a multiple choice format. Therefore; the main goal of students has been to develop a skill to answer the questions quickly rather than to learn mathematics. As a result, teachers teaching second and third year high school students and teachers working for private courses have focused more on solving multiple choice test questions in their classes. Unfortunately, some important components of mathematics such as learning some definitions, thinking over and proving theorems as well dealing with questions requiring complicated computations have been totally ignored. Instead, students prepare for this exam by solving thousands of multiple choice test questions.

Based on this assumption, the problem of this study is to investigate whether there is a relationship between the success of students taking Calculus Course given in

Science and Engineering Faculties at Turkish universities and the current mathematics education system in Turkish high schools.

2. PURPOSE OF THE STUDY

The aim of this study is to find out whether there is a relationship between the success of students taking Calculus Course given in Science and Engineering Faculties at Turkish universities and the mathematics education these students receive in Turkish high schools.

Therefore, the relationship of students' success in Calculus course with the following variables was investigated:

- The teaching method used by the teachers
    - Whether the following terms and concepts were taught in high schools or not; limit, continuity and derivations
- The types of mathematics examinations administered in high schools

3. METHODOLOGY

The part gives information about subjects, data collection instruments and methods as well as the data analysis methods.

The subjects of the study are 245 first year students of Science and Engineering Faculties at Anadolu University during the 2004-2005 academic year.

For the purposes of this study, a questionnaire was prepared by the researchers in order to gather data about the mathematics education the students had received in high schools. The educational background of students who the questionnaire was applied was three years' secondary education and three years' high school education. However; more than half of these students had four years education since they had one year English preparatory education in special-category high schools. Frequencies and percentages were calculated from the data and χ^2 test was applied and the results were interpreted accordingly.

4. FINDINGS

This part presents the findings obtained from the statistical analysis of the data gathered through the administration of the questionnaire to the students attending Science and Engineering Faculties at Anadolu University. The students were classified into two groups- successful and unsuccessful- based on the grades they received from two midterms and one final exam for the Calculus I course. The ones who got less than CC grade were considered unsuccessful and CC and over as successful. The reason for using this criterion is the credit system used at Anadolu University. According to this system, CGPA (cumulative grade point average) of a student should be at least two (2) to obtain the right to graduate and the coefficient of the grade CC is 2.

The data regarding the methods used while teaching mathematics in high school and the students' success in Calculus course are given in Table 1. The methods used are as follows:

    A: A brief explanation was given about the topic and a few sample questions were solved

B: A brief explanation was given about the topic and a lot of sample questions were solved

C: Detailed information was given about the topic and a few sample questions were solved

D: Detailed information was given about the topic and a lot of sample questions were solved

Table 1: The methods used while teaching mathematics in high school and the students' success in Calculus course

Methods Used	Successful		Unsuccessful		Total
	The number of Students	%	The number of Students	%	
A	16	37	27	63	43
B	20	45	24	55	44
C	30	37	51	63	81
D	49	64	28	36	77

$$\chi^2_{Hes.} = 13.45 \; ; \qquad \chi^2_{Tab.} = 7.815$$

According to the data in Table 1, it is clear that students who are taught with a method in which the topic is explained in detail and a lot questions are solved are found to be more successful in Calculus course. On the other hand, when the students are not explained the topics in detail and only a few samples are given to them, these students are found to be less successful (37 %). Therefore; it is necessary to examine whether there is a relationship between the success of the students in Calculus course and the methods their mathematics teachers used in high school. As a result, χ^2 test was applied to the data available in Table 1 and a relationship was found at 0.05 level. Chart 1 shows the distribution of teaching methods applied while teaching mathematics in high schools and the students' success in Calculus course.
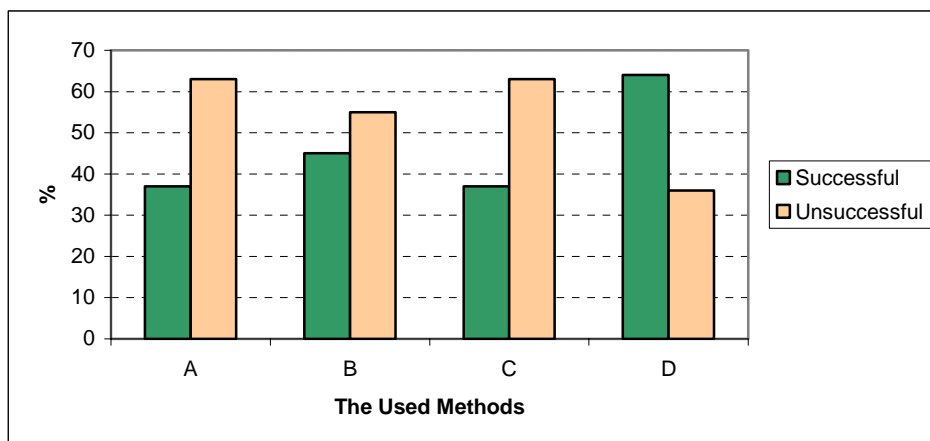

