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**ONLINE ENGAGEMENT AND SATISFACTION OF
UNDERGRADUATE ENGINEERING STUDENTS DURING THE
COVID-19 PANDEMIC**

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Abstract

The COVID-19 pandemic has significantly changed the teaching-learning-evaluation process with the transition of universities to emergency remote education. As universities have moved to a new way of learning, student engagement and satisfaction became an evolving concern among academics. The aim of study was to explore the student engagement and satisfaction with online learning experiences in engineering courses in a hybrid approach during the pandemic. A total of 135 undergraduate students from Technical University of Cluj-Napoca, Romania, responded to the online survey based on two previously developed surveys. According to the results, the online student engagement and satisfaction were at a medium level. Female student engagement was higher than male student engagement, and the 4th year students had higher satisfaction scores with online learning. The study found that student engagement was significantly correlated with satisfaction in online learning experiences. The results have implications for educational theory and practice in creating effective blended learning environments and for future research.

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1. Introduction

The COVID-19 pandemic has had a profound and rapid impact on educational systems around the world and has provided a rare opportunity to reflect on current educational practices and to reconsider significant pedagogical aspects that could transform teaching, learning and evaluation processes. In higher education the COVID-19 pandemic has forced teachers to move online their courses and this sudden shift has increased the existing and new challenges of technology-driven learning. An Emergency Remote Teaching (ERT) model has been adopted worldwide as a temporary and mandatory measure in crisis circumstances, and this education is approached as emergency remote education, not as effective online education based on careful instructional design (Bozkurt & Sharma, 2020; Hodges et al., 2020). Digitization in the educational system should be seen as an alternative measure in crisis situations or complementary to face-to-face schooling and not an online permanence of teaching and learning. Before the current pandemic, e-learning, and e-teaching, even in hybrid format, were something few people were familiar with, perhaps except for those enrolled in distance education and those specialized and curious about technology.

In recent decades, student engagement has been a popular topic in educational research. Researchers acknowledge that engagement is a broad and complex construct with own indicators. Students' engagement to courses was defined as motivation to actively participate in them and was approached as an effective predictor in the quality of learning experiences and learning outcomes (Redmond et al., 2018). There are three different types of student engagement: behavioral, cognitive, and emotional engagement (Fredricks & McColskey, 2012). For this study, Dixson's (2015) definition of online student engagement was chosen involving:

... students using time and energy to learn materials and skills, demonstrating learning, interacting in a meaningful way with others in the class (enough so that those people become 'real'), and becoming at least somewhat emotionally involved with their learning (i.e., getting excited about an idea, enjoying the learning and/ or interaction). (p. 4)

Researchers found that digital environments increase the academic and social engagement, autonomous learning, create diverse environments (Zilka et al., 2018), improve digital competences (He & Zhu, 2017), provide equal opportunities, and reduce differences between students (Horizon Report, 2017). Discussions about engagement have become more critical in the context of the COVID-19 pandemic, which had a negative impact on study engagement and work performance (Meo et al., 2020), leading to inadequate communication and interaction, difficulties in independent learning, in-depth learning, time management. However, research has shown that flexible learning environment, opportunities to review activities asynchronously, independence of time and space, use of innovative teaching-learning strategies, quality of learning materials and approach to assessment alternatives have had positive effects on student learning and satisfaction (Tang et al., 2020). Recent research in learning analytics provides tools for measuring online engagement during learning, by capturing data on student engagement through Internet of Things technology (Salas-Pilco & Yang, 2020).

Satisfaction refers “to how students perceive their learning experiences, and it is a fundamental link in student outcomes associated with higher level student engagement and achievement” (Kucuk & Richardson, 2019, p. 198). Student satisfaction in online learning can be linked to several factors: student-teacher-content interactions, platform value, tutorials, course quality, student expectations, teaching methods, assessment, computer and internet self-efficacy, perceived learning, teachers’ expertise, learning online skills (Joosten & Cusatis, 2020; Tratnik et al., 2019). An online student engagement and satisfaction model developed by Kucuk and Richardson (2019) focuses on the structural relations between teaching, social and cognitive online presence, student engagement and satisfaction, where teaching presence was the dominant determinant of satisfaction and necessary to maintain engagement. Research found that in online learning female students were more satisfied than male students and degree students were more satisfied than diploma students (Chung et al., 2020), while science and engineering students are relatively more satisfied than students from medical sciences and social sciences (Simsek et al., 2021). Student engagement is normally considered a key factor in online courses, an additional predictor of satisfaction in online learning environments (Martin & Bolliger, 2018).

