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The Impact of Online Education on Biology Students Motivation and Academic Achievement

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Abstract

Online teaching has changed the dynamics of students' work and led to a series of changes concerning student engagement, motivation and academic success. The main goal of this research was to analyze the success of students from the Department of Biology at the Faculty of Science in Sarajevo during online classes compared to traditional classes, and to assess their motivation in online classes. Independent samples t-test, descriptive statistics and one-way ANOVA were used for data analysis and coding. The impact of online teaching on student success was assessed by comparing the average grades in subjects from the first and second year of study during online and face-to-face teaching. In the academic year 2018/2019, 79 students attended the first year of study, and 66 students attended in 2020/2021. For the second year of study, 74 students attended in the 2018/2019 academic year, while 90 students attended in 2020/2021. From the third and fourth year of study 64 students took part in in the questionnaire to assess motivation. The results showed that online teaching had a positive impact on the academic success of students with a statistically significant difference in the success achieved during online and face-to-face teaching. The research showed that students have a neutral academic motivation and a high degree of cooperation with professors and colleagues, with a significant difference between years of study.

Keywords: *online teaching, academic success, motivation, biology students*

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1. Introduction

During 2020 and 2021, educational systems worldwide faced significant challenges in combating the spread of the virus. To ensure the continuity of schooling and academic progress during the 2019/2020 academic year, educational institutions at all levels swiftly adapted and developed emergency online education models. These models embraced the

concept of "disrupted classrooms, uninterrupted learning" (Huang et al., 2020), ushering in a new era of online learning (Anwar et al., 2021).

Higher education in Bosnia and Herzegovina (BiH) has not been exempt from the challenge of rapidly transitioning to online teaching. In both entities, due to the interruption of regular classes, online education has been organized through television, the internet, and other means. Given that education in the Federation of BiH is under the jurisdiction of cantons, there have been different approaches to maintaining the teaching process (Dedić, 2020).

1.1. Motivation and academic success in online classes

Motivation plays a significant role in determining learning outcomes, but due to its complexity, it represents one of the most challenging aspects to measure (Graham & Golan, 1991). Motivation in online education is primarily influenced by individual characteristics and specific contexts (Hartnett et al., 2011). According to previous research, a decrease in student motivation for active participation in online education has been observed (Kyewski & Krämer, 2018). In the field of educational research, the most easily measurable behavior is academic achievement, but the relationship between motivation and academic success is complex, particularly due to difficulties in clearly understanding intelligence. As a result, researchers must consider individual differences in motivation when drawing conclusions (Breen & Lindsay, 1999). The results of some previous studies indicate improved learning outcomes in online education (Green et al., 2018), while other studies have not identified significant differences (Pickering & Swinnerton, 2019).

Online education has become inevitable in times of crisis, but it is increasingly gaining durability and institutionalization (Meyer, 2014). Therefore, questions regarding the effectiveness of online teaching and the satisfaction of students and teachers are crucial. Considering the limited research on this issue in Bosnia and Herzegovina, especially at the university level, the main objective of this study is to evaluate the level of motivation and academic achievement among students of the Department of Biology at the Faculty of Natural Sciences and Mathematics in Sarajevo during online learning. Before the research, the following research hypotheses were formulated:

1. There is no statistically significant difference in the achieved success of students in online and traditional classes;
2. Students have no expressed motivation in online classes;
3. There are no differences in intrinsic motivation in online classes with regard to the year of study and major;
4. There are no differences in the satisfaction of students with online teaching with regard to the year of study and major;
5. There are no differences in academic motivation for cooperation with colleagues and professors in online classes with regard to the year of study and major;
6. There are no differences in the overall academic motivation regarding the year of study and major.

