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Impact of Online Learning on Engineering Students' Engagement, Anxiety, and Burnout amid the COVID-19 Pandemic*

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This study proposes a conceptual model that explores the relationship between online learning, student engagement, anxiety, and burnout during the COVID-19 pandemic. Students' attitudes towards online learning are measured using the Online Learning Questionnaire, anxiety is measured using the GAD-7 scale, student engagement using the UWES-17SF scale, and student burnout with the CBI-S scale. Structural equation modelling (SEM) analysis was used to verify the proposed conceptual model on the sample of 584 engineering students of the University of Belgrade, Faculty of Organizational Sciences who are majoring in information systems and technologies, and management and organization sciences. The results show that online learning positively affects student engagement and negatively student anxiety, whereas it only indirectly, through anxiety, negatively impacts student burnout. In addition, anxiety is proven to positively affect student burnout and has no significant effect on student engagement. In conclusion, while it is encouraging that even crisis-induced online learning positively influences student engagement, the confirmed impact of anxiety on student burnout is also valuable as the early identification and treatment of anxiety can significantly contribute to burnout prevention. This should not be neglected since our research has shown that 37.50% of the examined student population experience severe anxiety, while 62.33% and 45.54% of them experience moderate, high, or severe levels of personal and studies-related burnout, respectively.

Keywords: anxiety; burnout; COVID-19 pandemic; engagement; online learning; SEM; engineering students

1. Introduction

The outbreak of the COVID-19 pandemic seriously affected most aspects of life, including students, teachers, and the entire educational system [1]. Even though the Internet's global availability allowed many schools and universities worldwide to employ online learning as an alternative educational modality before the pandemic [2, 3], it was used only by a small percentage of students, while the majority was still educated traditionally [4]. However, the crisis has caused an urgent and complete transition to the online learning environment, and the student-related issues that were already on the increase before the outbreak are now threatening to escalate to unprecedented levels [5].

With this in mind, our paper focuses on the research problems connected to students' health and academic engagement that were previously examined within a traditional or systematically implemented online learning environment, and have not been sufficiently addressed during crises [6]. In particular, the study explores the problems of prevalent student anxiety [7] and student burnout syndrome [8, 9], as well as the problem of decreased student engagement [8, 10]. Anxiety is typified by the autonomic nervous system's activation and is described as an uncomfortable emotional condition marked by one's sense of apprehension, tension, and worry [11]. Burnout syndrome is classified as a state of vital exhaustion, characterized by the depletion of an individual's mental, physical, and emotional resources [9]. Both anxiety and burnout are shown to be highly detrimental to students' well-being [7] and have been proven to affect educational outcomes [12, 13]. On the other hand, student engagement has been shown to enhance students' achievement in the traditional learning environment [8], and a decrease in it can reduce students' success [10]. It is frequently depicted as a positive antipode of burnout [14] and is defined as "*students' willingness, need, desire, and compulsion to participate in and be successful in the learning process*" [15].

Even though there are numerous factors influencing student anxiety, burnout, and engagement, prior research has shown that all three constructs can be affected by the educational environment within which studying takes place [16–18]. However, studies imply that creating learning conditions that would reduce student anxiety and burnout, and increase student engagement demands time [10, 18, 19]. Unfortunately, to respect the measures of social distancing introduced due to the COVID-19 pandemic, educational institutions, prepared or not, shut down and transferred conventional in-class-

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room learning to the online environment [20]. As for post-secondary education, this overnight shift to ICT happened in most universities around the globe [21, 22]. The swift transition gave no time for universities to focus on the necessary adjustments of the teaching methods and strategies for syllabus delivery [20], nor to assess educators' digital literacy required for the creation of quality learning experiences [23]. Consequently, this has potentially further jeopardized both students' psychological health and their engagement [24, 25]. Regarding these problems, the effects of crisis-induced online learning in university education have been recommended for the research as the previous data in this study area were obtained under ordinary digital learning circumstances and are not, as implied, relevant to emergencies [6].

In addition, this paper focuses on another research problem – the connection between student anxiety and both student burnout and student engagement – identified by the studies conducted within the traditional educational environment [26, 27]. These studies mostly examined specific anxiety types, such as test or state anxiety. Nevertheless, as student general anxiety, after rising gradually over the last decade [28], has soared at the beginning of the pandemic [29], this study will examine its impact on two other constructs within the new learning environment.

Therefore, our research questions are formed to address the identified research problems within a crisis-induced online learning context:

Research Question 1: Are engineering student' engagement, anxiety, and burnout influenced by online learning during the COVID-19 pandemic?

Research Question 2: Does engineering students' anxiety during the pandemic influence their engagement and burnout?

To answer these research questions, we have configured an integrative model consisting of online learning, student anxiety, burnout syndrome, and student engagement. The proposed conceptual model modifies and improves several currently devised ones, and fills the gaps in the literature with the exploration of the aforementioned constructs within the recently established, emergency-driven educational environment, investigating the impact of such an environment on these constructs at the same time. Thus, the examination and the verification of the model should help obtain the main objective of the research which is to determine the relationship between crisis-induced online learning, student anxiety, burnout, and engagement.

To confirm or reject the hypotheses formulated concerning the model, an online survey was conducted among the students at the University of Belgrade, Faculty of Organizational Sciences in Serbia.

In addition to providing the results connected to the hypotheses, the descriptive data regarding the levels of student anxiety, burnout, and engagement will be presented, confirming the relevance of the problems.

