



Drivers of technology adoption during the COVID-19 pandemic: The motivational role of psychological needs and emotions for pre-service teachers

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Abstract

The vital role of motivation becomes even more evident when considering the digital transformation of learning and teaching environments, especially with the effect of the pandemic. Basic psychological needs and emotions, which have not been comprehensively examined together despite their important roles in motivating, draw attention. Accordingly, this study aims to reveal the psychological, emotional, and individual variables that influence the pre-service teachers' intention to use technology, and to evaluate and validate the predictive power of a proposed model. The technology acceptance model formed the basis of the proposed model, and the model was extended with the self-determination theory (competence, autonomy, relatedness) and a framework of emotions (enjoyment, playfulness, anxiety, frustration). Data were collected online from 591 pre-service teachers studying in 10 different departments of a state university. In data analysis PLS-SEM, PLSpredict and multi-group analysis were performed. The results revealed that the model explains 79.8% of the intention and that the predictive power of the model is high. The relationship between competence and perceived ease of use represents the strongest relationship in the model, and the most influential construct on intention is enjoyment. These findings suggest that both intrinsic and extrinsic motivation play a major role in technology acceptance, especially during the pandemic. In addition, innovativeness, which is related to technology use and motivation, had various moderator effects on the relationships. Findings indicate that the model, which offers a motivational approach based on basic psychological needs and emotions, provides rare information and has high relevance for the field.

Keywords Pre-service teachers · Self-determination theory · Psychological needs · Emotions · Motivation

1 Introduction

Technology has been one of the factors that have deeply shaped the field of education for decades. To increase the quality of education, significant investments have been made in technology, and the use of technology in education has been supported by many institutions worldwide. Furthermore, with the COVID-19 pandemic, we have entered a new era when the use of technology in education has become mandatory for the whole world, and investments and support have reached their peak. The education of more than 1 billion university students in 185 countries worldwide was disrupted (International Association of Universities, 2020), and higher education institutions resorted to providing education through information technologies - ITs (Toquero, 2020; Trust & Whalen, 2020).

Although the success of teaching and learning processes has been increased owing to a large number of information technologies, it is obvious that the potential of technologies cannot be fully reached by only investing and providing resources. Instructors are the biggest factor for using this potential. Studies particularly emphasize the importance of using ITs successfully by instructors in order for them to be able to provide effective and efficient learning settings (El Alfy et al., 2017; Garone et al., 2019). It is stated that the success of IT use in education is closely associated with teacher education (Baydas & Goktas, 2016; Ursavaş et al., 2019; Valtonen et al., 2015), and pre-service teachers' ability to use ITs effectively in their future lessons plays a critical role (Baydaş, 2015; Wong et al., 2012). In addition, the fact that the use of technology in education has ceased to be a choice as a result of the introduction of compulsory online education due to the pandemic has caused radical changes in the motivational nature of the intention to use information technologies (Şahin et al., 2021, 2022). Accordingly, considering the effects of sudden transition to online education on students during the pandemic, it can be said that examining pre-service teachers' IT use has an even more vital role.

Studies reveal that many factors affect the adoption and use of technology by instructors (Şahin, 2016; Ursavaş et al., 2019) and these are generally examined within the scope of acceptance, attitudes, and beliefs (Marangunić & Granić, 2015; Scherer et al., 2020). In addition to these, it is of great importance to take into account the emotions that have significant effects on beliefs, attitudes, choices, and behaviors and to include emotional variables in studies (Beaudry & Pinsonneault, 2010). When previous studies are reviewed, it is noteworthy that the emotions examined generally remain limited (enjoyment, anxiety, etc.) and how emotions may affect the initial technology use has not been addressed adequately. Studies also emphasize the importance of psychological factors and individual differences in technology acceptance and the need to add emotional constructs to models comprehensively (Lu et al., 2019). Accordingly, it can be said that psychological factors (Ryan et al., 2019) and emotions (Beaudry & Pinsonneault, 2010) play a key role in better understanding technology acceptance, especially in the context of motivation. In line with this, a comprehensive analysis of potential variables (psychological and emotional) influencing pre-service teachers' intention to use ITs provide an effective method. From this point of view, it is predicted that the integration of a framework that categorizes emotions in detail within the scope of information technologies (Beaudry & Pinson-

neault, 2010) with self-determination theory, which effectively explains the motivational role of basic psychological needs in education (Deci & Ryan, 2000; Ryan & Deci, 2020), will provide valuable findings.

