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A Model to Measure University Students' Learning Efficacy and Satisfaction During the COVID-19 Pandemic

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Abstract

The aim of this research was to assess the learning efficacy and level of satisfaction of university students as they adapted to the online teaching model amid the restrictions imposed as a result of COVID-19. The sample consisted of 467 students attending a public University of Spain. The study applied a structural equations methodology with a triangulated approach. The results show that the most influential factor in student online learning satisfaction is teacher-student interaction. On the other hand, student learning efficacy mainly depends on their attitude towards the use of technology; this makes it essential to understand which elements of the online learning system facilitate and incentivize the creation of a good learning environment. Moreover, the design quality of the system and the tools that make it function, and how they link to content and competences, all directly influence perceived ease-of-use and student satisfaction with online teaching.

Key words: *COVID-19; e-learning; satisfaction; structural equations; university.*

Introduction

Online teaching has suddenly acquired considerable importance since the onset of the COVID-19 pandemic. E-learning, also known as technology-mediated learning, is now widely accepted in all fields of education and academic institutions (Rodrigues et al., 2019). It has enabled new teaching models to emerge, not only in distance learning,

but also in hybrid forms such as blended learning, generating a more open, flexible type of education that can be accessed from mobile and ubiquitous scenarios (Vázquez-Cano & Díez-Arcón, 2021). Undoubtedly, the use of e-learning for teaching and learning will increase rapidly in the coming years, as new, more immersive, participatory technologies are developed for new learning and social interaction settings (Arkorful & Abaidoo, 2015; Paechter & Maier, 2010). The analysis of how this learning format is applied can help improve its usage and design to encourage greater student participation and collaboration in these online teaching models.

The situation caused by the COVID-19 pandemic required many educational institutions to substitute the traditional on-site model for the online format. These institutions are primary-elementary schools, secondary-high schools, and universities, all founded by the Ministry of Education in many countries. Their main role is to support and inspire teaching and learning. Numerous educational institutionsnow have the online learning model as the established format for delivering classes, even though most have not been directly affected by the pandemic. Other educational institutions apply a teaching system (blended learning) that combines on-site and online teaching, and the transition has not been traumatic. However, those institutions where teaching has been almost entirely in-person have been compelled by recent events to swiftly transition to online classes. The shift has necessitated a rapid redesign of teaching subjects which were previously taught exclusively in class. This makes it difficult to compare the way classes have been imparted online in the past few months, in terms of the experience, planning and development of proposals designed specifically for the online learning format (Hodges et al., 2020). This research has analysed how online education is perceived by a sample of Spanish university students.

E-learning and influential variables

The definition and characteristics of online teaching have evolved in the scientific literature. Al-Busaidi (2013) described it as computer technology applied to teaching students. Janda (2016) considered e-learning as the use and acquisition of knowledge through electronic media. E-learning can improve teaching and learning through developing capacities such as interaction, immediacy, efficacy, flexibility and self-learning (Bidin & Ziden, 2013; Jeong & Hong, 2013; Moreno et al., 2017). The success of e-learning systems has largely been measured by the Information Systems Success (ISS) model; users' behavioural intention towards technology use has been analysed by models such as the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT). Our research finds that these models are based on a set of factors that seek to explain student adoption of an e-learning system and their satisfaction with it; these factors are interrelated rather than independent.

Davis (1989) defined perceived usefulness as the degree to which a person believes that using a particular system would enhance successful outcomes. Perceived usefulness is also defined as users' ability to operate an innovative, user-friendly technology that gives them a greater sense of freedom (Pikkarainen et al., 2004). An individual's

predisposition towards using a particular system in daily activities is seen as depending on the perception of its use (Hanafizadeh et al., 2014). A useful e-learning system can help students to control and manage their learning process. For example, it enables them to download and read content at a time and place that best suits them. Previous studies have argued that when students have greater control over their learning process, they get better results (Islam, 2013). The perceived usefulness and ease-of-use of a technology, such as the Blackboard Learn platform in the e-learning context, can influence students' attitude towards online learning (Gandema & Brown, 2012). According to the basic TAM model, the perceived usefulness of a technological tool affects attitude towards the use of that technology.

Ease-of-use is defined as the degree to which a person believes that using a particular system would be free from effort (Davis, 1989). An easy-to-use system allows students to spend little time or effort operating it, as they can quickly learn how to use an e-learning system. This enables them to focus more on content and learning activities rather than on how to operate the system (Islam, 2013). Chen and Tseng (2012) showed that ease-of-use influences perceived usefulness in e-learning. Perceived usefulness and ease-of-use have a low cognitive load, which allows students to concentrate on other activities (Saadé & Bahli, 2005). Consequently, it is expected that ease-of-use has a positive effect on perceived usefulness and on attitude towards technology. The literature shows that attitude towards the use of technology is an important factor in satisfaction with online learning (Arbaugh & Duray, 2002; Hong, 2002). E-learning mainly depends on the use of computers or digital devices connected to the Internet. Teachers post material on online platforms and the students participate and interact within this system. A positive attitude towards technology makes learning more effective (Piccoli et al., 2001), just as discomfort with technology negatively affects satisfaction with learning. Another component of ISS is system quality, in reference to the communication system's security structure and efficiency in producing information (DeLone & McLean, 2003). A system's quality is based on the set of characteristics and aspects that it contains to facilitate learning (Hassanzadesh et al., 2012), such as availability, accessibility, flexibility, usability, ease-of-use for learning and response time (Wu & Zhang, 2014).

Several authors indicate that system quality has a positive, significant effect on user satisfaction in the e-learning context (Hassanzadeh et al., 2012; Kim et al., 2012; Wang & Chiu, 2011). System quality is also a determining factor in learning efficacy (Piccoli et al, 2001). Other authors have found that system quality has a positive effect on perceived ease-of-use (Rai et al., 2002; Wu & Zhang, 2014). Interaction with other users is also a significant element of e-learning, which is both synchronous and asynchronous. The synchronous feature of e-learning is in "live" mini-classes or simultaneous discussions in groups between teachers and students. On the other hand, the asynchronous feature relates to information that students do not engage with directly, as they might be unavailable at the time of live access, though the content remains permanently accessible. User interaction in both cases is enabled by e-learning tools (Abdalla, 2007; Leví-Orta et al., 2020; López-Meneses et al., 2020).

There are three types of interaction in e-learning: interactions between students and teachers, interactions between students and the learning materials, and interactions between students themselves. Virtual interaction contributes to problem-solving and improved learning. Paechter et al. (2010) argued that interaction between students enables them to exchange information on course content and to provide mutual socio-emotional assistance. The interaction between teachers and students is of particular importance and is decisive in the development of learning activities (Webster & Hackley, 1997). Teacher-student interaction not only occurs when the teacher provides information and knowledge, but when giving encouragement to students, offering full and positive responses to their doubts, and facilitating open communication (Sher, 2009). Abdalla (2007) found that interaction in e-learning is an indicator of learning efficacy. Some authors have also found that greater interaction between e-learners brings a greater sense of satisfaction with the learning process (Arbaugh, 2000; Goh et al., 2017). Learning efficacy is another component that conditions a system's viability and functionality. Educational authorities need to continually assess learning efficacy. Teachers can use e-learning to enhance learning efficacy (Al-Adwan et al., 2013), by regularly updating material, and enabling students to access all material instantaneously. Bandura (1993) stated that the degree to which students perceive their efficacy in learning will determine their cognitive functioning and development. Diep et al. (2017) said that educational institutions and teachers should focus on helping students to learn efficiently as this factor influences student satisfaction with their studies (Wang, 2003).

System satisfaction is another essential element of model fitness. Lin et al. (2008) described the concept of satisfaction as the ultimate objective of any product or service. Satisfaction would seem to be the most widely studied construct in the history of educational marketing (Fullerton & Taylor, 2002). Student satisfaction can be defined as the perceived value of their educational experiences within an educational institution (Astin, 1993). These perceptions of educational experiences can influence a student's decision to continue with a course (Carr, 2000) as well as overall satisfaction with their learning (Bolliger & Wasilik, 2009). Our research assumes satisfaction to be a subjective perception by the student, that is, perceived satisfaction is based on the extent to which the student believes that e-learning matches expectations (Lo, 2010). Sometimes, students are dissatisfied with the online experience. Bouhnik and Marcus (2006) considered student dissatisfaction to be caused by a lack of proper planning by the educational institution to guarantee a good level of student learning, little contact among students or a low efficiency learning process. Overall, satisfaction with e-learning is attributed to a wide range of factors that include system quality, learning efficacy and user interaction.

Based on the above comments, the main aim of this study is to assess the learning efficacy and level of satisfaction of university students as they adapted to the online teaching model amid the restrictions imposed during COVID-19.

