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Original Paper

Evaluation of students' results from Quantitative methods in marketing during COVID-19 pandemic: Case study

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ABSTRACT

The subject Quantitative Methods in Marketing is aimed at providing theoretical understanding and practical abilities in statistical methods that may be used in marketing and market research. The graduate of the course acquires theoretical knowledge and can apply the gained practical skills from the preparation and statistical processing of the questionnaire to the interpretation of the results of analyzes. The aim of the research is to analyze the e-learning method of the subject during the COVID-19 pandemic comparing to traditional teaching before pandemic. The partial aim of the research is a comparison of total points from the course' tests before and during COVID-19 pandemic for each study programme. The paper's data base consists of points gained from partial tests of the subject Quantitative Methods in Marketing, the results of which are included in the course's final evaluation. The analyzes were performed for two periods. The pre-covid period is represented by academic years 2017/18 and 2018/19 and the covid period is represented by academic years 2019/20 and 2020/21. Based on the results, we found that the students' performance has been improving from year to year. From the point of view of comparing the pre-covid and covid perids, the significant improvement of students' results was confirmed in both study programmes during e-learning. The improvement of results during online learning could be influenced by better home preparation and provided study materials and also by practical skills acquired from home assignments.

KEYWORDS: quantitative methods in marketing, comparative analysis, e-learning, Shapiro-Wilk test, Mann Whitney U test, COVID-19

JEL CLASSIFICATION: C02, C12, C14

INTRODUCTION

Nowadays, the world is facing the greatest crisis of modern times, caused by the COVID-19 pandemic, which has influenced not only healthcare, world markets and the economy,

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but also everyday life as such. Many countries worldwide closed education facilities in a global effort to combat COVID-19 pandemic [3]. Over 100 countries over the world implemented nationwide closures, affecting over half of the world's student population [15]. School closures caused significant interruptions in academic activities as well as in career goals. Students and educators were forced to alter the way of teaching to a distance form. Thankfully, a variety of modern methods are available to provide the distance learning [14].

Due to the exponential rise of the internet and information technology, e-learning has undergone substantial changes [4]. New e-learning platforms are being created for tutors to make assessments easier and for students to take part in lectures [1], [12]. The use of e-learning tools in higher education means that a larger amount of data can be examined, which improves teaching quality [2], [11], [13].

However, e-learning is also affected by numerous negative factors, such as consuming of time, self-study, and lack of control during examination. Moreover, according to other studies, if some electronic teaching materials are not involved in education process, it appears to be incomplete [8].

The benefits and problems of large data analysis in higher education have been conducted by many researches in recent years [16]. According to Gasević et al. [5], time management strategies had significant correlations with academic success. Aiding students with the management of their learning resources is according to Jovanović et al. [9] crucial for the regularity of their learning strategies. Private chat messages, team chat messages, two-participant calls, and multi-person-meetings are the most popular remote collaboration methods [4].

Learning effectiveness, cost effectiveness, and institutional commitment, as well as access, faculty satisfaction, and student satisfaction, are all aspects that affect the success of e-learning. The quality of learning material or online e-learning content becomes more challenging as it is the major criteria in teachers' up-to-date skills and student learning quality among the four components of e-learning, which comprise contents, learning management systems, communication, and evaluation [10]. During COVID-19 pandemic, the remote learning process in Faculty of Economics and Management in Slovak University of Agriculture has been provided by using Microsoft Teams. According to students' responses on remote learning using Microsoft Teams in other education facilities, some researches showed that students were satisfied with the teacher's presentation of the lecture, but the major issue was a poor internet connection [6].

MATERIAL AND METHODS

The paper's data base consists of points gained from partial tests of the subject Quantitative Methods in Marketing, the results of which are included in the course's final evaluation. The analyses were performed in four periods of the following academic years: 2017/18, 2018/19, 2019/20, and 2020/21. Students' results in the study programs Agrarian Trade and Marketing (AOM) and Quantitative Methods in Economics (KME) were also compared. During the traditional teaching periods (the first two analyzed periods), students took two partial tests over the course of the semester, each worth a maximum of 100 points. During the online teaching periods, only one test was written. For this reason,

for comparability, the results of the first two periods were recalculated as a percentage on the same basis. The individual analyzes were performed in the statistical software SAS 9.4.

From the methodological point of view, the following statistical methods were used in the paper:

- Shapiro-Wilk's test is used to verify the normality of the input data. If the H0 hypothesis is not rejected, it is assumed that the breach of the assumption of normality has not been sufficiently demonstrated. This means that it can be assumed that the analyzed data come from a basic file with a normal distribution.
- The Mann Whitney U test is a nonparametric form of the two-means match test, that is based on the order of values. With this test we verify the hypothesis whether there are statistically significant differences between the results of students before and after the pandemic.

RESULTS AND DISCUSSION

The subject Quantitative Methods in Marketing is specified as compulsory for students of study programme Agrarian Trade and Marketing and as a compulsory elective for students of the study programme Quantitative Methods in Economics. In the researched periods, both full-time and part-time students completed the course. Since teaching in external form does not fully correspond to the full scope of teaching full-time form, the analyzes in the given paper are performed only for full-time students. The requirement for the successful completion of the course is to theoretically and practically understand selected statistical procedures that can be used in evaluation of marketing survey. In addition to the final written test, students' knowledge is verified during the through partial tests. The following Tab.1 shows the total number of students enrolled in the course during analysed academic years.

Table 1 Total number of students enrolled in Quantitative Methods in Marketing

	Academic year			
	2017/18	2018/19	2019/20	2020/21
Total number of students	**187**	**201**	**152**	**133**
Passed at partial tests	164	180	149	128
Failed at partial tests	16	12	1	2
KME	2	1	0	0
AOM	14	11	1	2
Inactive students	7	9	2	3
Full-time study				
Learning in EN	7	1	4	0
Learning in SK	174	188	141	133
KME	45	36	31	38
AOM	108	131	96	94
Repeating students	21	21	14	1
Part-time study				
AOM	6	12	7	0
Course attainment	**88%**	**90%**	**98%**	**96%**
KME	96%	97%	100%	100%
AOM	88%	92%	99%	98%

Source: own processing

In addition to the number of students, Table 1 illustrates the course attainment. The overal success is computed as the percentage of students who completed the subject successfully

outof the total number of students. The subject attainment for each study programme is also measured. As shown in Table 1, students performed better during the period when teaching due to COVID-19 pandemic was carried out online. Students of study programme KME achieved better attainment than AOM's students. Based on the results, we analyze the evaluation of partial tests as follows:

1. Comparison of test results in pre-covid period and covid period, regardless of the study programme.
2. Comparison of test results for each study programme – Agrarian Trade and Marketing, Quantitative Methods in Economics.

Figure 1 shows the information on the achieved scores from partial tests expressed by the arithmetic mean.

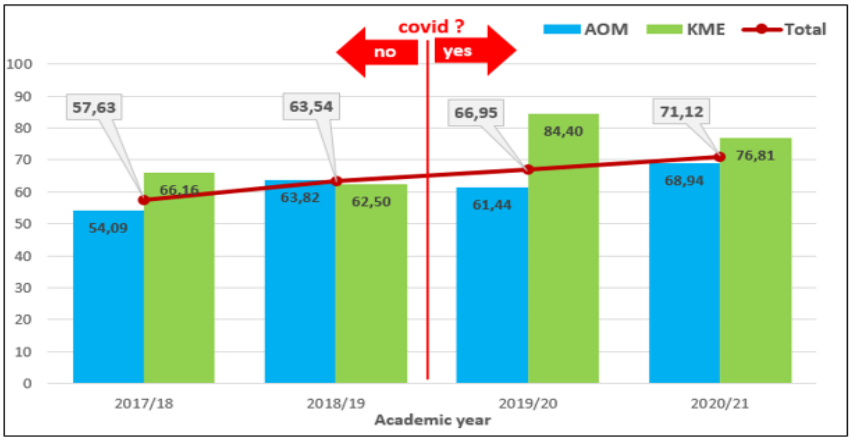


Figure 1 Average number of points achieved from tests according to study programme
Source: own processing

According to Figure 1, the average number of test points had an increasing trend over the analyzed periods, while in the first examined period, the average score was 57.63 test points. During the four analysed periods, there was an improvement of 13.49 points. Students of the Quantitative Methods in Economics (KME) program achieved the best average results (84.40 points) during the 2019/20 academic year. On the contrary, the lowest average number of points (54.09 points) was achieved in the 2017/18 academic year before the pandemic by the students of the study program Agrarian Trade and Marketing (AOM).

Comparative analysis of the student results in pre-covid and covid period

In the first part of study, we analyze study results from the subject Quantitave Methods in Marketing according to the period in which teaching took place. The first period was the period before the covid, within which the teaching took place as standard, so the issues taken over in the lectures were put into practice. In case of problems, the teacher could help the student immediately. The second analysed period is represented by pandemic COVID-19, when learning process took place online. During the academic year 2019/20, students were given study materials from which they had to complete homework assignments. Later, they also had video recordings explaining the issues discussed. MS Teams was used to carry out exercises in the academic year 2020/21, based on an online lecture. Students were given

individual calculations to complete. Throughout the class, the teacher was available to them, and he attempted to assist them with any problems they had with the computation via the shared screen. By the end of the lesson, all completed assignments were to be entered into the information system. Descriptive statistics for each analyzed period are shown in Table 2.

Table 2 Descriptive statistics of students' results for pre-covid and covid period

Analysis Variable : Results							
Covid_period	N Obs	Mean	Std Dev	Mode	Median	Minimum	Maximum
no	307	60.65	19.56	74.00	62.00	3.00	99.00
yes	255	69.07	20.03	86.00	71.00	13.00	100.00

Source: own processing

In the pre-covid period was subject Quantitative Methods in Marketing successfully completed by 307 students. Students in this period received an average of 60.65 points, with 50% of them getting more than 62 points. Because the majority of students received 74 points, the point distribution can be considered as negative asymmetric. The test results varied ± 19.56 points around the average from 3 to 99 points. The variability of the result was at the level of 32%. On the contrary, 255 students successfully completed the subject during the pandemic. The overall mean of 69.07 points was 8.42 points higher than in the pre-covid period. Half of the students received more than 71 points, while the majority of them received 86 points. That means, that also in this period was the modus value higher then median and mean, so it is a negative asymmetry, while the peak of the distribution is shifted more to the right in this case. The results in covid period varied ± 20.03 points around the mean value from 13 to 100 points, in relative terms, the variability was lower (29%) compared to the first period (Tab.2). Distribution of results in both analyzed periods is illustrated in Figure 2.

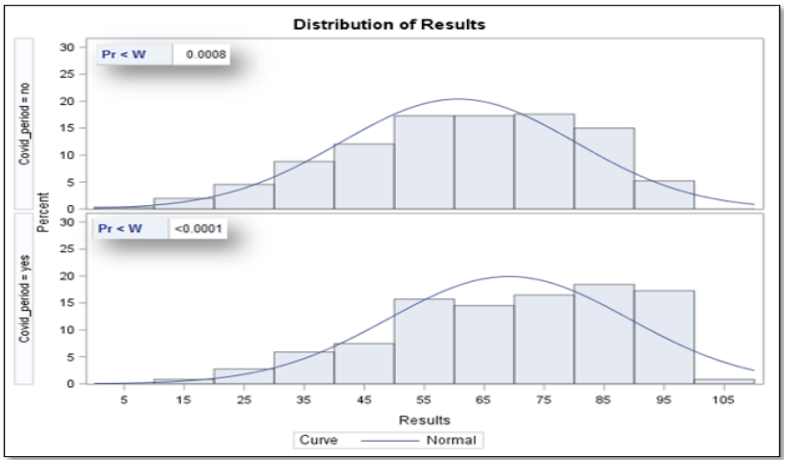
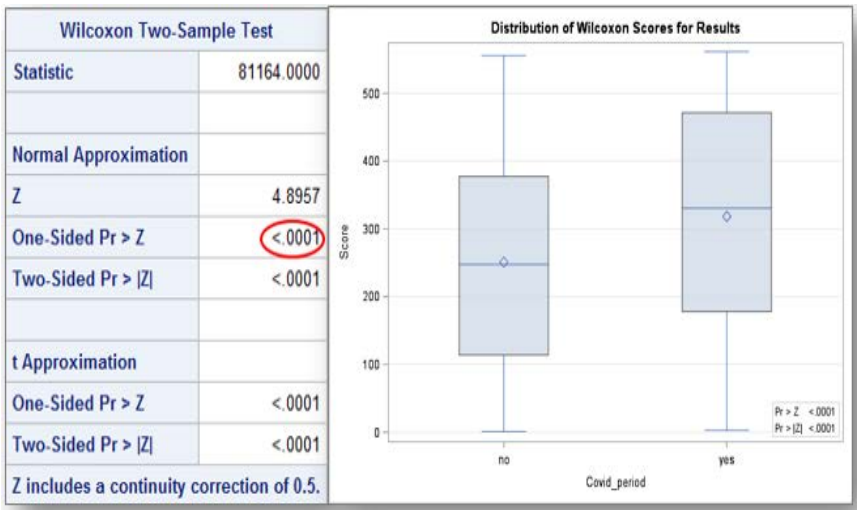


Figure 2 Distribution of results in pre-covid and covid period
Source: own processing

Based on the descriptive characteristics, according to which we can state that students achieved better results online in the covid period, we further verified the statistical significance of these differences. Before the test itself, we first verified the normality of the researched distributions.

