# Experience with Online Learning in the Subject 'Mathematics in Primary Education'

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**Abstract—**A spread of COVID-19 has significantly influenced teaching methods at universities all over the world. In 2020, face-to-face lectures at our university were banned, or were allowed only with limited number of students. Thus, in an effort to keep high academic standards, teachers had to rely on synchronous and asynchronous forms of online learning. The paper analyze our experience with online learning of the subject Mathematics in Primary Education. We focus on several problems: an influence of a ban of face-to-face lessons to students' ability to pass the final test, difference in level of knowledge of full-time and part-time students, correlation between an average study mean and results in a final test, impact of online learning on the satisfaction of students with their results, students' preference of face-to-face lessons to online learning. The paper expands the results presented on the international conference XXXV DIDMATTECH 2022, published in the collection of abstracts.

**Keywords—**blended learning, online learning, ICT in education, video lessons, teaching mathematics

## 1 Introduction

Since 1980, modern technologies have influenced teaching more and more. Nowadays, it is absolutely natural that even primary school children use mobile phones, tablets, and notebooks. Moreover, sometimes they can deal with modern technologies better than their parents or teachers. Thus, it is absolutely natural to utilize benefits of modern technologies integration into teaching process.

With development of modern technologies, the way of their integration into teaching also changes. At universities in Slovakia, some teachers prefer blended learning or e-learning to face-to-face instruction. Blended learning often seems to be an ideal way how to combine benefits of modern technologies and traditional face-to-face instruction. It is usually defined as a combination of e-learning and face-to-face teaching. For example, Fisher [7] considers this modern method of learning to be a selection of an optimum mix of instructional delivery strategies. By Thorne [21], blended learning is the most logical and natural evolution of the learning agenda. Graham and Dziuban [8] give reasons for blended learning adoption, such are cost effectiveness, learning effectiveness improvement, and increased access and convenience.

As for teaching mathematics, many researchers proved justification of replacing face-to-face teaching by blended learning. For example, Lin, Tseng, and Chiang [13] and Malatinská et al. [14] proved a positive effect of blended learning on learning outcomes, as well as on attitudes toward mathematics. By Chamorro-Atalaya et al. [5], students' satisfaction has presented a slight positive variation towards teaching performance when applying the virtual modality. Moreno-Guerrero et al. [16] show a positive influence of e-learning on results, grades, motivation, autonomy, and participation. By Alzubi [2], adoption of e-learning increases effectiveness of teaching and learning. By Lapuh Bele and Rugelj [12], students find blended learning a convenient and efficient approach to learning. Moreover, most of students plan to use it for learning in future. The study of Azizan [3] shows that students were highly favorable in using online learning, especially flexibility, suitability for learning, perceived ease of use, and perceived fit. The suitability of blended learning in mathematics teaching at universities is also proved in [15, 17, 22].

Nevertheless, there is a lot of teachers at our universities who ignore benefits of modern technologies integration into education and prefer only face-to-face instruction. Before 2020, for many of them, it was unthinkable to ban traditional teaching and to replace it by different forms of online teaching. Thus, majority of subjects was taught only by face-to-face instruction. However, a sudden spread of COVID-19 forced universities to ban a traditional face-to-face teaching, or to significantly limit a number of students in a classroom. In an effort to keep a quality of teaching process, teachers at Slovak universities had to rely on synchronous and asynchronous methods of online teaching, although many of them did not have sufficient experience with ICT integration into teaching. We have to agree with Štrbo [20], who states that pandemic situation tested a readiness of Slovak teaching system for online teaching. However, online learning could not solve all problems connected with the ban of face-to-face learning. For example, findings of Sarker et al. [18] reveal that most of students had unfavorable experiences with e-learning. A majority of them felt that e-learning ruined their social relationships by isolating them from their peers and instructors.

## 2 Teaching mathematics in primary education

The Faculty of Education, Trnava University prepares future teachers at primary and secondary schools, as well as in kindergartens. At master study, future primary school teachers form the largest group. During their study, they have to complete also a compulsory course *Mathematics in Primary Education 1*.

After completing the subject:

1. A student gain an overview of the goals and content of teaching mathematics in primary education.
2. A student can characterize stages of a cognitive process in mathematics and use this knowledge when teaching mathematics in primary education.
3. A student acquires basic knowledge about set operations, algebraic structures with one and two operations, and divisibility and can apply them appropriately in the work of a mathematics teacher in primary education.