The proposed theoretical framework consists of a set of hypotheses and a structural model (Figure 1).

Ease-of-use

H1: Perceived usefulness has a positive effect on attitude towards use of the technology.

H2: Perceived ease-of-use has a positive effect on perceived usefulness.

H3: Perceived ease-of-use has a positive effect on attitude towards use of the technology.

Attitude towards the use of technology.

H4: A positive attitude towards the use of technology has a positive effect on learning efficacy.

System quality

H5: System quality influences perceived ease-of-use.

H6: System quality has a positive effect on learning efficacy.

H7: System quality has a positive effect on user satisfaction.

Interaction with other users

H8: The higher the level of interaction among e-learning users, the greater the influence on learning efficacy.

H9: A higher level of interaction among e-learners has a positive effect on user satisfaction.

Learning efficacy

H10: The higher the level of learning efficacy, the stronger the positive influence on user satisfaction.

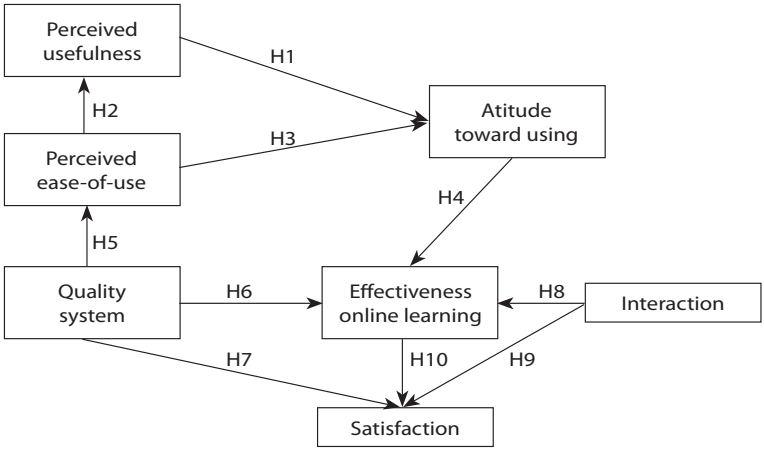

Figure 1. Structural model

Methodology

Previous studies in the literature have applied theories such as the Information Systems Success (ISS) model, the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Chen & Tseng, 2012; Davis, 1989; DeLone & McLean, 1992; Mohammadi, 2015; Venkatesh et al., 2003). As some

authors have suggested (Hassanzadeh et al., 2012; Li et al., 2012), it is crucial to examine the relationship between students' experiences, perceptions, system use and quality as indicators of system success; analysis of these elements can detect shortcomings or point to improvements in order to ensure quality teaching.

The research method applied in our research differs from other studies in two fundamental aspects: our research applies a methodological model that integrates elements from all three theories (…); the data used in this work are from a university that was forced to switch rapidly from the on-site to the online teaching model, due to COVID-19. The methodological approach of this work has allowed us to know which variables have greater influence on online learning efficacy and student satisfaction.

The research was conducted in a socio-educational context marked by lockdown, with classes carried out synchronously online, following the on-site class schedule. Many of the sessions were recorded to allow non-attending students to watch them later. During these sessions, students could ask questions using microphone or chat, as teachers had modified the settings to allow students to use these communication tools. Students could also resolve problems with their teachers by contacting them via email. Feedback was by email or by special online sessions set up by the teacher to respond to questions. Exams were taken on the platform was designed to support various exam formats, including multiple choice. Students sent in finished work via the platform that could be corrected by rubrics. The students attended their lessons through the university's virtual classroom system, Blackboard Learn 9.1., which was licensed to the university to enable students to use the system. This platform provides virtual tools for students to develop their learning process, including: a) tools for teachers to generate content; b) communication tools, such as email, internal messaging, chat, forum, electronic whiteboard, calendar and noticeboard; c) tools to enable synchronous class sessions, with microphone, video, interactive whiteboard and file sharing (Blackboard Collaborate Ultra) among users; d) tools for student assessment, through exams and questionnaires, activities, group work; e) tools for administering data on students, to monitor student access and attendance, course work scores; f) tools to detect plagiarism in students' work.

Participants

The study sample consisted of 467 undergraduate students (5% of the total University population), 37.9% men and 62.1% women. Of these students, 34.1% were in their first year of undergraduate studies, 26.4% in the second year, and 20.9% in the third, with 18.6% in their fourth and fifth years of joint-degree courses. The mean age of participants was about 21 (mean=21.34, standard deviation=2.45).

Instrument and variables

The data were collected from a sample of 467 students attending a public University in Spain from May 4th to May 27th , 2020. A questionnaire was designed for online completion by the students who had provided informed consent beforehand. The

sample was heterogeneous, with participants from various degree courses, to enhance the study's external statistical validity (Marks et al., 2005). The questionnaire was posted on the university's virtual platform via its Twitter account. To achieve the highest possible response rate, faculty authorities were contacted to send the survey to the students' email addresses and to post it on social networks. The questionnaire contained 24 items grouped as seven latent variables. The students had to respond to each item by scoring it on a 1-7 scale, 1 meaning "totally disagree" and 7 "totally agree". The items selected had been adapted from works by a range of authors (Table 1).

Table 1
Latent variables and items

Category	Dimension	Items	Authors
Utility	Perceived utility of online teaching	UT1. Online learning enables me to save time. UT2. Online learning helps me become a self-sufficient learner. UT3. Online learning helps me acquire knowledge relating to the subjects I study. UT4. Online learning helps me get better results in the subjects I study.	Chiu & Wang (2008) DeLone & McLean (2003) Hascanzadesh et al. (2012)
Use	Perceived ease of use of the virtual classroom	US1. It is easy to access the virtual platform. US2. The virtual platform is easy to use. US3. It is easy to learn how to use the virtual platform.	Abdalla (2007) DeLone & McLean (2003) Tarhini et al. (2017) Wang & Liao (2008)
Quality	System quality	Q1. The virtual platform environment is user-friendly. Q2. The virtual platform enables me to optimize my learning time. Q3. The virtual platform has attractive features. Q4. I trust the virtual platform. Q5. The virtual platform has many useful functions.	DeLone & McLean (2003) Ozkan & Koseler (2009) Wang et al. (2007)
Attitude	Attitude towards the use of technology	A1. Using the virtual platform is a good idea. A2. The virtual platform makes learning interesting for me. A3. Working on the virtual platform is fun. A4. I like to work with the virtual platform.	Hsieh et al. (2017) Tarhini et al. (2017)
Interaction	Interaction with other users	I1. Teaching online enhances interaction between teacher and student. I2. Teaching online enhances interaction between students.	Eom et al. (2006) Lee (2010) Liaw (2008)
Efficacy	Learning efficacy	EF1. I believe that online teaching can help me learn with greater efficacy. EF2. I believe that online teaching can help me acquire more knowledge. EF3. I believe that online teaching increases my motivation to learn.	Abdalla (2007) Liaw (2008)
Satisfaction	Satisfaction with online teaching	S1. I am satisfied with online teaching as a learning method. S2. I am satisfied with online teaching. S3. Online teaching satisfies my learning needs.	DeLone & McLean (2003) Lee (2010) Lee et al. (2009)

Results

Prior to structural equation modelling, an analysis of the data was carried out to test the validity and reliability of the scales. The Cronbach Alpha coefficient was above 0.7 and the Kaiser-Meyer index exceeded 0.75. The null hypothesis was rejected by the Bartlett sphericity test, thus enabling factor analysis. Factor analysis yielded seven factors with the varimax rotation method, thus confirming the validity of the questionnaire. The maximum likelihood estimation method was used to calculate the structural model's parameters. Although the data did not conform to the multivariate normal distribution, this method facilitated the convergence of estimates (Lévy et al., 2006). The model was assessed based on criteria from Bollen (1989) and Rindskopf and Rose (1988), who proposed that the measurement model and structural model be evaluated separately. The measurement model's validity and reliability were analysed, the latter in terms of the reliability of the items and of each construct. For validity, both convergent and discriminant validity were analysed, with the results shown in Tables 2 and 3.