According to the Shapiro-Wilk normality test (Figure 2), we can state that the results of students in pre-covid period and covid period do not correspond to the normal distribution. For this reason, we used the nonparametric Mann Whitney U test to verify the hypothesis that students' results in the covid period are better than in the pre-covid period. Based on the given results (Figure 3) we can conclude that the results in the covid period are significantly better than the results during traditional teaching in the pre-covid period (p-value < 0.001).



Wilcoxon Two-Sample Test	
Statistic	81164.0000
Normal Approximation	
Z	4.8957
One-Sided Pr > Z	<.0001
Two-Sided Pr > |Z|	<.0001
t Approximation	
One-Sided Pr > Z	<.0001
Two-Sided Pr > |Z|	<.0001
Z includes a continuity correction of 0.5.	

Figure 3 Mann Whitney U test of pre-covid and covid period
Source: own processing

Comparative analysis of the student results in pre-covid and covid period based on the study programme

In the previous part of study, we have confirmed that the results achieved during covid period are significantly better, than the results from pre-covid period. In this part of study, we analyze the students' results in pre-covid and covid period according to the study programme. Label AOM represents study programme Agrarian Trade and Marketing and label KME represents study programme Quantitative Methods in Economics. Descriptive statistics for pre-covid and covid period based on the study programme are shown in Table 3.

Table 3 Descriptive statistics of students' results for pre-covid and covid period based on the study programme

Analysis Variable : Results									
Study_programme	Covid_period	N Obs	Mean	Std Dev	Minimum	Maximum	Mode	N	Median
AOM	no	229	59.32	19.45	3.00	96.00	74.00	229	62.00
	yes	189	65.17	20.00	13.00	100.00	54.00	189	64.00
KME	no	78	64.56	19.48	17.00	99.00	81.00	78	65.00
	yes	66	80.26	15.49	29.00	100.00	87.00	66	84.50

Source: own processing

The average results from tests are higher in covid period in both study programmes. The students of Quantitave Methods in Economics (KME) achieved the greatest average results during the covid period (80.26 points) from all analyzed perods. The results varied around average ± 15.49 points. Most of the students of KME during pandemic achieved 87

points and 50% of them got more than 84.50 points. On the contrary, students of study programme Agrarian Trade and Marketing (AOM) achieved the lowest average results (59.32 points) from all analyzed groups in pre-covid period. The results varied around average ± 19.45 points. Most of them got 74 points and 50% of that students achieved more than 62 points from the course (Table 3). The variability of test results is approximately the same in the studied periods (around 30%), except for KME students in covid period, which had significantly lower variability (19%). Distribution of results for both study programmes in pre-covid and covid period is shown in Figure 4.

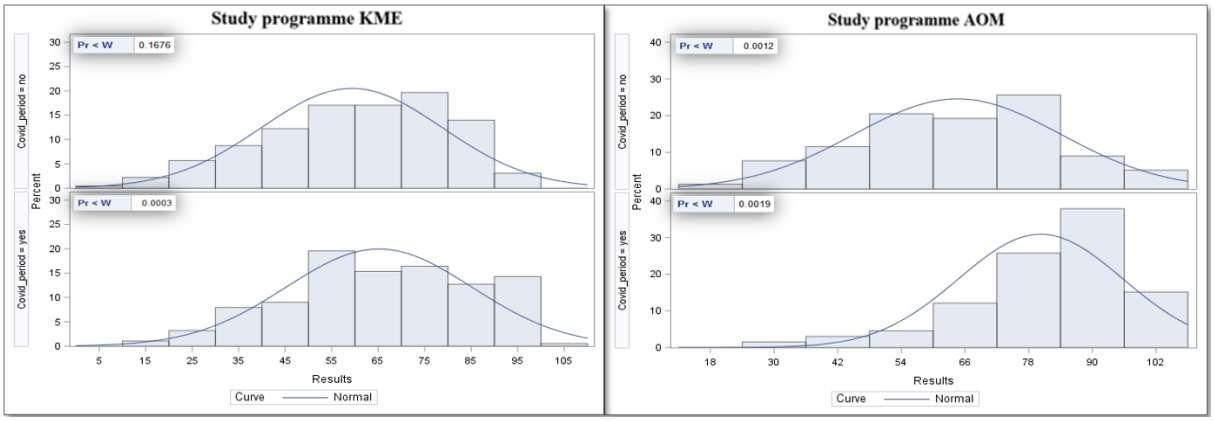


Figure 4 Distribution of results in pre-covid and covid period based on the study programme
Source: own processing

In this case, too, we subsequently verified the statistical significance of the presumed differences between the covid and nocovid periods. A normality test was performed before the test itself. Based on the p-values of Shapiro-Wilk normality test (Figure 4), we can conclude, that non-rejection of H0 hypothesis can by stated only in pre-covid period for study programme Quantitative Methods in Economics. However, the H0 hypothesis about normal distribution was rejected in other analyzed periods. For that reason we again used the nonparametric Mann Whitney U test to compare the differences between the analyzed periods for both study programmes.

Wilcoxon Two-Sample Test	
Statistic	42960.0000
Normal Approximation	
Z	2.7370
One-Sided Pr > Z	0.0031
Two-Sided Pr > |Z|	0.0062
t Approximation	
One-Sided Pr > Z	0.0032
Two-Sided Pr > |Z|	0.0065
Z includes a continuity correction of 0.5.	

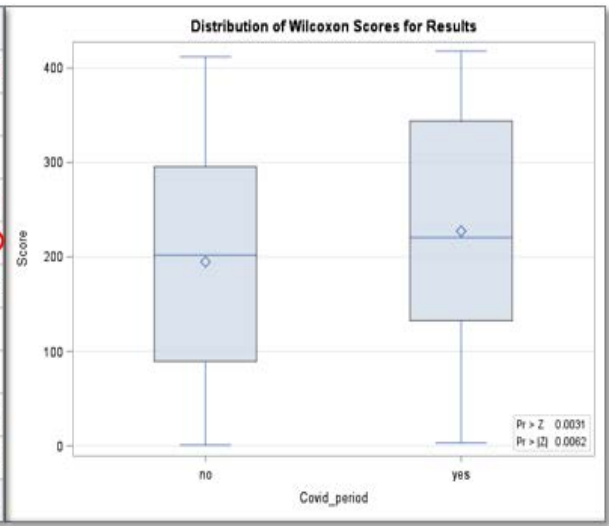
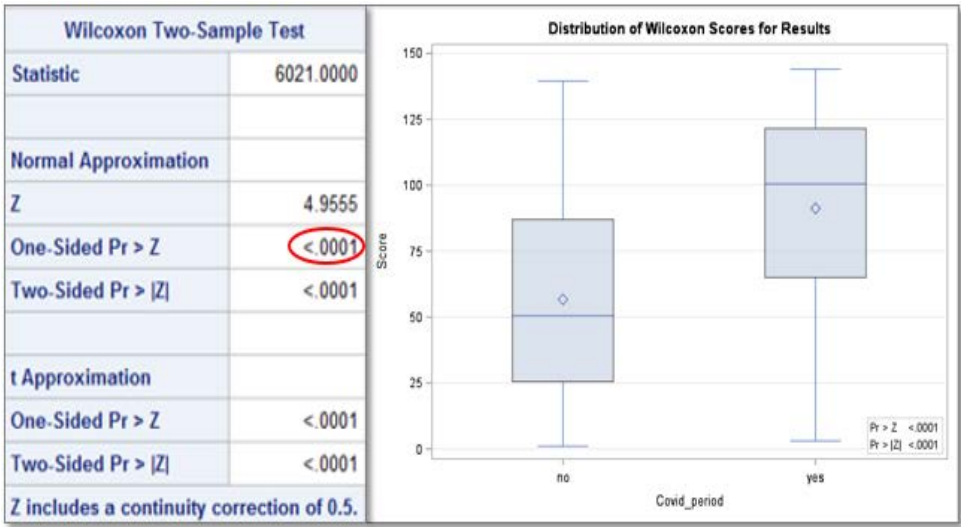


Figure 5 Mann Whitney U test of pre-covid and covid period (programme Agrarian Trade and Marketing)
Source: own processing

Figure 5 illustrates the output from Mann Whitney U test for the study programme Agrarian Trade and Marketing. Based on the results of the test (p-value=0.0031) and boxplots, we can conclude that in the case of this study programme, the study results during e-learning have significantly improved compared to the study results during standard teaching.



Wilcoxon Two-Sample Test	
Statistic	6021.0000
Normal Approximation	
Z	4.9555
One-Sided Pr > Z	<.0001
Two-Sided Pr > |Z|	<.0001
t Approximation	
One-Sided Pr > Z	<.0001
Two-Sided Pr > |Z|	<.0001
Z includes a continuity correction of 0.5.	

Figure 6 Mann Whitney U test of pre-covid and covid period (study programme Quantitative Methods in Economics)
Source: own processing

The output from Mann Whitney U test for study programme Quantitative Methods in Economics is shown in Figure 6. As well as for students of Agrarian Trade and Marketing, the results of the analyzed group of students has also improved significantly during the pandemic (p-value < 0.001). To summarize this section, we can therefore confirm the improvement of the results of both study programs during the pandemic compared to the period before the pandemic. Our results are in line with the Gonzales et al. [7] study about influence of COVID-19 confinement on students' performance in higher education. Authors studied the differences in assesments in two groups of students. First group corresponded to academic years 2017/2018 and 2018/2019 and the second group corresponded to academic year 2019/2020. Authors concluded, that COVID-19 pandemic improved the efficiency of learning strategies between students. For that reason, the better scores in students' assessment are expected during the pandemic.

CONCLUSIONS

The aim of the study was to evaluate the students' results of the subject Quantitative Methods in Marketing during the COVID-19 pandemic. We studied the differences in students' results for each study programme during the pandemic compared to pre-pandemic period, when the subject was taught standardly. We found that students scored an average of 69.07 points during the pandemic, with values fluctuating by ± 20.03 points around the average. This result was 8.42 points better then for students in the pre-pandemic period. The hypothesis that results of students from the pandemic period were better than the performance before the pandemic was confirmed through nonparametric Mann Whitney U Test. Subsequently, we verified whether there is a statistically significant difference in the results according to the study programmes during the pandemic period compared to pre-covid period. We found that

the best average results (80.26 points) were achieved by students of Quantitative Methods in Economics during the pandemic. The students of Agrarian Trade and Marketing achieved the worst average score (59.32 points) before the pandemic. We can state that the average results of both study programmes improved during the pandemic, which was confirmed by Mann Whitney U test. In conclusion we can state, that while test results have improved, it is impossible to say categorically that students' knowledge levels have improved. We are aware that the results of the tests may also reflect the fact that the tests were written by students at home in the covid period, without direct supervision by a teacher. Despite the above, based on interviews with students, the positives of online teaching were that students had more teaching materials and had the opportunity to consult their issues through MS Teams.

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Original Paper

Classification model of poverty risk in the European Union

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ABSTRACT

Analysis of the at-risk-of-poverty dataset using WEKA machine learning software tool aims for mining the relationship in selected data from database Eurostat for efficient classification. We used eight classification algorithms for analyzing dataset. We used WEKA tools to search the best classification algorithm. We evaluated accuracy of classification algorithms using various accuracy measures like Kappa statistic, TP rate, FP rate, Precision, Recall, F-measure, ROC Area and PRC Area. The accuracy of the models was monitored by the number of instances classified correctly. In this paper we describe the values of the monitored indicators of the best algorithm J48.