4. A student knows different methods of introducing a concept of natural number, he knows the basic properties of additive and positional systems and can use this knowledge when teaching numeration and arithmetic operations in primary education.
5. A student can create appropriate word problems for teaching areas Numbers, variables and numerical operations with numbers and Relations, functions, tables, diagrams.
6. A student acquires the competence to teach parts of the mathematics curriculum at the first grade of primary school.
7. A student can critically assess didactic materials from mathematics for primary education.

In previous academic years, the subject was taught by blended learning. Then, a sudden ban of face-to-face lessons, which was caused by a spread of COVID-19, forced us to change this modern teaching method. Although our students had an e-learning course, we did not want to rely on their self-study, especially because mathematics is quite difficult for many of our students. Thus, we decided to replace face-to-face lessons by video lessons. This solution was typical for majority of subjects taught at our faculty, because a suitability of this method has been confirmed by several studies. From the results of Insorio [11] it follows that teacher-made video lessons help students to understand mathematics lessons through watching conveniently and repeatedly. Bullo [4] proved that video lessons helped students better understand and comprehend the lessons even without teacher's help. The study of Ichinose and Clinkenbeard [10] proved that in a flipped class, students had higher levels of achievement than in a traditional class. The findings of Durgungoz [6] demonstrate significance of using asynchronous videos for creating a positive teacher image. By Hakala and Myllymäki [9], use of lecture videos increases participation activeness, and the increase in participation has a positive impact on completion of courses.

As for full-time students, they were taught by a combination of an e-learning course, pre-recorded video lessons that replaced face-to-face lectures, and synchronous online lessons in Teams that replaced face-to-face seminars. The online lessons were recorded, too. It is generally known that mathematics should be taught and learned by an active way. Passive transition of knowledge is not efficient enough. That is why we instructed our students how to work with pre-recorded video lessons to support active way of learning. However, active acquisition of knowledge was supported especially on online seminars. We respected recommendation of Al-Huneidi and Schreurs [1], who state that in blended learning environment, teachers should use a variety of ICT tools such as synchronous and asynchronous learning technologies to facilitate and encourage collaboration, interaction, communication, and knowledge construction and sharing among the students.

As for part-time students, they were taught by a combination of an e-learning course, pre-recorded video lessons, recorded video seminars with full-time students and two synchronous online meetings with a teacher, where they could ask questions and discuss problems.

## 3 Analysis of the results

To be able to measure a level of knowledge, both full-time and part-time students had to pass a final test. To get to know their opinions, after the term, the students filled out an anonymous questionnaire.

In the following part of the paper, we answer the following questions:

1. Are our students able to pass the final test despite of a ban of face-to-face lessons?
2. Is there a significant difference between a level of knowledge of full-time and part-time students?
3. Is there a correlation between an average study mean of our students and their results in a final test?
4. Does online learning have positive impact on the satisfaction of our students with their results and on their feeling that their assessment is objective?
5. Do our students prefer online learning to face-to-face instruction?

In the winter term of the academic year 2021/2022, the course *Mathematics in Primary Education 1* was completed by 28 part-time students and 47 full-time students. At the end of the term, both groups of students took a final test. We consider the final test as a measure of a level of students' knowledge. The maximum score in the final test was 100 points. To pass the test, students had to get at least 50 points. The results of the final test are given in Table 1 and are depicted in Figure 1.

**Table 1.** Results of a final test

| | **Full-Time Students** | **Part-Time Students** |
|---|---|---|
| Number of students | 47 | 28 |
| Number of students who passed the final test | 47 | 28 |
| Average score | 69.38 | 70.34 |
| Median | 67 | 71 |
| Standard deviation | 12.06 | 10.34 |
| *W* (Shapiro-Wilk normality test) | 0.934 | 0.9493 |
| Critical value (Shapiro-Wilk normality test) | 0.9592 | 0.9383 |
| Null hypothesis about normality | rejected | accepted |
| Average study mean during bachelor study | 1.67 | 1.79 |
| *W* (Shapiro-Wilk normality test) | 0.9796 | 0.9619 |
| Null hypothesis about normality | accepted | accepted |

