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Biology Majors' Performance in a Biomathematics Course

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The recent considerable developments in the field of biology have necessitated the knowledge of mathematics and its applications in biology. Therefore; most of the universities, now, believe that it is essential to include mathematics courses in the curricula of biology departments. Taking this fact into consideration, this study aims at exploring to what extent biology department students are successful in comprehending mathematical concepts and applying these in biology problems. The test administered to achieve this aim revealed that biology department students were more successful in the application of mathematics in biology

Keywords: Biomathematics Course, Performances of Biology Students, Application of Mathematics in Biology

INTRODUCTION

The rapid developments in biology in the last 50 years have required an intensive collaboration between biologists and other fields. Due to computer-based analyses and experiment facilities, it is crucial that biology department students should be equipped with mathematical knowledge (May, 2004). It is a known fact that it is not adequate to learn about genes, proteins, virus, molecules and environmental factors only through biological methods (Nowak and May, 2000). It is quite difficult for biology department students to understand and improve today's biology without having knowledge about single or multi variable functions, differential equations as well as linear algebra (Newby, 1980). The use of related computer programs and the interpretation of the results require a considerable knowledge of mathematics. By taking these facts into consideration, Biology Department at Anadolu University, like many other universities, decided to introduce a biomathematics course into the syllabus starting with the 2003-2004 academic year. At first, a three credits course of this nature may seem to be irrelevant for biology majors. Although, presumably, the main reason for most students to prefer this department is their special interest in biology, some choose this department with an assumption that it is a science-related major with no or little mathematics. In other words, these students prefer to attend a science department which has no relation to mathematics.

Indeed, if they wanted to attend a department using mathematics a lot, they would prefer a department from Engineering Faculty since such a department would be better for their future career and prosperity. In addition, it is a known fact that generally all the students in science departments are not successful in calculus courses and, therefore many studies have been conducted concerning this issue (Bloch, 2003; Cotrill, Dubinsky, at all., 1996; Eisenberg, 1991; Ferrini-Mundy, and Graham, 1994; Tall and Vinner, 1981). Thus, the lecturer teaching biomathematics in biology departments has to be motivating and also has to convince students about the place and importance of mathematics for the field of biology. As a result, lecturers should make use of samples from biology or closely related fields of science topic while explaining mathematical concepts. These conditions led the researcher to the following concerns about biomathematics course:

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- To what extent are biology department students successful in comprehending mathematical concepts?
- To what extent are biology department students successful in solving biology problems by using mathematical concepts?

On the basis of these concerns, this study aims at exploring to what extent are biology department students successful in comprehending and mathematical concepts and applying these concepts to biology problems.

METHODOLOGY

The first year students attending Anadolu University, Faculty of Science, Biology Department and having taken the biomathematics course were chosen as the subjects of this study. These students were first taught certain mathematical concepts such as function and its limit, continuity and derivation features, and then some applications of these concepts in biology were carried out in the classrooms. The total number of the subjects was 67. This group was administered an exam which consisted of four questions. Mainly, there were two types of questions; Type 1 included the first two questions testing mathematical knowledge directly, and other Type 2 questions were related to the application of mathematics in biology. Subjects were asked to provide expanded responses to questions in the exams.

The Exam Administered to the Subjects

Exam 1. $f(x)=\sqrt{x-1}$ and $g(x)=\dfrac{1}{x-1}$ functions are given

a) $(f\circ g)(x)=?$

b) Find the domain of the function $f\circ g$.

Exam 2. Find the interval of the following function where it is increasing and decreasing $f(x)=x^2e^{-x}$

Exam 3. A pharmacologist studying a drug that has been developed to lower blood pressure determines experimentally that the average reduction *f* in blood pressure resulting from a daily dosage of x *mg* of the drug is given by

$$f(x)=2(1+\frac{x-1}{\sqrt{x^2-1}})\ mm\ Hg.$$

(The units are millimeters of mercury (*Hg*).)

a) Determine the sensitivity of *f* to dosage x at dosage levels of 2 *mg* and 3 *mg*.

b) At which of these dosage levels would an increase in the dosage have the greatest effect?

Exam 4. A certain cell culture grows at a rate proportional to the number of cells present. If the culture contains 2000 cells initially, and 6000 after 20 minutes, how many cells will be present after a further 1 hour? ($\ln 3\cong 1.0986$)

In the evaluation of this exam, the correct solution meant correct calculations with a correct answer. All other situations were considered as a "wrong answer." Statistical analysis of the results included percentages and frequencies.

RESULTS AND DISCUSSION

The performances of the students in the exams are shown in Table 1. According to Table 1, 21.5 % of the students gave a right answer to Type 1 questions and 59.5 % to Type 2 questions. When these two averages are compared, it is clear that students are far more successful with type 2 questions which require the use of mathematics in biology. It can be said that students find it difficult to find a solution to the problems testing the knowledge of mathematics directly.

This result can be interpreted as follows: "Biology department students find it difficult to comprehend an abstract concept, but they are more successful in solving concrete problems. This situation might be also the reason why these students have chosen biology department, a field not closely related to mathematics. Therefore, it might be more logical to teach this course in such a way that students can figure out the abstract structure of mathematics with the help of concrete problems.

In other words, we believe that students will be more successful when they are given the chance to discover mathematical concepts with the help of a "real life problem."

Another reason to fail to comprehend abstract concepts of mathematics is the inadequacy of 3 hours

Table 1. Student performance according to question types

	Type 1				Type 2			
	Question 1		**Question 2**		**Question 3**		***Question 4***	
	N	%	*N*	%	*N*	%	*N*	***%***
Correct Answer	***11***	***16***	***18***	***27***	***39***	***58***	***41***	***61***

mathematics instruction for the students that are not good at abstract thinking. Still another reason is the lack of interest due to the doubt about the importance of mathematics since they rarely have mathematics courses in vocational courses in their departments.

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