Table 2
Standardized estimations for observable indicators, Cronbach's α values, convergent validity, and reliability assessment

Factors			λ	Cronbach's α	CR (Composite Reability)	AVE
Perceived utility of online teaching				0.872	0.841	0.573
UT1	<---	UTILITY	0.643			
UT2	<---	UTILITY	0.660			
UT3	<---	UTILITY	0.854			
UT4	<---	UTILITY	0.845			
Perceived ease of use				0.917	0.928	0.811
US1	<---	USE	0.903			
US2	<---	USE	0.963			
US3	<---	USE	0.831			
System quality				0.910	0.908	0.665
Q1	<---	QUALITY	0.827			
Q2	<---	QUALITY	0.815			
Q3	<---	QUALITY	0.871			
Q4	<---	QUALITY	0.745			
Q5	<---	QUALITY	0.815			
Attitude towards the use of technology				0.913	0.901	0.696
A1	<---	ATTITUDE	0.751			
A2	<---	ATTITUDE	0.887			
A3	<---	ATTITUDE	0.824			
A4	<---	ATTITUDE	0.869			
Learning efficacy				0.928	0.918	0.790
EF1	<---	EFFICACY	0.911			
EF2	<---	EFFICACY	0.932			
EF3	<---	EFFICACY	0.819			

Factors			λ	Cronbach's α	CR (Composite Reability)	AVE
Interaction with other users				0.793	0.744	0.593
I1	<---	INTERACTION	0.817			
I2	<---	INTERACTION	0.720			
Satisfaction with online teaching				0,952	0.940	0.840
S1	<---	SATISFACTION	0.895			
S2	<---	SATISFACTION	0.906			
S3	<---	SATISFACTION	0.948			

Table 2 shows that the reliability of the items is verified, as practically all the standardized coefficients exceed 0.707. Two coefficients failed to score more than 0.707 but the difference is minimal and, given that they are important items in online teaching, we decided to retain them in the analysis. In terms of the reliability of the constructs, all the values for the Cronbach α coefficient and the Composite Reliability (CR) coefficient exceed 0.7, which confirms the reliability of the constructs. Table 2 also shows that the average variance extracted (AVE) is above 0.5, which verifies the constructs' convergent validity.

Table 3 presents the results for discriminant validity. For this, the correlation matrix between the constructs was calculated, which confirmed that the correlations were less than the AVE square root.

Table 3
Discriminant validity of measures

	Use	Utility	Attitude	Quality	Efficacy	Interaction	Satisfaction
Use	**0.901**						
Utility	0.329	**0.757**					
Attitude	0.557	0.625	**0.834**				
Quality	0.741	0.458	0.722	**0.816**			
Efficacy	0.413	0.587	0.733	0.539	**0.889**		
Interaction	0.000	0.575	0.331	0.000	0.482	**0.770**	
Satisfaction	0.351	0.723	0.681	0.470	0.707	0.559	**0.918**

Note: the bold numbers of the diagonal are the square root of the AVE. Off-diagonal elements are correlations between constructs.

We observed that all correlations between the constructs amount to less than the corresponding AVE values for each construct, thus confirming that the factors measure different concepts. Finally, in assessing the structural model, it was found that the estimated value of the squared coefficient of multiple correlation for each dependent or endogenous construct exceeds 0.3, and that the factor loads between constructs is significant. Only the "usefulness" factor has a squared coefficient of multiple correlation less than 0.3, and that factor load of the quality variable on efficacy is not significant, thus confirming the validity of the structural model.

Table 4 presents the estimates for the model parameters, the standard error, critical proportion, and the parameters' standardized estimates. The critical proportion is the

quotient between the estimates and standard errors. For the parameters' estimates to be significant, it requires the critical proportion to be higher than 2.

Table 4
Parameter estimates

			Estimate	S.E.	C.R.	Standardized estimate	P
USE	<---	QUALITY	0.797	0.048	16.675	0.741	***
UTILITY	<---	USE	0.460	0.053	8.648	0.618	***
ATTITUDE	<---	UTILITY	0.646	0.066	9.746	0.576	***
ATTITUDE	<---	USE	0.515	0.050	10.326	0.618	***
EFFICACY	<---	INTERACTION	0.301	0.049	6.153	0.280	***
EFFICACY	<---	QUALITY	0.096	0.058	1.659	0.099	0,097
EFFICACY	<---	ATTITUDE	0.651	0.075	8.738	0.608	***
SATISFACTION	<---	INTERACTION	0.454	0.056	8.138	0.433	***
SATISFACTION	<---	QUALITY	0.308	0.045	6.906	0.329	***
SATISFACTION	<---	EFFICACY	0.256	0.051	5.046	0.262	***
UT1	<---	UTILITY	1			0.643	
UT2	<---	UTILITY	0.960	0.065	14.867	0.660	***
UT3	<---	UTILITY	1.078	0.074	14.577	0.854	***
UT4	<---	UTILITY	1.064	0.073	14.501	0.845	***
US1	<---	USE	1			0.903	
US2	<---	USE	1.052	0.031	34.332	0.963	***
US3	<---	USE	1.010	0.040	25.362	0.831	***
Q1	<---	QUALITY	1			0.827	
Q2	<---	QUALITY	0.947	0.046	20.606	0.815	***
Q3	<---	QUALITY	1.034	0.046	22.709	0.871	***
Q4	<---	QUALITY	0.981	0.054	18.038	0.745	***
Q5	<---	QUALITY	0.971	0.047	20.551	0.815	***
A1	<---	ATTITUDE	1			0.751	
A2	<---	ATTITUDE	1.072	0.053	20.064	0.887	***
A3	<---	ATTITUDE	0.987	0.053	18.615	0.824	***
A4	<---	ATTITUDE	1.103	0.056	19.612	0.869	***
EF1	<---	EFFICACY	1			0.911	
EF2	<---	EFFICACY	1.017	0.031	32.612	0.932	***
EF3	<---	EFFICACY	0.832	0.034	24.786	0.819	***
I1	<---	INTERACTION	1			0.817	
I2	<---	INTERACTION	0.870	0.066	13.103	0.720	***
S1	<---	SATISFACTION	1			0.895	
S2	<---	SATISFACTION	1.039	0.034	30.239	0.906	***
S3	<---	SATISFACTION	1.028	0.031	33.625	0.948	***

Source: *own elaboration*. S.E. = Standard Error. C.R. = Critical Ratio. P = p-value

Table 4 shows that the factor loads are significant, as the critical proportion exceeds 2, except in the case of the load of the effect of the "quality on efficacy" variable, which

is not significant. This is also corroborated by the associated p-value, which shows that the loads between constructs are significant to a confidence level of 99.9%. Therefore, the statistical evidence proves the hypotheses in the structural model, except in H6. The rest of the rows show the weighted regressions' standardized and non-standardized estimates, with all the standardized weighted regressions possessing high values.

Table 5 presents the total effects between the factors, calculated from the direct and indirect effects.

Table 5
Total effects

	Interaction	Quality	Use	Utility	Attitude	Efficacy	Satisfaction
Use	0.000	0.741	0.000	0.000	0.000	0.000	0.000
Utility	0.000	0.458	0.618	0.000	0.000	0.000	0.000
Attitude	0.000	0.722	0.974	0.576	0.000	0.000	0.000
Efficacy	0.280	0.539	0.593	0.351	0.608	0.000	0.000
Satisfaction	0.506	0.470	0.155	0.092	0.159	0.262	0.000

We see how the "interaction" variable has the greatest effect on "satisfaction". When the "interaction" value increases within a unit, the satisfaction value rises to 0.506. Thus, interaction is the most important predictor of satisfaction. The next most important predictor of satisfaction is system quality. Among the total effect values, perceived ease-of-use is indicated as a predictor of attitude towards using the technology. System quality is also the most important predictor of perceived ease-of-use. Attitude is the main predictor of learning efficacy.

Finally, Table 6 presents the values of the structural model's fitness indices. All the measures fall within the established limits, which confirm the data's goodness of fit.

Table 6
Fit indices for the structural equations model

Fit index	Recommended value	Actual
χ^2/df	<3 preferable <5	3.827
Goodness-of-fit index (GFI)	>0.80	0.864
Adjusted goodness-of-fit-index (AGFI)	>0.80	0.823
Comparative fit index (CFI)	>0.90	0.940
Root mean square error of approximation (RMSEA)	<0.08	0.078
Normed fit index (NFI)	>0.90	0.920
Non-normed fit index (NNFI)	>0.90	0.927
Parsimony normed fit index (PNFI)	>0.60	0.767

Based on this explanation, the model initially proposed is as presented in Figure 2.

