

Mathematical competences as a part of educational objectives in economical and technical study programs

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Abstract

The main aim of this paper is to present mathematical competences as a part of educational objectives in the curricula of study programs focusing on economics and technics which are provided by the Slovak University of Agriculture in Nitra. There is a trend of reducing the number of hours of contact teaching and this leads to the search for more effective methods and forms of education. In particular, mathematical subjects give us opportunities to use new elements, which are based on the implementation of IT tools and e-learning, in the educational process. Especially the graphical interpretation of tasks via information technology improves the imagination of students, develops their creativity and increases their motivation to study mathematics and an application in mathematics. This involves updating of objectives of mathematical education at universities and modernization of teaching methods by using the information technology. In the economic and technical study programs, compulsory courses in mathematics are included in the first year of the bachelor degree and are completed by passing the exams. The assessment of the level of mathematical competences of students is possible by means of the final grades of their math tests. In this paper mathematical competences of students have been compared through final grades in winter and summer semesters in the period of several academic years.

Keywords: *mathematics competences, objectives of education, study programs, study outcomes, information technology, e-learning, mathematical software*

JEL Classification: A23, C02, I21

1. Introduction

The quality of higher education and the increasing competitiveness of universities are subject to continuous updating of the academic content as a result of interaction with the requirements for university graduates in the labour market. The content innovations should be in terms of the latest knowledge in the scientific field. Moreover, in today's information society it is necessary to combine attractive tools of information technology with traditional teaching forms in the process of education.

Semrádová et al. (2010) state that in the preparation of courses and learning materials in a virtual environment it is necessary to consider “why” and “what instruments” to use. An advantage of a virtual environment is the possibility of flexible options, instant updates, which are set in the didactic process and readily available for pupils and students.

The present educational research comes with the concept of synograph and its interesting possibilities of application. Markechová (2013) presents the linear 3-dimensional 2-parametric synograph as an illustration of the importance of highly precise input of information into multiple-choice (MC) test questions in order to avoid an ambiguity. Another interesting application of synographical approach is presented by Markechová and Stúpalová (2014).

The importance of mathematical education should be evaluated in terms of the application of mathematical methods as quantitative tools in various fields of human activities. Presentation

and solving application tasks demonstrate the need to introduce new mathematical methods at faculties with economic and technical focus.

One of the important tasks of education should be an increase in students' motivation to learn. Based on the obtained results we can conclude that learning objectives are not clear to those students, who assume that their study subjects are not needed for their further education and professional application (Ferenczi Vaňová, Hornyák Gregáňová, Váryová & Košovská, 2014). Practical usage of exact procedures, samples of application of IT tools and presentation of abstract tasks in the form of research results is the best way of study (Nagyová, Berčík & Horská, 2014). The application of acquired knowledge can be used in many practical areas. In thesis and research projects students do statistical analyses, create various economic models, use a specification and a comparison of key elements, etc. (Mura, Grublova, Gecikova, & Kozelova, 2011). Problems of mathematical modelling curves in the plane and in space are complex and difficult; if you want to do this successfully, it is necessary to control complex mathematical apparatus, but in some cases it is quite difficult to understand them (Baraníková, 2014).

Not only students face the new requirements. University teachers and academic workers must also use modern IT tools and teaching methods. Present information technologies include an attractive and effective toolbox for educational process. Building a virtual learning environment, implementation of modern methods of e-learning and multimedia applications in education are influenced by the quality and attractiveness of an education provided at universities. In order to make teaching more effective, we need expertly trained teachers in IT; they do so by using computers and multimedia tools. The analysis of professional competencies of a lecturer in an adult education has been the subject of research of Žeravíková, Tirpáková and Markechová (2015).

Rating the quality of education is associated with the analysis of math knowledge and skills of students. The first aim of this contribution is to present actual mathematical topics in obligatory Math courses taught at the Department of Mathematics. The second aim is focused on the comparison of mathematical competences of students through learning outcomes and final exams in winter and summer semesters in years 2009 – 2014.

2. Data and Methods

The main material and data for processing of this contribution were gained during teaching compulsory Math courses at the Faculty of Economics and Management and at the Technical Faculty at the Slovak University of Agriculture (SUA) in Nitra. Additional material was obtained from the results of the research projects focused on the quality of mathematics education carried out by the members of the Department of Mathematics.