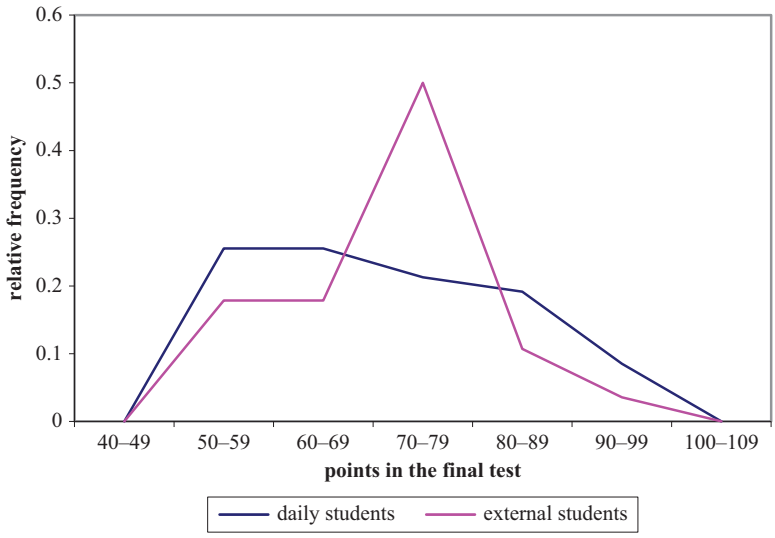


**Fig. 1.** Results of a final test

As we can see from the results of the final test, all 75 students were able to pass the final test. So, we can say that a ban of face-to-face lessons, that were replaced by synchronous and asynchronous forms of online learning, did not have any negative influence on students' ability to pass the final test.

In the following part, we compare results of full-time and part-time students. As we can see from Table 1, both median and average score were slightly better in a group of part-time students. Since we rejected the null hypothesis about normality in a group of full-time students by the Shapiro-Wilk normality test, we test the significance of the difference between both groups of students by a non-parametric Mann-Whitney U-test. Since the value of the test statistic Z in the Mann-Whitney U-test is 1.29, while the 95% critical value accepted range is [-1.96:1.96], we accept the null hypothesis 'There is no significant difference between the score of full-time students and part-time students in the final test.' Moreover, we compare the average study mean of both groups of students during their bachelor study (last three rows of Table 1). We can see that the average study mean is better in the group of full-time students. Since in both groups we accept the null hypothesis about normality by the Shapiro-Wilk normality test, we can compare the results by the parametric t-test. Since the probability of Type I error in the t-test is about 7.73 per cent, we accept the null hypothesis 'There is no significant difference between the average study mean of full-time students and part-time students in the final test.' To conclude, we can consider the level of knowledge of full-time students and part-time students from the subject *Mathematics in Primary Education 1* to be similar.

Now, let us compare a correlation between average study mean of our students and their score in the final test. The results are depicted in Figure 2.

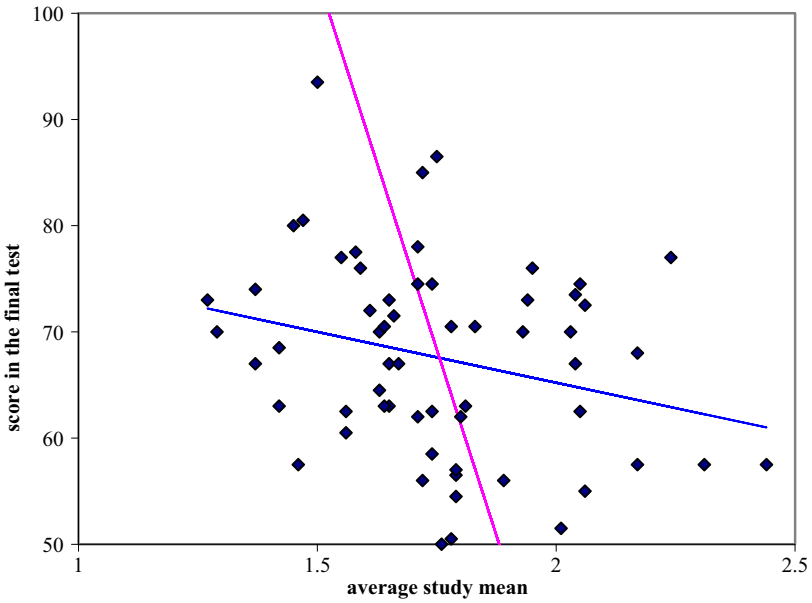


**Fig. 2.** Dependence of the average study mean and the score of the final test

The value of the correlation coefficient is −0.372 and its 95% confidence interval is [−0.555,−0.155]. This can be interpreted that there is small positive correlation between the results of the final test of our students and their average study mean. The fact that the correlation is small can be partly explained also by the fact that the average study mean contains subjects not only from mathematics, but also from Slovak language, pedagogy, psychology, arts, etc.