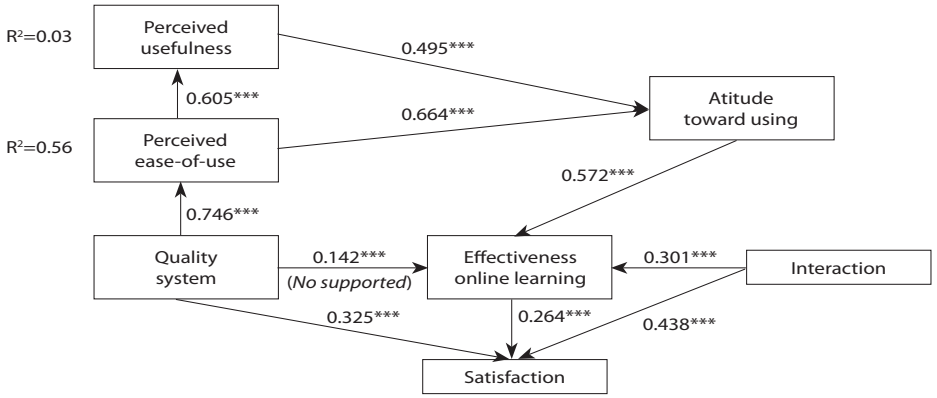

Figure 2. Path analysis of research model

(Note: ***p<0.001)

Discussion

The academic studies on education since the emergence of the pandemic emphasize the significant turning point in educational processes brought about by lockdown and quarantining (Burgos-Videla et al., 2020; Lichfield, 2020). Although online education and e-learning could become a unique teaching model, it is currently being developed as no more than a support to in-person teaching (Jowsey et al., 2020). Several authors have shown how online teaching and e-learning in pre-college education can enhance on-site student learning, although the online format has drawbacks. Students need to interact with their teacher and their schoolmates, being together and enjoying the shared experience of physically being in class. In this sense, e-learning would not appear to provide the support for essential aspects in the socio-educational construction of pre-college students (Burgos-Videla et al., 2020; Zhang & Ma, 2020). However, this is not the case in higher education, where results seem to be more promising, and where e-learning could play an important role in the future in the development of in-person teaching. Experiences such as massive open online courses (MOOC) or short learning programs are demonstrating that e-learning can provide quality education that is satisfactory for students (Hung et al., 2010; Uppal et al., 2018; Zhu et al., 2020). Yet, there is also evidence that different student learning styles have developed that do not relate to the digital platform format (Cho et al., 2009; Fang, 2015; Moreno, et al., 2017; Sangrá, et al., 2019).

Researchers emphasize the benefits of e-learning: it is easy to access and can reach students in rural and remote environments. It is seen as a cost-effective way to provide education when considering transport, accommodation, and the enrolment fees that students have to pay. Flexibility is another interesting aspect of online teaching, allowing students more freedom to plan their learning schedule. Students can learn anytime and anywhere, thereby developing new skills in the learning process (Ameen et al., 2019; Dhawan, 2020; Pham et al., 2019).

The results of this study provide several theoretical implications. A general conclusion is that the relationships defined in the research model are verified, except in reference to the effect of system quality on learning efficacy. These relationships have been derived from previous models and have been verified despite the fact that adaptation to the online model had to occur abruptly and without warning. The factor that most influences student satisfaction with the online learning model is interaction, which has a direct, positive effect on satisfaction. It also affects satisfaction through the mediating variable of learning efficacy. This aligns with the findings reported by authors such as Eom et al. (2006), Lee (2010), and Liaw (2008). Interaction is very important in online teaching since most of the learning inevitably takes place within a social context (Al-Azawei et al., 2017; Liaw et al., 2007). Therefore, being able to ask a question, share an opinion or disagree are fundamental activities in online learning (Yalçın & Kutlu, 2019).

Another finding from our research is that learning efficacy basically depends on students' attitude towards the use of technology. Attitude is formed of affective, cognitive, and behavioral components that configure a positive or negative predisposition towards an object or behavior. Understanding users' attitudes towards technology enables teachers to create a favorable learning environment (Liaw, 2008; Scherer & Teo, 2019; Vázquez-Cano et al., 2021). Both perceived usefulness and perceived ease-of-use impact on attitude towards technology. This corresponds with findings by other authors in the literature (Gandema & Brown, 2012; Hanafizadeh et al., 2014). Thus, to achieve learning efficacy in the e-learning context, it is important that the student is favorably disposed towards using technology.

In contrast to Piccoli et al. (2001), our study concludes that system quality has no direct effect on learning efficacy. This could be due to the fact that this study was concluded before students had received their end-of-year assessments. It is important to note that many students link learning efficacy to having passed their courses at the end of the year rather than to an overall acquisition of knowledge. Nevertheless, our study shows that system quality indirectly influences learning efficacy via other moderated variables such as perceived ease-of-use and attitude towards technology. Another conclusion is that system quality has a direct influence on perceived ease-of-use and on student satisfaction with online teaching, which fits with other authors' works (Aparicio et al., 2017; Urbach et al., 2010). Therefore, the e-learning system must be easy to use and easy to learn, designed with attractive features to enable good accessibility, stability and effective search capabilities. This is essential to ensure a quality experience and learning for students.

Conclusions

The COVID-19 pandemic is having a profound effect on the world economy. Many countries resort to measures such as confining their citizens to stop the spread of the virus, which has led many educational institutions to close temporarily. In this

situation, the problem faced by educational institutions is not whether online teaching and learning can provide good quality education but whether such institutions are geared towards adopting online learning on a mass scale (…). This adaptation process for both students and teachers has had to happen double quick, as an emergency response to the pandemic. There was no time for teachers to completely redesign courses initially intended for in-person teaching (or at best, partially online). Moreover, it was challenging to plan or ensure that all the subjects involved had access to the basic technology required, the necessary digital competences and an attitude that is willing to embrace sudden and enforced change (García-Peñalvo et al., 2020).

This study has also formed a set of practical implications for academic institutions. Educational institutions with an established in-person teaching system should make the most of the advantages of e-learning and the knowledge acquired during this pandemic-induced online teaching period as a way of reinforcing on-site teaching. However, it is also important to recognize the limitations of new technologies in teaching and learning online, such as the commonly aired complaints about downloading, installation and connection, and audio and video quality have shown. This is the time for educational institutions to invest in improving all aspects of online teaching so that users (teachers and students) can feel satisfied with these media. Clearly, e-learning reduces contact between users, diminishing interaction between students and teachers. This study concludes that interaction is the most important predictor of student satisfaction with online learning, thus, course planning and design need to focus closely on the interaction between students and teachers. It is fundamental that teaching develops a synchronous mode of operation. In synchronous learning, students participate in "live" classes where they can interact with other students and the teacher, and receive immediate feedback. Educational institutions must direct their efforts towards humanizing the learning process in this way.

Limitations

Firstly, the data gathered for this study came from a single educational institution. There may not be any significant differences with other institutions, but it would be convenient to acquire data from a range of institutions and observe possible variations. These differences might be influenced on factors such as the size of the universities, the teaching methods used by the teachers or the economic impact for the students. Specifically, students with low-income, students living in remote areas and special needs students have been hit hard, encountering economic hardship and living in emotional distress. The students who participated in this study use the Blackboard Learn platform, so it would be interesting to compare results from users of other platforms to analyse which yields greater learning efficacy and student satisfaction. Finally, the pandemic has caused widespread chaos and tension around the world, thus, it would be interesting to replicate this study in other countries to assess whether the outcomes are influenced by the various degrees of fear and unrest associated with the pandemic.

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Model mjerenja učinkovitosti učenja i zadovoljstva studenata tijekom pandemije bolesti COVID-19

Sažetak

Cilj ovoga istraživanja bio je procijeniti učinkovitost učenja i razinu zadovoljstva studenata tijekom privikavanja na online nastavu uslijed ograničenja nametnutih zbog pandemije bolesti COVID-19. Uzorak ispitanika sastojao se od 467 studenata državnoga sveučilišta u Španjolskoj. U istraživanju je primijenjena metodologija strukturnih jednadžbi i pristup triangulacije. Rezultati pokazuju da je najutjecajniji faktor zadovoljstva učenjem u online okružju interakcija između studenta i nastavnika. S druge strane, učinkovitost učenja najviše ovisi o njihovim stavovima prema korištenju tehnologije. Zbog toga je nužno razumjeti koji elementi učenja u online okružju pomažu i potiču stvaranje dobroga okružja za učenje. Štoviše, kvaliteta dizajna sustava, alati koji im omogućuju rad te kako se oni povezuju sa sadržajem i kompetencijama zajedno izravno utječu na percepciju lakoće korištenja i na zadovoljstvo studenata online nastavom.

Ključne riječi: *COVID-19; e-učenje; strukturne jednadžbe; sveučilište.*

Uvod

Online nastava iznenada je i značajno dobila na važnosti pojavom pandemije bolesti COVID-19. E-učenje, poznato i kao tehnologijom posredovano učenje, sada je široko prihvaćeno u svim područjima obrazovanja i akademskim institucijama (Rodrigues i sur., 2019). Ono je omogućilo pojavu novih modela poučavanja, ne samo u učenju na daljinu, već i u hibridnim oblicima poput *blended learning*, stvarajući otvoreniji, fleksibilniji tip obrazovanja kojemu se može pristupiti putem mobilnih uređaja i svuda dostupnih scenarija (Vázquez-Cano i Díez-Arcón, 2021). Bez sumnje, upotreba e-učenja za poučavanje i učenje u narednim će se godinama brzo povećavati s obzirom na razvoj novih, uključujućih i participativnih tehnologija za nove oblike učenja i socijalne interakcije (Arkorful i Abaidoo, 2015; Paechter i Maier, 2010). Analiza primjene ovoga formata učenja može pomoći u poboljšanju njegove upotrebe i dizajnu kako bi se potaknulo veće sudjelovanje studenata i suradnja u ovim modelima *online* nastave.