Technology acceptance can be expressed as the primary determinant of users' intention to use a technology and the driving force in their tendency to continue using it. Technology acceptance focuses on the technology adoption processes of users in a particular ecosystem. In this context, technology acceptance models are the most commonly used tools to examine potential variables (Sanchez-Prieto et al., 2017). The technology acceptance model (TAM) especially comes to the fore in the field of education among these models. The most prominent features of TAM are its simple structure that allows adding new constructs without making models complicated, its ability to explain the intention parsimoniously, and its reliable and effective framework (Davis, 1989; King & He, 2006; Venkatesh et al., 2003). Thus, TAM was preferred for the theoretical basis of the study, and it was extended by adding various constructs, including basic psychological needs, emotions, and individual differences.

In the context of model development, it is emphasized that a well-adapted model designed in an explanatory context may show a poor performance in terms of out-of-sample estimation (Shmueli, 2010), and therefore its practical usefulness may be limited (Shmueli et al., 2019). From this point of view, the predictive power of the model was evaluated and validated to reveal its practical relevance for the field. In this direction, the study aims to examine the psychological, emotional, and individual variables that influence the pre-service teachers' intention to use technology with an extended TAM, and to evaluate and validate the predictive power of the proposed model.

2 Theoretical background

2.1 Technology Acceptance Model

TAM, with its reliable and robust structure which has been demonstrated in various studies conducted with many different samples and in various settings (e.g. Lu et al., 2019; Şahin et al., 2021; Şahin et al., 2022), is among the leading models that have formed the basis of numerous studies in the field of education (Davis et al., 1989). TAM presents a reliable and robust structure (Davis et al., 1989). In the context of TAM, perceived ease of use (PEU), perceived usefulness (PU), and behavioural intention (BI) represent core constructs within the model. Actual use was not included in the model since the study aimed to examine pre-service teachers' IT use intentions for their future lessons, and attitude was not employed since direct effects were tested with BI. In the choice of not including the attitude, the findings that PU and PEU have a direct effect on the intention instead of being mediated by the attitude (Davis et al., 1989), and that not including the attitude serve to explain the intention more concisely were effective (Davis et al., 1989; Venkatesh et al., 2003). This choice is also supported by both popular acceptance models (e.g. TAM3, UTAUT) and a large number of TAM-based models that have been tested in the field of education (e.g.

Sánchez-Prieto et al., 2017; Şahin et al., 2021; Şahin et al., 2022; Tan et al., 2014). PEU is expressed as the degree of a pre-service teacher's belief in how much effort is required to use IT. PU is defined as the degree of a pre-service teacher's belief in the performance increase that can be obtained using IT. BI is explained as the behavioral intention of a pre-service teacher toward using IT (Davis et al., 1989).

In the field of education, many studies have achieved results suggesting that PEU, PU, and BI are related (e.g. Nikou & Economides 2017; Sanchez-Prieto et al., 2017; Teo et al., 2008; Teo, 2009; Ursavaş et al., 2019). Furthermore, it is stated in the literature that PEU and PU are the strongest determinants in terms of technology acceptance (Davis, 1989; Venkatesh & Davis, 2000). These widely accepted results suggest that core constructs of TAM are closely related. In the context of these relations, ease of use - usefulness, ease of use - intention and usefulness - intention relationships serve as the foundation of the model (Şahin, 2021). Accordingly, the following hypotheses were proposed.

H1. PEU has a positive effect on (a) PU and (b) BI.

H2. PU has a positive effect on BI.