The contributions of the study could be multifold. Firstly, it aims to fill a newly-formed research gap connected to the effects of crisis-induced online learning on students' health and engagement. Secondly, it proposes a conceptual model which encompasses several constructs that attract the attention of both practitioners and researchers, especially now in the post-COVID era. Next, since most of the research on students' anxiety, engagement, and burnout involves medical students [30, 31], this study will deliver findings on an under-examined student population. Also, insights into the effects of the fast online transition happening in a developing European country, such as Serbia, will be provided. Finally, this study's findings will be of great use to the academics interested in creating mental health protection programmes for students educated in the online environment.

2. Presentation

2.1 Literature Review

2.1.1 Online Learning

Online learning is usually defined as learning that entirely or partly occurs through the Internet [32]. As a learning environment, it expands rapidly, allowing its users to operate flexibly without place and time constraints [33]. Although it appeals to a broad spectrum of learners and is on offer in many educational institutions [33], its prevalence is still geographically and economically induced. Online learning is a rarity in undeveloped, rural or marginalized, and technologically disadvantaged areas [4]. By contrast, in developed countries, like the USA, it is among the most rapidly growing aspects of post-secondary education [34]. Its optimal usage necessitates adequate infrastructure and relevant changes regarding the course structure, the interaction among learners, and the instructors' role in comparison to traditional in-classroom learning [35]. It can use a great variety of new tools to raise students' motivation [36], and different forms of communication to positively influence students' knowledge and engagement, and reduce students' anxiety [37].

Nevertheless, most studies explored the implications of online learning before the COVID-19 pandemic, when it was an optional way of learning

or part of the prevailing 'blended learning' practices prepared and conceptualized to produce dominantly positive effects [38, 39]. Little is known about its effects during the ongoing pandemic [40] when the transfer to the online environment happened at an unprecedented speed, which many users found stressful [41].

2.1.2 Anxiety

Student anxiety has become one of the central concerns for universities worldwide [7]. Even though research has shown that lower levels of anxiety can enhance learning, higher degrees of anxiety impede the optimal learning process and its outcomes [42]. Indeed, in a survey conducted by American College Health Association in 2018, 27.4% of undergraduate students who experienced overwhelming anxiety reported that it negatively affected their academic success. Moreover, it has been found to paralyze intelligent and diligent learners, who would otherwise achieve great results [42].

Related both to achievement and its outcomes [12], anxiety contains 'worry' and 'emotionality' as its cognitive and affective components [26]. This kind of intensive worry and fear that frequently appear, for instance, in the situations of evaluation or assessment, are shown to enfeeble students' work memory and performance and negatively affect their well-being [43]. Research carried out in China during the current pandemic shows that anxiety is experienced by 21% of university students, and the researchers suggest that students' psychological health needs to be monitored [24].

2.1.3 Burnout

A notable percentage of university students have been found to experience academic burnout [9]. Apart from severe health deterioration, its final result can be losing interest in their studies [13]. Burnout is confirmed to be negatively connected to students' engagement, motivation, and academic progress [44]. By contrast, it is shown to be positively linked to decreased academic achievement-based self-esteem [45], increased students' dropout percentage, deteriorated psychological health, and low sense of one's well-being [46]. For all the damaging consequences of burnout on student well-being and performance, it is worth exploring its predictors, and thus, deliver guidelines for future burnout prevention initiatives for those who study in the online environment [47].

2.1.4 Student Engagement

Engagement is considered a hallmark of an optimum studying experience [48]. It is designated as emotional involvement with an object or intensive, interactive participation in the learning process [26]. Engagement is connected to enthusiasm, optimism, and generally positive attitudes toward one's studies [48, 49]. The feelings of self-efficacy and study-related accomplishment that stem from students' desire to dedicate more time to their learning and set their own learning goals are proven to increase engagement [48].

The difference between engaged and non-engaged students is that the former are absorbed in their studies and other activities connected to university and learning, whereas the latter are distant, detached, disinterested, and alienated from the university [50]. Thus, engagement is positively related to increased motivation to study, academic achievement and retention, decreased perceived stress, and useful coping mechanisms [9].

2.1.5 Online Learning and Students' Anxiety and Burnout

The swift transfer to the new studying environment and the different methods of learning involving the absence of direct interpersonal communication as well as the traditional ways of receiving both colleagues' and teachers' support, accompanied by the pandemic-related fear for one's health, are all the new potential sources of students' anxiety, stress and its final consequence – burnout syndrome [40, 51]. Also, many authors emphasize the connection between prolonged exposure to electronic devices used in online learning, such as computers and smartphones, and increased stress [2, 52]. Accompanied by other telecommunication stressors that influence a user's psychological health, it can produce mental and emotional exhaustion, jeopardizing students' physical health, and leading to eventual burnout [2].

On the other hand, anxiety is one of the most serious and probable consequences of crisis-induced online learning. Firstly, the transfer to the online environment was swift, whereas adjusting to the challenges of the unknown demands time, as otherwise, anxiety rises [40]. Secondly, the complete alteration of students' lifestyle, inability to go to university and socialize and communicate with their colleagues in person, as they used to do, raised their levels of tension, stress, fear, and boredom, potentially increasing the anxiety even more [53, 54]. Finally, the ongoing measures of physical distancing have reduced students' possibilities to meet their peers outside of classes, communicate, study, or do university-related projects in person, which could also elevate their anxiety levels [51].

Therefore, this study aims to determine the effect of online learning on student anxiety and student burnout in a crisis-induced educational environment.

