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Original Paper

Knowledge and skills in mathematics among 1st year students at the Faculty of Economics and Management SUA in Nitra

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ABSTRACT

In our paper we evaluate the level of mathematical knowledge and skills of students of the Faculty of Economics and Management of the Slovak University of Agriculture in Nitra in the winter semester of the school year 2023/2024. The students wrote 4 homework and 1 school paper evaluated with 55 points, of which at least 30 points were needed to obtain credit. The final exam paper worth 50 points was written in person on the campus of our university. They needed to have a total of at least 64 points so obtained to obtain an overall grade in Mathematics I A. Out of a total of 105 points, students scored an average of 75, which is only 71.5%. Only 73.13% and 80.33% of those who started and completed the semester, respectively, successfully completed the course and obtained a grade in the Mathematics I A examination. The evaluation of the obtained data was done by the method of mathematical descriptive statistics. We calculated the mean scores of the individual components and the total scores obtained by the students and entered these in a table. We also calculated correlation coefficients, with the help of which we found out whether if a student masters one subject unit it will affect the learning of another. It is probably logical that students scored more points for homework than for work written at school.

KEYWORDS*:* verification of mathematical knowledge and skills, home and school written work, evaluation of the data obtained

JEL CLASSIFICATION: C02, C11, I210

INTRODUCTION

For the third school year we have decided to test the knowledge and skills acquired by students in the subject Mathematics I A at the Faculty of Economics and Management of the Slovak University of Agriculture in Nitra in two forms. One part by means of home written assignments and one part and an exam in contact at school. Assessing a student's mathematics

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and mathematical literacy is not just about making judgments about the student's abilities. It is to monitor the student's understanding of mathematical language, concepts and skills and what he or she must do to succeed.

Thomas A. Romberg (1992) in his Mathematics Assessment and Evaluation (Imperatives for Mathematics Educators) discusses how authentic mathematics achievement can be assessed. Patrick M. Jenlink (2020) in his The Language of Mathematics. How the Teacher's Knowledge of Mathematics Affects Instruction argues that the complexity of teaching mathematics is undeniable and all too often ignored in the preparation of teachers with substantive mathematical content knowledge and mathematical teaching knowledge. In Assessing Mathematical Proficiency, Alan H. Schoenfeld (2007) argues that testing matters. It can determine kids' and schools' futures. In a conference at the Mathematical Sciences Research Institute, mathematicians, maths education researchers, teachers, test developers, and policymakers gathered to work through critical issues related to mathematics assessment. They examined: the challenges of assessing student learning in ways that support instructional improvement; ethical issues related to assessment, including the impact of testing on urban and high-poverty schools; the different (and sometimes conflicting) needs of the different groups; and different frameworks, tools, and methods for assessment, comparing the kinds of information they offer about students' mathematical proficiency. Also, Lesh and Lamon (2013) assess authentic performance in school mathematics. Hornyák Greganova and Váryová (2022) examine testing instruments in their work. Digital learning methods and students' level of knowledge in mathematics are addressed by Matušek et al. (2021). Hornyák Greganova et al. (2022) in their work use mathematical and statistical methods in the analysis of learning outcomes of students of economics and management. Cígler (2018) deals in details with mathematical abilities and mathematical skills, stating the main differences, ways in which they arise and could be measured. Pechočiak and Kecskés (2016) say that the use of mathematical and statistical methods not only allows for the detection of the occurrence of certain phenomena in the new global environment, but indirectly requires special attention. Also Országhová et al. (2013) state in their work that mathematical knowledge becomes permanent only if students sufficiently understand mathematical concepts with their logical meaning and process them appropriately.

MATERIAL AND METHODS

In our work we investigate the acquisition and verification of knowledge and skills in mathematics among students from three study groups studying at the Faculty of Economics and Management of the Slovak University of Agriculture in Nitra. A total of 72 students were enrolled in these 3 groups. Of these, five did not start their studies at all at the beginning of the semester, which means that 67 students started their studies. Six students dropped out (without giving any reason) during the semester. Of these, 2 after the first week, one each in the seventh, eighth and ninth weeks and one even just before the end of the semester in the eleventh week. Thus, only 61 students completed the semester, which is 84.72% of those who were admitted to the studies. Of these, 3 students did not meet the requirements for credit, i.e. they did not score at least 30 points out of 55 during the semester. Students could earn these points by completing 4 homework assignments for 10 points each and 1 written paper written at school for 15 points. Students had a full week to complete the homework assignments. Each assignment consisted of 3 problems related to the material covered in lecture and

practiced in the exercises, over a period of one week, with one problem being theoretical (except for the 2nd assignment). A list of all theoretical questions was given to students at the beginning of the semester. Thus, students were able to use their lecture notes, the problems worked out and practised in the exercises and, of course, the recommended literature to prepare the assignments. Examples of these homework assignments are given:

Assignment 1:

1. View the graph of a linear function *f* and write its properties if $f: y = -8x + 24$.
2. View the graph of a quadratic function *g* and write its properties if $g: y = x^2 - 9x + 14$.
3. Write the definition of a simple function and sketch the graph of it.

