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Original Paper

Comparison of study results in selected subjects depending on study program in Faulty of Economics and Management, Slovak University of Agriculture in Nitra

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ABSTRACT

Feedback is a crucial part of the educational process and the means by which by exam results and the quality of the educational process are being assessed. This article presents the analysis of the examination assessment results in Mathematics and Statistics in the Faculty of Economics and Management in the Slovak University of Agriculture in Nitra that depend upon the Bachelor Study Program. The main aim of this paper is to analyze the exam results in the compulsory subjects of Mathematics I, A, Mathematics II, B and Statistics. We have verified the following hypothesis: does the data dependence exist among the exam outcomes of the mentioned subjects that depend upon the bachelor study program. The following basic methods of the descriptive statistics and hypotheses testing were utilized in the assessment of the survey results. The existence of the statistically significant relations among the acquired assessments was verified by means of the χ^2–test.

KEYWORDS: study program, graduated subject, exam result, average mark, impact of student enlistment on acquired assessment

JEL CLASSIFICATION: I 21, C12

INTRODUCTION

The teaching of Mathematics and Statistics has a long tradition in the Faculty of Economics and Management in the Slovak University of Agriculture in Nitra (hereinafter referred to as FEM SPU). Mandatory subjects of Mathematics and Statistics provide the apparatus and

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methods applied in the scientific activities in various areas. Content, methods and forms applied in the mathematical education in universities are changing in accordance with the actual requirements of scientific departments, new education trends and practice. Appropriate attitude of students towards Mathematics is conditioned by several factors. Therefore it is crucial to create it since the primary school [4], [5].

Mandatory subjects are taught within the bachelor study as follows: Mathematics I, A in the winter term of the 1st study year, Mathematics II, B in the summer term of the 1st study year and Statistics in the winter term of the 2nd study year. Department of Mathematics of FEM SPU in Nitra provides the subjects of Mathematics I,A, Mathematics II, B. Department of Statistics and Operations Research of the FEM SPU in Nitra secures the subject of Statistics.

The main goal of our research, as part of internal evaluation process at FEM SPU in Nitra, was to find out whether there exist statistically significant differences between student exam results in the mentioned subjects depending on the study program (SP).

MATERIAL AND METHODS

The statistical sample included all students from the Faculty of Economics and Management (of the Slovak University of Agriculture in Nitra), in particular, a group of students of selected the accredited study program in the bachelor degree. Students of the bachelor study in FEM SPU are offered to study in 8 study programs (SP), out of which 7 study programs have been selected (Table 1). Subjects of Mathematics I, A, Mathematics II, B and Statistics form the knowledge core in all selected study programs studied in the bachelor study in FEM SPU in Nitra. Basic knowledge and skills obtained from the compared subjects are further developed in the subsequent taught specialized subjects in FEM SPU in Nitra within the bachelor and as well as engineering study. The exam results of before mentioned subjects reflect the fact whether respectively how students were successful in these subjects. Those data have been drawn from UIS in academic years 2012/13, respectively. 2013/14 and processed through MS Excel and SAS.

Tab. 1 List of offered SPs in FEM SPU 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 – SP in the English language		

Source: authors

The main task of our research was to find out whether there exist statistically significant differences between student exam results in the mentioned subjects depending on the study program (SP). Study results of mandatory subjects of Mathematics I, A, Mathematics II, B and Statistics were assessed using the standard statistical methods.

The following basic methods of descriptive statistics and hypotheses testing were utilized in the assessment of survey results. The existence of statistically significant relations between

acquired assessments was verified by mean of χ^2–test. The chi-square statistic is most appropriate for use with categorical variables, such as marital status [1].

Statistically demonstrated differences in the assessment were based on the significance of testing (*p*-value), presenting the error probability which is reached when the H_0 hypothesis is rejected even it is true. In case the p-value of testing characteristic is lower than 0.05, a null hypothesis about the equality of observed features is rejected and the difference in values of a statistical feature is considered as statistically significant [6].