2.1.6 Online Learning and Engagement

Students' engagement is of crucial importance for online learning [55]. Since it should enable students to learn and participate in various university activities actively and collaborate with their peers, stimulating engagement does not necessarily require a traditional learning setting [34]. Moreover, an online environment can successfully deliver most of the engagement prerequisites. A few studies connected it to the favourable outcomes of engagement compared to face-to-face settings, such as acquired knowledge, the development of better study habits, and more time invested in class preparation for the environment which students perceive as academically challenging [34]. However, most of the studies compared students' engagement in traditional and regularly developed online environments [56], whereas the findings on the effects of online learning on student engagement in a crisis, such as the pandemic, are still scarce [57]. Since students' engagement is positively linked to the most significant studying outcomes, it is of the utmost importance to explore how crisis-induced online learning affects students' engagement.

In this regard, our study aims to determine the effect of online learning on student engagement in a crisis-induced educational environment.

2.1.7 Student Anxiety, Burnout, and Engagement

Even though anxiety appears as a defensive mechanism against potentially menacing factors [58], extended anxiety may have a negative influence on the way a person deals with everyday stressors and might result in the employment of maladaptive coping mechanisms [59], eventually leading to burnout. Indeed, the connection between anxiety and burnout has been examined by researchers [59, 60], and anxiety was shown to contribute to burnout [61]. Nonetheless, there is a scarcity of research on the interconnection between anxiety and burnout syndrome of university students, let alone in the online environment. Equally, students' engagement has been examined mainly concerning their studies' outcomes [34], while the relation between study or work engagement and one's health has been barely investigated [62]. However, authors suggest that since anxiety may affect a person's daily functioning [58], or even make them lose interest in the roles they once valued, it may result in their diminished engagement [63]. Identifying the relationship between anxiety and engagement can contribute significantly to this pioneer scientific field and practice, shedding the light on how to enhance students' vigour, dedication, and absorption [63].

Hence, this study aims to determine the effect of student anxiety on student burnout and student engagement in a crisis-induced educational environment.

2.2 Proposed Conceptual Model and Research Design

2.2.1 Proposed Conceptual Model

The model this study proposes is derived from the theories that connect the concepts of student engagement and burnout syndrome with the concept of student anxiety. For instance, Caballero Domínguez, González Gutiérrez and Palacio Sañudo [27] examined the relationship between state anxiety, and student burnout and engagement, while de la Fuente, García-Torrecillas and Rodríguez-Vargas [26] explored the effects of test anxiety on academic engagement-burnout. However, since the latest studies have recognized the increased risk of students' general anxiety developed during the initial phases of the ongoing pandemic to both students' well-being and achievement [29, 64, 65], we have configured a new model that would examine the influence of students' general anxiety on both student burnout syndrome and engagement. Furthermore, the construct of Online learning has been introduced to the model. The conditions and the environment within which the educational process is carried out have been proven to have immense effects on student anxiety [17] as well as student burnout syndrome [16] and student engagement [18]. Since the previous studies investigated student anxiety, burnout, and engagement under ordinary learning circumstances, the new model will provide insights into the effects of the online learning environment established in times of crisis on all three phenomena and also examine their mutual relationship within the new educational context. The proposed conceptual model is given in Fig. 1.

Accordingly, five hypotheses are formulated:

Hypothesis 1: Online learning impacts student engagement.
Hypothesis 2: Online learning impacts student anxiety.
Hypothesis 3: Online learning impacts student burnout.
Hypothesis 4: Student anxiety impacts student engagement in the online learning environment.
Hypothesis 5: Student anxiety impacts student burnout in the online learning environment.

Following the path of a number of authors who examined the relationships between the phenomena mentioned above [5, 9], we have used SEM analysis to test our model. Moreover, to explore the relations between online learning, burnout, engage-

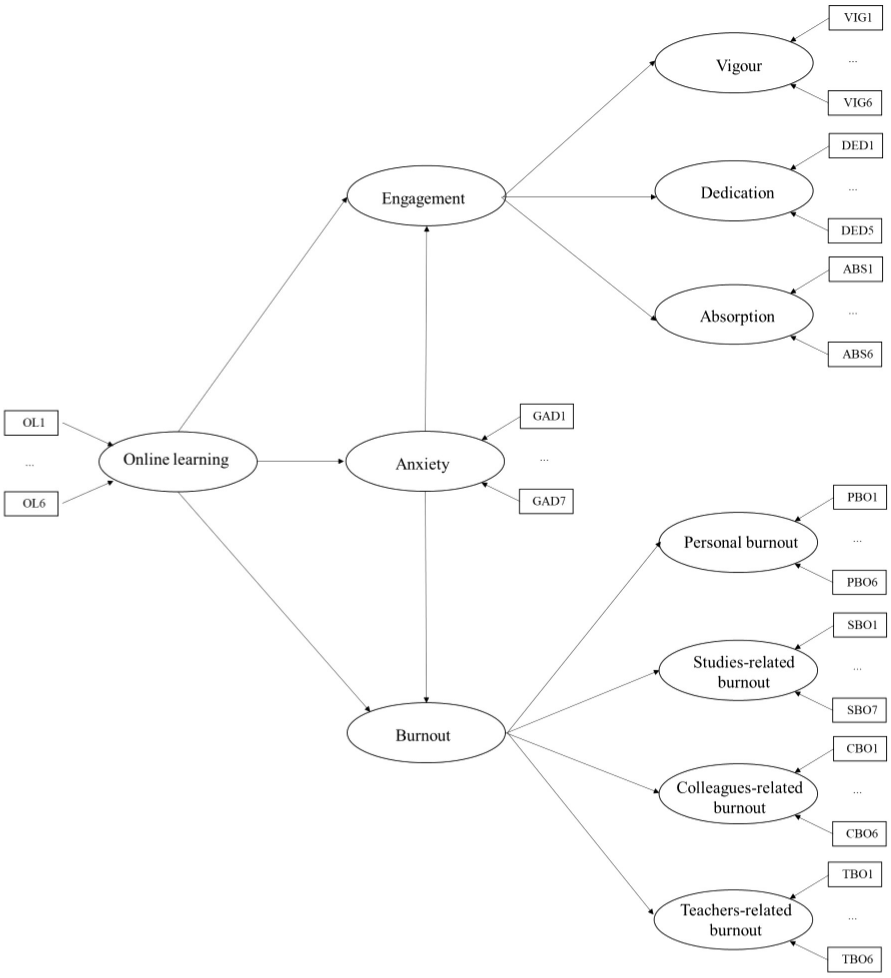

Fig. 1. The proposed conceptual model.