Situacija uzrokovana pandemijom bolesti COVID-19 navela je mnoge obrazovne institucije na zamjenu tradicionalnoga modela nastave *online* formatom. Te institucije

obuhvaćaju osnovne i srednje škole te sveučilišta, u mnogim zemljama sve su osnovala ministarstva obrazovanja Njihova je glavna uloga podržavati i poticati nastavu i učenje. Brojne obrazovne institucije sada imaju *online* model učenja kao uspostavljeni format za održavanje nastave, iako većina nije izravno pogođena pandemijom. Druge obrazovne institucije primjenjuju sustav poučavanja *blended learning*, koji kombinira nastavu na licu mjesta i online nastavu, i prijelaz nije bio traumatičan. Međutim, institucije u kojima se nastava održavala gotovo isključivo uživo, bile su prisiljene zbog pandemije, brzo prijeći na *online* nastavu. Ta je promjena zahtijevala brzo preoblikovanje predmeta čija se nastava ranije održavala isključivo u učionici. Upravo to otežava usporedbu načina na koji su se predavanja odvijala *online* u proteklim mjesecima, s obzirom na iskustvo, planiranje i razvoj prijedloga namijenjenih specifično za oblik *online* učenja (Hodges i sur., 2020). Ovim se istraživanjem analiziralo kako se *online* nastava percipira među studentima španjolskoga sveučilišta.

E-učenje i utjecajne varijable

Definicija i karakteristike *online* nastave razvijale su se i mijenjale u znanstvenoj literaturi. Al-Busaidi (2013) opisuje *online* nastavu kao primjenu računalne tehnologije u poučavanju učenika. Janda (2016) e-učenjem smatra korištenje i stjecanje znanja putem elektroničkih medija. E-učenje može poboljšati poučavanje i učenje razvijanjem kapaciteta poput interakcije, trenutačnosti, učinkovitosti, fleksibilnosti i samoučenja (Bidin i Ziden, 2013; Jeong i Hong, 2013; Moreno i sur., 2017). Uspješnost sustava e-učenja uvelike se mjerila modelom uspjeha informacijskih sustava (Information Systems Success – ISS); namjera korisnika prema korištenju tehnologije analizirana je pomoću modela poput Modela prihvaćanja tehnologije (Technology Acceptance Model - TAM) i Unificirane teorije prihvaćanja i korištenja tehnologije (Unified Theory of Acceptance and Use of Technology - UTAUT). Naše istraživanje utvrđuje da su ovi modeli temeljeni na skupu faktora koji nastoje objasniti usvajanje sustava e-učenja kod studenata i njihovo zadovoljstvo sustavom; ti su faktori međusobno povezani umjesto neovisni.

Davis (1989) je percipiranu korist definirao kao stupanj do kojega osoba vjeruje da korištenje sustava poboljšava uspješne rezultate. Percipirana korist također se definira kao korisnikova sposobnost uporabe inovativne, lako korisne tehnologije koja mu pruža veći osjećaj slobode (Pikkarainen i sur., 2004). Sklonost pojedinca prema korištenju određenoga sustava u svakodnevnim aktivnostima smatra se ovisnom o percepciji njegove uporabe (Hanafizadeh i sur., 2014). Koristan sustav e-učenja može pomoći studentima u upravljanju i kontroli njihova učenja. Na primjer, omogućuje im preuzimanje i čitanje sadržaja u vrijeme i na mjestu koje im najviše odgovara. Prethodna istraživanja tvrde da kada studenti imaju veću kontrolu nad svojim učenjem, postižu bolje rezultate (Islam, 2013). Percipirana korisnost i lakoća upotrebe tehnologije, poput platforme Blackboard Learn u kontekstu e-učenja, mogu utjecati na stav studenata prema *online* učenju (Gandema i Brown, 2012). Prema osnovnom modelu TAM, percipirana korisnost tehnološkoga alata utječe na stav prema upotrebi te tehnologije.

Lakoća upotrebe definirana je kao stupanj do kojeg osoba vjeruje da korištenje određenoga sustava ne zahtijeva trud (Davis, 1989). Sustav koji je jednostavan za korištenje omogućuje studentima da koristeći se tim sustavom troše malo vremena ili truda jer mogu brzo naučiti kako se koristiti sustavom e-učenja. To im omogućuje da se više usredotoče na sadržaj i aktivnosti učenja umjesto na način rukovanja sustavom (Islam, 2013). Chen i Tseng (2012) pokazali su da lakoća korištenja utječe na percipiranu korist od e-učenja. Percipirana korist i lakoća korištenja imaju niski kognitivni teret što omogućuje studentima koncentriranost na druge aktivnosti (Saadé i Bahli, 2005). Posljedično, očekuje se da će lakoća korištenja imati pozitivan učinak na percepciju korisnosti i na stav prema tehnologiji. Prema literaturi, stav prema upotrebi tehnologije važan je faktor u zadovoljstvu *online* učenjem (Arbaugh i Duray, 2002; Hong, 2002). E-učenje uglavnom ovisi o upotrebi računala ili digitalnih uređaja povezanih s internetom. Nastavnici postavljaju materijale na *online* platforme, a studenti sudjeluju i povezuju se unutar toga sustava. Pozitivan stav prema tehnologiji čini učenje učinkovitijim (Piccoli i sur., 2001), kao što nelagoda zbog tehnologije negativno utječe na zadovoljstvo s učenjem. Još jedan element modela uspjeha informacijskoga sustava jest kvaliteta samoga sustava koja se odnosi na sigurnosnu strukturu komunikacijskoga sustava i učinkovitost u generiranju informacija (DeLone i McLean, 2003). Kvaliteta sustava temelji se na skupu karakteristika i aspekata koje sadrži kako bi olakšao učenje (Hassanzadesh i sur., 2012), kao što su dostupnost, pristupačnost, fleksibilnost, upotrebljivost, lakoća uporabe za učenje i vrijeme odaziva (Wu i Zhang, 2014).

Nekoliko autora ukazuje da kvaliteta sustava ima pozitivan i značajan utjecaj na zadovoljstvo korisnika u kontekstu e-učenja (Hassanzadeh i sur., 2012; Kim i sur., 2012; Wang i Chiu, 2011). Kvaliteta sustava također je određujući faktor kod učinkovitosti učenja (Piccoli i sur., 2001). Drugi autori su otkrili da kvaliteta sustava pozitivno utječe na percipiranu lakoću upotrebe (Rai i sur., 2002; Wu i Zhang, 2014). Interakcija s drugim korisnicima također je značajan element e-učenja koje može biti sinkrono i asinkrono. Sinkrona značajka e-učenja odnosi se na manja predavanja „uživo" ili istovremene diskusije u grupama između nastavnika i studenata. S druge strane, asinkrona značajka odnosi se na informacije s kojima studenti ne komuniciraju izravno budući da možda nisu dostupni u vrijeme „stvarnoga/uživo" pristupa, iako sadržaj ostaje trajno dostupan. Interakciju korisnika u oba slučaja omogućavaju alati za e-učenje (Abdalla, 2007; Leví-Orta i sur., 2020; López-Meneses i sur., 2020).

Postoje tri vrste interakcije u e-učenju: interakcije između studenata i nastavnika, interakcije između studenata i nastavnih materijala te interakcije između samih studenata. Virtualna interakcija doprinosi rješavanju problema i poboljšanju učenja. Paechter i sur. (2010) tvrdili su da interakcija između studenata omogućava razmjenu informacija o sadržaju predmeta te pružanje međusobne socioemocionalne pomoći. Interakcija između nastavnika i studenata posebno je važna i ključna za kreiranje aktivnosti za učenje (Webster i Hackley, 1997). Interakcija nastavnika i studenata ne događa se samo kada nastavnik pruža informacije i znanje, već i prilikom poticanja

studenata, pružanja potpunih i pozitivnih odgovora na njihove sumnje te u poticanju otvorene komunikacije (Sher, 2009). Abdalla (2007) zaključuje da je interakcija u e-učenju pokazatelj učinkovitosti učenja. Neki su autori također utvrdili da veća interakcija između e-učitelja donosi veći osjećaj zadovoljstva procesom učenja (Arbaugh, 2000; Goh i sur., 2017). Učinkovitost učenja još je jedna komponenta koja uvjetuje održivost i funkcionalnost sustava. Obrazovne vlasti trebaju kontinuirano procjenjivati učinkovitost učenja. Nastavnici mogu koristiti e-učenje kako bi poboljšali učinkovitost učenja (Al-Adwan i sur., 2013), redovito ažurirajući materijale i omogućujući studentima trenutačan pristup svim materijalima. Bandura (1993) tvrdi da će stupanj percepcije učinkovitosti učenja studenata odrediti njihovo kognitivno funkcioniranje i razvoj. Diep i sur. (2017) kažu da se obrazovne ustanove i nastavnici trebaju fokusirati na pomoć studentima u učinkovitom učenju jer taj faktor utječe na zadovoljstvo studenata sa studijem (Wang, 2003).