KEYWORDS: Data Mining, Classification, WEKA, at-risk-of-poverty, EU countries

JEL CLASSIFICATION: C38, C88, I32

INTRODUCTION

Poverty and income inequality are a highly topical issue, not least because of the covid19 pandemic we are currently experiencing. This issue is not only important in developing countries, but reducing income inequality and reducing poverty are important goals for the Member States of the European Union. Monitoring the development of poverty levels is important in determining the socio-economic progress of society [12]. Eurostat publications state that one-fifth or more of the population was at risk of poverty in up to 7 EU countries in 2018 [2].

Poverty and social exclusion are multidimensional phenomena. Just as there is no only one or correct definition of poverty, there is no single generally accepted way of measuring it [11]. The at-risk-of-poverty line is set at 60% of the median national equivalent disposable income

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and is expressed in PKS (purchasing power parity). The foundation for comparing living standards between countries is often gross domestic product (GDP) per capita, which in monetary terms shows the basic measure of the total size of the economy divided by the number of people living in it and is used to measure a country's wealth and prosperity. However, this headline indicator does not provide information on the distribution of income within a country, nor does it provide information on non-monetary factors that can play an important role in determining the quality of living conditions of the population [2].

Long-term observations of income inequality and poverty show that countries with higher income inequality are most likely countries with high levels of poverty and countries with low income inequality, as well as countries with low at-risk-of-poverty. Janovičová & Bartová assessed the development of income inequality, the poverty risk rate in V4 countries over the years 2005-2017 using the panel of annual data and by econometric models [5]. They found that in Poland and Hungary, the at the risk of poverty rate was significantly higher than in Czech and Slovakia in the observed period. Carlsen and Bruggemann [1] studied the inequality within the 27 European Member States by partial ordering methodology multi-indicator system. They found that Luxembourg, The Netherlands, Austria, and Finland had rather low inequality and on the other hand Bulgaria and Romania was with the highest degree of inequality in the period under review. They also found that Luxembourg and Hungary were isolated countries, i.e., incomparable to any other EU Member State. Muster [7] based on Eurostat research (the EU-SILC survey) presented the dynamics of changes in the phenomenon of in-work poverty in individual EU countries in 2006-2019 in his work. He said that a particularly significant increase in poverty in 2006-2019 was observed in Bulgaria, Germany, Hungary, Malta and the Netherlands. Between the factors that have a key impact on the problem of impoverishment of the economically active he included low level of education, flexible work, part-time work, young age, low work experience and living in multiperson households. Janovičová stated that proportion of population aged 65 years and more, unemployment rate and people aged 18-59 living in jobless household have statistically significant positive effect on income inequality and at the risk of poverty rate growth [4]. She assessed development of income inequality, poverty risk rate in the 19 EU Member States over the years 2005-2017.

Accurate data on poverty prevalence are needed by policymakers in anti-poverty policies [12]. Žilinský et al. [12] in their study argue that subjective poverty indicators provide essential information and should be taken into account as a supplementary dimension for assessments of the poverty level in a society. They found that with the exception of a few countries, all three subjective poverty indices (headcount ratio, the poverty gap index, and the severity of poverty index) show consistent decreasing trends in subjective poverty of EU Member States. Their results suggest that objective poverty measures should be considering housing costs because social subjective poverty lines are considerably higher for households paying mortgages and tenants paying rent than for outright homeowners.

Ivanová and Grmanová [3] studied the sustainability of EU labor immigration in terms of poverty inequalities and employment. They argue in their study that immigrants coming out of the EU are significantly at higher risk of poverty because in most EU countries, the employment rate in the group “nationals” is lower than in the group “foreign” from the EU. Tkachova et al. [10] in their study determined that the policy of integration of immigrants does not ensure the achievement of the goal of inclusive and equitable social-economic welfare. Next a particularly vulnerable group in terms of the risk of poverty are the

unemployed. With almost half (48.6%) of all unemployed in the EU27 being at risk of poverty in 2018, with the undisputed highest rate recorded in Germany (69.4%). Another 11 EU Member States (Lithuania, Malta, Latvia, Sweden, Bulgaria, Hungary, the Czech Republic, Estonia, Slovakia, Spain and Belgium) reported that at least half of the unemployed were at risk of poverty in 2018 [2].

The Waikato Environment for Knowledge Analysis (WEKA) allow easy access to state-of the-art techniques in machine learning for researchers [9]. This software for analyzing data contains many machine leaning algorithms [8]. It is providing large number of different classifiers that are used in data mining task and analyze the output produced by these classifiers [6]. In this article we focused on classification as one of the data mining technique appropriate to extract patterns from data.

MATERIAL AND METHODS

We obtained the data in a secondary way from the international database Eurostat. We compiled a dataset consisting of 28 EU countries: Austria, Austria, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, the Republic of Poland, Portugal, Romania, the Slovak Republic, Slovenia, Spain, Sweden and United Kingdom (Table 1).

Table 1 Values of indicators forming the research dataset before its modification

Relation: udajeCSV-weka.filters.unsupervised.attribute.Remove-R4-6,16-17

No.	1: country	2: RiskRP	3: JoblessHch	4: UnemplT	5: TGGexp	6: GDPpc	7: PopTerEdu	8: PopSecEdu	9: PopPrimEdu	10: Pop65viac	11: S80/S20	12: **Gini**
	Nominal	Numeric	Numeric	Numeric	Numeric	Numeric	Numeric	Numeric	Numeric	Numeric	Numeric	Numeric
1	Belgium	14.8	10.9	5.4	52.1	35940.0	36.0	38.1	25.9	18.9	3.61	25.1
2	Bulgaria	22.6	9.3	4.2	36.3	6840.0	24.7	53.5	21.9	21.3	8.1	40.8
3	Czechia	10.1	5.5	2.0	41.3	18330.0	21.6	66.1	12.3	19.6	3.34	24.0
4	Denma...	12.5	7.5	5.0	49.2	49720.0	33.1	40.8	26.1	19.6	4.9	27.5
5	Germa...	14.8	8.4	3.1	45.2	35840.0	26.0	54.5	19.5	21.5	4.89	29.7
6	Estonia	21.7	7.3	4.4	38.9	15760.0	36.5	47.7	15.8	19.8	5.8	30.5
7	Ireland	13.1	10.9	5.0	24.5	60170.0	40.7	38.3	21.0	14.1	4.3	28.3
8	Greece	17.9	8.3	17.3	47.5	17740.0	27.8	46.3	25.9	22.0	5.11	31.0
9	Spain	20.7	8.3	14.1	42.1	25200.0	35.1	25.3	39.6	19.4	5.94	33.0
10	France	13.6	11.5	8.5	55.6	33270.0	33.7	42.9	23.4	20.1	4.27	29.2
11	Croatia	18.3	5.7	6.6	47.0	12450.0	22.0	59.9	18.1	20.6	4.76	29.2
12	Italy	20.1	9.4	10.0	48.6	26920.0	17.4	42.8	39.8	22.8	6.1	32.8
13	Cyprus	14.7	6.0	7.1	40.1	24570.0	40.0	38.5	21.5	16.1	4.58	31.1
14	Latvia	22.9	7.6	6.3	38.4	12510.0	31.4	53.8	14.9	20.3	6.54	35.2
15	Lithuania	20.6	8.5	6.3	34.6	14010.0	37.9	51.0	11.1	19.8	6.44	35.4
16	Luxem...	17.5	6.2	5.6	42.2	83640.0	41.0	32.3	26.7	14.4	5.34	32.3
17	Hungary	12.3	5.6	3.4	45.6	13260.0	22.5	57.6	20.0	19.3	4.23	28.0
18	Malta	17.1	7.0	3.6	37.2	21800.0	26.7	32.1	41.3	18.7	4.18	28.0
19	Netherl...	13.2	5.3	3.4	42.0	41870.0	34.8	39.7	25.5	19.2	3.94	26.8
20	Austria	13.3	6.2	4.5	48.4	38170.0	31.1	50.2	18.7	18.8	4.17	27.5
21	Poland	15.4	8.3	3.3	41.8	13000.0	28.2	58.5	13.3	17.7	4.37	28.5
22	Portugal	17.2	4.5	6.5	42.7	18590.0	23.8	28.7	47.6	21.8	5.16	31.9
23	Romania	23.8	7.3	3.9	36.1	9120.0	16.0	58.9	25.1	18.5	7.8	34.8
24	Slovenia	12.0	2.6	4.5	43.3	20700.0	29.3	54.9	15.8	19.8	3.39	23.9
25	Slovakia	11.9	7.5	5.8	42.7	15860.0	23.1	62.3	14.5	16.0	3.34	22.8
26	Finland	11.6	4.8	6.7	53.3	37170.0	38.5	44.6	16.9	21.8	3.69	26.2
27	Sweden	17.1	10.5	6.8	49.4	43900.0	37.8	41.5	20.8	19.9	4.33	27.6
28	United...	19.0	10.5	3.8	41.1	32910.0	40.6	40.2	19.1	18.4	5.63	33.5

Source: data Eurostat, author processing, output from WEKA

We used 11 numeric attributes for the analyzes (Table 1): Unemployment Rate (UnemplT), Children aged 0-17 years living in jobless households (JoblessHch), Total general government expenditure (TGGexp), Gross domestic product per capita (GDPpc), Population by educational attainment level, tertiary, levels 5-8 (PopTerEdu), Population by educational

attainment level, Upper secondary, post-secondary non-tertiary, levels 3-4 (PodSecEdu), Population by educational attainment level, Less than primary, primary and lower secondary education, levels 0-2 (PopPrimEdu), Proportion of population aged 65 years and more (Pop65viac), Income quintile share ratio (S80/S20), Gini coefficient of equivalised disposable income (Gini).

There was no missing data in the dataset, it was adjusted by discretizing the variables needed for classification methods (Table 2). As a classification attribute, we set the indicator - At the risk of poverty rate (RiskRP). We discretized the classification attribute to three nominal categories (Table 2).

We selected the relevant data on the basis of selection using the values of correlation coefficients expressing the relationship between individual attributes and the classification attribute. Based on the obtained values of correlation coefficients $(r > 0.2)$, we can conclude that there is a relationship between the at-risk-of-poverty rate and 6 attributes: Income quintile share ratio S80/S20 $(r = 0.586)$, Gini coefficient of equivalised disposable income $(r = 0.388)$, Gross domestic product per capita $(r = 0.24)$, Population by educational attainment level - upper secondary, post-secondary non-tertiary, levels 3-4 $(r = 0.21)$, Population by educational attainment level - less than primary, primary and lower secondary education, levels 0-2 $(r = 0.209)$, Total general government expenditure $(r = 0.203)$. In the following analyzes, we will use only 6 of the listed attributes.

Table 2 Discretization of selected attributes

Attribute	*Label*	*Variation*	*Count*
Gini coefficient of equivalised disposable income	$(-\infty, 28.8\rangle$	below average EU	13
	$(28.8, 34.8\rangle$	average EU	12
	$(34.8, \infty)$	above average EU	3
Income quintile share ratio S80/S20	$(-\infty, 5.72\rangle$	risk - free	21
	$(5.72, \infty)$	at risk	7
At the risk of poverty rate	$(-\infty, 14.67\rangle$	low	10
	$(14.67, 19.23\rangle$	medium	11
	$(19.23, \infty)$	high	7
Total general government expenditure	$(-\infty, 41.2\rangle$	below average EU	9
	$(41.2, 46.3\rangle$	average EU	10
	$(46.3, \infty)$	above average EU	9
Gross domestic product per capita	$(-\infty, 16800\rangle$	below average	9
	$(16800, 34555\rangle$	average	10
	$(34555, \infty)$	above average	9
Population by educational attainment level - upper secondary, post-secondary non-tertiary, levels 3-4	$(-\infty, 38.9\rangle$	low	7
	$(38.9, 52.5\rangle$	medium	11
	$(52.5, \infty)$	high	10
Population by educational attainment level - less than primary, primary and lower secondary education, levels 0-2	$(-\infty, 18.4\rangle$	low	9
	$(18.4, 25.3\rangle$	medium	10
	$(25.3, \infty)$	high	9

Source: data Eurostat, author processing by WEKA

We used data mining methods to extract the models describing the investigated data. We used and tested several methods of the classification: methods using information theory (algorithm J48), based on decision trees (Random Forest, Random Tree), methods based on conditional probability (Bayes Net, Naive Bayes), rules PART, classifiers on the principle of k-nearest neighbors (classifier lazy IBK, Instance Bases Learning with parameter K), meta-algorithm Bagging. We used Weka toolkit to analyze the performance of the classifiers. We used several sampling methods to test and build the model (Evaluation of Test Set): Cross Validation Fold, Use Training Set, 66% Percentage Split. We chose the best model based on the values of the following indicators: correctly classified instances, incorrectly classified instances, kappa statistics, area under receiver operating characteristic curve (ROC), area under precision-recall curve (PRC).

