ON THE MATHEMATICS COURSES
FOR SOCIAL SCIENCE MAJORS

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ABSTRACT. Teaching mathematics to non-math majors at the undergraduate level needs special care. We will discuss goals, contents and teaching of mathematics courses for social science majors with a focus on economics, business, and management on the basis of analyzed data.

1. INTRODUCTION

Mathematics for undergraduate students whose majors are not mathematics could be a totally different subject from mathematics for mathematics majors.

The students' motivation for studying mathematics is different. The fact that they prefer social sciences to other subjects already means that they have a somewhat different character. So, to teach the basic subjects of mathematics for university students whose majors are not mathematics, mathematicians who are well trained in mathematical thinking should give special care.

We will discuss what kind of special care is needed from the viewpoint of goal, content and method of teaching.

2. GOALS OF TEACHING MATHEMATICS TO NON-MATH MAJORS

In general, it is said that the goal of teaching mathematics to undergraduate students whose majors are not mathematics is twofold.

One is to ensure that they can get some of the tools and techniques from mathematics that are needed for their own majors. The Wharton School of the University of Pennsylvania requires three courses as a general education requirement. These are two introductory economics courses and one mathematics course. The description of the mathematics course says that “Mathematics, like economics, is an important tool in approaching business courses.”

The other is to enable them to develop skills in mathematical thinking so that they can apply them to solve problems in their own disciplines.

To find out what students think about the goal of learning mathematics, a survey was conducted at Handong Global University in May, 2005. The first question “What is your goal of studying math?” was given with the following 4 choices: 1) to develop logical thinking, 2) to use for major (I realized the need of math), 3) to use for major (recommended by faculty members or others) 4) other than the above (write: )

A total of 77 students replied as shown in the following table: 5) is the percentage of the numbers of students who chose both 1) and 2) or both 1) and 3).
goals of learning math | reason for taking the course
---|---
1) | 21 % (16) | 8 % (7) 
2) | 44 % (34) | 41 % (35) 
3) | 20 % (15) | 33 % (28) 
4) | 10 % (8) | 14 % (12) 
5) | 5 % (4) | 4 % (3) 
T | 100 % (77) | 100 % (85)

The numbers in ( ) mean the number of students who responded.

The second question asked the reason for taking the course “Mathematics for Economics, Business and Management” with the same 4 choices. This course is intended to be taken by sophomores with majors in economics, business and management in the first semester of an academic year. The prerequisite of the course is calculus of one variable functions (polynomials). This course is recommended (but not required) as a prerequisite for major courses. The students who responded to this survey were taking the course. Less than 20 percent of them are sophomores and most of them are juniors and seniors.

According to the survey, 21 percent replied that they would study mathematics to develop their logical thinking. But only 8 percent of them expect to get their logical thinking developed through the course they are taking. One reason for such low expectation could be the title of the course: Mathematics for Business, Management and Economics.

If the two goals of teaching mathematics are implemented in separate courses like “mathematics as a tool” and “mathematical thinking”, each course might attract students with appropriate expectations, and hence they might tolerate some difficulties without reluctance.

Another result that we can observe is that more than 40 percent of the students realized that they needed to learn more math. This high percentage could happen because about four fifths of them are juniors or seniors. This suggests that if mathematics courses are taught after they learn some topics in their own majors, then they can be easily motivated to study mathematics. Instead of teaching mathematics separately from their major courses, teaching those courses using tools and techniques from mathematics as a team with faculty members of those departments would be another option to try.

### 3. Teaching Mathematics

#### 3.1. Contents of teaching

When one discusses teaching, it is natural to think about what to teach and how to teach. In this section, we discuss the contents of teaching. For this purpose, we examined the curricula of various institutions.

The courses for economics, business and management provided by the department of mathematics are usually two courses of calculus.

The main topics of these two courses are as follows:

1) The first calculus course: calculus of one variable and applications (maximum and minimum, exponential and logarithmic functions, area, Taylor’s theorem and approximations).
Some institutes include infinite series and some do not. This might be because the undergraduate level of these majors deals with only geometric series and uses at most the ratio test to check the convergence of an infinite series, and even that rarely appears.

2) The second calculus course: functions of several variables, partial derivatives, constrained and unconstrained optimization, differential equations.

Some institutions include multiple integrals, introductory linear algebra and matrix theory with application. The Wharton School of the University of Pennsylvania includes elements of probability and statistics and applications in the second course of calculus.

It seems that for an undergraduate course, the Sloan School of MIT in the United States requires more mathematics than any other. It requires calculus of one variable, multivariable calculus (including vector calculus), and linear algebra for its management major.

Most business schools require only the first calculus course, while the other is optional. For graduate school in both economics and business, courses of microeconomic theory and macroeconomic theory are required, and the second calculus course and linear algebra provide basic tools for those theories.

In the home page of the undergraduate program of MIT Department of Economics, one can find the following statement: “The level of mathematics mastery among undergraduates allows economics courses to be taught at a high level” (http://econ-www.mit.edu/). So the amount of learning in mathematics required for economics, business and management depends on the academic level which a student pursues.