2. Material and Methods

2.1. Student success

The study examined the performance of students in 15 subjects from the first two years of study at the Department of Biology. Out of these subjects, seven belonged to the first year,

while eight were related to the second year of study. To compare the performance of students during online and traditional classes, the academic years 2018/2019 (when face-to-face classes were held) and 2020/2021 (when classes were conducted online) were analyzed. In the academic year 2018/2019, 79 students attended the first year of study, whereas in the 2020/2021 academic year, this number decreased to 66 students. For the second year of study, 74 students attended in the academic year 2018/2019, and in the 2020/2021 academic year, the number increased to 90 students. Table 1 presents the subjects included in this study.

Table 1. Subjects of the first and second year of study at the Department of Biology used in research

First year of study		
Winter Semester		**Summer Semester**
1	Cell Biology	Plant Morphology
2	Systematics of Algae and Fungi	Histology and Embryology of Animals and Humans
3	Systematics of Lower Non-Chordates	Systematics of Higher Non-Chordates
4		Organic Chemistry
Second year of study		
Winter Semester		**Summer Semester**
1	Systematics of Chordates	Molecular Biology
2	Comparative Anatomy of Animals and Humans	Systematics of Cormophytes
3	Biochemistry	General Physiology of Animals and Humans
4	General Microbiology	General Genetics

2.2. Student motivation

An online survey was used to collect data. The questions, with certain modifications, were taken from studies conducted by Pesidas et al. (2022) and Babakova et al. (2021) among students of culture and arts. The survey consisted of 23 items divided into three categories (satisfaction, intrinsic motivation, and collaboration), and students responded using a Likert scale: 5 - Strongly agree, 4 - Agree, 3 - Neutral, 2 - Disagree, 1 - Strongly disagree.

The research sample consisted of third- and fourth-year students of the Department of Biology at the Faculty of Science and Mathematics in Sarajevo. A total of 64 students responded to the survey, of which 38 (59.4%) were third-year students and 26 (40.6%) were fourth-year students. Of the total number of respondents, 6 were male (9.4%) and 58 were female (90.6%). The research included all five study majors, and Table 2 presents the distribution of participants across these majors.

Table 2. Distribution of participants' responses according to variable: major

	Major	f	%
1	Biochemistry and Physiology	16	25%
2	Microbiology	14	21,9%
3	Genetics	10	15,6%
4	Ecology	14	21,9%
5	Teaching major	10	15,6%

2.3. Statistical analysis

All research results were analyzed using statistical software programs Microsoft Excel and Past4.13 (Microfost Excel, 2019; Hammer, 2001). Alpha Cronbach was used to analyze the reliability of the entire instrument and its subscales. The reliability of the subscale "Satisfaction with online teaching" is 0.81, for the subscale "Intrinsic motivation" is 0.81, and for the subscale "Cooperation with professors and students" is 0.91. Overall, reliability for the entire instrument is 0.77, indicating moderate reliability.

To determine if there was a significant difference in academic motivation levels, when data was grouped by study program, inferential statistics known as one-way ANOVA were applied. Independent t-tests were used to analyze data on students' academic performance, comparing the mean exam grades of the subjects between the group that attended face-to-face classes during the 2018/2019 academic year and the group that underwent online teaching during the 2020/2021 academic year. The significance level was set at 0.05, with a confidence interval of 95%. This test was also used to compare the level of motivation, for each scale individually, between third-year and fourth-year students.

3. Results

3.1. Academic achievement

The average grades from the subjects that students took during face-to-face instruction (2018/2019) were compared with the average grades from the subjects that students took online (2020/2021). The compared subjects were from the first two years of study as all majors had the same subjects. Figure 1 shows the average grades from the subjects in the first year of study.