ment, and anxiety, we have used the hierarchical level latent variable (construct) model [66]. In particular, to create constructs consisting of multiple sub-scales, we have created higher-level constructs instead of using mean sub-scale values. For example, let us observe the case of construct *Engagement.* To create the construct *Engagement*, we have not used the mean values of scales *Vigour, Dedication*, and *Absorption.* Namely, each of the subscales is modelled as an individual construct. The same rationale can be taken in the case of construct *Burnout.*

2.2.2 Conducted Survey and Data Analysis

To verify the aforementioned conceptual model, we constructed a questionnaire that consisted of several sections presented in the following paragraphs. The survey was conducted in December 2020, during the COVID-19 pandemic, and it included the students from the Faculty of Organizational Sciences, University of Belgrade. The Faculty of Organizational Sciences belongs to the group of technical and technological faculties of the University of Belgrade and its students obtain the academic title 'engineers of organizational sciences'. The courses taught at the Faculty of Organizational Sciences are in the fields of computer and management engineering. The online questionnaire was distributed to the students during their online lessons held via the Microsoft Teams learning platform and was completed on the spot. Apart from the instruments analysed below, the questionnaire contained demographic and similar questions regarding students' gender, age, year of study, tuition-payment source, data about their residence, students' GPA (grade point average), and the like. After conducting the survey, the statistical analysis was carried out using SPSS 25, while the SEM analysis was performed using AMOS 22.

Online Learning Questionnaire. To collect the data regarding university students' attitudes towards online learning, we employed Adnan & Anwar's [20] version of Bernard et al.'s [20] widely used instrument for predicting online learning achievement. We opted for Adnan and Anwar's

[20] version of the instrument since it has been appropriated and validated for assessing the effectiveness of the online learning of university students during the COVID-19 pandemic. Sample items of the questionnaire are: "I am comfortable communicating electronically", "Online learning is more motivating than conventional learning", "Complete university courses can be completed effectively through the Internet". Students' attitudes were assessed on a self-reported Likert-type scale, with three-point answer possibilities (*agree, somewhat agree*, and *disagree*).

Academic engagement. The academic engagement was assessed using The Utrecht Work Engagement Scale for Students (UWES–17SF) proposed by Schaufeli et al. [8], consisting of seventeen items within the following subscales: Vigour, Dedication, and Absorption, containing six, five, and six items respectively. Sample items for the subscale Vigour are: "When I'm studying, I feel mentally strong", "I can continue for a very long time when I am studying", "When I get up in the morning, I feel like going to class", etc. Sample items for the Dedication subscale include: " My studies inspire me", "I am enthusiastic about my studies", "I find my studies challenging", etc.; while the Absorption was assessed through the items such as: "Time flies when I'm studying", "I feel happy when I am studying intensively", "I can get carried away by my studies", etc. All items are scored on a self-reported seven-point Likert-type scale varying from 0 (*'never'*) to 6 (*'always'*). UWES-17SF has been validated and used for students' engagement measurement [67].

Generalized Anxiety Disorder – 7 Scale (GAD-7). To measure students' anxiety over the last two weeks, we employed the GAD-7 scale, proposed by Spitzer et al. [68]. It consists of seven items assessed on a four-point Likert-type scale, from 0 (*'not at all'*) to 3 (*'nearly every day'*). The respondents were asked the following question: "Over the last 2 weeks, how often have you been bothered by the following problems?" with seven offered situations to assess, e.g., "Feeling nervous, anxious or on edge", "Becoming easily annoyed or irritable", "Feeling afraid as if something awful might happen". A total score obtained by adding scores from all the items, ranging from 0 to 21, is known as a GAD total score. Higher scores indicate increased severity of anxiety problems [68]. GAD-7 has been validated and used in numerous studies, including those examining university students [69, 70], and was frequently used in COVID-19 pandemic-related studies [71].

Student burnout. Student burnout syndrome was estimated using the students' version of the Copenhagen Burnout Inventory (CBI-S). Kristensen et al. [72] developed the original scale in 2005, while the student version was developed later and validated by Portuguese authors Campos, Carlotto and Maroco [73]. CBI-S inventory is composed of four scales that assess four dimensions of student burnout – Studies-related burnout, Personal burnout, Teachers-related burnout, and Colleagues-related burnout. Studies-related burnout is assessed through six items, such as: "Do you feel that every working hour is tiring for you?", "Do your studies frustrate you?", "Do you feel burn out because of your studies?". Personal burnout is measured through seven items, e.g: "How often do you feel tired?", "How often are you emotionally exhausted?", "How often do you feel worn out?", etc. Teachers-related burnout is measured through six items, such as: "Do you find it frustrating to work with teachers?", "Do you feel that you give more than you get back when you work with teachers?", "Are you tired of working with teachers?", etc. Colleagues-related burnout is assessed through six items, e.g.: "Do you find it hard to work with colleagues?", "Does it drain your energy to work with colleagues?", "Are you tired of working with colleagues?". Items' responses are measured on a five-point Likert-type scale from 1 (*never* or *0% of times*) to 5 (*always* or *100% of times*). CBI-S is a widely used student burnout assessment instrument [74].