Comparative data were obtained in final tests of mathematical subjects in the first year of the bachelor degree study at SUA in Nitra:

- The Faculty of Economics and Management (FEM): Mathematics I (winter semester), Mathematics II (summer semester),
- The Technical Faculty (TF): Mathematics 1 (winter semester), Mathematics 2 (summer semester).

The final grades were made up of the sum of points from the study work during the semester (two mid-term written tests and a seminary project) and points from the final test.

In data processing, methods of descriptive statistics, analysis and comparison were used.

3. Results and Discussion

At universities, the level of quality of teaching mathematics is constantly very important and discussed a lot. Many changes in higher education are related to the influx of large amounts of information from various areas that students have to take and handle during the study of theoretical basics and specialized subjects. New information sources are multiplying with the development and availability of information and communication technologies. This influence is connected with changes in the curriculum content, number of hours of contact teaching, demands for self-study and so on. Finally, these topics are reflected in the study outputs and exam results in mathematics.

3.1 The content of mathematical subjects at SUA in Nitra

Study results in mathematics are mostly influenced by students internal motivation, their attitude to mathematics and computer technology and moreover by their ability to use study and information resources. At the Slovak University of Agriculture in Nitra, the obligatory mathematical subjects include topics shown in Table 1. From these data it is evident that students in technical and economic study programs have the greatest range of topics.

Table 1: Topics in obligatory mathematics subjects

Topic	FEM	TF	FBFS	FESRD
Linear algebra	yes	yes	yes	yes
Function of one real variable	yes	yes	yes	yes
Limit of a function of one real variable	yes	yes	yes	yes
Differential calculus of a function of one real variable	yes	yes	yes	yes
Integral calculus of a function of one real variable	yes	yes	yes	yes
Function with two variables	yes	yes	no	no
Probability theory	yes	no	no	no
Infinite series	no	yes	no	no
Differential equations	no	yes	no	no

Explanatory notes: FEM - Faculty of Economics and Management, TF - Technical Faculty, FBFS: Faculty of Biotechnology and Food Sciences, FESRD: Faculty of European Studies and Regional Development.

Source: authors

3.2 The number of lessons of obligatory mathematics subjects at SUA in Nitra

In this section, we compare the number of lecture and seminar lessons in mathematical subjects after the accreditation of the faculty and the university, at first in 2009 and then in 2015.

Table 2: The number of contact teaching lessons per week after the accreditation in 2009

Faculty	Subject	Lectures	Seminars
FEM	Mathematics I (W)	2 lessons	2 lessons
FEM	Mathematics II (S)	2 lessons	2 lessons
TF	Mathematics 1 (W)	2 lessons	2 lessons
TF	Mathematics 2 (S)	2 lessons	2 lessons
FBFS	Mathematics (S)	1 lesson	3 lessons
FESRD	Mathematics (W)	1 lesson	3 lessons
HLEF	Mathematics (W)	1 lesson	3 lessons

Explanatory notes: HLEF - Horticulture and Landscape Engineering Faculty, W - winter term, S - summer term

Source: authors

In Table 2 are given data about mathematics subjects and a number of lessons after accreditation in 2009. Reduced number of lessons in contact teaching has had an impact on modification of

the subject content and has led to leaving out some topics (e.g. analytic geometry, geometry in the plane or in space, shortening the theoretical part and others). In Table 2 the Mathematics, taught at the Horticulture and Landscape Engineering Faculty, has been registered. After the accreditation, the obligatory subject taught by the Department of Mathematics was cancelled.

Table 3: The number of contact teaching lessons per week after the accreditation in 2015

Faculty	Subject	Lectures	Seminars
FEM	Mathematics I A (W)	3 lessons	1 lessons
FEM	Mathematics II B (S)	3 lessons	1 lessons
TF	Mathematics for Technicians (S)	2 lessons	2 lessons
FBFS	Mathematics (S)	1 lesson	3 lessons
FESRD	Mathematics (W)	1 lesson	3 lessons

Source: authors

In 2015, after the accreditation, more changes occurred in the scope and content of the mathematical subjects (Tab. 3). At the Technical Faculty, one obligatory mathematical subject remained in the summer semester. At the Faculty of Economics and Management the proportion of the lectures and the seminars has changed into 3 lessons/1 lesson. The trend of reducing the number of lessons in contact teaching leads to the search for effective methods, forms and methods of education. A new way of contact teaching is aimed at the implementation of new methods based on e-learning and IT; an individual activity of students is necessary as well.

