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Learning Mathematics Online Using Information Technology Tools during COVID-19 in Kosove

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Abstract

The COVID-19 pandemic has brought significant challenges to higher education worldwide. Due to the COVID-19 pandemic, e-learning has begun to be widely used and applied in the teaching and learning processes. However, learning under technological circumstances has proven not always to be a proper solution in education. A highlight challenge, in this regard, is considered to be learning Mathematics online. While some support its positive impact, others greatly oppose it by arguing that neither teaching nor learning has proven successful. Thus, this study examines Kosovo selected universities to see the effectiveness of learning Mathematics online as a case study. Further, it compares the online and traditional learning methods and explores how teachers in higher education in Kosova Universities apply and integrate technology into learning mathematics. This study employed a methodology encompassing questionnaires for students. The results show that students are not overall satisfied with learning Mathematics online leading to the conclusion that online learning is not an effective educational method for learning Mathematics.

Keywords

Online Platforms, Information Technology, Mathematics, Online Learning, COVID-19

1. Introduction

The world has been facing the COVID-19 for more than two years now, which has greatly affected the education field as well [1]. More precisely, the COVID-19 has brought the need to switch from traditional to online learning to a great

extent. Thus, online learning has become a major component of higher education throughout the modern world, due to the rise of the COVID-19 worldwide pandemic situation.

There are many reasons to start learning online, especially at the University and College level, namely, flexibility and an increased level of interaction, to mention a few. A higher level of interaction between professors and students living in different countries, is emphasized which is greatly facilitated because of the increasing use of the Internet for distance learning online [2]. This is also happening due to the flexibility in terms of location, time, work and different costs of transportation and accommodation [3], which makes it a more suitable option for training and assessment of students [4], given the dynamics of contemporary life. Additionally, several studies have supported the online learning mathematics. More precisely, the [5] study revealed that "math students who enrolled in online courses had better success than students enrolled in traditional lectures". [6] discusses the abilities and competencies that teachers need to possess to learn effectively in online learning contexts.

Learning online requires certain pedagogical knowledge, mainly in organizing and creating learning environments, with the help of digital technologies. To illustrate, interaction and online learning are provided through human-computer interaction information technology tools such as Microsoft PowerPoint, Google Meet, Moodle, Zoom, forums, blogs, online and media discussion groups, face-to-face chat and direct visual communication [7]. In a balanced mathematics program, the strategic use of technology strengthens mathematics learning [8].

In Kosova context, the Universities have found the transition from teaching in class to online classes quite challenging [9]. Kosova is among the countries where the challenges of switching from the traditional to online learning have been immensely felt. Considering the complexity, challenges and different opposing perspectives regarding the learning Mathematics online, this study closely investigates the difference of teaching mathematics traditionally versus online throughout the pandemic, and whether the latter has proven to be successful or not.

2. Methodology

In this research the quantitative method for data collection was chosen using as a questionnaire research tool with structured questions. The questions addressed tackled topics around the online learnign of mathematics and the differences between online and traditional learning of it. There were 10 questions in total. The questionnaire was distributed to 46 randomly selected students, 29 students from University of Applied Scienties in Ferizaj, first year in Industrial Engineering with Informatics, and 17 students from AAB College in Prishtina, first year in Computer Engineering. The data are analyzed, interpreted and presented with SPSS. In addition, the results are graphically represented so to provide a clear

understanding.

3. Data Analysis

In this paper, three types of analysis of the results of the questionnaire have been done:

- Descriptive analysis
- Comparative analysis between students of the same university
- Comparative analysis between two groups namely students of UASF and AAB College

The answers provided by the selected audience demonstrated revealing responses mainly showing that they deem the online learning of mathematics as successful during the pandemic, further affirming that they support the online learning of Mathematics more than the old traditional method. The results are elaborated in more details in the following subsections below.

3.1. Data Analysis with SPSS

The SPSS was used for data analysis. Initially we made a descriptive analysis and after we continued with the correlation analysis. Finally, we used the Pearson Chi-Square test to analyze whether there were significant differences between the two groups of surveyed students, UASF students and AAB students, in terms of their opinion in response to the six variables like below:

1) Has virtual learning influenced the process of learning mathematics?

