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Original Paper

Comparison of exam results in Mathematics at Faculty of Economics and Management, Slovak University of Agriculture in Nitra

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ABSTRACT

Mathematical education at the Slovak University of Agriculture in Nitra plays a very important role in university education because the subject of mathematics is a part of other subjects taught at the bachelor and master study programs. The content of Mathematical subjects differs from faculty to faculty of the Slovak University of Agriculture in Nitra because of their different orientation. At the Faculty of Economics and Management, Slovak University of Agriculture in Nitra, the basic course of higher mathematics together with example of their applications in economics is taught in the first year of the bachelor study. Subjects aimed at Economics and Finances which also comprise mathematical apparatus, are taught in the higher years of study. The aim of this paper is to analyze and evaluate the students' results in the subjects of Mathematics IA and Mathematics IB at the Slovak University of Agriculture in Nitra from 2015 to 2019. Feedback is an important part of an educational process because the analysis of the study outcomes enables teachers to evaluate its quality. The analysis of study results in selected mathematical subjects at the Faculty of Economics and Management, Slovak University of Agriculture in Nitra is carried out by selected methods of mathematical statistics. We found a long-term decline in the average mark in the research, confirming the decreasing level of knowledge and statistically significant difference in the values compared between the observed value and the long-term average. The hypothesis was confirmed by testing.

KEYWORDS: mathematics, study outcomes, mathematical education, mathematical subjects

JEL CLASSIFICATION: I21, C12

INTRODUCTION

The teaching of Mathematics has a long tradition at the Faculty of Economics and Management (FEM), Slovak University of Agriculture (SUA) in Nitra. Mandatory subjects of Mathematics provide the apparatus and methods applied in the scientific activities in various areas. As noted by Horská et al. [4], universities search for possibilities to attract students, to offer them an education of a high quality and to bring value added and differentiation to the university education. Snellman [10] claims, that "institutions of higher education are facing increasing pressures owing to the accelerating competition brought about by the globalization trend of higher education". The quality of higher education and the increasing

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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 [6]. University study programs reflect the requirements of the labour market that requires creative, flexible and quick minded people [8].

Carmona-García et al. says, that Mathematics as a knowledge field of the exact sciences, use specialized language, laws, properties, theorems, axioms, methods, and the results of the operations there of can be expressed in numerical, functional and graphical forms, which are commonly used in the academic field from arithmetic used in elementary education to higher mathematics used in Academic Programs related to engineering [1].

Many authors deal with the evaluation of study results of different subject taught at FEM SUA in Nitre. Hornyák Gregáňová, Pietriková [2] dealt with the evaluation of the study results of mandatory subjects of Mathematics I, A, Mathematics II, B and Statistics. The level of knowledge has been decreasing in recent years, the curriculum of mathematical subjects. We I suppose that the average mark has worsened in the compared subjects.

Országhová, Horváthová [7] dealt with the evaluation of the study results of subjects of Mathematics and English. Országhová et al. says, that university study programs reflect the requirements of the labour market that requires creative, flexible and quick minded people [8].

The subjects Mathematics IA and Mathematics IB are the core of the bachelor's degree at FEM SUA in Nitra. These are subjects of which the knowledge is further used in vocational subjects taught at FEM SUA in Nitra as part of bachelor and engineering studies. For these reasons, we consider it necessary to analyze the results of the examinations of these subjects to give an idea of how the students have mastered these subjects [3].

MATERIAL AND METHODS

All first year students studying at the Faculty of Economics and Management (Slovak University of Agriculture in Nitra, later SUA) of the selected accredited study programs (7 study programs together) at the bachelor's degree of study were included into the statistical sample (Table 1). The subjects Mathematics IA and Mathematics IB form the basis of all selected study programs studied at the bachelor's degree at FEM SUA in Nitra. The subject content of Mathematics IA is: Function of one real variable, Derivative of a function of one real variable and Function of two real variables. Mathematics IB covers topics: Indefinite integral, Definite integral, Linear algebra and Probability theory. Basic knowledge and skills obtained from the compared subjects are further developed in the subsequently taught specialized subjects at FEM SUA in Nitra within both, the bachelor and engineering degree of study. The exam results of earlier mentioned subjects reflect the success of students in the given subjects. Those data were drawn from University information system (UIS) in the academic years from 2015/16 to 2018/19 and processed by MS Excel.

The main task of our research was to find out whether there are statistically significant differences achieved in students' assessment in the mentioned subjects depending on the study program (SP). The theoretical sources for our paper were the publications and professional academic papers which deal with the educational research and with the use of the statistical methods in this research [5] and [9].