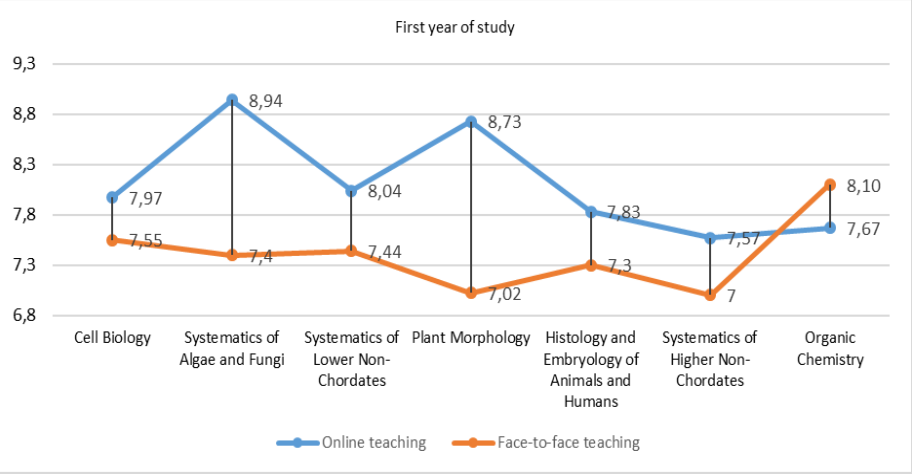

Figure 1. Success of students in the first year of study during online and face-to-face classes

The analysis of the results of students in the first year of study shows that the grades in the subject Organic Chemistry were better during traditional classes, while the results in all other subjects were better in online classes.

The results of descriptive statistics for the first year of studies can be seen in Table 3. The obtained p-value of 0.01 indicates statistically significant differences in favor of online teaching.

Table 3. Results of the analysis of the average grades from the first year of study

	Online teaching	Face-to-face teaching

	Online teaching	Face-to-face teaching
Average	8,11	7,4
Standard deviation	0,52	0,37
Variance	0,27	0,13
Minimum value	7,57	7
Maximum value	8,94	8,1
P-value	0,01	

In addition to the analysis for the first year of study, an analysis of academic success in subjects from the second year of study was also performed, the average grades of which can be seen in Figure 2.

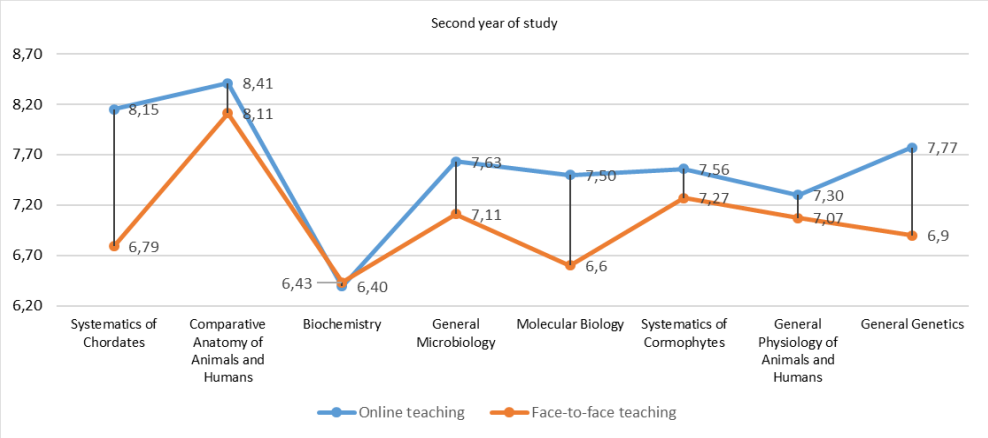

Figure 2. Success of students in the second year of study during online and face-to-face classes

Among the eight courses taken by students in the second year of study, the most significant difference is visible in the course Systematics of chordates, where students achieved significantly better results during online classes. There were no significant deviations in all other courses. The results of descriptive statistics for the second year of study can be seen in Table 4.

Table 4. Results of the analysis of the average grades from the second year of study

	Online teaching	Face-to-face teaching
Average	7,58	7,03
Standard deviation	0,6	0,5
Variance	0,36	0,26
Minimum value	6,39	6,43
Maximum value	8,41	8,11
P-value	0,06	

The p-value was 0.06, which means that there is no statistically significant difference in the success of students during online and traditional classes when it comes to subjects from the second year of study. Using the t-test for independent samples, the success in all subjects was compared for both years of study, in online and traditional classes, and a p-value of

0.004 was obtained. This means that there is a statistically significant difference in the success achieved in online and face-to-face classes.