2.2 Self-determination theory

The self-determination theory (SDT) assumes that humans are inherently inclined to psychological growth and hence to learn, master, and connect with others (Ryan & Deci, 2020). SDT is expressed as a human development theory with important implications for education, focusing on people's intrinsic motivational tendencies toward learning and development and how they can be supported (Ryan & Deci, 2020). According to SDT, people have inherent needs to be effective, autonomous, and socially related, which arise from their basic psychological needs in the form of competence, autonomy, and relatedness (Ryan & Deci, 2000b). To ensure an individual's healthy development, individuals should receive support for their basic psychological needs (Ryan et al., 2019). Competence (CMPT) is expressed as an individual's intention to interact effectively with his/her environment and a sense of expertise in order to feel the sense of competence while performing a task. Autonomy (AUT) is explained as an inner desire and a sense of initiative felt by an individual to experience a sense of choice and freedom in an activity. Finally, relatedness (RLTD) emphasizes an individual's sense of belonging and the need to connect with people in a social or professional setting (Deci & Ryan, 2000; Ryan & Deci, 2020). In the literature, positive relationships between basic psychological needs and TAM constructs have been reported in many studies. Examples of these findings are competence - usefulness and competence - ease of use (Fathali & Okada, 2018; Lu et al., 2019; Nikou & Economides, 2017), autonomy - intention, autonomy - usefulness and autonomy - ease of use (Fathali & Okada, 2018; Lu et al., 2019; Nikou & Economides, 2017; Racero et al., 2020), relatedness - intention, relatedness - usefulness and relatedness - ease of use (Fathali & Okada, 2018; Lu et al., 2019; Nikou & Economides, 2017; Racero et al., 2020). Considering the significant role of basic psychological needs in motivation and well-being, the potential to provide important

implications for the field of education (Ryan & Deci, 2020), and the importance of motivation for the intention to use ITs (Hashim et al., 2015; Baydaş & Yılmaz, 2018), it can be said that examining pre-service teachers' IT use in the context of motivation plays a critical role based on the rapid transformation from traditional to online education during the pandemic. Although there are various findings regarding the relationships between basic psychological needs and core TAM constructs, conflicting results have also been obtained in previous studies. From this point of view, in the formation of hypotheses, the most emphasized potential relationships in the literature were focused on (Şahin, 2021), and some of the relationships were not included in the research (e.g. CPMT-PU, RLTD-PEU) in order to keep the research model simple. In line with this, the following hypotheses were proposed.

- H3. CMPT has a positive effect on (a) PEU and (b) BI.*
- H4. AUT has a positive effect on (a) PU and (b) BI.*
- H5. RLTD has a positive effect on (a) PU and (b) BI.*

2.3 Emotions and Information Technologies

Usage and intention are generally addressed under two main headings. The first one is based on expectations from previous experiences, various beliefs, and rational calculations based on ease of use and usefulness (Bhattacharjee, 2001; Venkatesh et al., 2003). The second one is expressed as emotional variables for technology use (Agarwal & Karahanna, 2000; Kim et al., 2007). It has been emphasized that previous studies have generally focused on the first one and the role of emotions has often been ignored or superficially explored (Beaudry & Pinsonneault, 2010; Zhang & Li, 2005). In line with this, adding emotional variables to technology acceptance approaches draws attention as an important need (Beaudry & Pinsonneault, 2010). There are studies stating that users' emotions affect intentions, behaviors, and beliefs (Beaudry & Pinsonneault, 2010; Kim & Lennon, 2013), and the role of emotional variables are critical (Şahin et al., 2021). Moreover, studies that investigate the role of emotions mostly focus on perceived enjoyment and anxiety. However, the fact that perceived enjoyment and anxiety alone reveal only one aspect of positive and negative emotions indicates that they provide a relatively narrow and inadequate framework (Ding & Chai, 2015). Accordingly, a multi-dimensional approach was adopted in terms of emotions.

The research model includes a framework that has been developed to classify both positive and negative emotions towards ITs. This framework consists of four categories: achievement, challenge, loss, and deterrence (Beaudry & Pinsonneault, 2010). According to this classification, it is stated that feelings of achievement and challenge occur when users perceive IT as an opportunity that can create positive outputs. On the other hand, it is stated that ITs perceived as a threat can activate feelings of loss and deterrence (Beaudry & Pinsonneault, 2010). Accordingly, playfulness and enjoyment in the challenge and achievement categories, and anxiety and frustration in the deterrence and loss categories were included in the model.