2.3 Results

2.3.1 Sample Characteristics

The sample consists of 584 engineering students of the Faculty of Organizational Sciences, University of Belgrade (FOS), with 339 students (58%) who major engineering in Information Systems and Technologies, and 245 students (42%) who major in Management and Organization engineering. Most of the sample is female students, 72.9% of the sample, or 426 of them. The rest, 27.1%, or 158 of them, are male students. There is a visible disproportion in the gender of the covered respondents. However, such a result could have been expected as female students are more prone to participate in surveys, and more female students enrol in FOS. The mean age of the respondents is 20.611, with a standard deviation of 1.354. When it comes to the year of study, most respondents are third-year students (44.2%), followed by second-year students (26.7%), and first-year students (19.9%). The rest are fourth-year or master's students. Almost 71% of the respondents have their tuition covered by the budget of the Republic of Serbia, while the rest are self-financed or co-financed (29.0%). During their studies, most of the respondents reside with their parents (51.4%), followed by those who live with roommates (27.2%),

while others live or alone or with their relatives. The average GPA of the students who participated in the research is 8.162 on a scale of 10 with a standard deviation of 0.663.

2.3.2 Descriptive Statistics of the Observed Constructs

This study explores research problems connected to student anxiety, burnout syndrome, and student engagement that were examined before the COVID-19 pandemic, within systematically established learning environments. To show the relevance of these problems within a crisis-induced educational setting, the in-depth descriptive analysis of the four scales which comprise the model is provided herein. The following figures regarding student anxiety, burnout, and engagement delineate that previously identified problems are even more substantial during the ongoing pandemic, which confirms that their predictors and mutual relations demand further examination. However, we believe that these insights are not only valuable for the model development but that they also provide the bigger picture of students' behaviour, their state of wellbeing as well as their attitudes towards the new learning environment.

2.3.2.1 Online Learning

The online learning scale was measured as the mean of the six analyzed items. The mean satisfaction with online learning ranged from 1.17 to 3.00, with an average overall satisfaction of 1.86 and a standard deviation of 0.384. The most common mean online learning satisfaction was 1.67, 118 students or 20.00% of the sample, followed by 1.83, 99 students or 17.00%. We can conclude that, in general, the students are somewhat satisfied with the online learning experience.

2.3.2.2 Student Engagement

First, the three subscales were calculated as means of the items that make them. The mean of *the Vigour* subscale was 2.59 with a standard deviation of 1.19, the mean of *the Dedication* subscale was 3.93 with a standard deviation of 1.54, and the mean value of the *Absorption* is 2.97 with a standard deviation of 1.41. Interpreting the mean values, we can conclude that, in general, the observed students have low vigour, average dedication, and average absorption [75].

Afterward, the UWES scale values were calculated as the mean of the three scales. The analysis of the obtained UWES scale results is given in Table 1. Most of the students are averagely engaged, 266 of them. Attention should be focused on those engaged very low or low, 117 and 137 of them respectfully. These students make up 43.49% of the sample. This indicates that the students should be animated, motivated, and encouraged to be more engaged. Looking at the mean engagement on the sample of 3.16 with a standard deviation of 1.24, we can conclude that the students are averagely engaged in general.

2.3.2.3 Student Anxiety

The overall anxiety scale is calculated as the sum of the scores of all items. The sample's overall anxiety ranged from 0 to 21, with a mean of 12.47 and a standard deviation of 6.29. According to the obtained mean score and the official interpretation of the score, the observed students are moderately anxious [76]. The median anxiety is 14.00, indicating that more than 50% of the surveyed students are moderately and severely anxious. The frequency of respondents in each severity group is given in Table 2. As it can be noted, most of the sample, 37.50%, is in the severely anxious group.

2.3.2.4 Student Burnout

Burnout is measured on a scale from 0 to 100, with scales from 50 to 74 indicating moderate burnout, 75 to 99 high, and 100 indicating severe burnout

Table 1. Number of students by UWES severity, the percentage of the sample, the mean, and the standard deviation of the whole sample

Engagement	Score	Number of students	Percentage of the sample	Mean ± STD
Very low	<1.93	117	20.03%	3.16 ± 1.24
Low	1.94–3.06	137	23.46%	
Average	3.07–4.66	266	45.55%	
High	4.66–5.53	58	9.93%	
Very High	>5.54	6	1.00%	

Table 2. Number of students in each group of anxiety by severity and the percentage of the sample

Severity	None	Mild	Moderate	Severe
GAD-7 Score	0–5	6–10	11–15	16–21
Number of students	107	97	161	219
Sample percentage	18.32%	16.61%	27.66%	37.50%

[74]. Per each scale, the number of students and the percentage of the sample they make for each severity is given in Table 3. Also, the mean and standard deviation for the whole sample are presented.

The scale that indicates burnout is Personal burnout, with 40.07% of the sampled students exhibiting moderate burnout. The point of interest is that 22 students are severely burnout on this scale. Also, this scale has the highest mean, 55.14. The following scale, the studies-related scale, also shows that 32.71% of the sample is moderately burnout, while 72 have high studies-related burnout. The mean of this scale is 47.30. Regarding the colleagues-related and teachers-related burnout scales, the surveyed students exhibit visibly lower burnout than the other two scales.

The results presented in Tables 1–3 indicate that almost half of the surveyed students are low or minimally engaged in academic activities, that more than half of the respondents display moderate and severe anxiety levels, and that they have moderate to high personal and studies-related burnout. These insights are alarming, taking into account the average age of the respondents, which is just above 20. Thus, it is important to acquire knowledge on the effects of the learning environment on these constructs as well as of the mutual relationship between them to better understand their mechanisms and act accordingly to lower/raise their respective levels.

