E-learning in Teaching Basics of Graph Theory

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Abstract. The pandemic situation, caused by COVID-19, has significantly influenced the way of teaching at Slovak universities. Contact lessons have been completely banned and replaced by distance learning or on-line learning. In the paper, we analyze results of teaching basics of graph theory by a combination of video lessons and an e-learning course. Moreover, we compare the results of internal and external students.

Keywords: e-learning, blended learning, modern technologies in education, teaching mathematics

1. Introduction

In the beginning of 2020, the spread of COVID-19 has changed the way of teaching all over the world. By Reimers et al. [6], *"many governments are implementing measures that limit the number of people congregating in public places. Such measures have disrupted the normal functioning of schools and universities."* Thus, schools and universities have to use alternative methods to continue with lessons when contact teaching in a classroom is not possible. Naturally, the aim is to minimize negative effects of the ban of contact lessons on a level of students' knowledge.

At Slovak universities, face-to-face teaching was banned in both terms of the 2020/2021 academic year. To save the teaching process, online learning increased its use. However, majority of teachers had only limited experience with online learning or e-learning. In a very short time, teachers had to make a change to online teaching. They had to get used to teach from home or from an empty classroom. By Attard and Holmes [1], *"teachers were forced to rely on digital technology as the prime teaching and learning resource regardless of their existing technology-related beliefs and practices."* Fortunately, teachers could utilize experience from countries where online courses are an integral part of learning process at universities. Makamure and Tsakeni [4] conclude that *"the use of online platforms for teaching and learning is possible despite the challenges faced. Moreover, from now on, online classrooms could be part of the new normal in schools where they were not previously used."*

There are several ways how to ensure a high quality educational process. One of them is a proper use of modern technologies. For example, e-learning seems to be one of possible teaching methods. By Ehlers and Hilera [2], *"e-learning refers to a variety of different forms of technology-supported learning, usually characterized as an application of knowledge, information and educational technology to link people to each other and/or with educational resources, for the purpose of education."* The suitability of e-learning in teaching at universities was proved in a lot of studies. As for mathematics teaching, examples of a proper use of e-learning or blended learning can be found for example in [3,5,7].

2. Basics of Graph Theory

Our faculty primarily focuses on preparation of future teachers. The future teachers at primary schools have to master several subjects from mathematics. One of them is Basics of Graph Theory. The students obtain knowledge from the graph theory and its application to solving real life problems. Special stress is put on didactical possibilities of graph theory utilization in different parts of teaching mathematics at primary schools.