RESULTS AND DISCUSSION

Given the values of the monitored indicators, we chose the model created by the J48 algorithm as the best model (Figure 1). Although this model achieved the values of correctly and incorrectly classified instances the same as the model created on the basis of the rules PART classification and also the Bagging meta and the Bayes Net or lazy IBK classifier, J48 achieved a lower error rate and slightly higher area values under the ROC curve.

```
=== Summary ===

Correctly Classified Instances          25               89.2857 %
Incorrectly Classified Instances         3               10.7143 %
Kappa statistic                          0.8369
Mean absolute error                      0.1196
Root mean squared error                  0.2445
Relative absolute error                 27.3166 %
Root relative squared error             52.3038 %
Total Number of Instances               28

=== Detailed Accuracy By Class ===

               TP Rate   FP Rate   Precision   Recall  F-Measure  MCC      ROC Area  PRC Area  Class
               0,900     0,111     0,818       0,900   0,857      0,774    0,919     0,789     low
               0,818     0,059     0,900       0,818   0,857      0,774    0,922     0,850     medium
               1,000     0,000     1,000       1,000   1,000      1,000    1,000     1,000     high
Weighted Avg.  0,893     0,063     0,896       0,893   0,893      0,830    0,941     0,866

=== Confusion Matrix ===

 a b c   <-- classified as
 9 1 0 | a = low
 2 9 0 | b = medium
 0 0 7 | c = high
```

Figure 1 Output algorithm J48 (Use training set)
Source: data Eurostat, author processing by WEKA

The correctly classified instances were 89.29% and the incorrectly classified instances were 10.71%. Reached value of Kappa statics (0.84) is considered as very good. It is outstanding degree of agreement between two sets of categorized data, observed and predicted values. Mean absolute error is measure set of predicted value to actual value i.e. how close a predicted model to actual model [6]. The mean absolute difference between the predicted and

observed values reached the value of 0.12. Root mean square error (RMSE) is measuring the differences between values predicted by a model and the values actually observed, so small value of RMSE means better accuracy of model [6]. Root mean square error reached the value of 0.25. The relative absolute difference between the predicted and actual values was 27%. The ratio of the number of observations predicted as a low at-risk-of-poverty rate to the total number of observations representing a given low-at-risk-of-poverty category was $\frac{9}{10} = 0{,}9$. The ratio of the number of observations predicted as the average at-risk-of-poverty rate to the total number of observations representing the given category of the average at-risk-of-poverty rate was $\frac{9}{11} = 0.\overline{81}$. All of observations predicted as a high at-risk-of-poverty rate belonged to representing a given high-at-risk-of-poverty category $\left(\frac{7}{7} = 1\right)$. A false negative rate in the low at-risk-of-poverty category obtained value 0.11 and in the medium-on-poverty-weight category obtained value 0.59. Detailed accuracy (False positive rate, Precision, Recall, Matthews Correlation Coefficient, ROC Area, PRC Area) by class is shown in Figure 1. We have observed a high correlation between observed and predicted values (83%). The area under the ROC curve is graphically shown for two categories in Figure 2 and Figure 3. The area under the feedback and accuracy curve took on values of 79%, 85%, 100%, which means high accuracy and feedback for all categories.

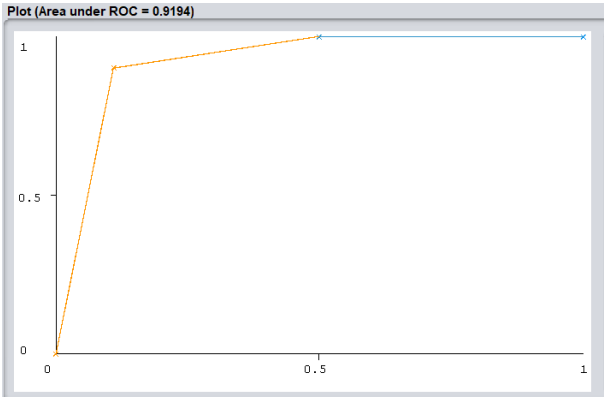

Figure 2 ROC curve of low variation at the risk of poverty rate (J48)
Source: data Eurostat, author processing by WEKA

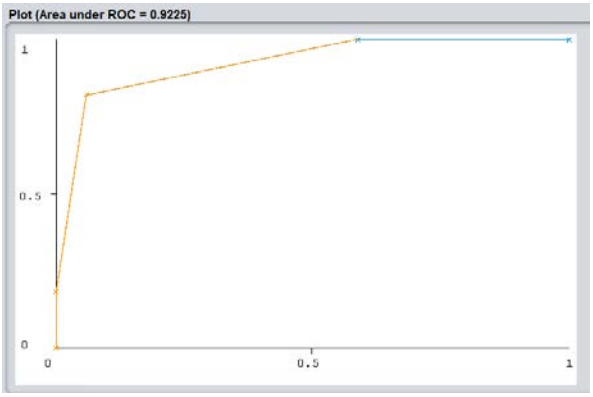

Figure 3 ROC curve of medium variation at the risk of poverty rate (J48)
Source: data Eurostat, author processing by WEKA

According to confusion matrix (Figure 1) we can say that one country had a low at-risk-of-poverty rate but was predicted as a medium at-risk-of-poverty rate and in two cases, countries achieved a medium at-risk-of-poverty rate but have been predicted to have a low poverty rate.

The decision tree is shown in Figure 4. The J48 algorithm decided that the root decision node would be the variable Income quintile share ratio (S80/S20). It builds the decision tree from labeled training data set using information gain and to make the decision the attribute with highest normalized information gain is used. The splitting procedure stops if all instances in a subset belong to the same class [9]. The tree contains two intermediate nodes (branches) formed by the variables Gini coefficient of equivalised disposable income (Gini) and the population with secondary education (PopSecEdu). The tree is terminated by 5 leaf nodes (leaves), which also contain the numbers of correctly and incorrectly classified variables.

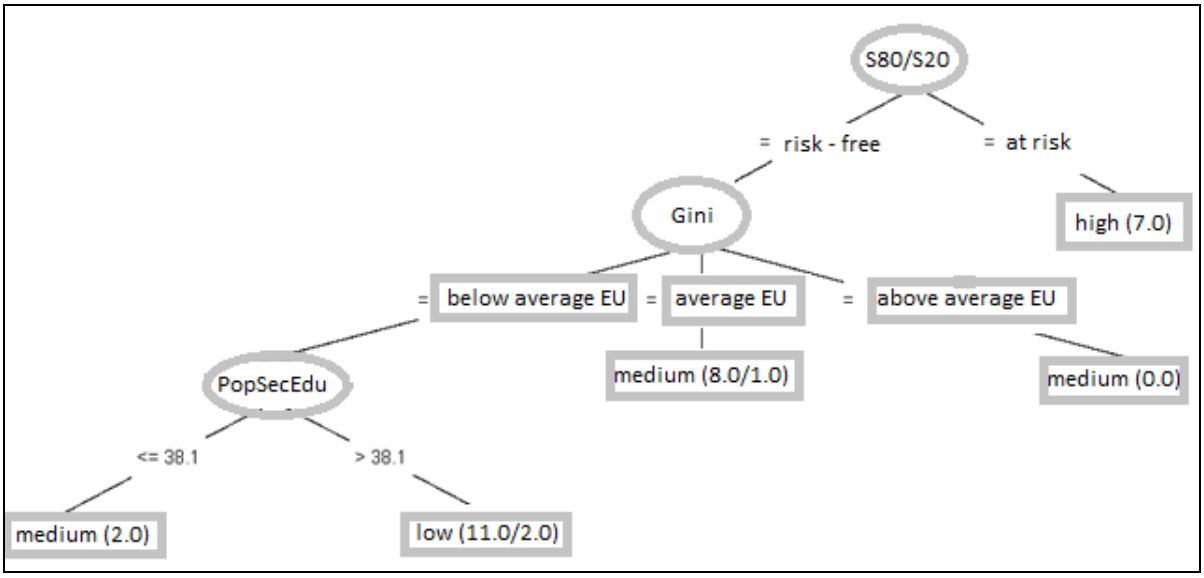

Figure 4 Decision tree of algorithm J48 (Use training set)
Source: data Eurostat, author processing by WEKA

CONCLUSIONS

In this article, we dealt with one technique of Data Mining. We applied the classification methods to the dataset of data obtained from the international Eurostat database. As a classification attribute, we determined the at-risk-of-poverty rate in the population. We focused on EU28 countries and 11 attributes. We found that the classification attribute was significantly positively affected by Total general government expenditure, GDP per capita, Income quintile share ratio (S80/S20), Gini coefficient of equivalised disposable income and also Proportion of population according to the level of primary and secondary education. We used Weka tools to search the best classification algorithm. The models created by classification techniques were building based on training data. To evaluate the performance of classifiers Weka data mining tool was used and the accuracy measures like Kappa statistic, TP rate, FP rate, Precision, Recall, F-measure, ROC Area and PRC Area. Overall observation was that the best algorithm suitable for predicting the at-risk-of-poverty rate in the monitored countries is J48.

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Original Paper

Modern forms of accounting teaching and obtaining professional knowledge of students: case study

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ABSTRACT

To limit the spread of COVID-19 disease universities and schools revised the mode of delivery from contact teaching to distance teaching. The implementation of educational activities by the distance method replaces the direct contact of the teacher with the students and places increased emphasis on the quality and comprehensibility of study materials and their availability for students. The aim of the paper is to present a modern form of an accounting teaching through a case study of distance teaching in the course Single-entry bookkeeping system at the Faculty of Economics and Management of the Slovak University of Agriculture in Nitra. Seminars from the course Single-entry bookkeeping system are realized in an accounting software, so it was necessary to find the optimal solution to ensure the distance teaching. We chose to make video tutorials using software which allows to record activities on the desktop together with the teacher as a narrator. Video tutorials allow students working in a demo version of the taught accounting software to gain professional knowledge and skills with working in the accounting software and as well as within the distance learning. The paper also evaluates the examination results from the course Simple-entry bookkeeping system for the last four academic years. The evaluation showed, that in the academic year 2020/2021 when the distance teaching started, the highest success rate on the first term and at the same time the worst average grade was achieved by students.

KEYWORDS: accounting, distance teaching, software, video tutorials

JEL CLASSIFICATION: A22, C10, I21, I23, M41

INTRODUCTION

One of the priority directions of the process of informatization of modern society is the informatization of education - the process of providing the sphere education methodology and practice of development and optimal use of modern, or, as they are called, new information and communication technologies [13]. The main aim of education at universities is the

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training of qualified graduates who will be able to apply in professional areas of the labour market. New information and knowledge are currently available through the Internet, social networks, media and multimedia tools. It is therefore necessary for higher education to be provided through information and communication technologies [11]. Information and communication technologies are also booming in the modernization of the creation of new study materials. Their introduction was also stimulated by the creation of new alternative methods and forms of teaching, the creation of new study materials - electronic study materials, materials intended for self-testing and testing of knowledge, or materials intended for the creation of seminar papers [8]. The inclusion of e-learning methods in education enables teachers to create modern learning resources, to provide support in the self-study of students, and motivate them to acquire knowledge actively [10].

Until recently, distance education in Slovakia was perceived as a passive use of the Internet through websites that serve to publish information about the study and a specific educational institution, as well as to publish organizational information related to the study. In today's higher education, the lecture form of teaching has clearly prevailed so far, when students sit in desks and passively accept the knowledge presented to them by the lecturer [5]. At state universities in Slovakia, the development in the field of online education was not very fast. Continuous problems with the lack of funding, the lack of qualified teachers and, consequently, the quality of teaching have been a long-term barrier to innovation [12].

COVID-19 disease is a global phenomenon that is exerting its influence on a lot more than just health sector. Educational institutes were also part of the lockdown that followed the outbreak [2]. The epidemic situation and the adaption of measures against the spread of COVID-19 disease required the interruption in full-time study at the universities and the immediate transition to the distance teaching and learning [3, 4]. The ongoing public health crisis has brought far-reaching influence to the teaching reform in universities and online teaching has become a new normal [6, 9]. There were some problems in online teaching, such as network jam, interference in home learning and lack of learning monitoring, however, timely online training, abundant online resources, convenient live broadcast tools and stable teaching platform had ensured the orderly development of the online teaching. In the post-epidemic era, online teaching will be integrated with offline teaching, which become "normalized" [1, 14]. The online teaching should meet most of the criteria of face-to-face teaching [7]. There is the need for professional development and institutional support for teachers who transition from a traditional to an online teaching environment, regardless of whether is a voluntary or forced shift [3].

