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Education of mathematics during the coronavirus crisis

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ABSTRACT

At the turn of 2019 and 2020, after the emergence of a new type of coronavirus, a new situation arose worldwide. This crisis has also caused changes in education at all levels schools in Slovakia. Primary schools, secondary schools, but also universities had to transfer their teaching from buildings to online space. We switched to distance education. We were forced to develop a number of new digital teaching aids, both in the form of Word texts, but also animated and spoken Power Point lectures. We also used the prepared lectures, which we found on the Internet. After the study materials presented and distributed in this way, we also performed a retrospective check of the acquired knowledge by the students. It was the elaboration of written works by students in individual study units, but also seminar works, credit and exam works. Students received points for each work submitted in this way. By adding the points obtained in this way, the students were awarded a total mark according to the ECTS credit scale. In our paper, we also deal with the evaluation of points obtained by students. We found out whether mastering individual knowledge had an impact on the control of others and how it affected the overall evaluation of the student.

KEYWORDS: coronavirus crisis, education of mathematics, distance education, points earned, correlation coefficient

JEL CLASSIFICATION: C02, C11, I210

INTRODUCTION

Digital technologies are changing our daily lives at a tremendous pace and have, of course, become an integral part of it. Since the beginning of this century, the digital revolution has been talked about in the world and in our country. Today, most of us cannot imagine life without mobiles, tablets, computers and, of course, the Internet. The Internet has become a source of information. Electronic communication and access to information have become part

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of many areas of life. For this reason, it is necessary to focus not only on classical education, but also on education using information technology.

By 2020, the European Union has set aside € 50 billion for such education. The countries where IT research programs are most developed are China, the USA and Switzerland.

At the end of 2019, a new type of coronavirus appeared in China. As today's world is globalized, including tourism, it soon moved from China to Europe and the rest of the world. He appeared with us at the beginning of March. After the closure of all types of schools, whether primary, secondary, but also universities and colleges, these schools were forced to move their teaching from buildings to online space. This crisis has forced us to move to distance education. For many teachers, but also for pupils and students, the digital form of education was so inspiring and creative that their knowledge progressed.

The summer semester of the school year 2019/2020 started normally. 4 weeks of teaching, ie lectures and exercises took place in contact. Due to the increase in the number of people infected with the coronavirus in Slovakia, the management of our university decided on March 9, 2020 to interrupt contact teaching for 2 weeks, with the proviso that we had to assign students to work for self-study. As the situation with the corona crisis did not calm down after this period, we had to "transfer" the teaching to the online space. We had to think about how we would continue teaching, how we would make new knowledge available to students and how we would verify how they acquired it. As stated in [3], mathematical knowledge becomes permanent only if students sufficiently understand the mathematical concept and its logical meaning and process it appropriately. An important part of the explanation is also the visualization of the curriculum, which facilitates it and can shorten the learning process [1]. Rumanová and Drábeková also dealt with this topic [6].

MATERIAL AND METHODS

In the summer semester of the school year 2019/2020, we taught the subject Mathematics for Technicians at the Faculty of Engineering of the Slovak University of Agriculture in Nitra. We will introduce the thematic areas of this subject (after the 5th point they are identical with the "normal" teaching, from the 6th point they are modified, simplified):

1. Function of one real variable

Definition a function of one real variable. Definition area and area of function values, function graph. Elementary functions. Basic properties and graphs. Inverse functions.

2. Differential calculus of the function of one real variable

Derivation rules. Derivatives of sum, difference, product and proportion of functions, derivation of a compound function. Formulas for deriving elementary functions.

3. Use of derivation

Monotony of the function. Intervals of convexity and concavity of a function. Extremes of a function, inflection points of a function.

4. Applications of derivatives

Investigation of the course of the function. Touch to the graph of a function.

5. Function of two real variables

Definition of a function of two variables. Definition area, graph of a function of two variables. Partial derivatives. Higher order partial derivatives.

6. Indefinite integral

Indefinite integral from polynomial function and indirect level.

7. Definite integral - Newton-Leibniz theorem.**8. Use of a definite integral**

Content of a planar formation, volume of a rotation solid.

9. Differential equations

Differential equations 1st order separated and separable. Higher order differential equations for which the order can be reduced by integration.