In our case we dealt with the statistical samples of range *n* and analysed two statistical features – the first observed feature *X* presents student exam results classified according to study program and the second observed feature *Y* present the results of total assessment of student knowledge conducted in a regular term of before mentioned subjects.

We tested the following null hypothesis H_0: There in no dependence between the observed features *X* and *Y*. The alternate hypothesis H_1 as opposite: There is dependence between the observed features *X* and *Y*.

Pearson was looking for a simple statistic, a value that could be easily computed and that would indicate whether the results of an experiment deviated from expected results [2].

The statistics χ^2 is used as a testing criterion and is presented by the following ratio

$$\chi^2 = \sum_{i=1}^{m}\sum_{j=1}^{r}\frac{\left(a_i \cdot b_j - \left(a_i \cdot b_j\right)_0\right)^2}{\left(a_i \cdot b_j\right)_0}$$

The testing statistics χ^2 has the χ^2 - division with the number of variance levels (m-1)*(r-1) under the validity of testing hypothesis H_0. The testing hypothesis H_0 is rejected on the significance level α, if the value of testing criterion χ^2 exceeds the critical value $\chi^2(\alpha;(m-1)*(r-1))$. The critical value χ^2 can be found in the table of critical values [3] (we use abbreviation "CritV" in the table 4).

The applying of χ^2 goodness of fit test finds out that there exists the dependence between the compared features; therefore it is suitable to determine the intensity of such a dependence. Several measures were defined for the determination of dependence intensity between categorical features out of which the mostly used are Pearson's contingency coefficients. Pearson's coefficient of square contingency is defined as follows

$$C = \sqrt{\frac{\chi^2}{n + \chi^2}}$$

Disadvantage of such a constructed coefficient is that the maximum coefficient value is strongly influenced by the size of pivot table. This feature is removed in the following so called Adjusted Pearson's contingency coefficient

$$C_{adj} = \frac{C}{\min\left\{\sqrt{1-\frac{1}{r}}; \sqrt{1-\frac{1}{m}};\right\}}.$$

This adjusted coefficient takes valued from the interval <0; 1> for a pivot table of optional size and values are mutually comparable [6].

The program Microsoft Excel 2010 was used for the realization of calculations and determination of critical values.

RESULTS AND DISCUSSION

The article compares the exam results from the subject Mathematics I, A (Mat I), Mathematics II, B (Mat II) a Statistics (Stat) aimed to find out whether there exist statistically significant differences in achieved students' assessment studied in individual study programs in FEM SPU.

We used the exam results from the academic years 2013/14 (Mat I a Mat II) and subsequently 2014/15 (Stat). Exam results from individual subjects are assessed by a standard scale ECTS: A(1), B(1,5), C(2), D(2,5), E(3) and FX(4).

Table 2 presents the assessment of student's successfulness in individual subjects in a regular term. As regards the total students' successfulness assessment in individual study programs of comparable subjects we can state that the students' share who were unsuccessful in the exam of a regular term from the subject Statistics is almost twice as high as in Mathematics, even all students who passed the education in the English language succeeded this subject and similarly as well as Mat II in a regular term. It is worth noting the comparison of students' successfulness EMA, out of whom 55.56 % was unsuccessful in the exam from Mat I in a regular term but in the subsequent subject Mat II the successfulness of such students reached even 94.44 % in a regular term. Totally the highest successfulness was achieved by the students of SP UCT in the subject Mat I (95.12 %), which simultaneously occurred in the total lowest average mark as regards the assessment of SP or as well as the compared subjects (Fig. 1, Tab. 3).