2) Have your participated in virtual classes of mathematics similar to the classroom-based classes?

3) Do you prefer learning mathematics online or in class?

4) Has learning mathematics online been more challenging compared to other courses?

5) Have you used any platform or software to learn mathematics?

6) Are you satisfied with the mathematical virtual teaching of professors?

For each analysis, a detailed interpretation of the frequency tables, correlation matrix and Chi-Square Tests presented in a summary table was made.

Such analyzes are presented below.

3.2. SPSS Descriptive Analysis

The chart below visually presents the composition of students who answered the questions of questionnaires, having UASF students highlighted in blue, and the AAB College students highlighted in green. As it is already illustrated in Figure 1, from a random sample of 46 respondents, 29 students or 63.04%, are from UASF and 17 students or 36.96% from AAB.

1) Table 1 shows that 60.9% of respondents estimate that virtual learning has influenced the process of learning mathematics compared to 39.1% of respondents who do not think that online learning has an impact on learning this subject.

At which University/College do you study?
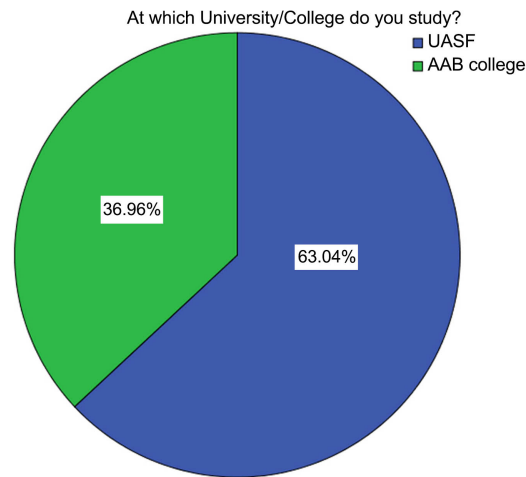
Figure 1. At which university/college do you study?

Table 1. Has virtual learning influenced the process of learning mathematics?

		Frequency	Percent	Valid Percent	Cumulative Percent
	Yes	28	60.9	60.9	60.9
Valid	No	18	39.1	39.1	100.0
	Total	46	100.0	100.0	

2) Regarding the participation in mathematics lessons in the virtual form, the research shows that for 71.7% of respondents it was similar to physical participation in the class, while 28.3% say that they did not have the same participation in online learning compared to that in class, as it is further illustrated in **Table 2** below.

3) The surveyed students do not prefer to learn the subject of mathematics in virtual form. **Table 3** demonstrates that 87% of surveyed students show a preference for classroom teaching, while 6.5% would like a combined form of teaching (virtual and physical). Only for 6.5% of the respondents no form of learning realization was a problem.

4) **Table 4** shows that learning mathematics online was more challenging for a considerable part of the respondents, with 58.7% confirming so, compared to teaching in the classroom with 41.3%.

5) Respondents for whom the online learning of mathematics was challenging, shared several challenges throughout the survey. The biggest challenges, as illustrated in **Table 5**, were "explanation without practice in class" and with not many opportunities for joint exercises (29.6% of respondents had this challenge), followed by the challenge "difficulty to understand" (22.2%), then "difficulties towards focus" with 18.5%, "grid and electricity problems" (14.8%), "the missing adequate programs" and "poor image quality" with 7.4% each.

6) Concerning the softwares, students were initially asked if they used any to learn mathematics. The results, as illustrated in **Table 6**, show that 39.1% of respondents stated that they have used software to teach math online. Whereas, when asked what software they specifically used, 44.4% of respondents responded that they used Mathcad, 44.4% White board and 11.1% Photomath, which is

shown in Table 7.

7) Table 8 shows that with the teacher 69.6% of students were satisfied and 30.4% dissatisfied

Table 2. Have your participated in virtual classes of mathematics similarly to the classroom-based classes?

		Frequency	Percent	Valid Percent	Cumulative Percent
	Yes	33	71.7	71.7	71.7
Valid	No	13	28.3	28.3	100.0
	Total	46	100.0	100.0	

Table 3. Do you prefer learning mathematics online or in class?