Zadovoljstvo sustavom još je jedan bitan element usklađenosti modela. Lin i sur. (2008) opisuju koncept zadovoljstva kao krajnji cilj bilo kojeg proizvoda ili usluge. Čini se da bi zadovoljstvo trebalo biti najčešće proučavani konstrukt u povijesti obrazovnoga marketinga (Fullerton i Taylor, 2002). Zadovoljstvo studenata može se definirati kao percipirana vrijednost njihovih obrazovnih iskustava unutar obrazovne institucije (Astin, 1993). Ove percepcije obrazovnih iskustava mogu utjecati na odluku studenta da nastavi sa studijem (Carr, 2000) kao i na opće zadovoljstvo učenjem (Bolliger i Wasilik, 2009). Naše istraživanje pretpostavlja da je zadovoljstvo subjektivna percepcija studenta, odnosno percipirano zadovoljstvo temeljeno na mjeri u kojoj student vjeruje da e-učenje odgovara očekivanjima (Lo, 2010). Ponekad studenti nisu zadovoljni *online* iskustvom. Bouhnik i Marcus (2006) smatraju da je nezadovoljstvo studenata uzrokovano nedostatkom pravilnoga planiranja koje provode obrazovne institucije kako bi se osigurala visoka razina učenja, malo kontakta među studentima ili niskom učinkovitošću procesa učenja. Sveukupno gledajući, zadovoljstvo e-učenjem pripisuje se različitim faktorima koji uključuju kvalitetu sustava, učinkovitost učenja i interakciju korisnika.

Na osnovi gore navedenih komentara, glavni je cilj ovoga istraživanja procijeniti učinkovitost učenja i razinu zadovoljstva studenata na sveučilištu nakon prilagodbe na *online* nastavu koja je nametnuta tijekom pandemije bolesti COVID-19.

Predloženi teorijski okvir sastoji se od niza hipoteza i strukturalnoga modela (Slika 1)

Lakoća korištenja

H1: Percipirana korisnost ima pozitivan učinak na stav prema korištenju tehnologije.

H2: Percipirana lakoća korištenja ima pozitivan učinak na percipiranu korisnost.

H3: Percipirana lakoća korištenja ima pozitivan učinak na stav prema korištenju tehnologije.

Stav prema korištenju tehnologije

H4: Pozitivan stav prema korištenju tehnologije ima pozitivan učinak na učinkovitost učenja.

Kvaliteta sustava

H5: Kvaliteta sustava utječe na percepciju lakoće korištenja.

H6: Kvaliteta sustava ima pozitivan učinak na učinkovitost učenja.

H7: Kvaliteta sustava ima pozitivan učinak na zadovoljstvo korisnika.

Interakcija s drugim korisnicima

H8: Što je viša razina interakcije među korisnicima e-učenja, to je veći utjecaj na učinkovitost učenja.

H9: Viša razina interakcije među e-učenicima ima pozitivan učinak na zadovoljstvo korisnika.

Učinkovitost učenja

H10: Što je viša razina učinkovitosti učenja, to je jači pozitivni utjecaj na zadovoljstvo korisnika.

Slika 1.

Metodologija

Prijašnja istraživanja spomenuta u literaturi primjenjivala su teorije poput Modela uspjeha informacijskoga sustava (ISS), Modela prihvaćanja tehnologije (TAM) i Unificirane teorije prihvaćanja i korištenja tehnologije (UTAUT) (Chen i Tseng, 2012; Davis, 1989; DeLone i McLean, 1992; Mohammadi, 2015; Venkatesh i sur., 2003). Kao što neki autori predlažu (Hassanzadeh i sur., 2012; Li i sur., 2012), od velike je važnosti proučiti odnos između studentskih iskustava, percepcija, korištenja sustava i kvalitete kao pokazatelje uspješnosti sustava. Analiza spomenutih elemenata može detektirati nedostatke ili ukazati na poboljšanja u svrhu osiguranja kvalitete nastave.

Metoda istraživanja primijenjena u našem istraživanju razlikuje se od drugih istraživanja u dva temeljna aspekta: naše istraživanje primjenjuje metodološki model koji integrira elemente iz svih triju teorijskih okvira (…); podatci korišteni u ovome radu potječu sa sveučilišta koje je zbog pandemije bolesti COVID-19 bilo prisiljeno brzo prijeći iz nastave u učionici na *online* model nastave. Koristeći takav metodološki pristup saznali smo koje varijable imaju veći utjecaj na učinkovitost *online* učenja i zadovoljstvo studenata.

Istraživanje je provedeno u društveno-obrazovnom okružju obilježenom *potpunim zatvaranjem,* tijekom kojega se nastava održavala sinkrono *online*, slijedeći raspored uobičajene nastave na lokaciji na kojoj se izvodi. Mnoge su sesije snimljene kako bi studentima koji nisu mogli prisustvovati omogućile njihovo naknadno pregledavanje. Tijekom tih sesija, studenti su mogli postavljati pitanja putem mikrofona ili internetskoga razgovora jer su nastavnici prilagodili postavke kako bi omogućili studentima korištenje tih komunikacijskih alata. Studenti su također mogli rješavati probleme zajedno s nastavnicima kontaktirajući ih putem e-pošte. Povratne informacije studenti su dobivali putem e-pošte ili posebnih *online* sesija koje su nastavnici organizirali kako bi odgovorili na pitanja. Ispiti su održani na platformi koja je osmišljena za podršku različitim formatima ispita, uključujući višestruki izbor. Studenti su slali završene radove putem platforme koje bi se mogle ispraviti pomoću rubrika. Studenti su pohađali nastavu

putem virtualne učionice sveučilišta, Blackboard Learn 9.1., koja je licencirana sveučilištu kako bi omogućila studentima korištenje sustava. Ova platforma nudi studentima virtualne alate kako bi razvili svoj proces učenja uključujući: a) alate za nastavnike u svrhu generiranja sadržaja; b) komunikacijske alate, poput e-pošte, internih poruka, initernetskoga razgovora, foruma, elektronske ploče, kalendara i obavijesti; c) alate za omogućavanje sinkronih nastavnih sesija, s mikrofonom, videom, interaktivnom pločom i dijeljenjem datoteka (Blackboard Collaborate Ultra) između korisnika; d) alate za ocjenjivanje studenata, putem ispita i upitnika, aktivnosti, grupnoga rada; e) alate za upravljanje podatcima o studentima, praćenje pristupa i prisutnosti studenata, rezultata radova na predmetu; f) alate za otkrivanje plagijata u studentskim radovima.

Ispitanici

Uzorak istraživanja sastojao se od 467 studenata prijediplomskih studija (5 % ukupnoga broja studenata na sveučilištu), 37,9 % muškaraca i 62,1 % žena. Od tih studenata, 34,1 % bilo je na prvoj godini prijediplomskoga studija, 26,4 % na drugoj godini i 20,9 % na trećoj godini, dok je 18,6 % bilo u trećoj ili četvrtoj godini integriranoga programa. Prosječna dob ispitanika bila je oko 21 godinu (srednja vrijednost =21,34, standardna devijacija =2,45).

Instrumenti i varijable

Podatci su prikupljeni iz uzorka od 467 ispitanika, studenata na državnom španjolskom sveučilištu u razdoblju od 4. do 27. svibnja 2020. godine. Za potrebe istraživanja izrađen je *online* upitnik a ispunili su ga studenti koji su prethodno dali svoj pristanak. Uzorak je bio heterogen, s ispitanicima iz različitih studijskih programa kako bi se unaprijedila vanjska statistička valjanost ispitivanja (Marks i sur., 2005). Upitnik je objavljen na virtualnoj platformi sveučilišta putem njihova Twitter računa. Kako bi se postigla najviša stopa odgovora, kontaktirali smo i upravu fakulteta uz zamolbu da se upitnik pošalje na e-adrese studenata i objavi na društvenim mrežama. Upitnik je sadržavao 24 čestice grupirane u sedam latentnih varijabli. Studenti su trebali odgovoriti na svaku česticu davanjem ocjene od 1 do 7, pri čemu je 1 značilo „u potpunosti se ne slažem", a 7 „u potpunosti se slažem". Odabrane čestice prilagođene su iz radova različitih autora (Tablica 1).

