

Motivation, education and knowledge

Erika Fecková Škrabul'áková¹

¹(Institute of Control and Informatization of Production Processes, Faculty BERG,
Technical University of Košice, Košice, Slovakia)

Abstract: *In this paper we are searching for the main reasons of troubles in mathematics for students of non-mathematical fields of study at a technical university. Here we combine a questionnaire technique with an analysis of the responds in the test of knowledge in a high-school mathematics. The questionnaire is applied in order to determine students' opinion about the usage of knowledge from mathematics in practice. We seek to find the connection between the usage of mathematical knowledge in practice and teaching of university mathematics. We ask for the value of the influence of the right motivation on educational process. The key claims are formed on the basis of analyzing the gathered data and their further matching. Besides presenting a view on the contemporary teaching we also offer some suggestions for making improvements in the studied area. We consider the research results being important for the teaching process reflection.*

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I. Introduction

There are many fields of study that one can choose aiming to study at a technical university. Some of them are more connected with mathematics; the connection of other ones is less tight. Although mathematics is not the main field of study at some of these fields, most of the universities of technical type in Europe arrange mathematics as one of the compulsory subjects. Hence, this way mathematics becomes a necessary turning point on the way towards successful graduation. The required status of mathematics evokes negative emotions towards it¹ and makes the attempts to motivate the students to study it in a positive way even harder.

Usually, the one of the good motivation points to pay some more attention on selected school subject is its expected utilization in practice. Therefore, we were interested in the opinion of students of non-mathematical fields of study on the practical usage of knowledge from mathematics in their daily life. In order to get this information, we gave the students a questionnaire. This questionnaire was answered both by the first semester university students and by the students of higher classes. The obtained results were compared.

The negative attitude towards mathematics often stems in vague knowledge. The larger is the gap between the knowledge gained through the previous education and the required starting point of knowledge to study mathematics at the university, the larger is the aversion towards its study. Therefore, we were interested in the amount of basic knowledge in mathematics the first class students of non-mathematical fields of study have at the start of their study at a selected university, where they were admitted to study without entrance examinations. In order to gain this information, we have prepared for students a test of high-school mathematics knowledge and let them fill it out on the second day of their first semester at university.

In this paper we confront the results in the subject-matter context and give some tips how the students of non-mathematical fields of study might be positively motivated to deal with mathematics and study it. These results are important for the teaching process reflection.

II. Material And Methods

The research was carried out on the students of the Technical University of Košice, Košice, Slovakia. The time horizon of the research was October, 2008 – October, 2009.

The questionnaire was answered by in total 150 students of different non-mathematical fields of study. (This questionnaire was a part of a larger project that focused on the study of mathematics and economics from the students' perspective of view. Some of the results of this project have been published in *Geysier Mathematicae Cassoviensis*¹.) The ¼ of the respondents were students of master study, the rest of the students were students in the first and fourth semester of their bachelor study at the university. 12.5 % of the students of bachelor study were students who had chosen an elective subject called Decision Theory where they got to know some more information about the usage of the university mathematics in daily life.

The test of knowledge in high-school mathematics was filled out by in total 152 students of different non-mathematical fields of study, which were admitted to study at technical university without entrance examinations. As they had to fill out this test on the second day of their first semester at the university, its results

really brought the valid information about the knowledge in mathematics the first class students of non-mathematical fields of study have at the start of their university study.

III. Results

Several questions in the questionnaire asked if mathematics is useful in practice, what is it useful for and whether the students encountered mathematics at all.

The respondents perceived a personal need for mathematics. They highlighted its need especially for development of different cognitive functions. One third of the students was aware of a need of mathematics in order to deal with different situations of everyday life. The everyday mathematics was very often connected with payments, finance, business, and economic. Roughly, 20 % of students perceived mathematics as a subject needed to successfully complete their schooling. 11 students were unable to answer the question “What is mathematics for?” and, what is really sad, 4 students even said that it is useless. In contrast, 3 % of respondents highlighted the real application of mathematics in practice.

Comparing the answers of master study students and bachelor study students we have realized the following:

The bachelor degree students, understand that mathematics is for solving manifold situations of everyday life such as providing some simple calculations in stores. Hence, they see the utilization of basic mathematics. The higher mathematics is according to them more or less connected only with the development of multiple cognitive functions, and pass the exam in mathematics is necessary on the way to successful termination of the university study. They are mostly unable to see its applications in engineering^{2,3}, biology or medicine⁴, geography⁵, music or art^{6,7}, although they admit its usage in physics⁸ or business, economics and finance^{9,10,11}. In the master degree students group we have observed a shift from the answers dealing with utilization of mathematics for successful termination of school towards the set of answers dealing with practical application of mathematics in work, but still the highest percentage of answers was associated with the utilization of mathematics for development of diverse cognitive functions.

The question “Where do I encounter mathematics?” was mostly answered as “Everywhere / Almost everywhere in everyday life” followed by “At school”, and roughly 10 % of students recorded the answer “At work” – see Figure no 1.