2.3.3 Validation of the Proposed Conceptual Model

The initial step of the SEM analysis is to inspect the internal consistency of the proposed constructs. The most commonly used metric for assessing internal consistency is Cronbach's alpha [77]. Besides Cronbach's alpha, the commonly used metrics of scale validity are Average Variance Extracted (AVE) and Composite Reliability (CR). According to the literature, the acceptable levels of Cronbach's alpha range from 0.70 to 0.95, the same accounts for CR, while the acceptable values of AVE are above 0.5 [78, 79].

The calculated Cronbach's alpha, AVE, and CR per latent variable and the number of items per scale are given in Table 4. The lowest measured reliability is for the construct *Online learning*, whose two observed metrics are below the threshold. Its Cronbach's alpha is 0.69, but, as it is close to the 0.7 threshold, we found it acceptable. The same accounts for its AVE, which is slightly below 0.5 Looking at the three constructs of the UWES scale, all three sub-scales are consistent, with alphas from 0.84 (*Vigour*) to 0.94 (*Dedication*). The measured AVE and CR within this scale are acceptable. The Anxiety scale also has high reliability. Finally, the

Table 3. Number of students per burnout scale by severity, the percentage of the sample, the mean, and the standard deviation of the whole sample

	Severity	Score	Number of students	Percentage of sample	Mean ± STD
Personal burnout	Moderate	50–74	234	40.07%	55.14 ± 21.67
	High	75–99	108	18.49%	
	Severe	100	22	3.77%	
Studies-related burnout	Moderate	50–74	191	32.71%	47.30 ± 20.33
	High	75–99	72	12.33%	
	Severe	100	3	0.50%	
Colleagues-related burnout	Moderate	50–74	72	12.33%	25.20 ± 22.61
	High	75–99	18	3.08%	
	Severe	100	4	0.70%	
Teachers-related burnout	Moderate	50–74	74	12.67%	22.32 ± 21.38
	High	75–99	14	2.40%	
	Severe	100	2	0.30%	

Table 4. Obtained Cronbach's alpha per construct and the number of items per construct

	Online learning	Vigour	Dedication	Absorption	Anxiety	Personal burnout	Studies-related burnout	Colleagues-related burnout	Teachers-related burnout
Items	6	6	5	6	7	6	7	6	6
Cronbach's alpha	0.69	0.84	0.94	0.87	0.92	0.86	0.79	0.90	0.92
AVE	0.45	0.58	0.81	0.61	0.68	0.60	0.57	0.68	0.72
CR	0.77	0.88	0.96	0.90	0.94	0.90	0.90	0.93	0.94

burnout subscales consistency ranges from 0.79 (Studies-related burnout) to 0.92 (Teachers-related burnout). The validity measured through AVE and CR of the burnout scales is also acceptable. As all the observed scales and sub-scales have an acceptable internal consistency and validity level, we proceed with the analysis.

The initial model had solid fit to the data (Chi-square = 3634.01, $p < 0.000$, CFI = 0.892, TLI = 0.887, RMSEA = 0.052). We fine-tuned the model using modification indices and correlated the errors solely within the same construct in the next steps. The final model had better fit to the data (Chi-square = 3178.16, $p < 0.000$, CFI = 0.913, TLI = 0.907, RMSEA = 0.047). In our model, we decided not to delete the insignificant coefficients as they could provide some insights. Also, some of the retained coefficients are quite low and close to zero, but they were not removed from the model as we aimed to create a model of high quality and find as many predictors as possible [80]. To assess the significance of regression coefficients, we used critical ratio (C.R.). If the C.R. is in an absolute value greater than 1.96, the regression coefficient is statistically significant. The outer model is assessed in Table 5.

The outer model observed one predictor of *Anxiety, Online learning*. The predictor proved to be statistically significant, with a standardized regression coefficient of –0.15. The obtained coefficient indicates that the more the student is content with online learning, the less anxiety will he or she has. The adjusted R square is 0.021, showing that *Online learning* is responsible for 2.1% of the variability of anxiety. Such a low R square could have been expected, having in mind the complexity of the anxiety and the various factors which cause it.

The construct *Burnout* was modelled using two predictors, *Online learning* and *Anxiety.* Measured anxiety has a positive statistically significant influence on burnout with a standardized regression coefficient of 0.66. On the other hand, *Online learning* has a low, negative, and insignificant impact on burnout. The obtained model is of solid quality as 45.5% of its variability is explained.

Finally, we aimed to model *Engagement* using *Anxiety* and *Online learning.* The students' positive opinion of online learning leads to increased students' engagement. The obtained standardized regression coefficient is 0.20, and it is statistically significant. On the other hand, Anxiety does not have a statistically significant impact on students' engagement, and the measured standardized regression coefficient is negative. The R square of this model is low, 4.3%. Such R square could have been expected, having in mind the complexity of the students' engagement and the various factors which lead to it.

As mentioned before, in our model we used the hierarchical level latent variable (construct) model, meaning that the constructs we focused on *Burnout* and *Engagement* consist of separate constructs – their subscales. Therefore, to gain better insights into the model in table 6 we provide the assessment of the two hierarchical constructs. When creating hierarchical level latent variables, the regression

Table 5. Assessment of the model: construct, predictors, obtained standardized and unstandardized coefficients, Critical Ratio (C.R.), conclusion on the hypothesis, and the R square of the construct

Construct	Predictors	Std. Coeff.	UnStd. Coeff.	C.R.	Hypothesis	R^2
Anxiety	Online learning	–0.15	–0.30	–2.89**	H_2 – Confirmed	0.021
Burnout	Online learning	–0.08	–0.12	–1.72	H_3 – Not confirmed	0.455
	Anxiety	0.66	0.53	11.64**	H_5 – Confirmed	
Engagement	Online learning	0.20	0.49	3.73**	H_1 – Confirmed	0.043
	Anxiety	–0.03	–0.03	–0.60	H_4 – Not confirmed	

Note: **$p < 0.01$.