According to the national regulations and university autonomy, educational institutions have offered their students blended learning, which is a mixture of enhanced learning through online technology and face-to-face experiences. Although there is a growing consensus on the benefits of blended learning, the findings on the effectiveness of blended learning are mixed (Bruff et al., 2013). Because hybrid learning maintains all available options, students' successful learning experiences require cognitive engagement skills to find the right combination of learning options (Xiao et al., 2020).

2. Problem Statement

The sudden transition to online learning has presented several problems for students, such as the digital divide, equity, internet connection, accessibility of student data, low student-student, and teacher-student interaction etc., leading to disengagement or dissatisfaction. Given these considerations, Technical University of Cluj-Napoca is in the process of assessing whether the online pedagogy during the pandemic has determined students to engage in online learning and how it influences their satisfaction. At the beginning of the 2021-2022 academic year, Technical University of Cluj-Napoca approved the transition to online courses and face-to-face seminars, laboratories, and other forms of practical activity, using hybrid learning environments. The motivation of this study is to make the university aware of the level of online student engagement and satisfaction in hybrid learning environments during the pandemic, of the impact of demographic characteristics on them, to initiate actions to increase student engagement and satisfaction in engineering courses.

3. Research Questions

The research questions are set as follows:

- i. What are the levels of student engagement and satisfaction with online learning in a hybrid approach during the pandemic?

- ii. Do student engagement and satisfaction with online learning in a hybrid approach during the pandemic show significant differences according to gender, residence area and year of study?
- iii. Is there a significant relationship between student engagement and satisfaction with online learning in a hybrid approach during the pandemic?

4. Purpose of the Study

This paper aims to explore how students are engaged and satisfied with online activities in engineering courses in a hybrid approach during the COVID-19 pandemic.

5. Research Methodology

5.1. Research design

Data were collected from undergraduate students enrolled at the Technical University of Cluj-Napoca, using quantitative research methods. The students were assured of the confidentiality and anonymity of the questionnaire. The data were arranged, organised, tabulated, and analysed using descriptive statistics in the SPSS version 24.0. During the data processing and interpretation, means were used to assess the level of student engagement and satisfaction with online learning. After verifying the normal distribution of the data using the Kolmogorov-Smirnov Test and the Shapiro-Wilk Test, it was decided to use non-parametric tests ($p < 0.05$). The online student engagement and satisfaction according to gender and residence area were analysed with the Mann-Whitney U test. According to the year of study the data were analysed with the Kruskal Wallis test. Moreover, the effect sizes of the tests were calculated. We used a Spearman rank correlation to analyse the significant relationship between the measured variables.

5.2. Sample

The study sample consists of students from the 1st to the 4th year studying hybrid in various undergraduate programs at the Technical University of Cluj-Napoca in the winter of the 2021-2022 academic year. The research was conducted on a group of 135 participants with 63 female (46.7%) and 72 male students (53.3%), and 100 lived in urban areas and 35 lived in rural areas. Regarding the year of study, the participants were enrolled in 1st year (N = 23, F = 17%), 2nd year (N = 44, F = 32.6%), 3rd year (N = 48, F = 35.6%), and 4th year (N = 20, F = 14.8%).

5.3. Measures

The exploratory online instrument assessed students' responses using closed-ended questions to obtain respondents' information about demographic background, in the first part, and opinions about their online engagement and satisfaction, in the second part. This second part was based on two previously developed surveys in the literature. One survey was adapted from Dixson's research (2015), The Online Student Engagement Scale, using the 19-item questionnaire on a 5-point Likert-type scale (from 1 = not at all characteristic of me to 5 = very characteristic of me) with Cronbach's Alpha of 0.925 for this scale.

The other survey was based on satisfaction scales in online education developed by Kucuk and Richardson (2019) and Simsek et al. (2021), consisting of 7 items with a 5-Likert type response format from strongly disagree (1) to strongly agree (5) with reliability of this scale of 0.946. The Cronbach's Alpha for the entire questionnaire is 0.934, which indicates a high level of internal consistency.

6. Findings

Aiming to investigate the students' level of engagement with online activities in a hybrid approach during the COVID-19 pandemic, on the dimensions of skills, emotion, participation, and performance engagement, it was resorted to the calculation of the means for each dimension of the engagement scale. The analysis based on observed scores by subscales, for each variable followed, showed a medium level of online student engagement ($M = 3.40$; $SD = 0.73$). The mean and standard deviation values are shown in Table 1.