MATERIAL AND METHODS

The course Single-entry bookkeeping system is a compulsory elective course at the bachelor's degree in the 5th semester. It is offered for six study programs at the Faculty of Economics and Management (study programs: Accounting, Business Economics, Trade Entrepreneurship, Environmental Economics and Management, International Business with Agrarian Commodities) and one study program at the Faculty of Agrobiology and Food Resources (study program: Sustainable Agriculture and Rural Development). The course is taught in full-time and part-time form of study. The scope of the course is in the full-time form of study 2 hours of lectures and 2 hours of seminars per week, i.e. a total of 52 hours per semester of study. The scope of the course in the external form of study is 10 hours of lectures

and 10 hours of seminars, i.e. a total of 20 hours per semester of study. After successful completion of the course, the student will gain and ECTS grade and 6 credits. In the current academic year 2021/2022, 95 full-time students and 8 part-time students are enrolled in the course of Single-entry bookkeeping system. This course is important for students who are considering a sole trader business. After completing this course, students will be able to record accounting transactions and complete the financial statements of self-employed persons. Students will be able to analyse income and expenses of self-employed persons and how it affects tax base, work out tax base and income tax and also prepare a tax return.

The Mann-Whitney U Test was used in the analysis of the educational outputs of the course Single-entry bookkeeping system. This test belongs to the category of non-parametric statistical tests and is used to compare the medians of two independent samples. In our case, the observed characters are the characters X, Y, where X indicates the mark from the exam test in one academic year and the character Y indicates the mark from the exam test in the second academic year. The null hypothesis will be tested:
H0: The medians of marks obtained in the Single-entry bookkeeping system exam are equal in each year.
An alternative hypothesis is:
H1: The medians of marks obtained in the Single-entry bookkeeping system exam vary from year to year.

RESULTS AND DISCUSSION

Implementation of economic software in accounting teaching

The cooperation with the software company Kros was established in 2020. This company provided free educational licenses of Alfa plus, Omega and Olymp economic software. In the last academic year, Alfa plus accounting software became a part of the teaching process in the Simple-entry bookkeeping system course. This accounting software offers a solution for single-entry bookkeeping, tax records or flat-rate expenses. It allows to account for income and expenses, issue invoices, orders, or tax returns. Regarding the development of the epidemic situation in the autumn of 2020, the Slovak University of Agriculture decided to educate students by the distance method. Taking into account the measures, it was necessary to consider how the seminars from the course Single-entry bookkeeping system will take place, as the necessary software for single-entry bookkeeping was installed in the classroom in the building of the Faculty of Economics and Management. The software company Kros offers the opportunity to try single-entry bookkeeping in the Alfa plus accounting software through a free demo version, which allows to fully account for a period of three months. This demo version provided a solution to the problem of how to enable students to work in an accounting software within distance learning.

Organization of distance accounting teaching

Before starting online teaching, it was necessary to consider which way of conducting lectures and seminars would be the most suitable for ensuring quality distance education. The lectures were given as "live" lectures through the Microsoft Teams application. Regarding the

seminars to be conducted in the accounting software, the following requirements were set in order to search for the optimal solution:

- Students must be able to follow the teacher´s work in the accounting software.
- Students must be allowed to listen to the teacher's accompanying word at the same time.
- Students must be allowed to take notes during the teaching.
- Students must be able to solve tasks in the demo version of the taught accounting software simultaneously with the teacher.

The requirements set in this way showed that the originally considered "live" teaching in the accounting software through the Microsoft Teams application with the possibility of sharing the screen of the teacher's computer during his work in the accounting software will not allow to meet all these requirements. Therefore, we chose to make video tutorials that allow students working in the demo version of accounting software to acquire skills with working in the accounting software as well as in the distance education.

Video tutorials were made using OBS Studio software, which was recommended by the Centre of Information Technologies of the Faculty of Economics and Management of SUA in Nitra for this purpose. It is open source software that allows:

- record desktop and desktop activity along with computer audio to video format,
- record sound from the microphone - the accompanying word of the teacher,
- upload a webcam image,
- upload unlimited videos,
- convert recordings to mp4 format,
- pause video recording,
- easy operation with keyboard shortcuts.

During the preparation of video tutorials for working in the accounting software, the need arose to find a tool for video editing, which would facilitate the work of creating video tutorials. From the available freeware software, MiniTool MovieMaker was chosen, which allows:

- merge multiple videos into one,
- split one video into several,
- remove unwanted parts from a video.

MiniTool MovieMaker offers a simple user interface suitable for beginners and allows to edit videos without a watermark as well.

As the students worked in the demo version of the accounting software according to the prepared video tutorials in the home environment, it was necessary to ensure control of their work in the accounting software. The given accounting software allows to transfer issued accounting documents, tax returns, accounting books and various print reports to pdf format. This function of the accounting software was used to control the work of students in this accounting software. Within the individual video instructions, students were given tasks, which they demonstrated by issuing the relevant accounting documents exported in pdf format and sharing with the teacher via the Microsoft OneDrive cloud storage, which is a part of Office 365. Accounting documents were issued by students so that their name appeared as the name of the employee who issued the accounting document at the relevant accounting documents (see Figure 1).

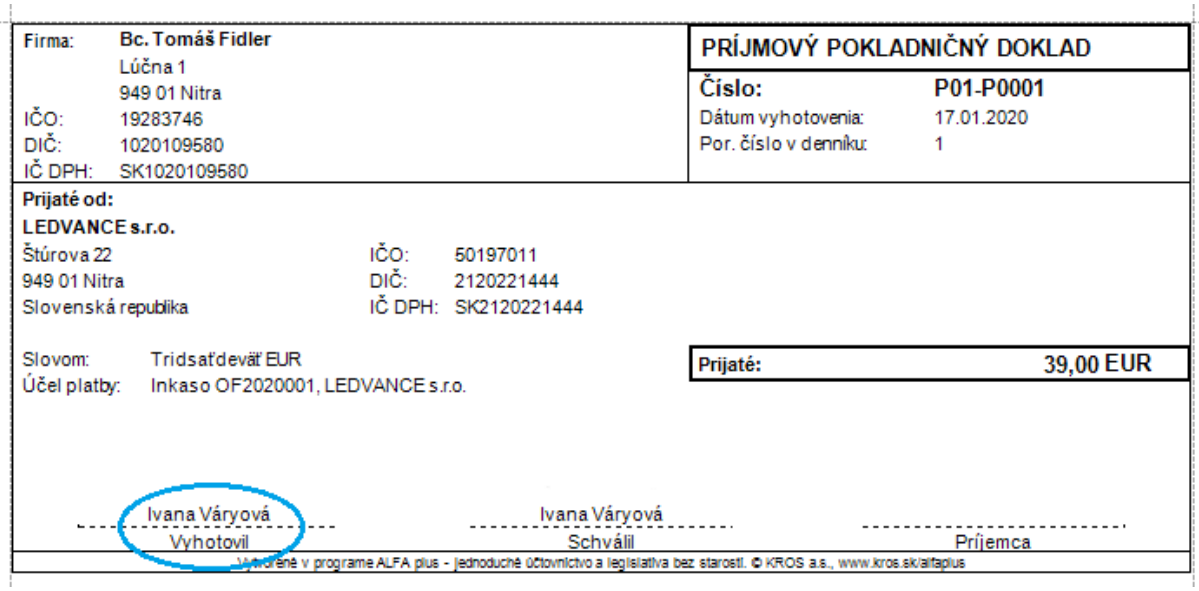

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Figure 1 The accounting document prepared by the accounting software
Source: authors

Evaluation of examination results from the course Simple-entry bookkeeping system

The analysed data were obtained from the teaching of the course Single-entry bookkeeping system, while we focused on the results of examinations in the period from 2017 to 2021. In the first three assessed academic years, the full-time examination took place in a written form through open-ended questions tests. In the last assessed academic year 2020/2021, it was necessary to switch to the distance form of examination. The examination in the course Simple-entry bookkeeping system took place in the form of closed-ended questions tests with options from which to choose a correct response. These tests were created through Microsoft Forms. This web application can be used to easily create tests, surveys, polls and quizzes. An overview of the marks obtained is presented in Table 1.

Table 1 Evaluation of examination results in individual academic years

Academic year	Evaluation of examination results						Number of successfully completed students
	A	B	C	D	E	Average grade	
2017/2018	86	5	27	9	3	1.38	130
2018/2019	81	1	36	2	15	1.52	135
2019/2020	82	0	12	2	2	1.19	98
2020/2021	8	6	15	14	15	2.19	58

Source: authors

Graphic processing of students' success in the exam as regards the term order (1st, 2nd and 3rd term) is presented in Figure 2. In order to explain, we state that the 1st term is also called a "regular" term. The other two terms (2nd and 3rd) are also referred to as the "correction" term. We see that in the studied years, the highest success rate on the 1st term was achieved by

students in academic year 2020/2021. At the same time, we see that a minimum percentage of students participate in the 3rd term. As we can see, the worst average grade was achieved by students also in academic year 2020/2021 when the distance education started.

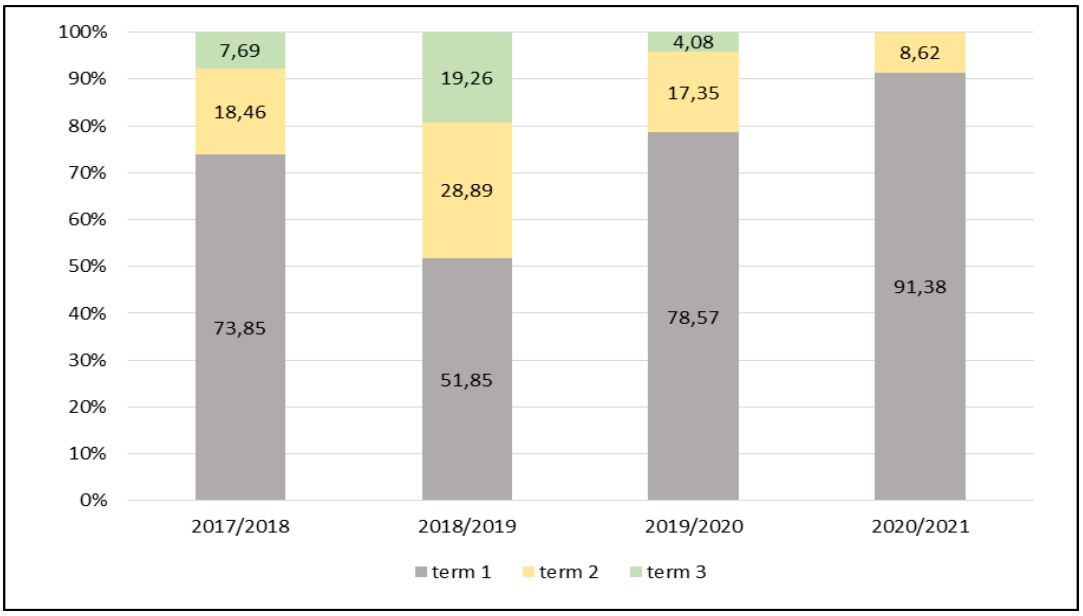

Figure 2 Students´ success rate according to the term
Source: authors

Graphical representation of marks using box plot graphs (Figure 3) shows differences in comparison over the years. In academic years, the research teams had about the same number of students and the teaching took place in a contact form. In the years 2019/2020 and 2020/2021, the number of students in the research samples decreased, while in 2020/2021 the teaching took place only in a distance form.