Chart 1

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The data regarding the success of students in Calculus course and how frequently theorem proofs are made in high school mathematics courses are given in Table 2.

Table 2: The success of students in Calculus course and how frequently theorem proofs are made in high school mathematics course

Theorem Proofs	Successful		Unsuccessful		Total
	The number of Students	*%*	*The number of students*	*%*	
Never done	28	36	50	64	78
Only a few done	67	48	73	52	140
A lot of done	20	74	7	26	27

$$\chi^2_{Hes.} = 11.83 \quad ; \qquad \chi^2_{Tab.} = 5.991$$

Table 2 shows that theorem proofs done in high school classrooms increase the success level of students because the success rate of the students whose mathematics teachers made a lot of theorem proofs in the classroom is 74 %. This relationship was also analyzed through χ^2 test. Based on the findings of this test, a relationship was found at 0.05 between success of students in Calculus course and whether theorem proofs were done in mathematics courses in high schools. Chart 2 shows the distribution of the success of students in Calculus course and how frequently theorem proofs are made in high school mathematics courses.
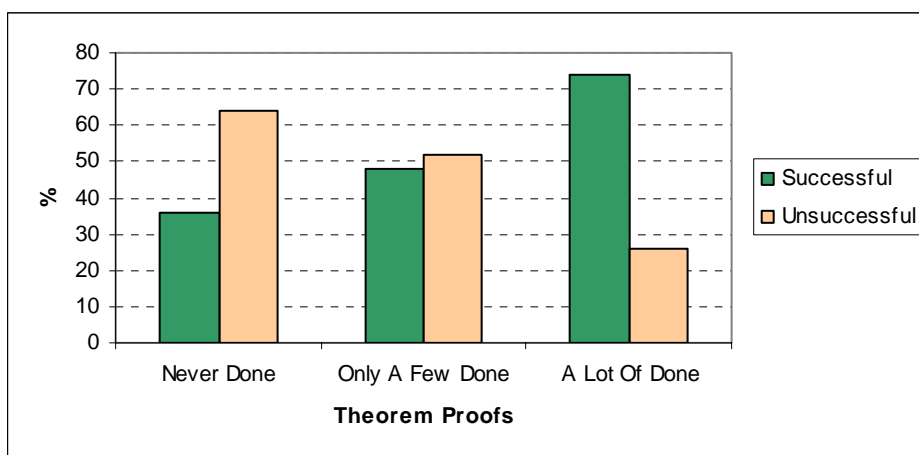

Chart 2

Table 3 presents data about the success of students in Calculus course and whether limit, continuity and derivation topics were covered in high school mathematics courses.

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Table 3: The success of students in Calculus course and whether limit, continuity and derivation topics were covered in high school mathematics courses

Topic coverage	*Successful*		*Unsuccessful*		*Total*
	The number of students	*%*	*The number of students*	*%*	
Topics Never covered	26	37	44	63	70
Topics covered superficially	50	37	85	63	135
Topics covered in detail	24	60	16	40	40