Assignment 2:

Given a function $f: y = 4^{x+1} - 32$.

1. View the graph of the function f (exponential function).
2. Express the inverse of the function f^{-1}.
3. View the graph of the inverse function f^{-1} (logarithmic function).

Assignment 3:

1. Use the one-sided limits to find the asymptotes without the directive for the graph of the function $f: y = \frac{3x^2}{x+1}$. Plot the found asymptote in the coordinate system.
2. Find the equation of the asymptote with directive for the graph of the function $f: y = \frac{3x^2}{x+1}$. Plot the found asymptote in the coordinate system.
3. Write the definition of an asymptote with a directive.

Assignment 4:

1. Calculate the derivative of the function $f: y = 7x^2 \cdot \cos x$.
2. Calculate the derivative of the function $g: y = \ln\left(3x^2 + 7x - 2\right)$.
3. Derive the formula for the derivative of the function $\operatorname{cotg} x$.

The test written in school, for which students could earn 15 points, was also from the one week's material covered. Here is a sample:

1. Find the monotonicity intervals of the function $f: y = x^3 + 3x^2 - 9x + 1$.
2. Find the local extrema of the function $f: y = x^3 + 3x^2 - 9x + 1$.
3. Write the definition of a concave function and the definition of an inflection point.

About when they will develop or write the works and of which subject area, students were told at least a week in advance.

Students (three) who did not obtain the required number of points for credit, i.e. at least 30 points, were given the opportunity to correct their credit written work. The remedial credit written work consisted of five examples of 10 points each, each attributed to individual assignments written by the students during the semester and one from the school written work. We present a sample of such a remedial credit test:

1. View the graph of the function f, state what the function is called, what its graph is called, and list its properties if $f: y = x^2 - 25$.
2. Given a function $g: y = 3^{x+2} - 3$. Express the inverse function g^{-1}.
3. Find the equation of asymptote with directive for the graph of the function $h: y = \frac{2x^2}{x-1}$. Plot the found asymptote in the coordinate system.
4. Calculate the derivative of the function $y = 2x^4 \cdot \sin x$.
5. Find the intervals of monotonicity of the function $k: y = 4x^3 - 12x^2 + 8$.

Students were entitled to 2 make-up terms (regular term was during the semester). Neither student managed to get the required 30 points, so they had to "carry over" the course to the second year.

So out of the 72 students originally enrolled, only 58 students were able to take the exam. They were entitled to one regular and two make-up dates. The written examination paper consisted of 4 examples and several theoretical questions for a total of 50 marks. A set of 33 theoretical questions was given to the students at the beginning of the semester. These consisted of basic definitions and theorems or derivations of some formulas. A sample of one of the possible exam written papers is given:

1. Find the asymptotes of the graph of the function $f: y = \frac{2x^2}{x+3}$.
2. Find the intervals of monotonicity of the function $g: y = x^4 - 2x^2 + 5$.
3. Find the inflection points of the function $h: y = x^4 - 4x^3 - 18x^2 - 3x + 5$.
4. Find the local extrema of the function $k: z = 4x - y - x^2 - y^2 - xy + 5$.
5. Theoretical questions.

In order to receive a grade on the mathematics exam, the student must have written an exam written paper such that the sum of the points earned on the exam written paper and the points earned during the semester is at least 64. We determined the exam grade using the ECTS scale, in which the worst grade of E - sufficient is assigned for a total sum of points expressed as a percentage between 64 and 71, and for example, A - excellent is assigned for a student scoring 93 or more percentage points. The sum of the points obtained by the students in this way could have been 105, so we left 5 points as a bonus, i.e. the students needed a minimum of 64 points and not 67, which would correspond to a percentage of 105 points.

2 students did not show up for the exam at all. 7 students did not write a written examination paper for a sufficient number of points. Of these, 2 were only on one deadline, one was on two and 4 were on all 3 possible deadlines. So, in the end, 49 students successfully completed the course and obtained a grade in the mathematics exam, which is 80.33% of those who completed the whole semester or 84.48% of those who could sit for the exam, i.e., obtained credit. If we subtract the 2 students who did not sit for the exam, although they received credit, the proportion rises to 87.50%.

We evaluated the obtained data by methods of mathematical descriptive statistics. We calculated the average scores of the individual components of the verified knowledge and the total number of points, as well as their percentage. We entered these data into tables. We also

calculated correlation coefficients, which we used to detect the influence of the individual data among themselves.

RESULTS AND DISCUSSION

In this section we analyse the students' success in mathematics (the number of points obtained by students during contact teaching and the points obtained on the exam). Table 1 shows the average number of points obtained by students for each assignment, the school written work and the points obtained in the exam written work and their totals. In row 2 the data are in nominal value, in row 3 their percentages.