Tab. 2 Percentage of students' successfulness in subjects when taking the exam in a regular term

Subject		**Mat I**		**Mat II**		**Stat**		**Students number**
Assessment		**A - E**	**FX**	**A - E**	**FX**	**A - E**	**FX**	
Study program	**EKP**	85.06 %	14.94 %	91.95 %	8.05 %	68.97 %	31.03 %	**87**
	EMA	44.44 %	55.56 %	94.44 %	5.56 %	72.22 %	27.78 %	**18**
	IBA	75.00 %	25.00 %	**100.00 %**	**0.00 %**	**100.00 %**	**0.00 %**	**16**
	MAP	79.73 %	20.27 %	77.03 %	22.97 %	63.06 %	36.94 %	**74**
	MPA	72.73 %	27.27 %	81.82 %	18.18 %	72.73 %	27,27 %	**11**
	OBP	88.64 %	11.36 %	61.36 %	38.64 %	56.82 %	43.18 %	**44**
	UCT	95.12 %	4.88 %	87.80 %	12.20 %	80.49 %	19.51 %	**41**
Total FEM		**82.13 %**	**17.87 %**	**83.16 %**	**16.84 %**	**69.42 %**	**30.58 %**	**291**

If we assess the students successfulness from the point of mean mark (Tab. 3, Fig. 1) we find out that the mean mark is getting worse in the compared subjects (2.309; 2.318; 2.758) and as well the median value of mark with the term number spent in the university is arising.

The big differences exist between compared subjects concerning the students' successfulness assessment of mostly occurred results as well as within the result comparison from one subject among SPs. Students of SP EKP in both subjects of Mathematics mostly acquired the mark A, but in the subject Statistics they worsened as well as in the majority of other SP, and they were most often assessed with the mark FX.

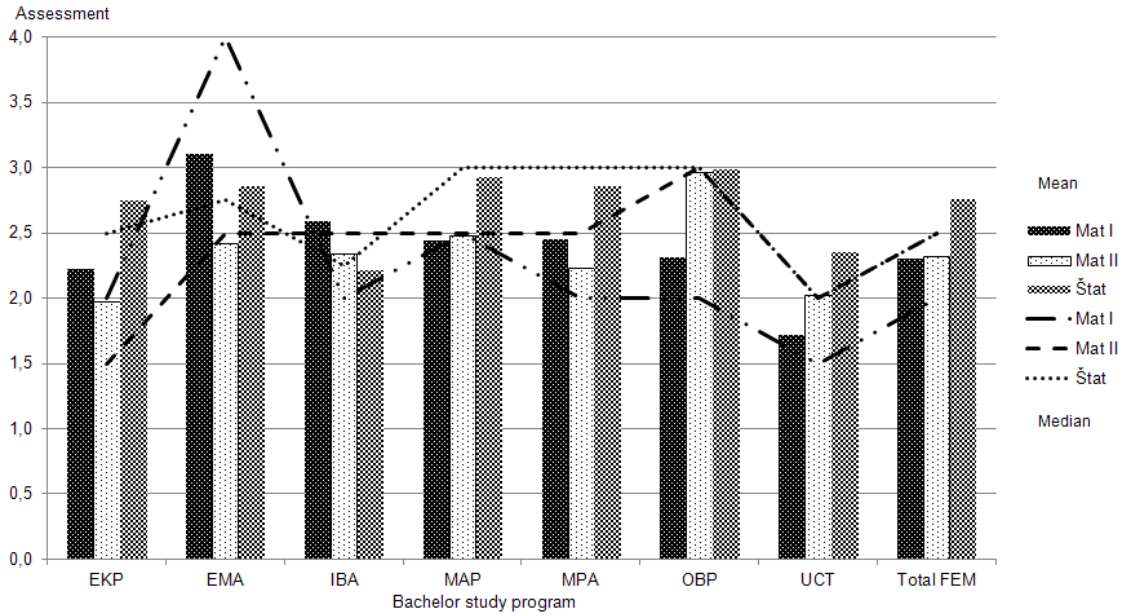

Fig. 1 Comparison of students' percentage in terms of mean and median assessment

As regards the students' successfulness of compared SP in individual subjects the best result were obtained by the students of Accounting in the subject Mat I and in the subject Mat II were only slightly worse. If we take into account that the majority of these students are graduate of secondary schools where the mathematics teaching does not belong to the main subject taught during the whole study period, so it is a surprising finding which is simultaneously confirmed by the results in the subject Statistics where the students of SP Accounting achieved the best results, as the median and modus of students' assessment reached the value 2 in comparison with other students.