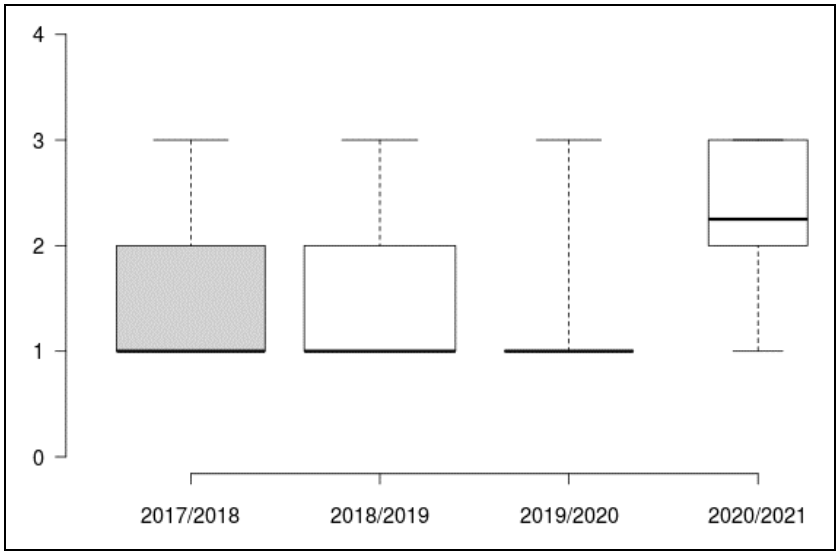

Figure 3 Box plot of examination results according to academic years
Source: authors

We used the Mann-Whitney U Test (Table 2) to verify statistically significant differences between the marks in the individual academic years. The test results confirmed that there were no statistically significant differences between 2017/2018 and 2018/2019 (p-value 0.242). In all other cases, the p-value is less than 0.05, which was the selected significance level of the used test. Thus, statistically significant differences in the marks from the exam were confirmed between the assessed years (except for the first case).

Table 2 Results of Mann-Whitney U Test

Compared years	2017/2018	2017/2018	2017/2018	2018/2019	2018/2019	2019/2020
	2018/2019	2019/2020	2020/2021	2019/2020	2020/2021	2020/2021
p-value	0.242	0.027*	0.000*	0.000*	0.000*	0.000*

Source: authors

CONCLUSIONS

In the distance form of education, it is necessary to place increased emphasis on the quality of teaching, as distance education replaces the direct contact with teacher´s communication with students through information and communication technologies. In order to ensure quality distance learning within the course Single-entry bookkeeping system, we chose the creation of video tutorials that allowed students to gain skills with working in the accounting software in the home environment through a free demo version. It can be stated that this way of performing the seminars suited the students, as they had the opportunity to return to the video tutorials. Students consider this to be a great advantage compared to "live" teaching, when the issue of working in the accounting software would be explained to them once, without having to capture the whole sequence of work steps. Video tutorials enabled students to work and solve assigned tasks in the accounting software at an individual pace of their work.

Analysis of the test results showed that there were statistically significant differences between the assessed years in five out of six cases. In the last two assessed academic years, pandemic constraints have intervened in the teaching process. This was the main reason for the changes in teaching methods at the university, to which both students and teachers had to adapt very quickly. The evaluation also showed, that in the academic year 2020/2021 when the distance teaching started, the highest success rate on the regular term and at the same time the worst average grade was achieved by students.

Distance education will not fully replace the full-time method of the educational process, but the current situation has allowed us to gain valuable experience with online learning, which will certainly be used in the future.

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Original Paper

Managerial key competencies from students´ point of view

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ABSTRACT

Faculty of Economics and Management of the Slovak University of Agriculture in Nitra (FEM SUA) in the Slovak Republic provides the students with complex study for granting managerial – economic skills necessary for practice. The aim of the paper is to analyze key competencies of managers in practice and teachers, as managers of the teaching process, from students´ point of view at FEM SUA in Nitra. For better employment of the FEM SUA graduates in practice the key competencies of managers have a huge significance, and their identification is inevitable for them to become successful managers in companies throughout Slovakia and the world in the future. A part of the paper is the questionnaire survey focused on findings of key competencies of managers and teachers as a manager of the teaching process (defined according to Belz & Siegrist) from students´ point of view that are assessed as the most important within employment in practice by the FEM SUA students. From results follows that up to 72% of respondents consider ability of manager to solve problems and creativity as the most important key competence of manager. Another result of the research is that up to 82% of respondents chose the sense of justice as the most important key competence of the teacher as a manager of the teaching process.

KEYWORDS: key competencies of managers, university education, questionnaire survey

JEL CLASSIFICATION: A2, C1, J5, M1

INTRODUCTION

The Faculty of Economics and Management of the Slovak University of Agriculture in Nitra (FEM SUA in Nitra) is providing quality economic and managerial education within the accredited study programs [7]. The main goal of the study program Company Management on the bachelor level of the study is to provide the students with knowledge from the managerial

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economical field of the company with aspect on domestic and international environment. Such knowledge based on the study of the subjects provide the students with the possibility to perform managerial functions on lower level and on the middle level of company management as well [12].

The graduate of the study program – future manager – after graduation at the FEM SUA in Nitra is able to solve less demanding managerial economical decision-making issues of the company. They can perform the first level, middle level managerial functions and positions in companies focused on agricultural, food, as well as economical industry [5].

According to Országhová [9] "understanding appropriate managerial competencies within the studies at the FEM SUA in Nitra is an important educational priority of the study at this faculty. The graduates of the economic faculties are professionally trained to work in the fields of economics, management, marketing, banking, finance, insurance, social services, in general, and in many other areas."

For the university graduates with economic and managerial focus it is important to know what abilities and competencies the future employer might request. Except high quality education and vocational skills, the following key competencies in general are more and more requested:

- Ability to communicate (discuss, clarify, know how to formulate thoughts, present, process information and so forth),
- Ability and willingness to educate more, to improve own performance,
- Ability to solve problems and be responsible,
- Ability to work in team and cooperate,
- Social sensitivity, ability to motivate,
- Ability of numeric application, understanding statistical methods,
- Ability to deal with information technologies, ability to work with information,
- Understanding at least one, or better yet two foreign languages.

Findings of the recent years show that among main causes of failure of the graduates within seeking employment there are especially insufficient ability to present oneself, insufficient communicational skills, overestimating own abilities, and at the beginning of career development insufficient work productivity [8].

For present managers the important things are flexibility, ability to adjust to new conditions, as well as knowledge gained at a university or various courses and trainings within lifelong education. Companies need employees who are willing to educate themselves and develop their potential and furthermore people look for companies which offer possibility of development and education.

According to Dziekoński [3] very important are for example features related to personality (expressing confidence, self-confidence, intellectual abilities, creativity) and managerial competence (ability to assess the impact of action taken, ability to work in a team, ability to formulate goals, ability to deal with stress and ability to make decisions).

MATERIAL AND METHODS

Managers together with their abilities significantly influence competitiveness of a company. Economic results of companies are dependent on abilities of the management, and these can

be exactly expressed by competencies. There are many skills, knowledge, and abilities necessary for the managerial work. Only some of them make difference between excellent managers and average ones, these competencies must be found and defined to develop them further.

According to Prokopenko, Kubr et al. [10] competency of a manager "is his ability to perform a certain function or set of functions and reach a specific level of efficiency. Managers´ competencies are described according to division to certain components, mostly to knowledge, character features, attitudes, and abilities". Tureckiová [13] presents four components of professional competencies of managers, i.e. vocational (technical), methodical (conceptual), social and personal competence. The basic prerequisites to perform managerial work are vocational, interpersonal, analytical, conceptual prerequisites, enterprising and specific features to organize work of other people. Prokopenko, Kubr et al. [10] divide request on managers to four groups. The first group are analytical conceptual abilities (what to do), which means that on lower level of management the managers must understand basic tools of business like accounting, financial analyses, analysis of data and general knowledge and abilities. On the higher level of management these are ability to manage individual activities like marketing, finance, production, control, human resource management. The second groups are managerial process abilities (how to do it). This group involves the art of negotiation, communication, evaluation, time management and ability to set priorities. The third group are personal features and abilities, especially ability to work hard, being punctual, self-motivation, creativity, cultural adaptability and understanding, ability to work in team, self-confidence and knowing oneself, charisma, own system of values. The last prerequisite is a field know-how, which has three images, that is set of basic knowledge about products, services, technologies, production, distribution and marketing, as well as intimate knowledge of the environment and competition and nevertheless personal relationships with people. Armstrong [1] defines mutual features of managerial competencies of a manager and divided them to five characteristic groups (Table 1).

Table 1 Key competencies of a manager

COMPETENCE	
BEHAVIORAL /PERSONAL COMPETENCES	Basic characteristics of a person which are naturally transferred to working activities: interpersonal skills, leadership, orientation on success, analytical skills. These competencies are used in favor of performance, within selection and development of employees.
WORK COMPETENCES	Set of competences belonging to expected performance and goals on workplace involving professional qualification.
GENERIC, BASIC, SPECIFIC COMPETENCES	Generic competences are related to managers of the same or similar working position. Basic competences are disposable for all the employees, each category of employees. Specific competences are related to specific job.
PERFORMANCE COMPETENCES	Inevitable for performing specific job.
DIFFERENTIATING COMPETENCES	Differ highly performing managers from less performing ones.

Source: [1]

Managers must be able to analyze and identify problems and decide how to solve those problems. They also need to know how to plan, organize, and control the processes in a company. Their task is to lead people as well, though, and motivate them. Managers are responsible for running companies and their nature of work differs according to the level of management. A manager must have proper knowledge and skills. Managers work via their subordinates, manage their work, they are responsible for elaboration of given tasks, motivate their subordinates in accordance with the needs of a company.

According to Slobodová & Šulík [11] typical managerial competencies are as follows:
1. Business spirit and entrepreneurial thinking.
2. Strategic thinking.
3. Ability of communication, representing and cooperation.
4. Ability to solve problems in new situations.
5. Self-control, self-motivation and internal independence.
6. Change management.
7. Leadership.

Belz & Siegrist [2] divide key competences of managers to seven characteristic groups given in the scheme below in the Figure 1.

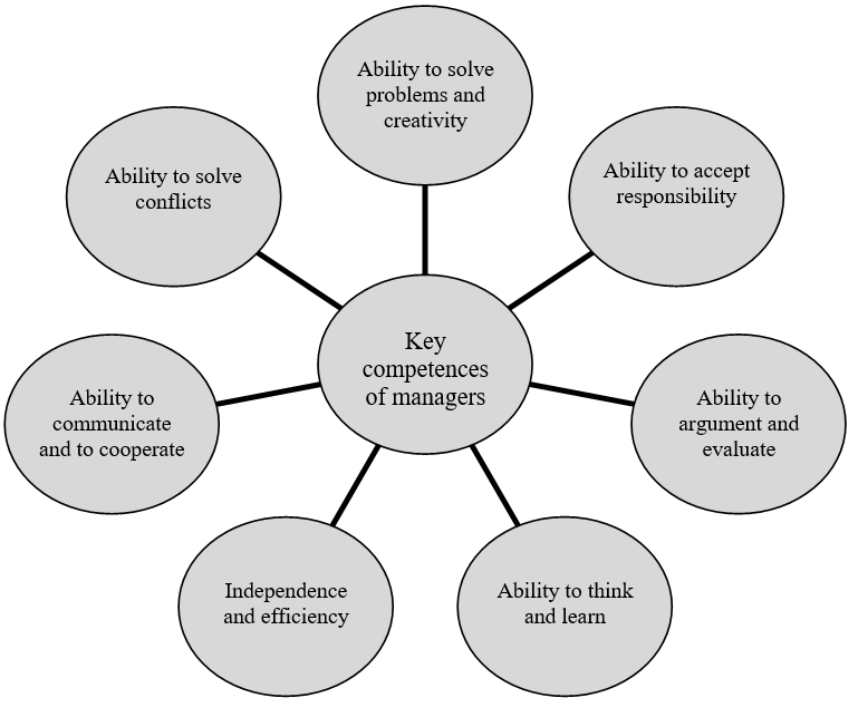

Figure 1 Key competences of managers
Source: [2]

The aim of the paper was to analyze key competencies of managers in practice and teachers, as managers of the teaching process, from students´ point of view at FEM SUA in Nitra. The evaluation of the questionnaire survey was carried out using selected methods of mathematical statistics. Student´s data for analysis were obtained via the questionnaire survey.

RESULTS AND DISCUSSION

We asked 102 FEM SUA in Nitra students of the third-year study about the given key competences of managers in practice and the teachers, as managers of the teaching process, which represents approximately 32% of the total number of students of the 3rd year study at FEM SPU in Nitra.

The aim of the questionnaire survey was to find out which of the above mentioned seven competencies of managers (according to Belz & Siegrist, [2]) they consider as the most important within application in practice. The students had a possibility to select various answers. The most, 72% respondents answered that ability to solve problems and creativity were the most important key competence of managers, then the respondents selected independence and efficiency (68% of respondents), then ability to argument and evaluate (56% of respondents), followed by ability to communicate and cooperate (54%), then ability to accept responsibility (50%), then ability to think and learn (48%) and last ability to solve conflicts (45%). The evaluation of the survey is shown in the Figure 2.