Contact lessons took place in the first 4 weeks, on Monday the 5th week we still had a lecture. Thus, the students had lectured the first five thematic units from the given schedule and practiced the first three units. Although lectures are compulsory, not all students attend them, for a variety of reasons. Therefore, we developed a detailed procedure for students to calculate partial derivatives in Word. We drew on these and other materials from textbooks [5] and [2], which we wrote together with colleagues from our department. After a week, we gave them materials for credit written work, which were also planned at this time. Each student received their assignment with 3 examples, which they had to work out and send back in the allotted time. He could get a maximum of 30 points for it. We will give an example of assigning such a work:

1. Calculate the definition area D_f and the inverse function f^{-1} to the function

$$f: y = 4 + 5 \log_3(2x - 3).$$

2. Calculate the monotonicity intervals of the function $g: y = 3x^4 - 4x^3 - 36x^2 + 7$.

3. Calculate the second partial derivatives of the function

$$h: z = 3x^4 y^3 + 5x^2 y^5 - 2x^2 + 7y + 6.$$

The following week, we sent students links to freely accessible pages on YOUTUBE with lectures on the topic of indefinite and definite integral. Students could get two points by manually writing formulas for derivatives and integrals of functions and sending them to us in front of them. To verify whether they learned to compute integrals using such lectures, we sent them assignments of 4 examples, for which they could get 7 points (1st example 1 point, next 2). We present them:

1. Calculate $\int (3x^5 - 6x^3 + 4x - 5) dx$.

2. Calculate $\int \left(\frac{5}{x} + 7\sqrt[4]{x^3} \right) dx$.

3. Calculate $\int_1^3 (4x^3 + 3x^2 - 4x - 3) dx$.

4. Calculate $\int_0^{\frac{\pi}{2}} (2 \sin x - 4 \cos x) dx$.

Then we sent them sample examples for home seminar work, which concerned the calculation of the contents of planar structures and volumes of rotation solids. They could get 15 points for the work. We present the assignment of such work:

- Sketch an image of the area bounded by curves $f : y = 2x + 4$ and $g : y = x^2 + 1$ and calculate the x -coordinates of the intersections of these curves.
- Calculate the content of this area.
- Calculate the volume of the rotation solid created by rotating this surface around the x -axis.

Finally, we are left with the last topic: differential equations. We have prepared a separate lecture on this topic using the OSB studio program. We used an animated POWER POINT presentation, which we verbally commented on. For verification, we again sent students an assignment of 3 examples, for which they could get 6 points. Here are some examples:

- Solve the equation $3y^3y' - 5x^4 = 0$.
- Solve the equation $\frac{5}{y^2} + 4xy' = 0$.
- Solve the equation $y^{(4)} = 2x^2 + 3$.

In total, students were able to obtain 60 points, while they needed at least 30 points to be awarded the credit. Those who received the credit could prepare a written test. With less than 30 points, we made it possible to write corrective credit papers. The exam work consisted of 5 examples from the whole semester curriculum, while students could get 50 points for it. It took 120 minutes to complete and submit. Here is an example of such work:

- Specify the definition area of the function $f : y = \sqrt{\frac{3x}{4-x}}$.
- Calculate the derivative of the function $y = \frac{2 \ln x}{3+2x}$.
- Calculate the second partial derivatives of the function $z = 2xy^3 + 4x^3y^2 - 3 \ln y - 5$.
- Calculate the integral $\int_{-1}^2 (2x^3 + 6x^2 - 5) dx$.
- Calculate the equation $\frac{2}{y^2} + 4x^3y' = 0$.

We awarded the final grade after adding up all the points that the students could get during the whole semester. We used the ECTS scale for evaluation:

- 93 – 100% – excellent – A(1)
- 86 – 92% – very good – B(1,5)
- 79 – 85% – good – C(2)
- 72 – 78% – satisfactory – D(2,5)
- 64 – 71% – sufficient – E(3)
- ≤ 63% – fail – FX(4).

In the next part of the work we evaluated the results obtained by students in this form of study. We used the method of mathematical descriptive statistics for this. From the obtained data, we created databases in Excel by arranging the results of individual parts of this course for each student from each group below each other. From these data, we calculated the average score of the individual components and the number of points for each student. We also found out the correlation coefficients between the individual parts of this course, for which students could get points, ie whether it applies, if students master one part, they

manage others, that is, whether there is any dependence between them. Similarly, we addressed the role in the paper [4]. A weak dependence is when the correlation coefficient is from an interval $\left\langle -\frac{1}{3}, \frac{1}{3} \right\rangle$, a medium dependence for values from intervals $\left\langle -\frac{2}{3}, -\frac{1}{3} \right\rangle \cup \left\langle \frac{1}{3}, \frac{2}{3} \right\rangle$ and a strong dependence for values from intervals $\left\langle -1, -\frac{2}{3} \right\rangle \cup \left\langle \frac{2}{3}, 1 \right\rangle$.