Tablica 1
Latentne varijable i čestice

Kategorija	Dimenzija	Čestica	Autori
Korisnost	Percipirana korisnost *online* nastave	UT1. *Online* nastava omogućuje mi uštedu vremena. UT2. *Online* nastava pomaže mi u autonomiji učenja. UT3. *Online* učenje pomaže mi u usvajanju znanja vezanoga uz predmete koje studiram. UT4. *Online* učenje pomaže mi u ostvarenju boljih rezultata u predmetima koje studiram.	Chiu i Wang (2008) DeLone i McLean (2003) Hascanzadesh i sur. (2012)

Kategorija	Dimenzija	Čestica	Autori
Korištenje	Percipirana lakoća korištenja virtualnoga razreda	US1. Lako je pristupiti virtualnoj platformi. US2. Virtualna se platforma lako koristi. US3. Lako je naučiti koristiti se virtualnom platformom.	Abdalla (2007) DeLone i McLean (2003) Tarhini i sur. (2017) Wang i Liao (2008)
Kvaliteta	Kvaliteta sustava	Q1. Okružje na virtualnoj platformi pogodno je za upotrebu. Q2. Virtualna platforma omogućuje mi optimizirati vrijeme učenja. Q3. Virtualna platforma ima privlačna obilježja. Q4. Vjerujem virtualnoj platformi. Q5. Virtualna platforma ima mnoge korisne funkcije.	DeLone i McLean (2003) Ozkan i Koseler (2009) Wang i sur. (2007)
Stav	Stav prema korištenju tehnologije	A1. Korištenje virtualne platforme je dobra ideja. A2. Virtualna platforma čini mi učenje zanimljivijim. A3. Rad u virtualnoj platformi je zabavan. A4.Volim raditi s virtualnom platformom.	Hsieh i sur. (2017) Tarhini i sur. (2017)
Interakcija	Interakcija s drugim korisnicima	I1. *Online* učenje potiče interakciju između nastavnika i studenta. I2. *Online* poučavanje potiče interakciju među studentima.	Eom i sur. (2006) Lee (2010) Liaw (2008)
Učinkovitost	Učinkovitost učenja	EF1. Smatram da mi *online* poučavanje može pomoći ostvariti veću učinkovitost u učenju. EF2. Smatram da mi *online* poučavanje može pomoći usvojiti više znanja. EF3. Smatram da *online* nastava povećava moju motivaciju za učenjem.	Abdalla (2007) Liaw (2008)
Zadovoljstvo	Zadovoljstvo *online* nastavom	S1. Zadovoljan sam s *online* poučavanjem kao metodom učenja. S2. Zadovoljan sam s *online* poučavanjem. S3. *Online* poučavanje zadovoljava moje potrebe za učenjem.	DeLone i McLean (2003) Lee (2010) Lee i sur. (2009)

Rezultati

Prije primjene strukturalnoga modeliranja jednadžbi, provedena je analiza podataka kako bi se testirala valjanost i pouzdanost skala. Koeficijent pouzdanosti Cronbachova alpha bio je iznad 0,7, a indeks Kaiser-Meyer premašio je 0,75. Nulta hipoteza prema Bartlettovu testu sferičnosti je odbačena i time je omogućena faktorska analiza. Faktorska analiza s metodom varimax rotacije rezultirala je sa sedam faktora što potvrđuje valjanost upitnika. Metoda maksimalne izglednosti korištena je za izračunavanje parametara strukturnoga modela. Iako se podatci nisu slagali s multivarijatnom normalnom

distribucijom, ova je metoda omogućila konvergenciju procjena (Lévy i sur., 2006). Model je procijenjen prema kriterijima Bollena (1989) i Rindskopfa i Rosea (1988) koji predlažu da se mjerni model i strukturni model evaluiraju odvojeno. Valjanost i pouzdanost mjernoga modela analizirane su, potonja u smislu pouzdanosti čestica i svakoga konstrukta. Što se tiče valjanosti, analizirane su konvergentna i diskriminantna valjanost, a rezultati su prikazani u tablicama 2 i 3.

Tablica 2

Tablica 2 pokazuje da je pouzdanost čestica potvrđena jer su svi standardizirani koeficijenti veći od 0,707. Dva koeficijenta nisu premašila 0,707, ali je razlika minimalna i s obzirom na to da su to važne stavke u *online* nastavi, odlučili smo ih zadržati u analizi. Što se tiče pouzdanosti konstrukata, sve vrijednosti Cronbachova α koeficijenta i koeficijenta kompozitne pouzdanosti (CR) prelaze 0,7 što potvrđuje pouzdanost konstrukata. Tablica 2 također pokazuje da je prosječna varijanca (AVE) viša od 0,5 što potvrđuje konvergentnu valjanost konstrukata.

Tablica 3 prikazuje rezultate diskriminantne valjanosti. Za to je izračunata korelacijska matrica između konstrukata, što potvrđuje da su korelacije manje od korijena AVE.

Tablica 3

Primijetili smo da su sve korelacije između konstrukata manje od odgovarajućih AVE vrijednosti za svaki konstrukt što potvrđuje da faktori mjere različite koncepte. Konačno, prilikom procjene strukturalnoga modela, utvrđeno je da je procijenjena vrijednost kvadratnoga koeficijenta višestruke korelacije za svaki zavisni ili endogeni konstrukt veći od 0,3 a faktorska su opterećenja među konstruktima značajna. Samo faktor „korisnost" ima kvadrirani koeficijent višestruke korelacije manji od 0,3, a faktorsko opterećenje varijable kvalitete na učinkovitost nije značajno, potvrđujući time valjanost strukturnoga modela.

Tablica 4 prikazuje procjene za parametre modela, standardnu pogrešku, kritički omjer i standardizirane procjene parametara. Kritički omjer je kvocijent između procjena i standardne pogreške. Da bi procjene parametara bile značajne, kritički omjer mora biti veći od 2.

Tablica 4

Tablica 4 pokazuje da su faktorska opterećenja značajna, s obzirom na to da kritički omjer prelazi 2, osim u slučaju opterećenja varijable „kvaliteta na učinkovitost" koje nije značajno. To potvrđuje i pripadajuća p-vrijednost, koja pokazuje da su opterećenja između konstrukata značajna na razini pouzdanosti od 99,9 %. Stoga, statistički dokazi potvrđuju hipoteze u strukturalnom modelu, osim u H6. Ostatak redaka prikazuje standardizirane i nestandardizirane procjene ponderiranih regresija, pri čemu sve standardizirane ponderirane regresije imaju visoke vrijednosti.

Tablica 5 prikazuje ukupne učinke između faktora dobivenih izračunima izravnih i neizravnih učinaka.

Tablica 5

Vidljivo je kako varijabla „interakcija" ima najveći utjecaj na „zadovoljstvo". Kada se vrijednost „interakcije" poveća unutar jedinice, vrijednost zadovoljstva poveća se do 0,506. Dakle, interakcija je najvažniji prediktor zadovoljstva. Sljedeći najvažniji prediktor zadovoljstva je kvaliteta sustava. Među vrijednostima ukupnoga efekta, percipirana lakoća upotrebe naznačena je kao prediktor stava prema korištenju tehnologije. Kvaliteta sustava također je najvažniji prediktor percipirane lakoće upotrebe. Stav je glavni prediktor učinkovitosti učenja.

Konačno, u Tablici 6 prikazane su vrijednosti indeksa prilagodbe strukturnoga modela. Svi izračuni nalaze se unutar utvrđenih granica, što potvrđuje dobru usklađenost podataka.

Tablica 6

Na temelju ovoga objašnjenja, izvorno predloženi model prikazan je u Slici 2.