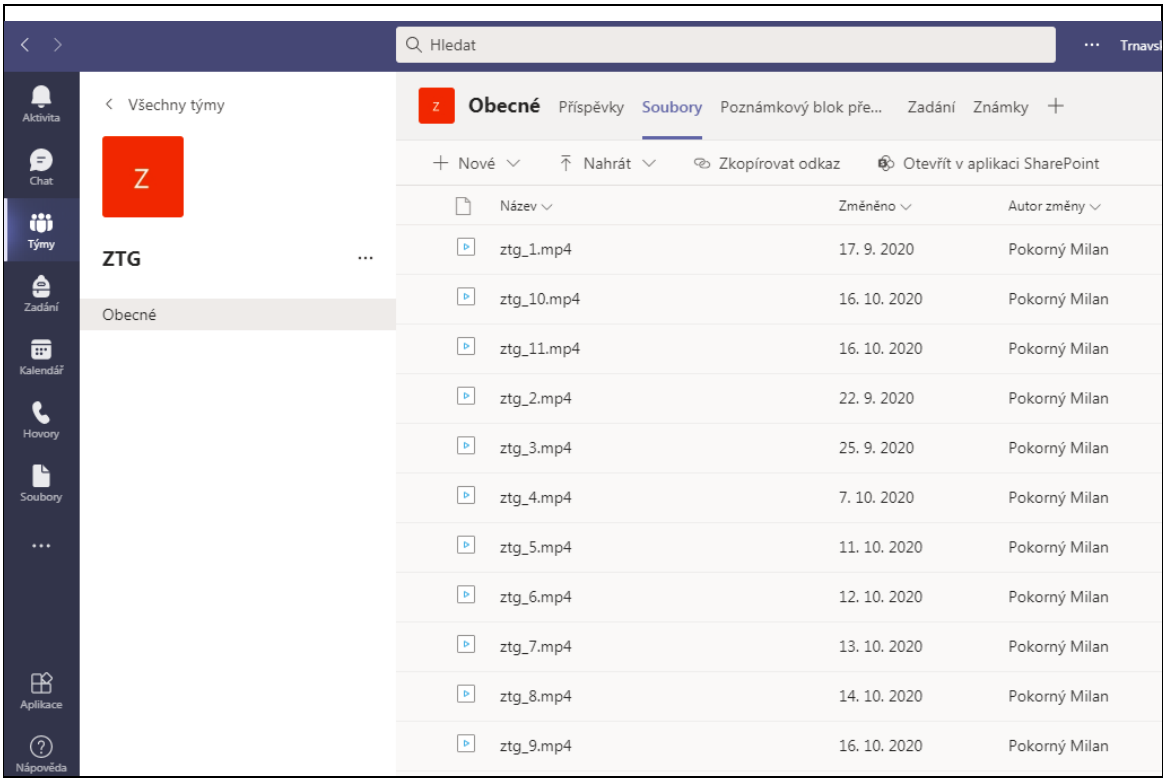

Figure 1: Video lessons in Teams

In the previous academic years, the subject was taught by blended learning, a combination of face-to-face lessons with a teacher in a classroom and an e-learning course. Our experience with this modern method of teaching was positive. We were satisfied with the level of students' knowledge. Moreover, the feedback given by students was really positive. Thus, we did not plan any change of teaching methods. However, the pandemic situation caused the ban of face-to-face lessons. We decided to replace them by video lessons in Teams (see Figure 1).

It is generally known that mathematics should be learned by an active approach of the learners, not by a passive transmission of information from a teacher to students. It means that the students cannot watch the video lessons like a movie. Thus, we gave instructions to our students how to work with the video lessons to strengthen the active way of learning. For example, the students were encouraged to stop videos, make notes, and solve problems by their own way.

3. Analysis of Results

At the end of the term, our students had to pass the final test, which we consider as a measure of the level of students' knowledge. The test consisted of ten problems, ten points each. To pass the test, the students had to obtain at least fifty points. The average score of 64 students was 77.13, median 80, and the standard deviation 14.36. All 64 students managed to pass the test. Thus, we can conclude that the level of students' knowledge is sufficient.

In our country, it is often stated than there is a gap in the level of knowledge of internal and external students. Thus, we compare the results of these two groups of students in our subject. From 64 students, 41 students were internal and 23 students were external. The average score of 41 internal students was 78.34, median 80, and the standard deviation 13.77. The average score of 23 external

students was 74.96, median 80, and the standard deviation 15.41. The results of the students can be seen in Figure 2.

As we can see, the average score of the group of internal students is slightly greater. To test the significance of the difference, we use the methods of statistics. Firstly, we test the normality of the results of both groups. We use the Shapiro-Wilk normality test. For internal students, the value of the test statistics W is 0.912, and the critical value for 10 per cent probability of type I error is 0.954. Thus, we reject the null hypothesis about normality of the results of the internal students. Similarly, for external students, the value of the test statistics W is 0.908, and the critical value for 10 per cent probability of type I error is 0.928. Thus, we reject the null hypothesis about normality of the results of the external students, too. Reasons for rejection is visible in Figure 2. We can see that there are two types of students. The majority of students try to learn as much as possible. However, there are also students who learn only sufficient amount of knowledge to pass the final test. That is why there is quite a lot of students with the score of the final test in the interval [50-59].