Table 1. Levels of student engagement and satisfaction with online learning

Variables	N	Mean	SD	Descriptive Level
Online student engagement domains				
Skills	135	3.51	0.828	Medium
Emotion	135	3.33	0.894	Medium
Participation	135	3.17	0.802	Medium
Performance	135	3.57	0.973	Medium
Total Engagement	135	3.40	0.733	Medium
Satisfaction	135	3.45	1.189	Medium

Engagement domains received mean scores: for skills a medium level ($M = 3.51$, $SD = 0.82$), for emotion a medium level ($M = 3.33$, $SD = 0.89$), for participation a medium level ($M = 3.17$, $SD = 0.80$), and for performance a medium level ($M = 3.57$, $SD = 0.97$). The results showed that performance engagement achieved the highest mean scores, followed by skills engagement and emotional engagement. The participation engagement obtained the lowest mean scores. The data suggested that students have a medium level of online engagement, keeping up with reading courses and striving to accomplish their tasks. They are also involved in interesting courses on a medium level and, as a result, apply them in their lives. At a medium level, students interact and actively participate in online discussions. In terms of performance in online courses, students do well in tests and get good grades.

Descriptive statistics on student satisfaction with online learning are presented in Table 1. University students are on average satisfied to have online learning activities during the COVID-19 pandemic ($M = 3.45$; $SD = 1.189$). Although students believe that online learning helps their academic and professional development, the results showed that, in general, they are not very satisfied to attend online activities and that practical activities cannot be done at a sufficient level.

The second objective of the research was to identify the significant differences in levels of engagement and satisfaction with online learning experiences during the pandemic in terms of gender, residence area and year of study. The Mann-Whitney U test was used to analyse students' engagement and satisfaction scores by gender and residence area. The results are presented in Table 2:

Table 2. Engagement and satisfaction in online learning according to gender and residence area

Variable	Cases	N	Mean Rank	Sum Rank	U	Z	p	Effect Size
Gender								
Engagement	Female	63	79.91	5034.50	1517.500	-3.310	.001*	0.28
	Male	72	57.58	4145.50				
Satisfaction	Female	63	65.41	4121.00	2105.00	-.721	.471	0.06
	Male	72	70.26	5059.00				
Residence area								
Engagement	Urban	100	64.72	6471.50	1421.50	-1.649	.099	0.14
	Rural	35	77.39	2708.50				
Satisfaction	Urban	100	64.42	6442.00	1392.00	-1.803	.071	0.15
	Rural	35	78.23	2738.00				

*p < .05

Table 2 shows that the online students' engagement scores differ significantly depending on their gender ($U = 1517,50$; $p < .05$, $r = 0.28$). Regarding their mean rank, it is found that female student engagement is higher than male student engagement and the effect size is moderate. The data show that there is no statistically significant difference in online satisfaction according to the gender ($U = 2105.00$, $p = .471$) and the effect size is very low ($r = 0.06$). The data analysis also indicated that there is no statistically significant difference regarding residence area both in terms of student engagement ($p = 0.99$, $r = 0.14$), and in student satisfaction ($p = .071$, $r = 0.15$).

Online student engagement and satisfaction scores were analysed according to year of study in which they are enrolled. The Kruskal Wallis H test was used to examine student engagement and satisfaction scores (see Table 3).

Table 3. Engagement and satisfaction in online learning according to the year of study

Variable	Cases	N	Mean Rank	df	χ^2	p	Effect Size
Engagement	1 st year	23	74.13	3	1.665	.645	0.10
	2 nd year	44	63.78				
	3 rd year	48	66.34				
	4 th year	20	74.20				
Satisfaction	1 st year	23	69.65	3	24.764	.000*	0.40
	2 nd year	44	49.13				
	3 rd year	48	70.83				
	4 th year	20	100.83				

*p < .05

In terms of online engagement scores, it was found that there is no statistically significant difference according to the year of study ($\chi^2 = 1.665$; $p = .645$), and effect size is very low. However, when examining Table 3, we can see that students' satisfaction scores differ significantly depending on the year of study ($\chi^2 = 24.764$; $p < .05$, $r = 0.40$). Given the mean rank, it is understood that 4th year of study students have the highest satisfaction with online learning. Also, it has been observed that there are significant differences between 1st and 4th years of study ($U = 94.500$, $Z = -3.336$, $p = .001$, $r = 0.50$) and

between 2nd and 4th years of study ($U = 101.000$, $Z = -4.919$, $p = .000$, $r = 0.61$), 4th year students being more satisfied with online learning compared to 1st and 2nd years students. When the effect size is analysed, it is understood that this difference is a large one.