Rasprava

Znanstvena istraživanja obrazovanja od pojave pandemije naglašavaju značajan preokret u obrazovnim procesima koji je uzrokovan potpunim zatvaranjem i karantenom (Burgos-Videla i sur., 2020; Lichfield, 2020). Iako bi *online* obrazovanje i e-učenje mogli postati jedinstveni model poučavanja, trenutačno se razvijaju tek kao podrška nastavi uživo (Jowsey i sur., 2020). Neki su autori pokazali kako *online* nastava i e-učenje u predvisokoškolskom obrazovanju mogu poboljšati učenje studenata uživo, iako *online* oblik ima nedostatke. Studenti trebaju interakciju sa svojim nastavnikom i kolegama, biti zajedno i uživati u zajedničkom iskustvu fizičke prisutnosti u učionici. U tom smislu, čini se da e-učenje ne pruža potporu ključnim aspektima socioobrazovnoga razvoja učenika predvisokoškolskoga obrazovanja (Burgos-Videla i sur., 2020; Zhang i Ma, 2020). Međutim, ovo nije slučaj u visokom obrazovanju u kojem se rezultati čine obećavajućima i u kojem bi e-učenje moglo igrati važnu ulogu u razvoju buduće nastave uživo. Iskustva poput masovnih otvorenih *online* tečajeva (MOOC) ili kratkih obrazovnih programa pokazuju da e-učenje može pružiti kvalitetno obrazovanje koje je zadovoljavajuće za studente (Hung i sur., 2010; Uppal i sur., 2018; Zhu i sur., 2020). Ipak, postoje i dokazi da su se (Cho i sur., 2009; Fang, 2015; Moreno, i sur., 2017; Sangrá, i sur., 2019) kod studenata razvili različiti stilovi učenja koji nisu povezani s oblicima digitalnih platformi.

Istraživači ističu prednosti e-učenja: lako je dostupno i studentima u ruralnim i udaljenim područjima. Smatra se ekonomičnim načinom obrazovanja kada se uzmu u obzir troškovi prijevoza, smještaja i upisnina koje studenti moraju platiti. Fleksibilnost je još jedan zanimljiv aspekt *online* nastave koji studentima pruža više slobode u planiranju

rasporeda učenja. Studenti mogu učiti bilo kada i bilo gdje, razvijajući pri tome nove vještine u procesu učenja (Ameen i sur., 2019; Dhawan, 2020; Pham i sur., 2019).

Rezultati ovoag istraživanja pružaju nekoliko teorijskih implikacija. Opći je zaključak da su odnosi definirani istraživačkim modelom potvrđeni, osim u vezi s utjecajem kvalitete sustava na učinkovitost učenja. Ti su odnosi izvedeni iz prethodnih modela i potvrđeni unatoč činjenici da je prilagodba *online* modelu morala nastupiti iznenada i bez upozorenja. Faktor koji najviše utječe na zadovoljstvo studenata *online* modelom učenja jest interakcija, koja ima izravan, pozitivan učinak na zadovoljstvo. Također utječe na zadovoljstvo putem posredne varijable učinka učenja. Ovo se podudara s rezultatima koje su objavili autori poput Eom i sur. (2006), Lee (2010) i Liaw (2008). Interakcija je vrlo važna u *online* nastavi jer se većina učenja neizbježno odvija unutar društvenoga konteksta (Al-Azawei i sur., 2017; Liaw i sur., 2007), stoga je mogućnost postavljanja pitanja, dijeljenja mišljenja ili neslaganja temeljna aktivnost u *online* učenju (Yalçın i Kutlu, 2019).

Još jedno saznanje iz našega istraživanja jest da učinkovitost učenja u osnovi ovisi o stavu studenata prema upotrebi tehnologije. Stav se sastoji od afektivnih, kognitivnih i bihevioralnih komponenti koje konfiguriraju pozitivnu ili negativnu sklonost prema objektu ili ponašanju. Razumijevanje stavova korisnika prema tehnologiji omogućuje nastavnicima stvaranje povoljnoga okružja za učenje (Liaw, 2008; Scherer i Teo, 2019; Vázquez-Cano i sur., 2021). I percepcija korisnosti i percepcija lakoće uporabe utječu na stavove prema tehnologiji. To se podudara s nalazima drugih autora u literaturi (Gandema i Brown, 2012; Hanafizadeh i sur., 2014). Dakle, kako bi se postigla učinkovitost u učenju u kontekstu e-učenja, važno je da student ima sklonost prema korištenju.

Za razliku od Piccoli i sur. (2001), na osnovi rezultata našega istraživanja može se zaključiti da kvaliteta sustava nema izravan utjecaj na učinkovitost učenja. Razlog bi mogao biti što je ovo istraživanje zaključeno prije nego što su studenti dobili ocjene na kraju akademske godine. Važno je napomenuti da mnogi studenti povezuju učinkovitost učenja s položenim ispitima na kraju godine, a ne s općim stjecanjem znanja. Ipak, naše istraživanje pokazuje da kvaliteta sustava neizravno utječe na učinkovitost učenja putem drugih umjerenih varijabli poput percipirane lakoće upotrebe i stava prema tehnologiji. Drugi je zaključak da kvaliteta sustava izravno utječe na percipiranu lakoću upotrebe i na zadovoljstvo studenata *online* nastavom, što se podudara s nalazima drugih autora (Aparicio i sur., 2017; Urbach i sur., 2010). Stoga, sustav e-učenja mora biti jednostavan za upotrebu i učenje, oblikovan s atraktivnim značajkama koje omogućuju dobru dostupnost, stabilnost i učinkovite mogućnosti pretraživanja. To je ključno kako bi se za studente osiguralo kvalitetno iskustvo i učenje.

Zaključci

Pandemija bolsti COVID-19 ostavlja veliki trag na svjetsko gospodarstvo. Mnoge zemlje primjenjuju mjere poput ograničavanja kretanja svojih građana kako bi zaustavile širenje virusa, što je dovelo do privremenoga zatvaranja mnogih obrazovnih institucija.

U ovoj situaciji, problem s kojim se suočavaju obrazovne institucije nije pružaju li *online* nastava i učenje obrazovanje visoke kvalitete, već jesu li takve institucije usmjerene prema usvajanju *online* učenja na masovnoj razini (…).Ovaj proces prilagodbe, kako za studente tako i za nastavnike, morao se dogoditi izuzetno brzo kao hitan odgovor na pandemiju. Nastavnici nisu imali vremena za potpuno redizajniranje kolegija koji su prvotno bili namijenjeni za nastavu na lokaciji (ili u najboljim uvjetima, djelomično *online*). Nadalje, bilo je izazovno planirati ili osigurati da svi ključni dionici imaju pristup osnovnoj potrebnoj tehnologiji, potrebne digitalnim kompetencije i stav koji je spreman prihvatiti naglu i prisilnu promjenu (García-Peñalvo i sur., 2020).

Ovim se istraživanjem također formiralo niz praktičnih implikacija za obrazovne institucije. Obrazovne institucije s ustaljenim sustavom nastave na određenoj lokaciji trebaju iskoristiti prednosti e-učenja i znanja stečena tijekom ove pandemijom izazvane *online* nastave kao način osnaživanja nastave uživo, odnosno na lokaciji. Međutim, važno je prepoznati i ograničenja novih tehnologija u *online* nastavi i učenju, kao što su učestale pritužbe vezane uz preuzimanje, instalaciju i povezivanje te na kvalitetu. Ovo je vrijeme kada obrazovne institucije trebaju ulagati u poboljšanje svih aspekata *online* nastave kako bi korisnici (nastavnici i studenti) mogli biti zadovoljni tim medijima. Očito je da e-učenje smanjuje kontakt između korisnika, smanjujući interakciju između studenata i nastavnika. Ovim istraživanjem zaključuje se da je interakcija najvažniji prediktor zadovoljstva studenata *online* učenjem, stoga se planiranje i dizajn kolegija trebaju usredotočiti na interakciju između studenata i nastavnika. Temeljno je da se kroz nastavu razvije sinkroni način rada. U sinkronom učenju, studenti sudjeluju u „*live*" nastavi pri čemu mogu komunicirati s drugim studentima i nastavnikom te odmah primati povratne informacije. Obrazovne institucije moraju usmjeriti svoje napore prema humanizaciji ovakvoga procesa učenja.

Ograničenja

Podatci prikupljeni za ovo istraživanje dolaze iz jedne obrazovne institucije. Možda u drugim obrazovnim institucijama nema značajnih razlika, ali bilo bi korisno prikupiti podatke iz različitih institucija kako bi se mogle uočiti moguće varijacije. Te razlike mogu biti pod utjecajem faktora kao što su veličina sveučilišta, metode poučavanja koje nastavnici koriste ili ekonomski status studenta. Suočavajući se s ekonomskim poteškoćama i emocionalnim stresom, posebno su pogođeni studenti s niskim prihodima, studenti koji žive u udaljenim područjima i studenti s posebnim potrebama. Studenti koji su sudjelovali u ovom istraživanju koriste platformu Blackboard Learn, pa bi bilo zanimljivo usporediti rezultate s korisnicima drugih platformi kako bismo analizirali koja pruža veću učinkovitost učenja i zadovoljstvo studenata. Konačno, pandemija je izazvala opću konfuziju i napetost diljem svijeta, stoga bi bilo zanimljivo replicirati ovo istraživanje u drugim zemljama kako bismo procijenili utječu li na ishode različite razine straha i nemira povezane s pandemijom.

Napomena

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