Table 6. Assessment of the hierarchical constructs: construct, latent variables, obtained standardized and unstandardized coefficients, and Critical Ratio (C.R.)

Construct	Latent variables	Std. Coeff.	UnStd. Coeff.	C.R.
Burnout	Personal burnout	0.87	1.00	
	Studies-related burnout	0.83	1.10	11.16
	Colleagues-related burnout	0.35	0.38	6.67
	Teachers-related burnout	0.42	0.46	7.79
Engagement	Vigour	0.84	1.00	
	Absorption	0.95	1.22	14.01
	Dedication	0.81	1.00	15.00

Note: **$p < 0.01$.

weight of one latent variable must be fixed to 1. In the case of *Burnout*, the fixed variable was *Personal burnout*, while for *Engagement* it was *Vigour.* When the regression weight is fixed, C.R. cannot be computed. So that is the reason why there is no C.R. available for the two latent variables. Within the hierarchical construct *Burnout*, the most important latent variable is the fixed one, *Personal burnout*, followed by *Studies-related burnout.* The remaining two latent variables are less important, but are, as well as the first two, statistically significant. This result indicates that in our sample and study, not all four types of burnout were equally important. Within the hierarchical construct *Engagement*, the most important latent variable is *Absorption*, followed by the fixed latent variable *Vigour.* The remaining latent variable is slightly less important and is, as well as the first two, statistically significant. This result indicates that in our sample and study, all three aspects of engagement were equally important.

Looking at the model, what should also be examined are the indirect effects of *Online learning* on *Engagement* and *Burnout.* The indirect effect of *Online learning* via *Anxiety* on *Engagement* is 0.004. As this indirect effect is close to 0, there was no need to further elaborate on it, as besides, it is shown that *Online learning* has a direct positive statistically significant impact on *Engagement.* Regarding the second indirect effect, *Online learning* has a negative statistically significant effect on *Burnout* through *Anxiety* with a standardized regression coefficient of -0.096. This indicates that although *Online learning* does not directly affect *Burnout*, it affects *Burnout* through *Anxiety* and decreases it. Namely, if the interest in *Online learning* increases, the student's overall level of burnout will decrease.

3. Discussion

The current study has proposed and verified an integrative conceptual model of online learning, student engagement, anxiety, and burnout. After the review of the descriptive data connected to individual constructs, the findings regarding the five hypotheses are discussed.

Online Learning. The findings of our study show that university students are moderately satisfied with online learning. Our results differ from the results of Agarwal & Kaushik [81], showing that more than 95% of medical students are very satisfied with the online lessons, but mostly coincide with the findings of Adnan & Anwar [20], which showed that only 50.8% of students think that they can effectively complete their courses in the online environment. *Student Engagement*. The values for student engagement show that students are averagely engaged (mean value of 3.163). Using the same instrument, de la Fuente et al. [82] showed a somewhat higher mean of 3.47 in the sample of Spanish students. Although there is an evident lack of data regarding other countries' student engagement during the current pandemic, the substantial proportion of disengaged students raises attention. *Anxiety.* Some of the most alarming results are those showing high levels of anxiety (27.66% of the students experience moderate and 37.5% severe anxiety), which strongly coincide with those of Saddik et al. [83], who found that around 30% of students experienced severe anxiety and two-thirds of them mild levels of anxiety. The results are also congruent with Unger & Meiran's [40] findings, stating that 75.6% of students experienced some level of anxiety connected to the rapid shift into the online environment. These numbers are dramatic compared to the figures showing the prevalence of anxiety within the general population before the pandemic, 7.3% on the global level, with 13% regarding the populations from emerging economy countries [84]. Even though Huang and Zhao [85] found that elevated anxiety during the COVID-19 pandemic appeared more frequently in people younger than 35, this disproportion is still striking. Various pandemic-related factors may explain the existing levels of anxiety. For instance, the unexpected shift to an online studying environment, which had an adverse effect on students' lifestyle, study schedules, and plans [86], the situation of students and their parents (or those living with them) being forced to share the same working space for studying and working respectively [87], the prolonged exposure to computers and smart devices necessary for online learning [88] as well as the increased boredom resulting from the isolation [89] have all been found to influence the development of students' anxiety. The effect of online learning itself on students' anxiety, which is examined herein, will be analyzed later in the text. *Burnout*. Our results show high levels of personal and studies-related burnout. This indicates that the factors inducing the colleagues and teachers-related burnout, such as decreased interaction among the students or between the students and their professors [74], are addressed and reduced in the new learning environment, while the factors causing personal and studies-related burnouts are still largely present. Apart from previously reported predictors of burnout, such as inappropriate teaching methods [20], excessive course loads [90], or information overloads generated in the online environment [91], another important antecedent of burnout determined by this study is anxiety, as it will be later discussed.