3.2. Student motivation

3.2.1. Academic motivation: Satisfaction with online teaching

Responses to the subscale "Satisfaction with online teaching" were carefully examined and subjected to coding and analysis. The findings are presented in Figure 3, which illustrates the participants' responses to each item on the questionnaire, along with the corresponding mean (M) value. The data were coded based on the following scale: 1.0 – 1.79 (Strongly Disagree), 1.80 – 2.59 (Disagree), 2.60 – 3.39 (Neutral), 3.40 – 4.19 (Agree), and 4.20 – 5.00 (Strongly Agree).

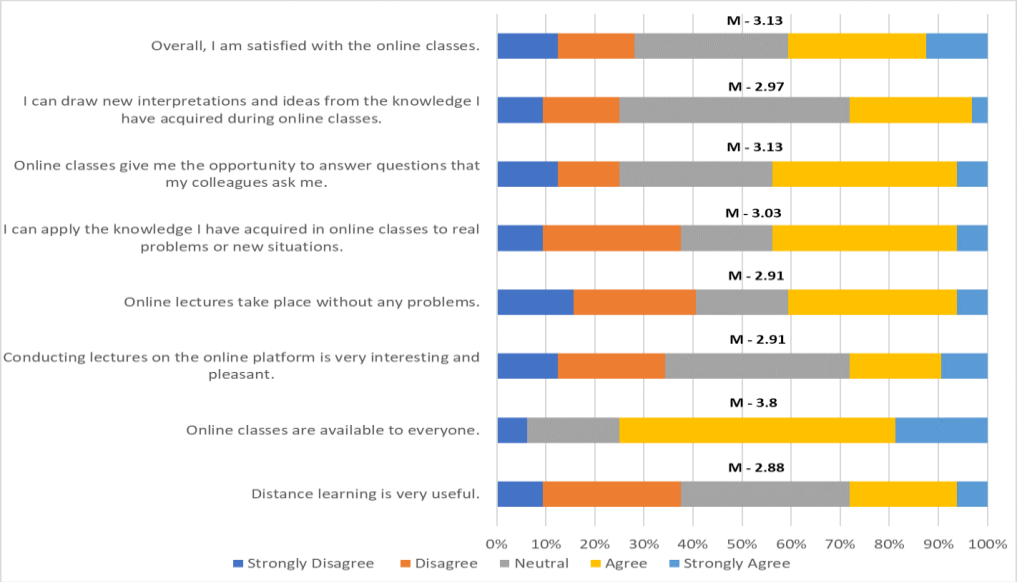

Figure 3. Results of student responses on academic motivation: Satisfaction with online teaching

The results shown in Figure 3 indicate that the respondents expressed a "neutral" attitude in most of the statements, which is further confirmed by the mean value (M) of 3.09 for all analyzed questions. However, the one statement that most respondents agreed with was that online classes are accessible to everyone.

3.2.2. Academic motivation: Intrinsic motivation

Responses to the subscale "Intrinsic motivation" were carefully examined and subjected to coding and analysis. The findings are presented in Figure 4, which illustrates the participants' responses to each item on the questionnaire, along with the corresponding mean (M) value. The data were coded based on the following scale: 1.0 – 1.79 (Strongly Disagree), 1.80 – 2.59 (Disagree), 2.60 – 3.39 (Neutral), 3.40 – 4.19 (Agree), and 4.20 – 5.00 (Strongly Agree).