		Frequency	Percent	Valid Percent	Cumulative Percent
	Class	40	87.0	87.0	87.0
Valid	It does not matter	3	6.5	6.5	93.5
	Online + Class	3	6.5	6.5	100.0
	Total	46	100.0	100.0	

Table 4. Has learning mathematics online been more challenging compared to other courses?

		Frequency	Percent	Valid Percent	Cumulative Percent
	Yes	27	58.7	58.7	58.7
Valid	No	19	41.3	41.3	100.0
	Total	46	100.0	100.0	

Table 5. If you answered yes, what has made online learning of mathematics challenging?

		Frequency	Percent	Valid Percent	Cumulative Percent
	Difficulties towards focus	5	10.9	18.5	18.5
	Difficulty to understand	6	13.0	22.2	40.7
	The missing adequate programs	2	4.3	7.4	48.1
Valid	Problems with network and electricity	4	8.7	14.8	63.0
	Explanations without practice in class	8	17.4	29.6	92.6
	Poor image quality	2	4.3	7.4	100.0
	Total	27	58.7	100.0	
Missing	N/A	19	41.3		
	Total	46	100.0		

Table 6. Have you used any platform or software to learn mathematics?

		Frequency	Percent	Valid Percent	Cumulative Percent
	Yes	18	39.1	39.1	39.1
Valid	No	28	60.9	60.9	100.0
	Total	46	100.0	100.0	

Table 7. If you answered yes, what platform or software have you used?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Photomath	2	4.3	11.1	11.1
	Mathcad	8	17.4	44.4	55.6
	White board	8	17.4	44.4	100.0
	Total	18	39.1	100.0	
Missing	I have not used any	28	60.9		
	Total	46	100.0		

Table 8. Are you satisfied with the mathematical virtual teaching of professors?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	32	69.6	69.6	69.6
	No	14	30.4	30.4	100.0
	Total	46	100.0	100.0	

3.3. SPSS Comparative Analysis

To find out if the challenges faced by the students were influenced by other measured factors such as: attendance at the lesson, use of software and satisfaction with the subject professor, we conducted a correlation analysis.

From the correlation matrix presented below, it can be seen that:

1) The degree of participation in virtual classes does not correlate with how challenging for the surveyed students was virtual learning compared to that in the classroom, this is because the significance *sig.* = 0.683 > 0.05.

2) Regarding the impact of software used on the challenges faced by students during online learning, the data (*sig* = 0.001 < 0.05 and *r* = 0.492 **) show that these two variables have a positively and statistically significant correlation. This means that for students who used software, online learning was more challenging than for students who did not use any concrete software.

3) Statistically significant correlation is also shown between the variable "satisfaction with the subject professor" and "challenges". The following table shows a not very strong negative correlation (*sig.* 0.023 < 0.05 and *r* = −0.267) between the two factors. This shows that for students who were satisfied with the professor of mathematics in virtual teaching, this form of teaching was less challenging compared to students who did not show much satisfaction to the professor.

4) Statistically significant correlation, with a negative direction is also shown between the variables "use of software" and "satisfaction with the professor". The results (*sig.* = 0.02 and *r* = −0.341 *) show that professors who use software to teach mathematics were more considered by students although the use of software to present it posed additional challenges in lessons (Table 9).

Table 9. Correlations.

		Have your participated in virtual classes of mathematics similarly to the classroom-based classes?	Has learning mathematics online been more challenging compared to other courses?	Have you used any platform or software to learn mathematics?	Are you satisfied with the mathematical virtual teaching of professors?
Have your participated in virtual classes of mathematics similarly to the classroom-based classes?	Pearson Correlation	1	0.062	0.108	−0.205
	Sig. (2-tailed)		0.683	0.477	0.171
	N	46	46	46	46
Has learning mathematics online been more challenging compared to other courses?	Pearson Correlation	0.062	1	0.492**	−0.267
	Sig. (2-tailed)	0.683		0.001	0.023
	N	46	46	46	46
Have you used any platform or software to learn mathematics?	Pearson Correlation	0.108	0.492**	1	−0.341*
	Sig. (2-tailed)	0.477	0.001		0.020
	N	46	46	46	46
Are you satisfied with the mathematical virtual teaching of professors?	Pearson Correlation	−0.205	−0.267	−0.341*	1
	Sig. (2-tailed)	0.171	0.023	0.020	
	N	46	46	46	46

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

3.4. Comparative Analysis with Two Groups

To find out if the findings of these analyses had significant differences between the two groups of students surveyed, UASF students and AAB students, we conducted the Pearson Chi-Square test to compare the differences between the groups.