Finally, we analyze the answers of our students in a questionnaire. There were fourteen questions and to each of them, the students chose one of the following: strongly agree (1), agree (2), neutral (3), disagree (4), strongly disagree (5). The frequencies of the answers are given in Table 2 and depicted in Figure 3.

The questionnaire was anonymous and optional. Thus, it was filled by 71 out of 75 students. The return rate is about 95 per cent.

**Table 2.** Relative frequencies of answers in the questionnaire

| Question | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Q1 | 0.69 | 0.21 | 0.06 | 0.03 | 0.01 |
| Q2 | 0.21 | 0.45 | 0.23 | 0.08 | 0.03 |
| Q3 | 0.63 | 0.17 | 0.08 | 0.07 | 0.04 |
| Q4 | 0.26 | 0.41 | 0.20 | 0.10 | 0.03 |
| Q5 | 0.06 | 0.14 | 0.28 | 0.21 | 0.31 |
| Q6 | 0.79 | 0.10 | 0.07 | 0.03 | 0.01 |
| Q7 | 0.62 | 0.17 | 0.11 | 0.10 | 0 |
| Q8 | 0.77 | 0.13 | 0.04 | 0.01 | 0.04 |
| Q9 | 0.54 | 0.15 | 0.14 | 0.07 | 0.10 |
| Q10 | 0.68 | 0.24 | 0.04 | 0.04 | 0 |
| Q11 | 0.65 | 0.27 | 0.04 | 0.04 | 0 |
| Q12 | 0.43 | 0.16 | 0.23 | 0.11 | 0.07 |
| Q13 | 0.04 | 0.04 | 0.07 | 0.20 | 0.65 |
| Q14 | 0.89 | 0.03 | 0.04 | 0 | 0.04 |