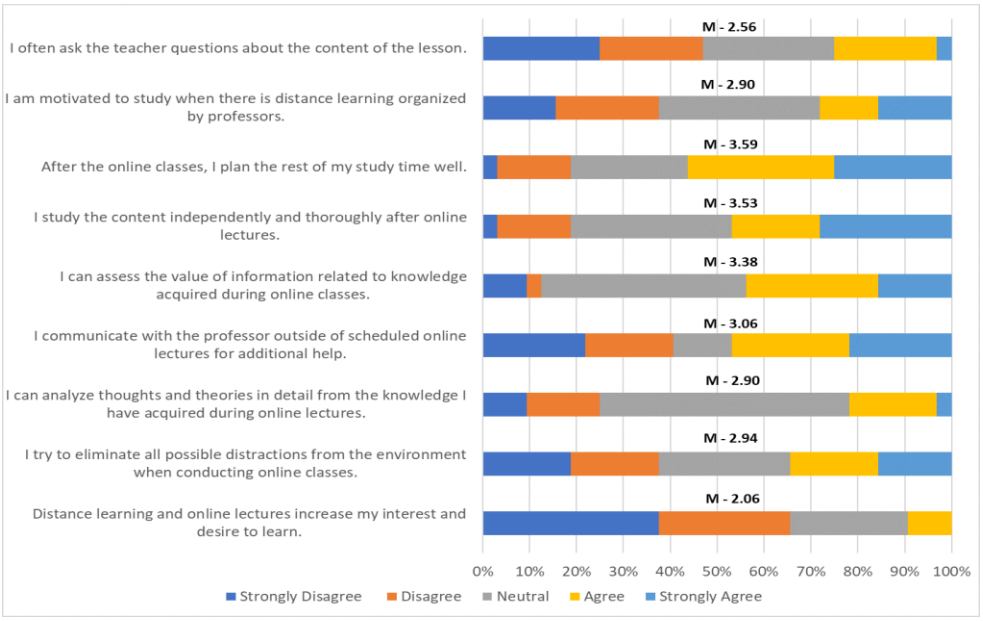

Figure 4. Results of student responses on academic motivation: Intrinsic motivation

The analysis of the data shown in Figure 4 indicates the academic motivation of the students of the Department of Biology in terms of intrinsic motivation (items 1-9). The results show that the respondents are "neutral" in statements 2, 5, 6, 7 and 8. Students agree with statements 3 and 4 and disagree with statements 1 and 9. The mean value for the entire subscale is 2.99 which means that the respondents expressed a neutral attitude towards internal motivation in online classes.

3.2.3. Academic motivation: Cooperation with professors and students

Responses to the subscale "Cooperation with professors and students" were carefully examined and subjected to coding and analysis. The findings are presented in Figure 5, which illustrates the participants' responses to each item on the questionnaire, along with the corresponding mean (M) value. The data were coded based on the following scale: 1.0 – 1.79 (Strongly Disagree), 1.80 – 2.59 (Disagree), 2.60 – 3.39 (Neutral), 3.40 – 4.19 (Agree), and 4.20 – 5.00 (Strongly Agree).

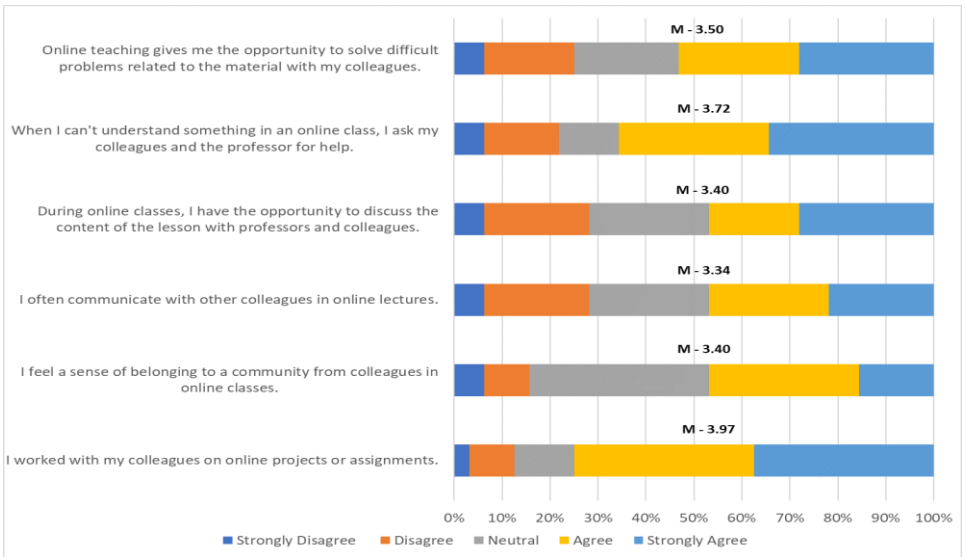

Figure 5. Results of student responses on academic motivation: Cooperation with professors and students