Currently, human society is experiencing extremely fast changes due to the development of technologies. This influences not only calculus reform but also continuous mathematics reform as R. Douglas predicted ([4]). The calculus courses listed above might change sooner or later in the direction of reducing topics in order to enable students to engage more deeply in mathematics as pointed out in [8].

3.2. Methods of Teaching. A way of presenting the contents mentioned in the previous section can be observed through the examination of textbooks. By reviewing some textbooks ([1], [2], [3], [5], [6], [7], [10], [11], [12]) we could see that there are two different styles:

1) Introduce mathematics and then show some examples of applications.
2) Introduce practical problems and derive mathematical theories.

The first style is logically well ordered and could be preferred by a mathematician.

The books of the second style (Cf. [3], [7]) came out after the so-called calculus reform in the United States of America. In the preface of [7], the authors say that a basic principle of writing the book is “the way of Archimedes: Formal definitions and procedures evolve from the investigation of practical problems.” This principle seems to be adequate for the characteristic of empirical sciences like business.

The learning style of students could be an important factor to be considered when we decide a way of presenting the contents. Their preference for business or management rather than to other subjects might have some relation with their learning style.
To check this claim, a survey was conducted at Handong Global University using selected questions from [9] in May, 2005. The answers to the following four questions out of ten questions given in the survey show a significant difference between the students whose majors are social sciences (most of them are double majors in economics and business) and the students whose majors are engineering (two thirds of them are freshmen who are going to choose majors in engineering):

1. If I were a teacher, I would rather teach a course (a) that deals with facts and real life situations. (b) that deals with ideas and theories.
2. I prefer courses that emphasize (a) concrete material (facts, data). (b) abstract material (concepts, theories).
3. I prefer to get new information in (a) pictures, diagrams, graphs, or maps. (b) written directions or verbal information.
4. I like teachers (a) who put a lot of diagrams on the board. (b) who spend a lot of time explaining.

<table>
<thead>
<tr>
<th>Question</th>
<th>Social science</th>
<th>Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-(a)</td>
<td>67 % (45)</td>
<td>45 % (15)</td>
</tr>
<tr>
<td>1-(b)</td>
<td>33 % (22)</td>
<td>55 % (18)</td>
</tr>
<tr>
<td>2-(a)</td>
<td>55 % (36)</td>
<td>30 % (10)</td>
</tr>
<tr>
<td>2-(b)</td>
<td>45 % (29)</td>
<td>70 % (23)</td>
</tr>
<tr>
<td>3-(a)</td>
<td>83 % (55)</td>
<td>66 % (21)</td>
</tr>
<tr>
<td>3-(b)</td>
<td>17 % (11)</td>
<td>34 % (11)</td>
</tr>
<tr>
<td>4-(a)</td>
<td>52 % (33)</td>
<td>47 % (14)</td>
</tr>
<tr>
<td>4-(b)</td>
<td>48 % (30)</td>
<td>53 % (16)</td>
</tr>
</tbody>
</table>

The above results show that students in social sciences prefer concrete materials like facts and data from real life situations to theories and concepts, while students in engineering (including the students who are going to major in engineering) prefer theories and concepts. Although such an outcome has been expected, it carries some meaning that we could provide actual data.

We were able to obtain other data that might show the effect of using a computer projector for teaching. It was heard that most students in engineering were not in favor of using an overhead projector instead of writing on the board in mathematics or physics classes. The course “Mathematics for Economics and Business” was taught by the author in the first semester of both academic years 2004 and 2005. There were two classes of the course each year. One class was instructed in English and another in Korean. In the year 2004, a computer projector was used in both classes except for the section of integration by substitution because the lecture notes were not ready in time. On-line lecture notes were provided ahead of class in both years. In the second midterm, three problems similar to the problems in 2004 about Gauss-Jordan elimination and determinants were given. Also, the problem of computing \( \int_{1}^{2} \frac{x}{x^2+1} \, dx \) was given in both years. The results were as follows:

The percentage of the number of students who got right answers for all 3 problems and 1 integral problem, respectively.
The number in ( ) means the number of students in class.

In the class taught in English, most students are Korean except for two or three foreigners. Most of these Korean students are not fluent in English.

It seems that projecting the lecture notes in class helps students to understand the contents better, at least when the lecture notes are available ahead of time.

4. Conclusion

The characteristics of each discipline could be reflected in the style of teaching. Mathematicians are very logical. More than 50% of new Ph.Ds get teaching positions each year according to AMS survey. In [8], Schoenfeld claims that mathematicians have to use what they know; just knowing isn’t enough.

A little bit of training as a teacher might have a large effect on teaching. We suggest implementing a program concerning teaching within a mathematics Ph.D. program. Currently, it is known that more than 80 institutions from among 171 universities and colleges in Korea have some sort of teaching and learning center. This could be an indication that not only mathematics, but also other Ph.D. programs, should include a program about teaching. It may save much time and effort to improve undergraduate education.

References


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