Tab. 3 Comparison of students' successfulness in subjects

Subject	**Mat I**			**Mat II**			**Stat**		
SP	**Mean**	**Modus**	**Median**	**Mean**	**Modus**	**Median**	**Mean**	**Modus**	**Median**
EKP	2.230	1	2	1.977	1	1.5	2.753	4	2.5
EMA	3.111	4	4	2.417	2.5	2.5	2.861	4	2.75
IBA	2.594	-	2	2.344	3	2.5	2.219	3	2.25
MAP	2.446	2.5; 4	2.5	2.480	3; 4	2.5	2.926	4	3
MPA	2.455	2	2	2.227	1	2.5	2.864	3; 4	3
OBP	2.318	3	2	2.966	4	3	2.989	4	3
UCT	1.720	1	1.5	2.024	1	2	2.354	2	2
Total FEM	**2.309**	**1**	**2**	**2.318**	**1**	**2.5**	**2.758**	**4**	**2.5**

Based on the before mentioned we suppose the existence of differences in achieved assessment of compared subjects between students classified in several SPs. Examination was therefore focused on the difference determination in knowledge assessment in a regular exam term arising between students of individual SPs. As the subject Statistics A is characterised by the high percentage of unsuccessfulness therefore the final results were used as so called final students' assessments after the graduation of all three exam terms.

Tab. 4 Verification of difference and dependence existence

	Acquired assessment	**Value of testing statistics**	
	***p*-value**	χ^2	**CritV$_{0.05\ (0.01)}$**
SP vs. Mat I	0.002619	63.1266	43.7730 (50.8922)
SP vs. Mat II	0.000990	65.6792	
SP vs. Stat	0.037263	48.9548	

Table 4 presents the verification results of students' SP enlistment impact on the acquired assessment in three associate subjects. In case of subjects Mathematics I respectively II we can state the existence of statistically high influence of SP in the exam result as there exists only 0.26 % respectively 0.099 % probability of independence between the study program and final student's assessment. In case of the subject Statistics there exists 3.73 % risk that there is no mutual contingency between the observed features.

Based on the before mentioned findings we quantified the intensity of confirmed dependence by means of Pearson's contingency coefficient (Table 5).

Tab. 5 Quantification of analysed dependence tightness

Tightness level of assessed dependence	**Study program vs.**		
	Mat I	**Mat II**	**Stat**
Pearson's contingency coefficient	0.36218	0.42912	0.37948
Adjusted Pearson's contingency coefficient	0.39675	0.47007	0.41570

The coefficient values acquired the value higher than 0.33 for all analysed dependences which is generally considered as the limit between weak and medium strong dependence between compared categorical features. In all three cases we can state the existence of medium strong impact of studied SPs on the assessment result of compared subjects.

CONCLUSIONS

The comparison of students' result assessment in the exams from the subjects Mathematics I, II a Statistics graduated within the bachelor study in FEM SPU in Nitra found out the assessment differences. The proven impact is represented by the students' enlistment in study

programs. Surprisingly the best results were achieved by the students of study program Accounting as regards the character of compared subjects where the majority of students were assessed by the mark „A“ in case of subjects Mat I, II. Students of this program achieve the best study results at high school and are better placed to be successful in the university study. Concerning the subject Statistics it was the mark „C“ in comparison with the mostly occurred mark of all students (FX). The analysis found out that there exists statistically proven impact of a study program on achieved students' assessment in the exam of selected subjects. In case of arranging from the weakest to the strongest impact the intensity size of such an impact is following: Mathematics I, Statistics and Mathematics II.

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