The mean value of the answers for this subscale is 3.56, which shows that the respondents "agree" that there is cooperation between professors and students in online classes. They expressed a neutral attitude only in the claim related to communication with colleagues in online lectures.

3.2.4. Motivation of students in relation to the year of study

To determine if there is a significant difference in academic motivation during online classes with regard to year of study, the data set was analyzed using inferential and parametric statistics known as the T-test for independent samples (Table 5). Based on the data presented in table 5, it can be concluded that there are significant differences in overall academic motivation in online classes in relation to the year of study (value sig.= 0.04 < a = 0.05). The year of study has a significant impact on students' motivation.

Table 5. Academic motivation of students in online classes in relation to the year of study

Variables					
Dependent	Independent	N	M	SD	Sig. (2-tailed)
Satisfaction with online teaching	third year	38	2,96	0,74	0,24
	fourth year	26	3,26	0,64	
Intrinsic motivation	third year	38	2,85	0,75	0,21
	fourth year	26	3,19	0,74	
Cooperation with professors and students	third year	38	3,16	1,03	0,003
	fourth year	26	4,12	0,67	
Overall motivation	third year	38	2,97	0,70	0,04
	fourth year	26	3,47	0,60	

3.2.5. Students' motivation in relation to the major

To determine whether or not there was a significant difference in the level of academic motivation during online classes on the subscales when the data were grouped by major, the data set was subjected to an inferential statistic known as one-way ANOVA.

Table 6 shows the results of the one-way ANOVA. As shown in the table, there was no statistically significant difference in academic motivation among majors in terms of academic motivation in online classes. P-values are greater than 0.05 implying that academic motivation in online classes is statistically similar among majors. Since p-values are greater than 0.05, performing post hoc tests is no longer necessary.

Table 6. Academic motivation of students in relation to the major

Subscale		MS	Sig.
Satisfaction with online teaching	Between groups	0,48	0,49
	Within groups	0,54	
Intrinsic motivation	Between groups	0,50	0,5
	Within groups	0,58	
Cooperation with professors and students	Between groups	0,18	0,96
	Within groups	1,15	
Overall motivation	Between groups	0,20	0,82
	Within groups	0,53	

4. Discussion

4.1. Academic success

The recent global pandemic of COVID-19 suddenly forced teachers to replace traditional written exams with alternative assessment methods (Borgaonkar et al., 2021; Clark et al., 2021; Sletten, 2021). Thus, at the Department of Biology, which is located at the Faculty of Science, all exams were held online during the pandemic.

The analysis of the results of this research showed significant differences in the academic success of students between face-to-face and online classes. In the first year of study, it was noticed that the results of most subjects were better in online classes. This leads to the conclusion that online teaching was equally and even more effective in most subjects compared to traditional teaching. Although the subject Histology and Embryology of Animals and Humans requires a lot of practical work, the knowledge was transferred well and the students achieved better results in online classes. Similarly, the results of a study conducted by Zheng and colleagues (2021) show that students had an equal or higher percentage of success in obtaining an "A" grade in online classes compared to face-to-face classes in Anatomy and Histology.