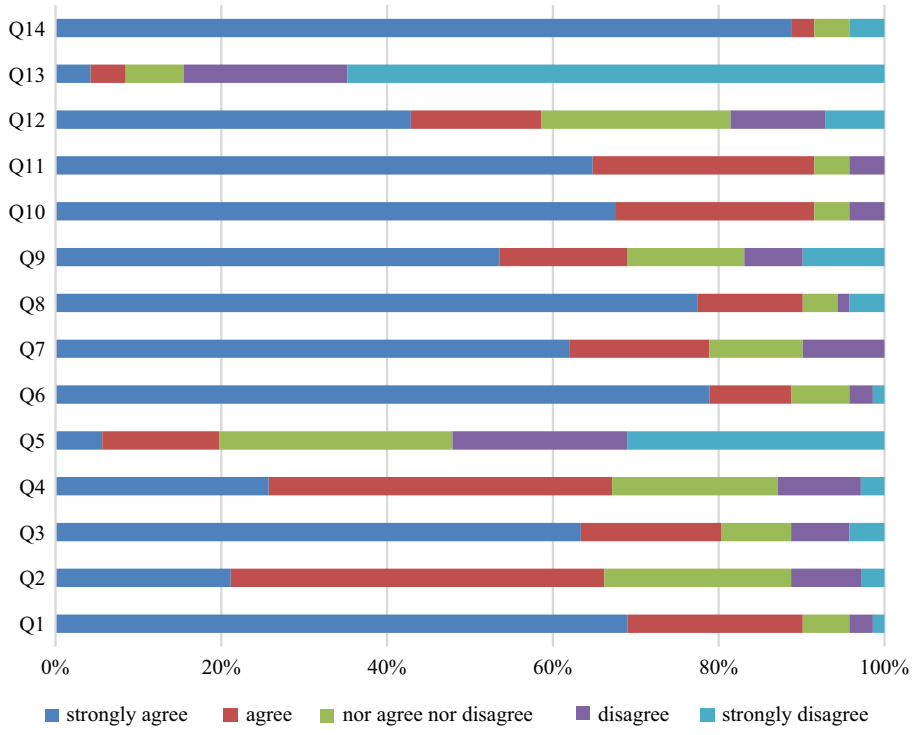


**Fig. 3.** Answers in the questionnaire

In the first two questions we asked whether the students consider their final assessment from *Mathematics in Primary Education 1* (MPE1) and other subjects (OS) in the winter term of the academic year 2021/2022 to be objective. The average score for MPE1 is 1.46, the average score for OS is 2.27. We can conclude that the students consider final assessment from MPE1 to be more objective than the final assessment from OS. As we can see, 90 per cent of our students consider their final assessment from MPE1 to be objective.

In the third and fourth question we asked whether the students are satisfied with their final assessment from MPE1 and from OS. The average score for MPE1 is 1.72, the average score for OS is 2.23. Again, we can conclude that the students are more satisfied with final assessment from MPE1 than from OS. As we can see, 80 per cent of our students are satisfied with their MPE1 final assessment.

The fifth question asks whether the MPE1 final assessment would be better if there were no COVID-19. As we can see, the students refused this statement, as the average score is 3.58. Thus, our students confirmed that there is no negative impact of COVID-19 to their results in MPE1.

The following three questions asked whether video lessons and the e-learning course were helpful and whether students would like to have similar materials also for OS. As we can see, the answers to these questions are highly positive with average scores 1.38 for video lessons and 1.69 for the e-learning course. Thus, the students confirmed usefulness of prepared study materials.

The analysis of the answers to the ninth question reveals that 69 per cent of students would prefer video lessons and online learning even in situation when face-to-face lessons are not restricted. It expresses their satisfaction with the method of MPE1 teaching. In our opinion, they appreciate time and place independence of this teaching method. Similarly, in twelfth question, the students express that they prefer blended learning to face-to-face instruction.

The answers to the tenth and eleventh question reveal that our students exactly knew what they had to master (average score is 1.45) and that texts in the e-learning course were clear (average score is 1.48).

In the 13th question, the students refused having technical problems. Finally, in the 14th question, 89 per cent of students strongly prefer written tests to oral exams at mathematics.

## 4 Conclusion

The paper deals with online learning of the course *Mathematics in Primary Education 1* at the Faculty of Education, Trnava University. A spread of COVID-19 forced us to a sudden change of teaching methods, since face-to-face lessons were banned. Thus, we have to rely on synchronous and asynchronous forms of online learning.

Naturally, a sudden change of teaching methods brought the threat of students' knowledge decrease. However, the analysis of the students' results in the final test, as well as their answers in the questionnaire, refuted this threat. Similar results were published also by Žilková and Kondeková [23], who state that an online form of teaching was equivalent to an in-person form. Moreover, we proved that online learning has a

positive influence not only on a level of students' knowledge, but also on their satisfaction with the final assessment and on feeling of their objectiveness. In case our students have proper study materials, majority of them prefer online learning and blended learning to face-to-face instruction. One of the positives is the fact that in our subject there is no difference in a level of knowledge of full-time and part-time students.

Understandably, online learning brings new challenges also to teachers. These challenges relate not only to teaching, but also to testing. Stoffová and Horváth [19] remind that online teaching projected itself also on methods of assessments and exams. In online testing, it is much more difficult to prevent frauds. Fortunately, there are many software products that are really useful for preventing frauds. On the other hand, it is necessary to mention that a preparation of an online test is much more time consuming that a preparation of a test administered in a classroom. Thus, we suggests that universities need to offer training programs for their teachers about online learning and online testing. It is necessary to mention that online testing brings challenges also to students. For example, Žilková and Žilková [24] warn that students perceived e-testing to be more stressful.

Before COVID-19, we used blended learning in majority of our subjects. During a pandemic, this turned out to be an advantage, since both we and our students were used to modern technologies integration into education. Therefore, in our opinion, teachers should integrate modern technologies into teaching even when there are no restrictions of face-to-face instruction.

Finally, we are aware of limitations of our research. The presented results were obtained only on one subject, thus it is not possible to generalize them to other subjects. To be able to obtain more general results, further research have to be realized.

In our online lessons, all students formed one group. However, in face-to-face instruction, the students are usually divided into smaller groups. An influence of a class size to students' results could be a matter of future research.

## 5 Acknowledgment

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