$$\chi^2_{Hes.} = 10.71 \quad ; \qquad \chi^2_{Tab.} = 5.991$$

Table 3 clearly shows that the students taught above mentioned topics in details were found to be more successful in Calculus course. χ^2 test applied at 0.05 reveals that there is a relationship between success rate in Calculus course and whether these topics covered or not in high school mathematics courses. Chart 3 shows the distribution of the success of students in Calculus course and the extent to which limit, continuity and derivation topics were covered in high school.
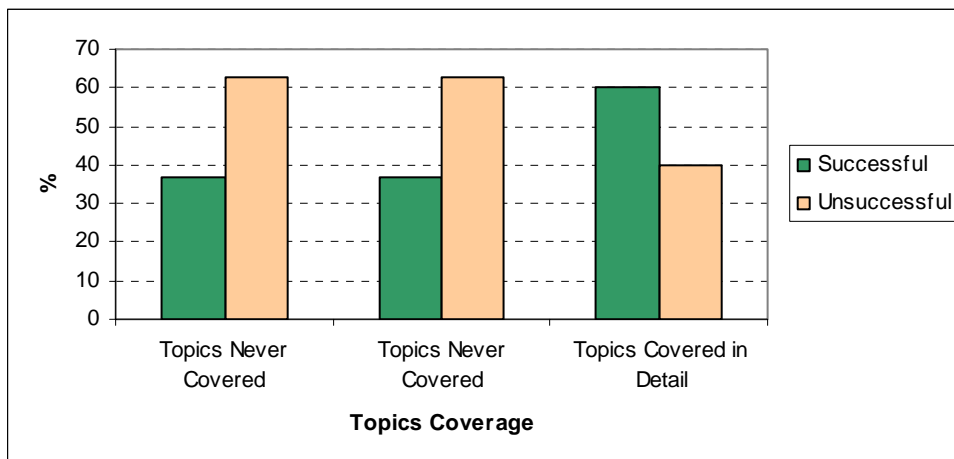

Chart 3

Table 4 shows the data regarding the success of students in Calculus course and the types of mathematics exams administered in high schools.

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Table 4: The success of students in Calculus course and the types of mathematics exams administered in high schools

	Successful	*Unsuccessful*
Exam Types	*The number of Students*	*The number of Students*
Multiple Choice Test	2	5
Classical Format	113	125

The data in Table 4 shows that almost all the exams in high school mathematics courses were administered in classical format rather that multiple choice. Therefore, it is not meaningful to search for a relationship between the success of students in Calculus course and the types of exams administered in high school mathematics courses.

5. RESULTS AND DISCUSSION

According to the findings of this study, the following conclusions and implications can be drawn:

There is a relationship between the success of students in Calculus courses and the methods used in high schools in mathematics education. In other words, when the basic mathematics topics are covered in detail and many related problems are solved in high schools, the success of these students in Calculus courses at universities considerably increases since they comprehend the topics better and, therefore; have a better mathematics background. In addition, dealing with a lot of topic related exercises helps students to internalize those topics and result in long-lasting learning.

The inclusion of a lot of theorem proofs in mathematics education in high schools was found to increase the success of students in Calculus courses. One reason lying behind this is that studying on such proofs highly contributes students' thinking skills improvement. In other words, students are led to comprehend the topic rather than memorize it.

The fact that the limit, continuity and derivation topics are not covered or covered quite superficially affects the success of students in a negative way. Since these topics are the crucial components of mathematics education, not having or having inadequate knowledge about these topics results in failure in Calculus course. This finding is also supported by the study conducted by Papanastasiou (2002), who stated that the success in mathematics courses highly depends on students' background knowledge about basic topics of mathematics. Although the topics "limit, continuity and derivation" are included in the third year syllabi of high

schools in Turkey, they are never covered or superficially covered due to ÖSS exam system. In conclusion, if ÖSS exam includes questions from the syllabi of all three years of high school mathematics education (not only from first year's syllabus), it is quite likely that the success of the students will increase in Calculus course at universities.

APPENDIX

Questionnairre

Please put a tick in the parentheses next to the option that suits you.

1. Your grade in Calculus course

   ( )FF   ( )DD   ( )DC   ( )CD   ( )CC   ( )CB

   ( )BC   ( )BB   ( )BA   ( )AB   ( )AA

2. In mathematics courses throughout my high school education

   ( ) no theorem proofs were made

   ( ) a few theorem proofs were made

   ( ) a lot of theorem proofs were made

3. In mathematics courses throughout my high school education

   ( ) we had multiple choice tests

   ( ) we had classical format exams

4. In mathematics courses throughout my high school education

   ( ) limit, continuity and derivation topics were not covered

   ( ) limit, continuity and derivation topics were covered superficially.

   ( ) limit, continuity and derivation topics were covered in detail.

5. Which of the following methods were used n mathematics courses throughout your high school education?

   ( ) A brief explanation was given about the topic and a few sample questions were solved

   ( ) A brief explanation was given about the topic and a lot of sample questions were solved

   ( ) Detailed information was given about the topic and a few sample questions were solved

   ( ) Detailed information was given about the topic and a lot of sample questions were solved

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