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Table 1 List of offered Saps at FEM SUA and their determination

EKP	Company economics	**MAP**	Company management
EMA	Economics and management of agro sector	**OBP**	Commercial entrepreneurship
MPA	International business with agrarian commodities	**UCT**	Accounting
IBA	International business with agrarian commodities (the study program in the English language)		

Source: authors

Another source of the material was the experience and knowledge from teaching of subjects Mathematics IA and Mathematics IB in the first year of the undergraduate study at SUA in Nitra. Study results of mandatory subjects of Mathematics IA, Mathematics IB were assessed using the standard statistical methods.

We have verified the assumptions and used the test characteristic $T = \dfrac{\overline{X} - \mu_0}{\dfrac{\widetilde{S}}{\sqrt{n}}}$ with a critical value $W_\alpha = \{t; t \geq t_{1-\alpha}\}$. The program Microsoft Excel 2017 was used for realization of calculations and determination of critical values.

RESULTS AND DISCUSSION

The article compares the exam results from the subject Mathematics IA (Math IA) and Mathematics IB (Math IB) aimed at finding out whether are statistically significant differences in achieved students' assessment in individual academic years at FEM SUA. We used the exam results from the subjects of Mathematics IA and Mathematics IB in the academic years 2015/16 to 2018/19. Exam results from individual subjects were assessed by a standard scale ECTS A(1), B(1,5), C(2), D(2,5), E(3), FX(4). Table 2 presents the assessment of student's study results in individual subjects in research in academic years 2015/16 to 2018/19.

Table 2 Overall students' evaluation results

	2015/16 Math IA	**2015/16 Math IB**	**2016/17 Math IA**	**2016/17 Math IB**	**2017/18 Math IA**	**2017/18 Math IB**	**2018/19 Math IA**	**2018/19 Math IB**
A	36	31	34	28	37	37	32	36
B	51	39	45	37	35	18	30	31
C	92	70	61	57	56	48	54	55
D	80	73	105	84	75	54	54	58
E	162	194	178	171	109	133	112	123
FX	11	10	10	4	13	6	20	21
average	**2.38**	**2.48**	**2.36**	**2.46**	**2.36**	**2.43**	**2.44**	**2.44**

Source: authors

Table 2 shows the overall student success rate in individual study programs of the compared subjects. The average of grades varies over the years studied. We would like to draw your

attention to the fact that when comparing students' learning outcomes in the last three semesters of our research we found that the average of their grades was almost the same.

Overall, the highest average was reached by students in the subject Mathematics IB in the academic year 2015/16 (2.48), but it was not the highest success rate in the subject in terms of passing the exam.

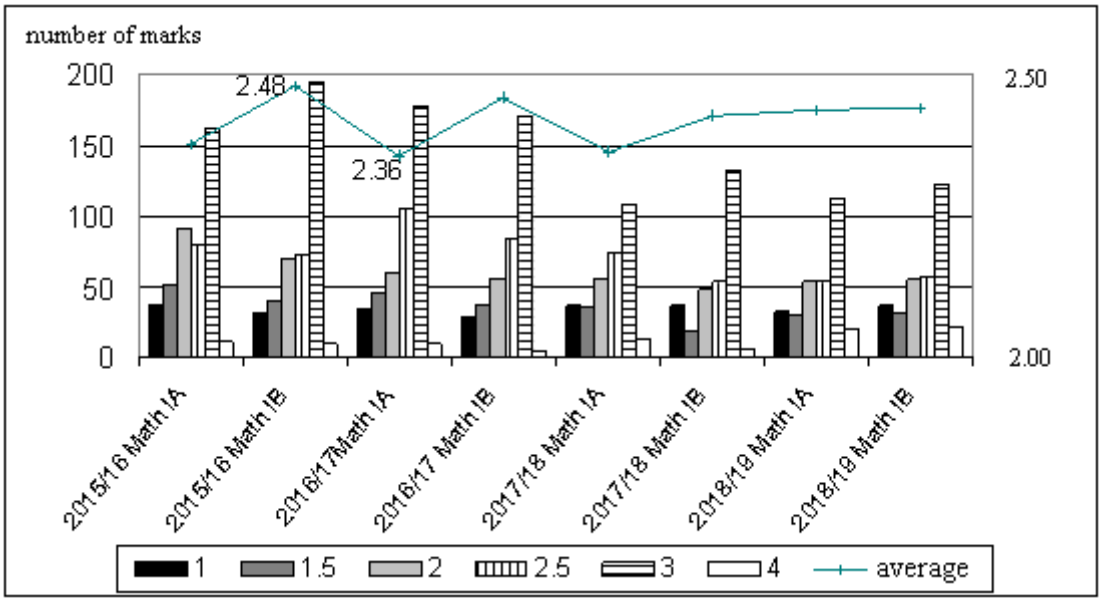

Figure 1 Comparison of students grades averages in selected years in terms of mean and median assessment
Source: authors

If we assess the students success rate from the point of the average mark (Table 3, Figure1) we have found out that the average mark has worsened in the compared subjects. There are big differences between compared subjects concerning the students' success rate.