Hypothesis 1 has been confirmed by our results,

showing that the relation between online learning and engagement is significant and positive, indicating that students with more positive attitudes toward online learning will be more engaged in their studies. This result is congruent with studies investigating student engagement in regularly implemented online environments that determined a positive relation between these constructs [92]. Students' engagement involves not only their behaviours (e.g., intention to complete the given tasks) but also their emotions (e.g., having a sense of belonging) [26]. Unfortunately, online learning during the pandemic negatively influenced their sense of belonging to the university environment. However, the studies showed that the universities' efforts to facilitate mutual interaction among students and between students and their professors in the online environment positively influence students' engagement [93]. Moreover, thus generated engagement may decrease the respective dimensions of student burnout [9], which is probably the case herein since our results show that burnout is much less induced by peer and student-teacher interaction than by other factors. Nonetheless, since our findings show that the students are only somewhat satisfied with their online learning experience, there is much space to improve their attitude and thus increase their engagement.

Apart from its effects on student engagement, online learning introduced during the COVID-19 pandemic can have negative psychological impacts on students [89]. By contrast, Bolatov et al. [74] demonstrated in their study that online learning due to COVID-19 had a positive impact on medical students' mental state – decreasing the level of students' anxiety and burnout. Therefore, our research aimed to examine whether online learning influenced students' anxiety (*Hypothesis 2*) and burnout (*Hypothesis 3*). The results have confirmed *Hypothesis 2* as online learning significantly and negatively impacts students' anxiety, indicating that students with more positive attitudes towards online learning are less prone to anxiety. Although in contrast with the findings of Mheidly, Fares and Fares [2], the positive impact of online learning is encouraging. Since the students' anxiety levels determined in our study are still very high, this finding suggests that the instructors can help decrease them by working more on the students' adjustment to the online environment. Regarding *Hypothesis 3*, although no direct statistically significant impact is found between online learning and burnout, a negative indirect statistically significant impact through anxiety is detected. It means that if the interest in online learning increases, the students' overall level of burnout will decrease. Therefore, we can say that *Hypothesis 3* has been partially confirmed. Despite being indirect, the found relation contrasts with the results showing a positive connection between telecommunication and burnout [2, 52]. In this respect, our result is more encouraging and in line with the studies showing that burnout levels will decrease when engagement is increased (such as with the students inclined towards online learning) [8].

Chin et al. [43] confirmed the relation between students' anxiety, burnout, and engagement, but the compound interaction of these three constructs had not obtained sufficient attention [47]. Therefore, we intended to examine whether students' anxiety influences students' engagement (*Hypothesis 4*) and student burnout in the online learning environment (*Hypothesis 5*). *Hypothesis 4* has been rejected, in contrast to the rare studies suggesting the existing link between these two constructs [63]. Considering the high rates of students' anxiety determined herein, it is highly comforting that it does not affect students' engagement. On the other hand, as expected, *Hypothesis 5* has been confirmed, indicating that the more anxious the students are, the more they will be at risk of developing burnout syndrome. The results of our research are aligned with the findings proving that intense anxiety among university students is significantly related to either some components of burnout [94] or all of them [2]. The verification of this relationship is highly valuable. Namely, as the diagnosis of anxiety and the appropriate treatment are far less complicated than those of burnout, timely anxiety identification could lead to decreased burnout rates. This could be of great significance since both problems are prevalent among university students, particularly during crises.

To summarize, the study has shown that the COVID-19 pandemic has dramatically raised the levels of student general anxiety and some aspects of student burnout. The sudden changes of life and educational routines the crisis has brought [41] are confirmed to have damaging effects on students' well-being. Apart from these changes, other pandemic-related factors, such as the fear of the ongoing disease and the unexpected financial strain, have probably contributed to the registered students' mental health decline, which should be acknowledged and addressed in due time. Otherwise, it may worsen in the years to come when students encounter other stressful and life-changing situations or when they enter the labour market and face job stress [96]. Therefore, this study's confirmation of the beneficial effects online learning can have on both student engagement and their mental health may serve this aim. However, students' inclination towards online learning should be raised to increase the rates of these favourable

outcomes. It may imply that educators and institutions should better adapt to the changed environment since their ability to adapt to changes is the key to sustainability [97].

One of the limitations of this study is that it involved only the specific technical and technological sciences profile students. The results could have been different if the students of other profiles had been examined. Also, it was impossible to compare some of our findings to previous ones, such as the influence of anxiety on student engagement in the online environment, since these relations are underinvestigated.

We suggest that future research should investigate the relationship between other pandemic-related factors and student anxiety and explore the mediating role of coping mechanisms on the relationship between online learning and student burnout. Also, we suggest examining the effects of different online learning tools, such as online quizzes, on student engagement.

4. Conclusion

This study has examined the influence of online learning, introduced during the COVID-19 pandemic, on engineering student engagement, anxiety, and burnout. The findings show that if the students' aptitude towards online learning rises, their engagement will also rise while their anxiety and burnout levels will decrease. The validation of the positive effects that even emergency-induced online learning can have on students' engagement and mental health should reduce the resistance and increase motivation for participating in such an educational environment.

In addition, the study has explored whether engineering students' anxiety during the pandemic impact their engagement and burnout. The results show that while anxiety does not influence student engagement, it significantly increases student burnout. As students' anxiety has soared since the coronavirus outbreak, it is comforting to learn that it does not affect student engagement. On the other hand, confirming the causal relationship between anxiety and burnout is immensely important and may contribute to the creation of student burnout prevention programmes that will include the reduction of anxiety. Moreover, as the examination of the relation between anxiety and student engagement and burnout is a research area in its infancy, these results will hopefully encourage further examination of the constructs' interconnectedness.

Nevertheless, our research data showing extremely high levels of anxiety and burnout experienced by the students amid the COVID-19 pandemic are alarming. These findings should raise awareness of the problem and direct educational institutions to actively address students' mental health. Finally, as the COVID-19 related measures are currently almost completely relaxed, the context described in the study can be generalized to the future similar crises if they occur.

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