Table 1 Numbers of points obtained by students during the semester and their percentage

	1.a	**2.a**	**3.a**	**4.a**	**∑1-4**	**SWW**	**PEDS**	**EWW**	TSP
Points	9.606	9.653	8.367	8.653	36.204	9.224	45.429	29.673	75.102
%	96.06	96.53	83.67	86.53	90.51	61.50	82.60	59.35	71.53

Source: own

Explanatory notes to the table:
i.a - i-th assignment
∑1-4 - sum of points from 4 assignments
SWW - school written work
PEDS - points earned during the semester
EWW - exam written work
TSP - total sum of points

As can be seen from Table 1, the first two assignments on functions and their graphs were still well done by the students, at over 96%. The third assignment, in which they had to calculate the asymptotes of the graph of a function and then plot them, was the worst of all, at just under 84%. The fourth assignment, in which students were asked to calculate relatively simple derivatives, also did not fare as well, at 86.5%. Students also lost a lot of marks for the theoretical questions. They confused definitions with sentences, often not knowing how to derive the formulas, even though they had enough time and notes and literature to do so. The students were relatively poor at writing the written work they did in class, only 61.5% of the time. Here, of course, they could not use their notebooks with notes, but they knew the content of this work a week in advance and, of course, this topic unit was lectured and practised. Thus, the average number of points obtained during the semester was over 45, which is 82.6%.

On average, students wrote the exam written work for less than 30 points, which is 59.35%. If only this work were taken into account, as was the practice many years ago, most students would not pass the exam (a minimum of 64% is required to pass). But after adding the points earned during the semester with the points from the exam paper, it averaged just over 75points, which in percentage terms is 71.53%, which is right at the lower end of the D - satisfactory grade.

In Table 2, we report the correlation coefficients between the numbers of individual points representing the relationships between these items. That is, whether a gain of a certain number of points will affect the gain of another number of points. A weak dependence is when the correlation coefficient is from the interval $\left\langle -\frac{1}{3}, \frac{1}{3} \right\rangle$, mean dependence for values from intervals $\left\langle -\frac{2}{3}, -\frac{1}{3} \right) \cup \left(\frac{1}{3}, \frac{2}{3} \right\rangle$ and strong dependence occurs if the correlation coefficient is of the intervals $\left\langle -1, -\frac{2}{3} \right) \cup \left(\frac{2}{3}, 1 \right\rangle$.

Table 2 Correlation coefficients between the individual number of points

	∑1-4	SWW	PEDS	EWW	TSP
∑1-4		0.074903	0.559972	-0.10045	0.192852
SWW	0.074903		0.868128	0.210367	0.596473
PEDS	0.559972	0.868128		0.124783	0.591567
EWW	-0.10045	0.210367	0.124783		0.873772
TSP	0.192852	0.596473	0.591567	0.873772	

Source: own

Table 2 shows that there was a strong relationship between school written work scores and total points earned during the semester (coefficient of 0.868) and exam written work and total points earned (coefficient of 0.874). This shows that relatively poorly written both papers written in school affected the individual point totals. A mean dependence occurred in three cases: between assignment point totals and semester point totals, i.e., the points needed to receive credit (coefficient 0.560), between school written work and semester point totals (coefficient 0.596), and between semester point totals and semester point totals (coefficient 0.592). The other relationships showed weak dependence, that is, they did not influence each other or only minimally.

CONCLUSIONS

At the Faculty of Economics and Management of the Slovak University of Agriculture in Nitra for several school years (after the global covida pandemic of 2020) in the subject Mathematics I A we verify the acquired mathematical knowledge and skills of students in two ways: 4 independent written papers are prepared by students at home, another one during the semester, and the exam written work is completed in school. In this way, they can get up to 105 points in total (4 times 10 points for homework, 15 points for school written work and 50 points for exam written work. On average, students scored 36.2 points for home written work, which is 90.5 % of the 40 points possible. Of course, students could use lecture notes, exercises or other literature to work them out and they had a week to do so. They wrote the school written work at 61.5%, which was an average of 9.2 points out of 15. And they wrote

the exam written work at an average of only 59.35%, which was less than 30 points. In total, that was only 71.53% out of 105 points, just over 75 points.

These results were obtained from 3 study groups, and of the 72 students originally enrolled, only 67 students started their studies, of whom only 61 eventually completed the semester. Only 49 students successfully completed the course and obtained a grade in the mathematics exam, which represents 73.13% of those who started studying at our faculty, or 80.33% of those who completed the semester. We think that if we switched to only doing written work in the classroom, as we did before the pandemic, the success rate would be very low and students would have a hard time passing this teaching subject. Students do not know learn mathematics continuously, but many of them do not even want to because they chose this school because of its proximity to where they live, or some were "forced" to study by their parents.

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