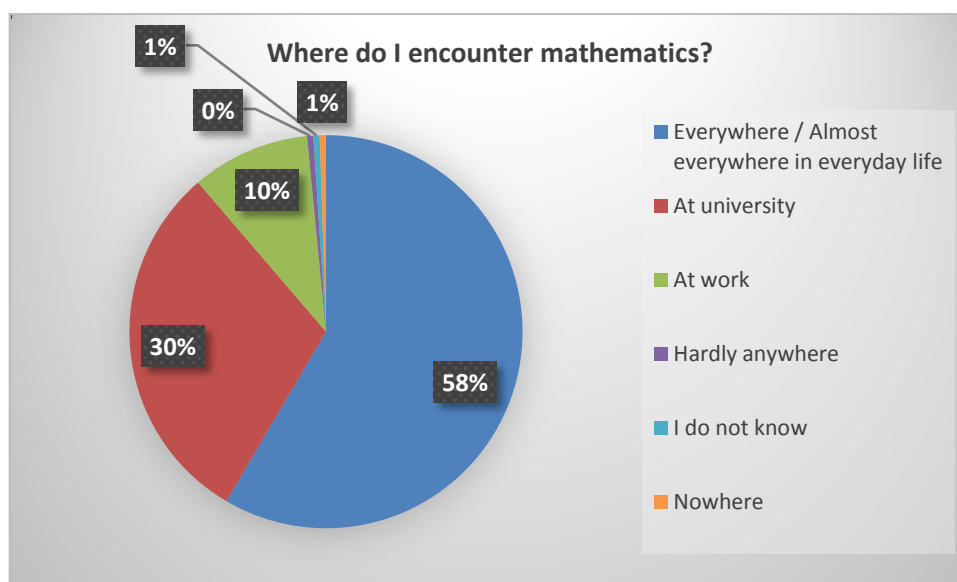


Figure no 1: Where do I encounter mathematics?

143 out of 150 students considered mathematics being useful in practice, what is positive. 37 students of this group conditioned the utilization of mathematics depending on the profession – in some kind of profession it is needed, while in other ones it is not required. 7 students answered the question about utilization of mathematics in practice in the negative way or could not answer it at all.

At least 70 percent of the answers for the tasks in the test of knowledge in high-school mathematics were correct only in 43 % of cases.

The highest stumbling block was in handling with variables and mathematical expressions, what occurred in 63 % of cases. The algebraic equations and inequations of degree at most two and systems of these equations and inequations of at most 2 variables made troubles 41 % of students. This number was even higher (57 %) in a case of logarithmic and exponential inequations.

Finding the solution of a cubic equation is not a standard part of the high – school curriculum. Therefore, this task had been considered as a bonus task. Only 15 % of students solved it correctly.

The concept of the graph of a function had been coped out by 54 % of students and the handling with a function of one variable by 58 % of students. Out of this topic the best score had been achieved in a task dealing with finding the value of a function by knowing its graph (71 %) followed by finding the value of a function by knowing its formula or algebraic expression (67 %).

The concept of handling with fractions had been overmastered by 69 % of students. Although this number seems to be high, it could not be considered as satisfactory, as handling with fractions is intrinsic fundamental knowledge in mathematics.

IV. Discussion

It can be stated that students are aware of the interconnection of mathematics with real life situations, although this is often perceived financially, so through economically related aspect. Although the majority of students admit that mathematics is useful in practice, there are still some of the respondents that learn mathematics for several semesters and they do not see its practical usage. The personal need for mathematics is too often connected only with the development of different cognitive functions, especially, considering the higher mathematics. The students of the bachelor degree of the university study mostly did not perceive mathematics being necessary for their own practice. They limit the utilization of mathematics very often to the school environment.

Our results point out to the need of incorporation of examples of practical use of mathematics during mathematical lessons and the need of incorporation of school subjects that use mathematical knowledge in solving practical tasks to the university students' curriculum. These examples should not be restricted to financial literacy elements or physics, but they have to demonstrate the diverse spectrum of real situations and their solutions via tools of mathematics. The advantages of such approaches had been confirmed via several surveys^{12,13} that show that by incorporation of some extra lessons on the utilization of mathematics in practice (such as Decision Theory) in higher classes of the university changes the student's attitude towards mathematics.

Secondary mathematics plays an important role in the performance of students in introductory courses at universities. Students who pass more advanced secondary mathematics subjects perform significantly better in introductory courses¹⁴. Good secondary education in mathematics is beneficial for studying at university¹⁵ not only in mathematics, physics and economic classes, but also in classes of so called non-mathematical fields of study.

Our students of non-mathematical fields of study have lacunae in base knowledge in mathematics such as handling with variables and mathematical expressions and other ones mentioned above. At the other side, handling with variables and mathematical expressions could be found throughout the curriculum of all fields of study at technical university. Therefore, its importance is indisputable.

The problems in secondary mathematics reflect in problems in mathematics and relative subjects at university. The effect is the negative attitude towards mathematic. As this effect is caused by lacunae in base knowledge in mathematics, we decided to empanel a new subject for our first class university students where they can fill the gap between their actual knowledge in mathematics and the amount of basic knowledge in mathematics that is required at the start of their university study. Although this subject is donated only by 2 hours per week, after 6 weeks of the semester the first positive effects could be observed: $\frac{1}{4}$ of the students that could not make the test of knowledge in high-school mathematics correctly for at least 70 percent at the beginning of the semester was able to manage it in this time horizon. The more lessons in mathematics result in better performance of these students at other subjects where a higher amount of mathematical knowledge was required. Moreover, finding out, that mathematics is something that can be learnt, changed the attitude of some students towards it.

The motivation to study mathematics can be elevated not only by its need in order to successful termination of the university study and by showing its usage in practice, the utilization in daily life. The motivation can be also pushed up by curiosity, hence, by solving some uncommon, rare, extraordinary tasks^{16,17,18} (e. g. the tasks dealing with fractals⁷). These findings were confirmed by previous studies.

V. Conclusion

In this paper we searched for the main reasons of troubles in university mathematics of students of non-mathematical fields of study. We have found out that these problems stick in both lacunae in base knowledge in mathematics and weak motivation to study it. The solution can be found in higher amount of mathematical lessons both at high-school and university and incorporation of solving more tasks that are either curious or deal with problems from practice and daily life. The bigger is the motivation to study the subject, the deeper is the interest to get the knowledge, the better is the result of the education process.

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