Figure 2 Evaluation of the survey about the key competences of managers from students´ point of view
Source: authors

Figure 3 shows the students' answers to the question about the personality characteristics of the teacher as a manager of the teaching process. The students had a possibility to select various answers. The most, 82% respondents answered that ability to communicate and cooperate were the most important key competence of teacher as a manager of the teaching process, then the respondents selected ability to argument and evaluate (74%of respondents), then ability to solve problems and creativity (61% of respondents), followed by ability to solve conflicts (60%), then ability to accept responsibility (57 %), then ability to think and learn (51%) and last independence and efficiency (47%).

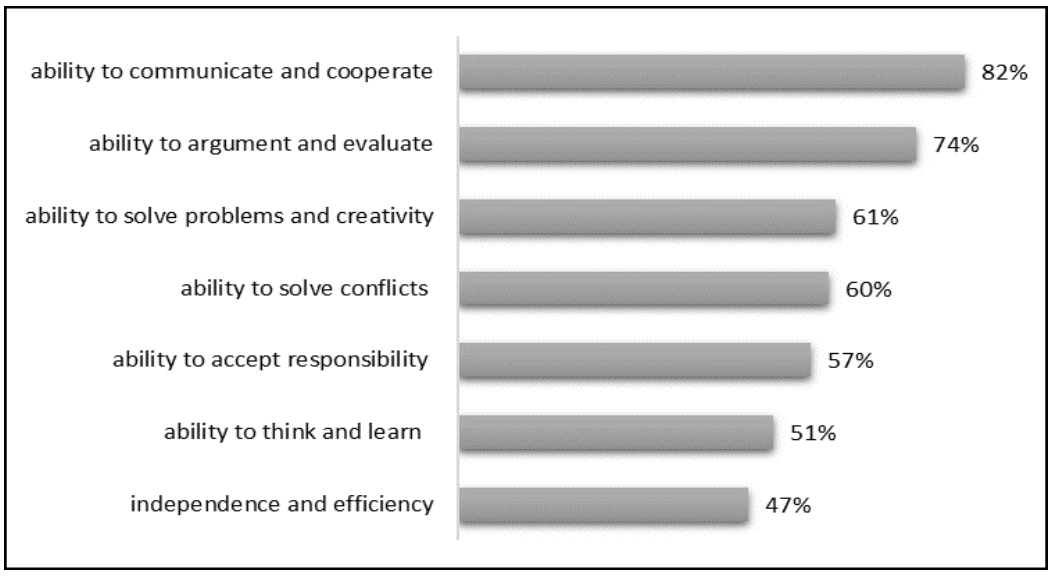

Figure 3 Evaluation of the survey about the key competences of teachers as a manager of the teaching process from students´ point of view
Source: authors

CONCLUSIONS

Identification and characteristic of key competences of managers is, for the FEM SUA students, a part of complex studies for gaining managerial economic skills for practice of the graduates of FEM SUA in Nitra. It is important to realize that key competences may differ according to company because each company has their own key competences. According to Goliński et al. [4] "it is also important the attention to the necessity of precise and up to date describing of entrepreneurs needs for specific competencies and skills and possibility to declare acquired skills by people seeking employment".

From the economic point of view key competences contribute to effectiveness of given plans, management of company and its employees. For each company it is important to identify key competences inevitable for performance of given tasks. "From a professional manager a right level of management knowledge is required. In this case, both the practical and theoretical knowledge are needed. Just theoretical knowledge may be insufficient. Given the scope of management competences which are related to entire enterprises, the ability to structure knowledge and its practical application are necessary" [6].

The aim of the paper was to analyze and define key competences of managers in the context of education at the FEM SUA in Nitra which give good basis to graduates of the FEM SUA in Nitra within application in practice. Lifelong education and practice provide managers with appropriate knowledge, skills and experience to make successful managers in companies throughout Slovakia, and in the world as well, out of them in the future. A part of the paper was the questionnaire survey aimed at finding which one of the presented seven managers' key competences students of the FEM SUA in Nitra consider as the most important key competence within application in practice. From the results given we can see that up to 72% of respondents consider ability of manager to solve problems and creativity as the most important key competence of manager. Another result of the research is that up to

82% of respondents chose the sense of justice as the most important key competence of the teacher as a manager of the teaching process.

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Original Paper

Seminary projects in the process of obtaining mathematics knowledge, digital skills and time management competences

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ABSTRACT

University study consists of a variety interconnected tasks that student must complete to pass exams. Seminary projects are part of the study of mathematical subjects and assessment of students' knowledge. In this paper, we analyze a set of seminary projects in mathematics, which students elaborated and sent for evaluation in electronic form. The main goal of the paper was to analyze the time interval of uploading projects into the university information system and to compare the score of particular projects. The approach of students to seminary projects in terms of time management was the basis for determining the uploading models using tools for expressing trends in MS Excel. Results of analysis confirmed that part-time students are able to use digital tools and methods of individual learning in the process of obtaining and development of mathematics knowledge.

KEYWORDS: mathematics knowledge, seminary projects, individual study, digital skills, time management

JEL CLASSIFICATION: I21, C02

INTRODUCTION

The aim of mathematical education in economic and managerial study programs is the theoretical and practical training of future graduates who will apply the acquired knowledge, professional expertise and creative thinking in solving practical problems. Quantitative and qualitative analysis of students' knowledge, evaluation of the impact of digital forms and methods of e-learning on students' knowledge are the subject of pedagogical research focusing on current issues of mathematics education.

Information technology (IT) and digital educational applications influence the course of the educational process and have brought many changes in the competencies of teachers and students [6]. Electronic forms and means of education bring new elements to the work of

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teachers and enable to support students' activity in their studies [5], [8]. The development of competencies in a complex form is important in the context of expected changes in the professions and the employment of graduates in the near future [10]. During distance learning, digital competences come to the fore as an important factor in learning and acquiring knowledge [9]. Educators bring new possibilities of using information technology tools in the teaching various topics and acquiring knowledge with new methods [1]. Students have access to educational materials, electronic courses created in digital space, graphics and computer software [2], [7]. IT enables the creation of electronic materials and educational courses in mathematics in a logical sequence, the complexity of tasks to be adequately graded and the process of study systematically arranged. The results of the educational process are evaluated using various factors and include students' grades obtained in exams [4].

Electronic forms of education are supported by study materials in various forms, in educational platforms (e.g. university systems, LMS Moodle, MS Teams), e-learning includes e-mail communication, new educational and digital applications. The wealth of information and the digital learning environment requires students to have clearly defined priorities and deadlines. Universities provide support to their students through counseling centers on how to improve time management and create a plan with priorities in meeting tasks, projects and study goals (e.g. [3]).

Mathematical subjects are also included in the study programs of the Faculty of Economics and Management of the Slovak University of Agriculture in Nitra. Students will apply the acquired knowledge in application tasks and in the study of professional subjects. Distance learning during the coronavirus pandemic separated teachers and students, so it was necessary to include activities in mathematics that would support motivation to study. Seminary projects are among the methods that support active and individual study and are a means of individualizing education. Acquiring knowledge through seminary projects is the basis for successful completion of the course by exam. In this paper, we focused on the analysis of selected factors of seminary projects in mathematics, which were elaborated by students of economic study programs.

MATERIAL AND METHODS

Study subject Mathematics IA belongs to the group of obligatory subjects of bachelor study programs “Accounting” and “Business Management” that are provided by the Faculty of Economics and Management, the Slovak University of Agriculture in Nitra. Main source of research data was completed from mathematics seminary projects in the winter term of academic year 2021/2022. Research sample consisted of 31 students of the 1st year in the part-time study.

During individual study they elaborated five seminary projects with these topics:
Assignment no. 1: Functions with one variable, graphs and features.
Assignment no. 2: Asymptotes of a function graph.
Assignment no. 3: Derivative of a function with one real variable.
Assignment no. 4: Application of derivative to find function monotonicity and local extremes.
Assignment no. 5: Application of derivative to find function concavity and points of inflection.

For each assignment, the student could get a maximum of 10 points, a total of 50 points, which were part of the evaluation on the exam. At the beginning of the semester, students received detailed instructions from the teacher on how to process the seminary project, create an electronic version and upload it into the created repository in the University Information System (UIS) with deadline for submission. Students knew conditions about points score during the semester and how points are included in the evaluation in mathematics exam.

We analyzed students' mathematical knowledge through an average of project scores. Students had to apply digital skills to create an electronic version of the project. To evaluate the competencies of students in terms of time management, we used own methodological procedure, which is based on a comparison of the section 7 days before the deadline for inserting the project into the repository. We used MS Excel tools to determine uploading models for seminary projects.

RESULTS AND DISCUSSION

During distance learning in a time of coronavirus pandemic (March 2020 - December 2021), the mathematics seminar project became an important part of assessing students' knowledge. During the semester, students gradually study mathematical topics and elaborate seminary projects. Projects in the electronic version are placed in a designated repository (UIS), where they are accessible for evaluation by teacher. It is important for students to satisfy time conditions of the project, because it is not possible to upload the project after the deadline. In this case, the student must communicate with the teacher to justify the delay and with the consent of the teacher can submit the work by e-mail. Mentioned phases of the project work combine mathematics knowledge, digital skills and time management competencies.

As mentioned above, the students had to work out 5 assignments in the winter semester of 2021. Students received instructions from the teacher and knew conditions about projects elaborations. We analyzed the time period of 7 days when students entered assignments into UIS and we arranged the data according to the date of project submission. Students who submitted a project more than 7 days before the deadline are listed together in the value "Before" data. Students who, for various reasons, missed the deadline and apologized, were able to submit their work by e-mail. These students are listed together in the value "After".

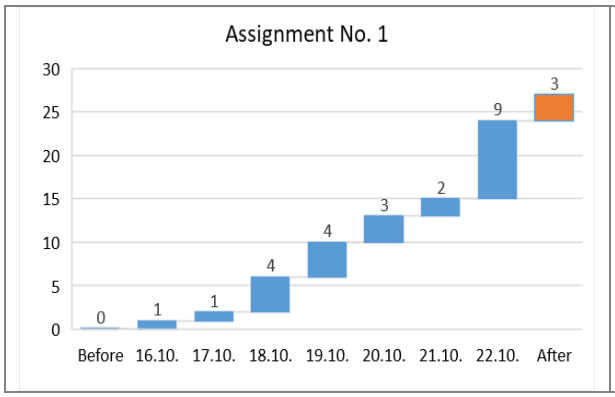

Figure 1 Days of uploads for projects ASS 1
Source: author

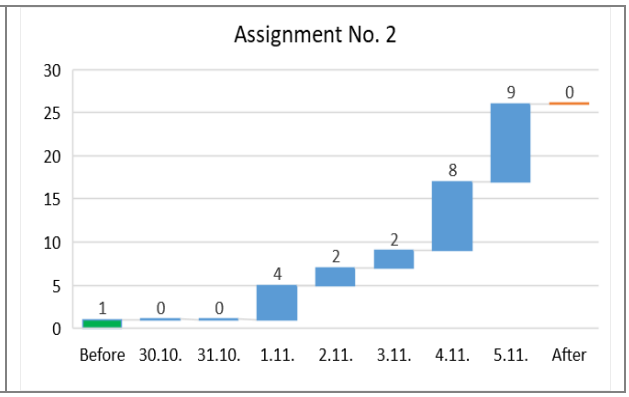

Figure 2 Days of uploads for projects ASS 2
Source: author

Pictures (Fig. 1 - Fig. 5) show the graphical processing of the project submission time interval. Assignments are marked with the abbreviation ASS and with the serial number. We see that in all five cases the insertion of projects was gradual, while on the deadline the largest number of projects was uploaded into the repository (we remind, that each assignment was entered by a different number of students together).

- The first assignment ASS 1 was crucial for students. Within the first monitored 7 days' period the largest number of projects (9) was entered exactly on the deadline day. No student submitted the project more than 7 days before the deadline.
- In elaboration of ASS 2 students applied experience from the first project. We see the same number of projects uploaded on the deadline day (9, in comparison with ASS 1). And at the same time, we register the largest number of submitted projects one day before the deadline (8, out of all five seminary projects). In addition, no student submitted the ASS 2 after the defined deadline.
- When analyzing ASS 3 (and also ASS 5) we see 3 submitted assignments 7 days before the deadline.
- On the assignment ASS 4, we can mention these differences: the largest number of students submitted a project on the deadline day (12, out of all 5 projects). No one submitted the project until 7 days before the deadline.