The third research objective was to identify whether there was a significant relationship between student engagement and satisfaction with online learning experiences in a hybrid approach during the COVID-19 pandemic. To explain the relationships between the constructs of online student engagement and satisfaction, an analysis of the Spearman correlation coefficient was performed. The results in Table 4 show that when the online student engagement was correlated with satisfaction, it obtained a correlation value of 0.457 with $p < .001$ or 'significant'. When the student engagement domains were correlated with satisfaction, results showed correlation values and p-values, as follows: skills ($r_s = 0.369$; $p < .001$ or 'significant'), emotion ($r_s = 0.367$; $p < .001$ or 'significant'), participation ($r_s = 0.453$; $p < .001$ or 'significant'), and performance ($r_s = 0.300$; $p < .001$ or 'significant'). This implies that student engagement is a significant factor influencing student satisfaction in online learning. On the other hand, students who are satisfied with online courses, ways of interaction, assessment, participation, have a higher level of online engagement in terms of skills, participation, performance, and emotion.

Table 4. Correlation between student engagement and satisfaction with online learning

Variable		Engagement	Skills	Emotions	Participation	Performance	Satisfaction
Engagement	Spearman's rho	-	.860	.863	.662	.797	.457
	Sig. (2-tailed)	-	.000	.000	.000	.000	.000
Skills	Spearman's rho		-	.805	.415	.564	.369
	Sig. (2-tailed)		-	.000	.000	.000	.000
Emotions	Spearman's rho			-	.468	.563	.367
	Sig. (2-tailed)			-	.000	.000	.000
Participation	Spearman's rho				-	.413	.453
	Sig. (2-tailed)				-	.000	.000
Performance	Spearman's rho					-	.300
	Sig. (2-tailed)					-	.000
Satisfaction	Spearman's rho						-
	Sig. (2-tailed)						-

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

The aim of this study was to identify and analyse the levels of student engagement and satisfaction with online learning in engineering courses in a hybrid approach during the COVID-19 pandemic.

Given the advantages and disadvantages of online learning, it can be deduced from this study that student engagement and satisfaction remain moderate. When online presence is higher in courses through different ways of interaction and communication with teachers and colleagues, student engagement levels increase (Dixson, 2015). Although students believe that online learning helps their academic and professional development, it has been found that they are generally not very satisfied with activities completely online and that the subjects requiring practice cannot be done at a sufficient level. The results indicated that performance engagement achieved the highest mean scores, followed by skills, emotional and participation engagement. Students devote time and energy to online learning through their medium level of skills, online interactions, positive attitude, and performance. The data also show that female student engagement is significantly higher than that of male students. This may be because females naturally have a better involvement compared to male. A part of changes from contemporary world is the ongoing struggle to eradicate gender in-equality which is one of the major themes of globalization that the whole world is targeting. A significant result was that satisfaction scores differ significantly depending on the year of study, the 4th year students having the highest satisfaction, followed by 3rd year, 1st year and 2nd year. The relatively lower level of satisfaction of the 2nd year students could be interpreted by increasing the number and difficulty of course contents in undergraduate programs and by the transition from theory to practice. On the other hand, students in the 3rd and 4th years studying engineering have experienced online learning since the early months of this pandemic. According to residence area, there is no statistically significant difference in student engagement and satisfaction. Furthermore, this study found that student engagement was correlated with satisfaction in online learning. Students engaged online in terms of skills, emotion, participation, and performance, are more likely to be satisfied with online learning opportunities provided by their teachers. The universities should consider student satisfaction in online learning as a significant factor in the quality of online pedagogy, affecting students' engagement in online learning.

The implications of these findings lead to: transforming technical higher education (combining face-to-face training with online training), providing adequate professional development (applying emerging technologies and combining technological and pedagogical skills), ensuring the quality of online learning (designing flexible learning with appropriate pedagogical methods, access to digital resources and evaluation of learning outcomes), improving students' well-being (providing emotional support and developing coping skills).

For future post-COVID-19 strategies in higher education, the blended approach can be improved as an alternative to a changing world, enabling the implementation of teaching based on new technologies and innovative pedagogies (Potra et al., 2021). Technology is a reality of the modern world, a constantly changing field, which can bring enormous benefits to the educational system, if it is used in an efficient and adapted way. What we need to keep in mind as teachers or researchers is that using an educational tool or "using technology" is not a goal, it is just a tool for achieving educational goals, to form and develop functional educational competencies. The effectiveness of online learning depends on appropriate learning resources, teacher facilitation and involvement, as well as authentic and meaningful teacher-student-content interactions. Universities should invest in efficient, effective, and easily accessible online learning platforms, Learning Management Systems (LMSs), and online educational resources. The

continuous development of online educational resources is necessary for the academic environment so that online courses are easier and more efficient, given the medium level of students' engagement and satisfaction in online learning. To achieve quality learning experiences for students, a key element is to provide teachers and students with not only educational resources, but also digital skills, to adapt the teaching and learning style to the online environment, to assist students' online learning needs and to develop positive attitudes towards learning.