RESULTS AND DISCUSSION

At the beginning of the summer semester, 83 students started studying in my groups. During the semester, 9 students completed their studies due to failure to do this and other subjects, or for unknown reasons. So 74 students successfully completed the subject Mathematics for Technicians. As we mentioned above, students could get 30 points for credit written work, 7 points for calculating integrals, 2 points if they wrote and sent me formulas of derivatives and integrals of selected functions, for seminar work they could get 15 points, for calculating differential equations 6 points and 50 points for a correctly calculated exam written work.

In Table 1, we present the number of points for the individual units of the subject, ie the full number of points that the students could get, the average number of points that they received and their percentage. As we can see in the table, the best students wrote the credit work, at 83.15%, then the seminar work, at 81.26% and the exam work at 76.22%. They wrote the worst control work on differential equations, only at 60.59%. The average sum of points obtained was 85.3 points, which represents 77.54% of the total number of 110 points.

Table 1 Points obtained during the semester and their sum

	CWW	ECI	FDI	SW	ECDE	SPODS	POEW	TP
FNP	30	7	2	15	6	60	50	110
ANP	24.95	5.01	1.41	12.19	3.64	47.19	38.11	85.30
ANPP	83.15	71.62	70.27	81.26	60.59	78.65	76.22	77.54

Source: own

Explanations of the abbreviations in the table:

CWW - credit written work

ECI - examples for calculating integrals

FDI - formulas of derivatives and integrals

SW – seminar work

ECDE - examples for calculating differential equations

SPODS - the sum of points obtained during the semester

POEW - points obtained of the exam work

TP - total points

FNP - full number of points

ANP - average number of points

ANPP - average number of points in percent

In the next part of the research, we calculated the correlation coefficients between the individual components of the subject. We wanted to find out whether if a student can (or does not know) calculate one part of a given thematic unit, he can (or does not know) calculate another. We wrote these coefficients in Table 2.

Table 2 Correlation coefficients between the points obtained individually and their sums

	CWW	ECI	SW	ECDE	SPODS	POEW	TP
CWW		0.0017	-0.0165	0.1785	0.6082	0.1045	0.4653
ECI	0.0017		0.3381	0.3665	0.5393	0.0193	0.3600
SW	-0.0165	0.3381		0.2471	0.6658	-0.0952	0.3592
ECDE	0.1785	0.3665	0.2471		0.5960	0.2621	0.5704
SPODS	0.6082	0.5393	0.6658	0.5960		0.0807	0.6998
POEW	0.1045	0.0193	-0.0952	0.2621	0.0807		0.7685
TP	0.4653	0.3600	0.3592	0.5704	0.6998	0.7685	

Source: own

The description of the abbreviations in Table 2 is the same as in Table 1.

The highest dependence (0.7685) was confirmed between the points for the exam work and the total sum of points, a slightly smaller but still strong dependence (0.6998) between the sum of points obtained by the students during the semester and the total sum of points. Both of these additions were to be expected. The mean dependence was shown between the individual components that the students worked on during the semester and the sum of the points thus obtained, but also the total number of points. There was a weak dependence between the individual components and their sum in comparison with the test written work. We explain this by the fact that students gained an average of 47.19 points per semester, which represents 78.65% of the total possible number of points, and they thought that they no longer have to prepare so much for the exam, because they have a sufficient number of points. It so happened that the student received almost the full number of points for the semester and after adding up the points for the exam written work, he received only the evaluation sufficient – E (3).

CONCLUSIONS

The coronavirus crisis forced us and taught us to make changes in education. We led the teaching process in other, distance ways. We have developed a number of new digital teaching aids, lectures and instructions for practicing their curriculum. In this way, we also checked the students as they studied new mathematical knowledge and skills. We are glad that we, teachers, but also students have mastered this form of study. After all, almost 90% of enrolled students successfully completed the subject Mathematics for Technology, and this number could be even higher if we knew the reason for not continuing the study for some students. We hope that such a situation will not last long, because after all, contact teaching,

especially in a subject such as mathematics, is probably more positive for most students and they themselves prefer it to the distance form.

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