3.3 Results of classification in mathematical subjects

Exams and their results are one of the quantitative tools for measuring the quality of educational outputs.

Table 4 shows the summarized results of the tests in mathematics at the Faculty of Economics and Management. In terms of the quality of educational outcomes we can state that students have better average classification in the subject Mathematics II in the summer semester. We assume that it is due to the experience gained during the winter semester and students adaptation to the university system study. In the economic study programs the percentage of students who leave the faculty or the university without completing their studies is generally smaller.

Table 4: Classification of the results in Mathematics at the Faculty of Economics and Management

Academic year	Average classification Mathematics I	Rate Fail vs. Pass	Average classification Mathematics II	Rate Fail vs. Pass
2010/2011	2.19	0.006	2.16	0.016
2011/2012	2.24	0.003	2.05	0.006
2012/2013	2.34	0.200	2.20	0.015
2013/2014	2.24	0.014	2.23	0.008
2014/2015	2.31	0.027	2.36	0.039

Source: author's calculations

Table 5 shows the summarized results of the tests in mathematics at the Technical Faculty. It is evident that, within the observed period, students' achieved better average grades in the subject Mathematics 2 in the summer semester. The percentage of students who leave the faculty without completing their studies is higher compared to the FEM. This is related to the fact that the students are graduates from vocational schools, which are primarily focused on different

skills and abilities of students than studying. In the first year, university students have a big problem to adapt to a different system of study and to handle theoretical basis of subjects.

Table 5: Classification of the results in Mathematics at the Technical Faculty

Academic year	Average classification Mathematics 1	Rate Fail vs. Pass	Average classification Mathematics 2	Rate Fail vs. Pass
2010/2011	2.39	0.12	2.49	0.05
2011/2012	2.25	0.15	2.54	0.09
2012/2013	2.51	0.21	2.48	0.13
2013/2014	2.57	0.10	2.48	0.27
2014/2015	2.47	0.10	2.41	0.04

Source: author's calculations

The trend of reducing the number of lessons in contact teaching is a new phenomenon at universities. Záhonová (2015) states that reforms in educational system have a considerable influence on mathematics knowledge of secondary school graduates. This situation has a negative effect on students' study results in Mathematics I at the Faculty of Mechanical Engineering at the Slovak University of Technology in Bratislava. Since the academic year 2008/09 she has been presenting the results of secondary school entry tests from mathematics and comparing them with their final results.

In 2006 – 2011, Mišútová and Mišút (2012) carried out joined research projects and presented the obtained results. The primary goal of these projects was to improve the quality and flexibility of mathematical education at the University of Technology by implementing the teaching models with the emphasis on an improvement of creativity and an information technology support.

4. Conclusion

The quality of education and abilities of students are evaluated mainly via exam results. The aim of this paper was to present the main facts which are associated with the quality of mathematical education at different faculties at the Slovak University of Agriculture in Nitra that prepare future economists, managers, entrepreneurs and technicians. In this context we have dealt with two thematic areas:

1. Mathematical topics in obligatory math subjects at SUA in Nitra.
2. The comparison of the level of mathematical competences of students through learning outcomes and the final test results in winter and summer semesters in 2009 – 2014.

The results of analysis of learning outcomes in Mathematics at SUA in Nitra confirm that in 2010 – 2015 there were no extreme differences in average grades of students in Mathematics.

Math teachers of future engineers (in the technical and economic fields) reflect on changes that have appeared in the educational environment. They face much higher requirements of mathematical knowledge on students now. The mentioned change is the subject of our research, where we are going to concentrate on the mathematical education of engineers (Országhová, Gregáňová & Matušek, 2013).

There are a lot of economic and technical branches where mathematical methods can be applied. This is the main educational goal and it is in accordance with updating of study literature in terms of applied problems and tasks (Pechočiak & Matušek, 2012). This kind of tasks supports

the improvement of the quality of math education and could increase students' study motivation.

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