The analysis of the results for the second year of study showed that the most significant difference in the success of students is visible in the subject Systematics of chordates. From this, it can be concluded that online teaching methods are potentially useful, especially in areas that focus on theoretical education rather than practical skills. Although there were no significant differences in other subjects, the majority showed slightly better results in online classes. These results are consistent with previous studies in which researchers concluded that online teaching has a positive impact on students' academic achievement (Mahmoodi et al., 2015; Handique, 2017; Gonzalez et al., 2020). In the research conducted by Lestari et al. (2022), students achieved significantly better results in microbiology in online classes, which also coincides with this research. A recent study by Stevens and colleagues (2019) found similar results, showing that online teaching in clinical microbiology was well received by students and had a positive impact on their academic performance.

It is clear, based on this research, that students from subjects from the first year of study had statistically significantly better results on exams during online classes, while there was no statistically significant difference in subjects from the second year of study. Similarly, in the research conducted by Lestari et al. (2022), first- and second-year students had good results on exams during online classes, unlike third-year students, which means that the year of study has a significant impact on the success of students during online classes.

Limitations of this research include the limited sample of students from the same faculty and the specific subjects included in the analysis. Also, the duration of the research was limited to one academic year. Future research could expand the sample and include more faculties in order to gain a more comprehensive view of the impact of online teaching on students' academic success.

4.2. Student motivation

Due to the widespread phenomena brought about by the pandemic, the results show that the respondents do not have a pronounced or positive academic motivation for studying

online. These findings support the conclusions of Lee and Choi (2011), who pointed out that the distance between teachers and students hinders full communication and interaction, leading to a decrease in engagement in teaching. Babakova et al. (2021) and Pesidas et al. (2022) also investigated similar topics, but the difference in results is possible due to the different populations in their studies. Also, it is important to note that Babakova et al. (2021) and Pesidas et al. (2022) conducted research with a focus on students from the fields of culture and art.

In this research study, it is observed that there is a neutral degree of satisfaction among students regarding online teaching. It is possible that the root cause of low satisfaction with online teaching lies in the expectations that students have. It is likely that students had high expectations regarding online classes, but these expectations were not met. Some authors emphasize the importance of the psychological contract between students and teachers and claim that this contract plays a key role in achieving satisfaction with online teaching (Dziuban et al., 2015). The results of the intrinsic motivation test showed that students have neutral motivation, which is in line with the research conducted by Pesidas et al. (2022). The respondents expressed a neutral attitude towards most of the statements, but they agree with the statements related to independent study of the content after online lectures and good planning of study time after online lectures. The research on the cooperation of students with professors and colleagues indicates a significant engagement of students in these interactions. Roddy and colleagues (2017) note that teachers play an important role in the motivation and success of students in online classes. In contrast to this research, Bączek et al. (2021) suggest that students are less active during online lectures. Rovai et al. (2007) reveal differences in student motivation according to years of study in online education, which is also confirmed in this study with a statistically significant difference of 0.04 between students in the third and fourth year of study. However, the research results of Osmanagić (2021) show that, despite the existence of differences in the motivation of students of different years of study, these differences are not statistically significant. Regarding the motivation of students in different courses, no statistically significant differences were found, which coincides with the research of Francis et al. (2019), who found that although students in e-learning and traditional face-to-face education may differ in terms of academic achievements, motivation was not significantly different. Overall, these findings highlight the complexity of student motivation and satisfaction in the context of online classes.

5. Conclusions

Based on the analysis of student motivation and success in online education, our research gave key insights into the dynamics of contemporary education.

Confirming our first hypothesis, we observed a significant difference in achievement between online and traditional classes. However, the results did not support our expectations from the second hypothesis about expressed motivation in the online environment, which indicates the neutrality of student motivation. Our analysis revealed no significant differences in students' intrinsic motivation and satisfaction, confirming our third and fourth predictions. On the other hand, we observed differences in cooperation with professors depending on the year of study, while differences related to major were less significant, partially supporting our fifth hypothesis. Furthermore, our sixth hypothesis regarding the lack of differences in overall academic motivation by major was also

confirmed, while significant differences emerged depending on the year of study, highlighting the need for further research to better understand the specific factors that influence motivation in online environments. These findings emphasize the importance of developing strategies aimed at improving the online education experience for all students.

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