In the following table we have presented in summary form the comparison findings for all variables. The findings show that we have no significant differences in any of the variables, in terms of students of these two universities in which the research was conducted.

		Chi-Square Tests		
		Value	df	Asymp. Sig. (2-sided)
Has virtual learning influenced the process of learning mathematics? * At which University/College do you study?	Pearson Chi-Square	2.75	1	0.09
Have your participated in virtual classes of mathematics similarly to the classroom-based classes? * At which University/College do you study?	Pearson Chi-Square	0.69	1	0.42
Do you prefer learning mathematics online or in class? * At which University/College do you study?	Pearson Chi-Square	2.90	2	0.24
Has learning mathematics online been more challenging compared to other courses? * At which University/College do you study? Crosstabulation	Pearson Chi-Square	0.37	1	0.54
Have you used any platform or software to learn mathematics? * At which University/College do you study? Crosstabulation	Pearson Chi-Square	0. 17	1	0.68
Are you satisfied with the mathematical virtual teaching of professors? * At which University/College do you study? Crosstabulation	Pearson Chi-Square	0.37	1	0.54

4. Discussion

The results obtained from the questionnaires delineate that, as fairly expected, the transition from traditional to online learning of Mathematics has been challenging in terms of adjustment. Students affirmed because of this transition, the learning of Mathematics has had an impact on learning this subject. That is, respondents claimed it is challenging. The challenges the respondents mentioned the most are as following: explanation without practice, not enough opportunities for joint exercises, difficult to understand, electricity problems etc. Of all these challenges listed, one can conclude how crucial it is the methodology that students are used with. Regardless that the subject of Mathematics is not new to students, the transition of its methodology of teaching is. Because students asserted that they find it difficult to adapt with it, they deemed almost every action of a lecture as challenging, starting off with highlighting the lack of practice and joint exercises to actually properly understanding lectures. Especially the last one is concerning since the performance of students can be lowered and have students left behind accordingly. Electricity, on the other hand, remains a common problem for students who apparently find it challenging since it unables them to attend classes as they usually do. Given these results, one can conclude that students do not favor online learning compared to traditional learning. There was a specific question addressing such issue whether they would like to continue learning Mathematics online, and the answer was convincingly no, with a small percentage claiming a combined form of teaching would do, if not for traditional learning only.

5. Conclusions

The COVID-19 pandemic has undoubtedly generated profound changes in several life fields. Inevitably, education is along the most affected fields. It has altered the whole methodology of learning from traditional (in-class learning) to online learning. Such situation has triggered the need to investigate how successful—if at all—such learning methodology transition is for students. Given that the Mathematics is among the subjects that require plenty of practical exercises, and demands specific platforms of learning compared to other more theoretical courses, it has added another challenge to it. Thus, in this article we have investigated whether students deem online learning of Mathematics successful, if not why. The results revealed that students found it hard to firstly adjust to the new way of learning, and second, they deemed that learning Mathematics online is challenging per se. In light of all the challenges elaborated above, they conclude they don't support learning Mathematics online as much as they do learning it in traditional way. Practically, the online learning of Mathematics is not as successful as one might have thought.

Considering that the pandemic is still ongoing and further research is taking place, this article fulfills the gap of investigating the online learning in this case of Mathematics. This article paves the way for future similar research that can be

undertaken about other subjects as well, or be spread even further since our results are limited to only three universities in Kosovo. Nevertheless, there are many questions to ask and research in the future: what kind of online classes are best suited for students; is online education more financially rewarding; should we stop offering classes in the field; etc. More data needs to be collected and analyzed to pinpoint all the advantages and disadvantages of online learning.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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