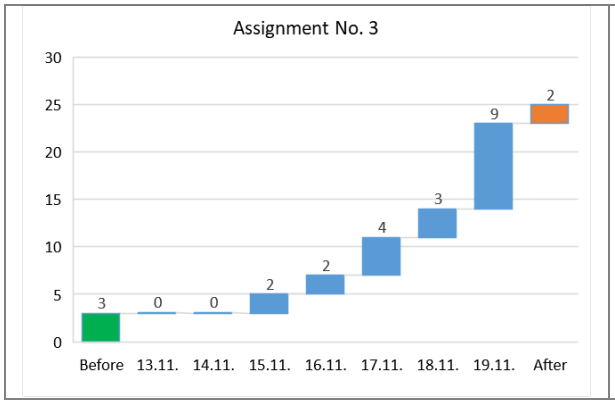

Figure 3 Days of uploads for projects ASS 3
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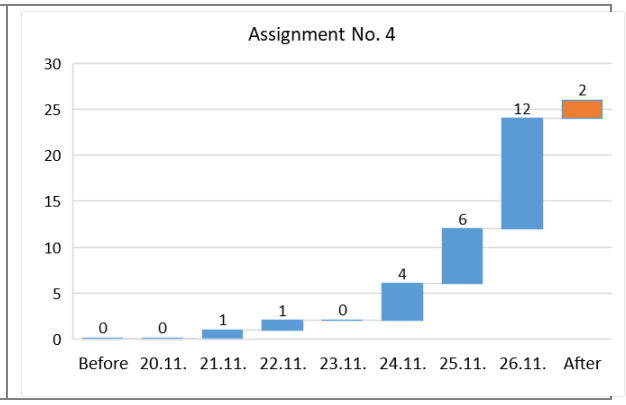

Figure 4 Days of uploads for projects ASS 4
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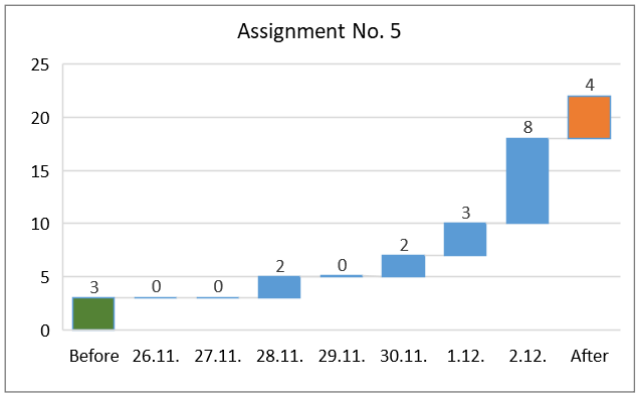

Figure 5 Days of uploads for projects ASS 5
Source: author

- When elaborating ASS 5, students could apply all experience from previous assignments. On the deadline day, the largest number of assignments was entered again (8) and the largest number of students (4) submitted the assignment after the deadline (out of all 5 assignments).

To evaluate all assignments, we marked the period of 7 days as follows: the day of the deadline is D and gradually one day before the deadline is 1D, two days before the deadline 2D, etc., up to 6 days for the deadline 6D. We merged the projects entered earlier (or later) together and included them at the beginning (or end) of the time interval. The number of submitted assignments 7 days before (or after) deadline D is in the data "Before" (or "After"). An overview of all submitted seminar projects, expressed in a percentage in relation to the day of submission, is shown in Fig. 6.

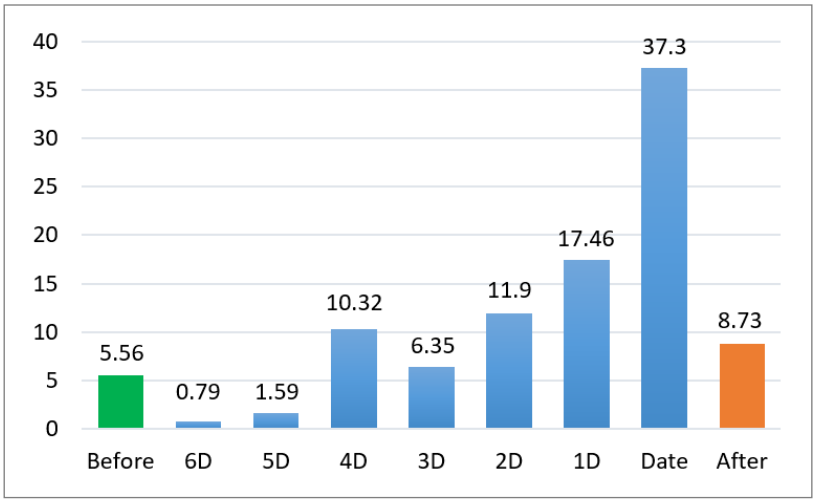

Figure 6 Days of uploads for all projects (in percentage)
Source: author

The analysis shows that most projects were submitted on the day of deadline D (37.3%) and on day 1D before the deadline (17.46% of projects), which is a total of 54.76% of all evaluated projects. There are also active students in the research group, as 5.56% of projects were submitted 7 days before the deadline. 8.73% of projects were submitted after the deadline. The reasons for the delay varied, from problems with technology, digital applications, file size, to the student's personal reasons.

The analysis of time data on the submission of seminary projects and the scoring of elaborated projects will help a teacher to find out how a group of students works on individual tasks. Using tools for expressing and displaying trends in MS Excel, we created two models for projects uploading with the prediction.

The first model M1 (Fig. 7) is based on data about all projects uploaded till the deadline (projects after deadline were excluded):

$$\text{M1: } y = 1.4583x^2 - 8.1369x + 13.84;\ R^2 = 0.9036.$$

The model has increasing values, while x is the day of submission. Students are submitting more projects as the date of deadline is approaching.

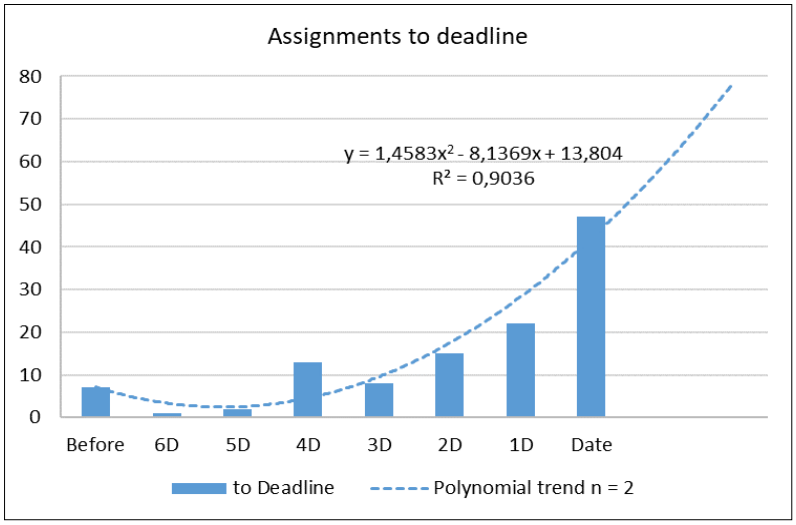

Figure 7 Uploading model M1 with trend line (projects uploaded to deadline)
Source: author

The second model M2 (Fig. 8) is approximating data about projects submitted after deadline (with the permission of teacher):

$$\text{M2: } y = 0.5714x^2 - 3.0286x + 5;\ R^2 = 0.9036.$$

The model is increasing, while x is the serial number of assignment. Presented model does not include reasons of students for late project submission.

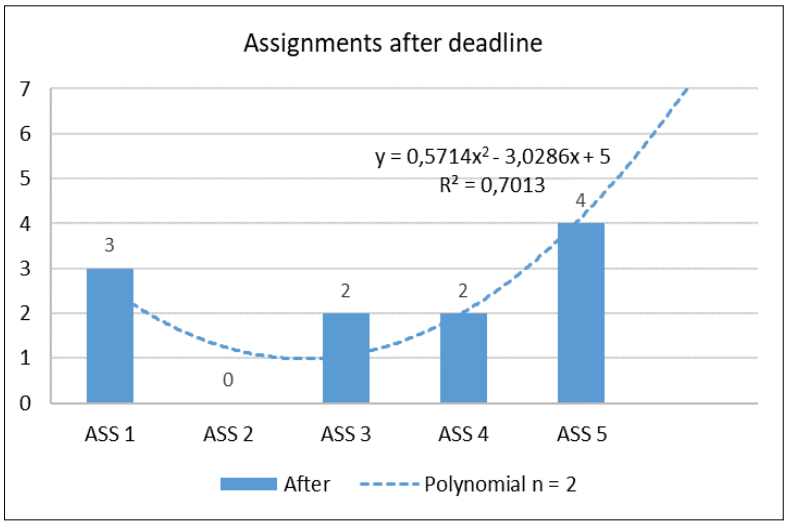

Figure 8 Model M2 with trend line (projects uploaded after deadline)
Source: author

Each seminary project represents a test of these three factors: mathematical knowledge, digital skills of creating an electronic form of the project and time management activities. In the next part we present an analysis of the point score of students from the completed assignments, obtained on the basis of mathematical knowledge (Fig. 9). The average number of points from all submitted assignments is 9.05 (out of 10 possible points). We see that the obtained scores

differ according to the particular assignments. The average number of points from the assignment ASS 1 is 8.63. Because this was the first seminary project, the students started to obtain necessary skills and achieved the least points.

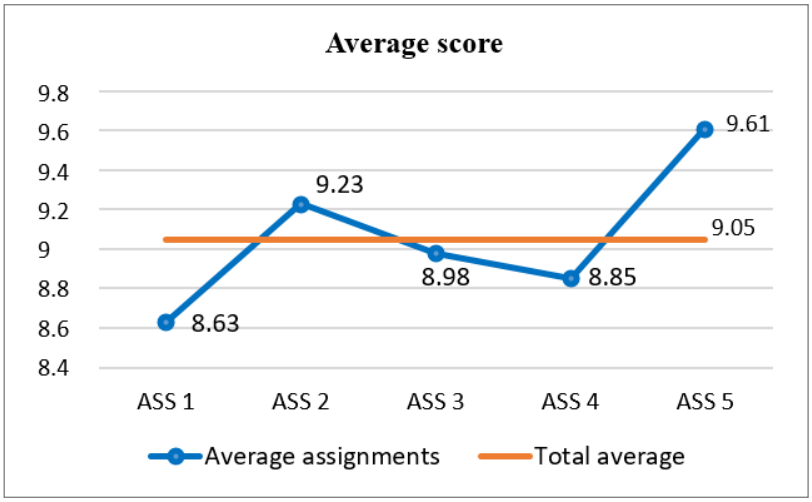

Figure 9 Average score in particular assignments and total average score
Source: author

The second seminary project ASS 2 was on a topic that is new to university students. The average score of 9.23 indicates that students understood the topic and processed it with only minor errors. Assignments ASS 3 and ASS 4 again included new topics for students, the point score worsened compared to ASS 2. The average number of ASS 5 assignment is the highest of all (9.61), where students were motivated to get a good score for the exam. The content of ASS 5 followed the ASS 4, so students understood the mathematical method and solved the problems correctly.

Students have associated the submission of a seminary project with a certain amount of stress, whether tasks are solved correctly and whether the file will be uploaded to the repository correctly. Time management is very important for external students, because some of them also work or have their own family with children. The points score and the uploading time of projects will show the teacher what needs to be discussed with students. Find out what problems they had in elaborating and submitting the project (mathematical, technical, digital, time management, other) so that they could subsequently improve their preparation for the mathematics exam.

CONCLUSIONS

Seminary projects are a means of individual study and place demands on the student's self-learn skills. Seminary projects activate students, which is important in the educational process at the university. In this paper, we analyzed seminary projects in the study subject Mathematics IA, which were elaborated by first-year bachelor's students in the external form of study at the Faculty of Economics and Management, the Slovak University of Agriculture in Nitra. The content of the seminary projects included mathematical problems on the studied topics. Seminary projects are the part of the preparation for the exam and during their processing students gain new knowledge.

The analysis shows that students have the knowledge and skills needed to elaborate a project. It is a combination of digital skills and time management competencies that have been used in the process of acquiring mathematical knowledge. From the point of view of time management, it follows that students solve projects and enter them into UIS gradually, even though the largest number of students entered the completed assignment on the last possible day. Obtained results are important for pedagogical communication, so that students could apply the necessary changes in the time management of projects, devote more time to the study of problematic topics and be able to obtain higher points in the mathematics exam.

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