Table 3 shows that the best average does not mean the highest success rate in the subject. The study results deteriorated last year and the number of students with the "FX" mark increased significantly (6.62% and 6.48%). In terms of students' success rate in individual subjects, the best result were obtained by students in the subject Math IB in the academic year 2015-16 and in the subject Math IA they were only slightly worse. We take into account that the majority of these students are graduates of technical secondary schools where mathematics is not considered the main subject. The median assessment reached the value of 2.5 and modus assessment reached the value 3 in all academic years. In the academic year 2018/19 the average of marks was the same in subjects Math IA and Math IB.

We calculated the value of p for all comparisons, which makes it possible to decide not to reject the null hypothesis for different levels of significance (Table 4).
Based on the before mentioned we suppose the existence of differences in achieved assessment of compared subjects between students. Examination was therefore focused on the difference determination in knowledge assessment in a regular exam term arising between students of individual academic years.

Table 3 Comparison of students' success rate in different subjects

	2015/16 Math IA	2015/16 Math IB	2016/17 Math IA	2016/17 Math IB	2017/18 Math IA	2017/18 Math IB	2018/19 Math IA	2018/19 Math IB
A	8.33%	7.43%	7.85%	7.35%	11.38%	12.50%	10.60%	11.11%
B	11.81%	9.35%	10.39%	9.71%	10.77%	6.08%	9.93%	9.57%
C	2130%	16.79%	14.09%	14.96%	17.23%	16.22%	17.88%	16.98%
D	18.52%	17.51%	24.25%	22.05%	23.08%	18.24%	17.88%	17.90%
E	37.50%	46.52%	41.11%	44.88%	33.54%	44.93%	37.09%	37.96%
FX	2.55%	2.40%	2.31%	1.05%	4.00%	2.03%	6.62%	6.48%
Total	432	417	433	381	325	296	302	324
average	2.38	2.48	2.36	2.46	2.36	2.43	2.44	2.44
students' success rate	97.45	97.60	97.69	98.95	96.00	97.97	93.38	93.52

Source: authors

Table 4 Values of testing statistics

	2015/16 Math IA	2015/16 Math IB	2016/17 Math IA	2016/17 Math IB	2017/18 Math IA	2017/18 Math IB	2018/19 Math IA	2018/19 Math IB
Value of testing statistics	1.985 *	4.,747 **	4.207 **	4.117 **	1.300	2.527*	2.818 **	2.764 **
p-value	2.36 E-02	1.03 E-06	1.30 E-05	1.92 E-05	9.68 E-02	5.75 E-03	2.42 E-03	2.85 E-03
	* statistically significant difference				** statistically highly significant difference			

Source: authors

CONCLUSIONS

The comparison of students' results at the examination in Mathematics IA and IB at FEM SUA in Nitra confirmed the differences in exam results. Surprisingly, the best students´ success rate were achieved by students in the subject of Mathematics IB in the academic year 2016/17 and the best average of marks in the academic year 2015/16 in the subject Mathematics IB. Regarding the character of compared subjects where the majority of students were assessed by the mark "E", but the grade "A" was achieved only in 7.43% and 7.35% of students respectively. In the following years, the average of the grades was worse, but the grade "A" was more common than in previous years. In case of arranging exam results from the poorest to the best, the order of subjects is as follows: Mathematics IB, Mathematics IA. We found a statistically significant difference in the values compared between the observed value and the long-term average.

In the last two academic years, the average of exam grades were balanced, teachers tried to change students' attitudes towards mathematics by introducing new methods in teaching terms:

- illustrating the introduction of new concepts by illustrative examples,
- elaborating new concepts,
- determining the relationship between concepts by theoretical and practical solutions tasks,
- drawing students attention to the correct solutions,
- using the knowledge of mathematical logic in working with concepts, vetoes and evidence.

By using appropriate teaching methods, the learning process can be improved and the students' level of knowledge improved, too.

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