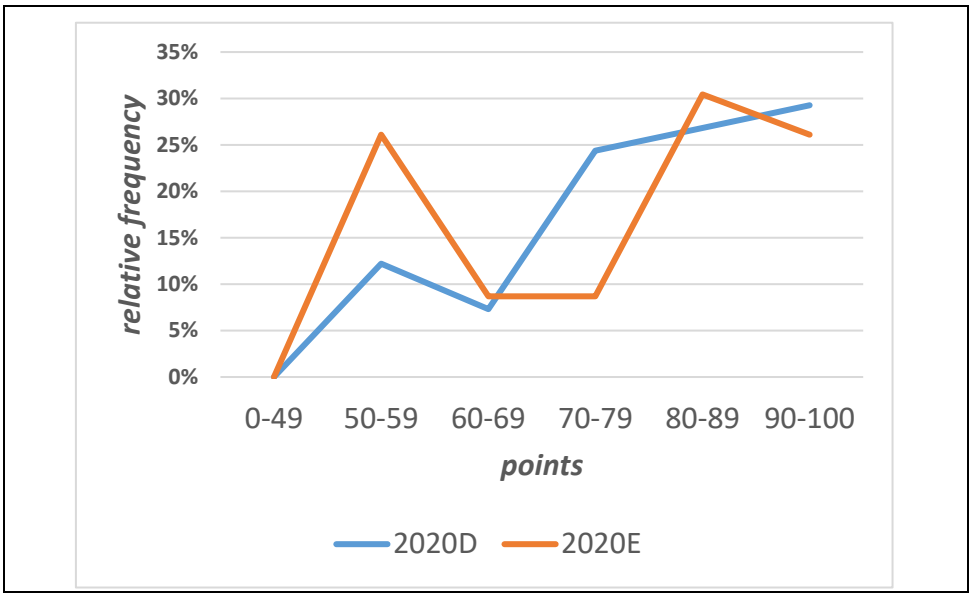

Figure 2: Results of the final test (2020D means internal students, 2020E external students)

Since we reject the normality of the results of the final test in both groups, we use a non-parametric Mann-Whitney U test to compare the significance of the difference between internal and external students. The value of the test statistics Z is 0.70 and the 95% critical value accepted range is [-1.96:1.96]. Thus, we accept the null hypothesis 'There is no significant difference between the results of the internal and external group in the final test'. To conclude, the score of the internal students in the final test is not significantly better than the score of the external students.

4. Conclusion

From the results of the students in a final test it follows that a combination of video lessons and an e-learning course is a suitable method of teaching Basics of Graph Theory, which can eliminate the negative impact of the ban of face-to-face lessons caused by a COVID-19 pandemic. However, if we compare the results of students in the 2020/2021 academic year with the results of the students in the previous academic year, we can observe a slight decrease of the results (97 students, average score 82.19, median 85, standard deviation 13.37). Thus, if it is possible, in the following

academic year we plan to return to blended learning again. However, the video lessons would be used as an additional study material.

We can also observe additional benefits of integration of modern technologies in teaching mathematics at our faculty. One of them is that a combination of video lessons and an e-learning course can remove the gap between the level of knowledge of internal and external students. The second benefit is connected with the use of blended learning also when a face-to-face lessons are allowed. Our experience shows that the students taught by blended learning are better prepared to a sudden change of face-to-face teaching to on-line learning. That is why we recommend to increase the utilization of modern technologies in teaching.

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Bibliography

1. C. Attard, K. Holmes: *An exploration of teacher and student perceptions of blended learning in four secondary mathematics classrooms*. Mathematics Education Research Journal, (2020) 1–22 DOI: 10.1007/s13394-020-00359-2
2. U.D. Ehlers, J.R.Hilera: *Special Issue on quality in e-learning*. Journal of Computer Assisted Learning, 28(1) (2012) 1–3
3. A.C.K. Cheung, R.E. Slavin: *The effectiveness of educational technology applications for enhancing mathematics achievement in K-12 classrooms: A meta-analysis*. Educational Research Review, 9 (2013) 88–113
4. Ch. Makamure, M. Tsakeni: *COVID-19 as an agent of change in teaching and learning STEM subjects*. Journal of Baltic Science Education, (2020) 19.6A
5. S. Malatinská, M. Pokorný, P. Híc: *Efficiency of Blended Learning in Teaching Mathematics at Primary School*. Information, Communication and Education Application, Advances in Education Research, 85 (2015) 6–11
6. F. Reimers, A. Schleicher, J. Saavedra, S. Tuominen: *Supporting the continuation of teaching and learning during the COVID-19 Pandemic*. OECD, 1(1) (2020) 1–38 https://globaled.gse.harvard.edu/files/geii/files/supporting_the_continuation_of_teaching.pdf
7. P. Voštinár: *GeoGebra applets for graph theory*. EDULEARN17 Conference, Barcelona, (2017) 10142–10148

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