Teachers should make changes in course content and use teaching-learning strategies to help students feel emotionally, cognitively, and behaviourally engaged throughout online learning. Student engagement can be stimulated using interactive teaching-learning strategies, active learning ideas, as well as adaptive and innovative pedagogies for engineering courses. Thus, teachers should try to control the length of course videos and interact with students synchronously in the learning platforms. It is important for teachers to create different strategic designs to turn blended learning into a more effective and efficient approach. For example, practical problems may arise in conducting online courses and, in this context, online alternatives should be considered. The effectiveness of teaching and learning in engineering disciplines is determined by laboratories, practical exercises, and experiments. Augmented and virtual reality technologies, tutorials, simulations etc. could be developed to acquire field-specific psychomotor skills. Well-designed online instruction should utilize elements of Universal Design for Learning where students have access to materials through multiple means of engagement, representation, and action and expression. Further, teachers could strengthen their online communication and feedback practices. Engaging in activities with real-life problems, cultivating relationships through learning, and authentic feedback significantly improved online student enjoyment and satisfaction (Guo 2018). An essential recommendation for educational policies and practices refers to avoid neglecting the human factor in defining learning processes with the help of new technologies, aiming at both personalization of e-learning pathways and humanization of the e-learning process, for example, by integrating game-based elements, new opportunities for interaction and participation in student decisions, aspects of social learning in e-learning programs (Istrate, 2020). Teachers could include activities that will support students' social presence in online learning. An active and interactive approach can reduce negative emotions and increase the student well-being. Pandemic teaching could be beneficial in building student resilience. Strategies promoting student engagement may include facilitating personal interaction, making the visual message in video meetings as interesting and encouraging as possible, including "non-academic" exercises, and trying new approaches enabled by online settings. Online etiquette suggestions in teaching include verbal/ visual confirmation of student attendance, frequent requesting students to raise hand or participate, use of polls, discussion forums, and breakout rooms. It is useful for students to start learning how to respond critically and creatively and to try to understand answers or projects through peer-to-peer approaches.

One of the academic challenges is educating students to be able to activate and maintain thoughts, emotions, motivation, and behaviours in pursuit of learning goals, a process called self-regulated learning. Learning strategies by involving students in metacognitive processes are desirable to properly regulate their learning, to gain more in-depth knowledge, to pursue learning objectives and to achieve higher performance. Students could be encouraged to monitor their own progress and performance, for example,

by providing regular opportunities to test their knowledge and understanding, to reflect on feedback and to engage in dialogue with teachers and/ or peers.

Teachers could devote more time to continuous assessment to provide quality online learning by identifying learners who may be struggling with online learning, facilitating assessment criteria, providing prompt and useful feedback, supporting reflection processes, avoiding over-assessment activities, focusing more on continuous assessment, encouraging ethical practices. Increased student engagement and satisfaction could be gained by conducting online exams more transparently, applying current LMSs features and secure exam browser settings. Multimodal quizzes in technical higher education contribute to more engagement, as students can benefit from formative assessment.

7. Conclusions

As universities moved to online learning, student engagement and satisfaction became a constant concern among academics. The data revealed that students have a medium level of engagement and satisfaction in online learning but have different levels of satisfaction in terms of the year of study. However, according to gender, there was a difference in student engagement, it was found that students could not fully adopt online learning. Technical higher education should focus on developing pedagogical and digital competencies, on developing skills to use teaching-learning-evaluation strategies that promote student engagement and satisfaction in online learning. Equity-oriented engagement requires that student engagement be a task for higher education to be inclusive and to provide access to opportunities for all students.

The fact that the data were collected only from a Romanian public university, from undergraduate programs and through self-reporting tools is a limitation of this study. Future research could supplement the data with qualitative analysis of students' online behaviours to support the results of this study. However, the study makes important contributions not only to online student engagement and satisfaction, but also to improving our understanding of how blended learning could be conducted effectively.

This pandemic challenge in higher education which has taken a hybrid approach, could allow for a more efficient and effective learning process. In online learning environments, future research could examine students' learning performances, factors affecting student engagement and satisfaction investigated in depth and from sociological, psychological, and field-specific perspectives or changes in online student engagement and satisfaction during and after this pandemic.

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