2.4 Classification of emotions

2.4.1 Playfulness and enjoyment

Playfulness (PLY), which is addressed in connection with the flow, is expressed as a complex construct that includes the pleasure, psychological drive, and interests of an individual (Csikszentmihalyi & Csikszentmihalyi, 1990) and focuses on interactions regarded as intrinsically interesting (Moon & Kim, 2001). Studies regarding PLY have generally identified significant relationships with the core constructs of TAM (Huang et al., 2012; Lin & Yeh, 2019; Padilla-Meléndez et al., 2013; Venkatesh & Bala, 2008). Perceived enjoyment (ENJ) is described as the degree to which the user perceives a technology as enjoyable independently of any external reward (Park et al., 2012; Ryan & Deci, 2000a). Similar to PLY, relationships of ENJ with TAM have been determined in many studies (Sánchez-Prieto et al., 2019; Şahin et al., 2021; Teo et al., 2019; Ursavaş, 2014). In addition, studies point to the effects of ENJ-PLY on PU and BI (Şahin, 2021) and it is suggested that ENJ may have a stabilizing effect on the perception of potential performance increase that can be obtained with the use of IT in education (Şahin et al., 2021). Accordingly, the hypotheses presented below were proposed.

H6. PLY has a positive effect on (a) PU and (b) BI.

H7. ENJ has a positive effect on (a) PU and (b) BI.

2.4.2 Anxiety and frustration

Anxiety (ANX), is described as emotional reaction such as concerns that emerge when an individual fulfills a duty (Venkatesh & Bala, 2008). ANX, which is emphasized to affect the use intention by weakening especially the perceived ease of use (Gelbrich & Sattler, 2014), may cause reluctance to use IT (e-learning etc.) (Al-alak & Alnawas, 2011). Additionally, it is stated that emotions such as anxiety are among the factors that should be emphasized during the pandemic where the use of IT has become obligatory (Şahin et al., 2021). Frustration (FRST), is described as a user's emotional reaction which is the result of an event that occurs when there is a situation that prevents or stops a goal from being realized (Lazar et al., 2006) and is related to a failure regarding digital technologies (Hadlington & Scase, 2018). While the fact that successful events are compatible with the user's purpose enables the user to perceive these events as pleasant, the presence of obstacles in human-technology interaction leads to the emergence of feelings such as frustration because it contradicts the user's purpose (Jokinen, 2015). In the literature, it is stated that successfully completed tasks cause users to perceive their skills positively, while obstacles encountered or tasks that cannot be completed cause a sense of techno-frustration in users (Saariluoma & Jokinen, 2014). Therefore, it can be interpreted that the emotional user experiences of pre-service teachers with ITs influence their skills and perceived ease of use, and can play a significant role in terms of intention to use. In the use of ITs in education, special emphasis on the effects of negative emotions such as anxiety on the tendency

to use, the perception of ease of use and the expectation of the effort required for an effective use also supports this inference (Baydaş, 2015; Şahin, 2016; Şahin, 2021; Ursavaş, 2014). Thus, the following hypotheses were proposed.

H8. ANX has a negative effect on (a) PEU and (b) BI.

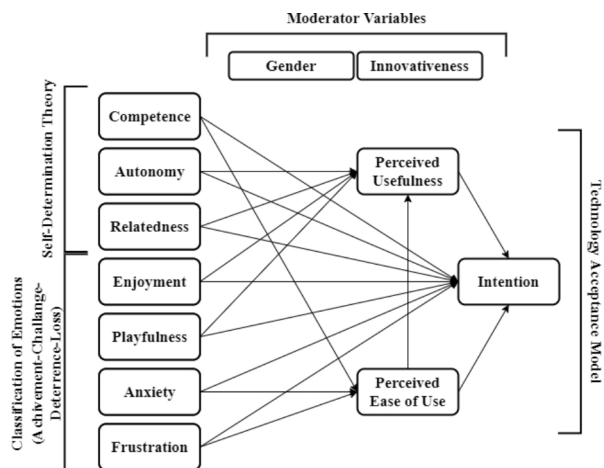
H9. FRST has a negative effect on (a) PEU and (b) BI.

2.5 Individual differences

2.5.1 Innovativeness

Innovativeness is expressed as the degree to which a user adopts an innovation faster than other individuals within a social system (Rogers & Shoemaker, 1971). In the literature, it is emphasized that a high level of innovativeness enables more positive approaches toward technologies (Ali, 2019) and that pre-service teachers with high levels of innovativeness also have high technology acceptance (Şahin, 2016). Accordingly, it can be said that innovativeness plays a role in pre-service teachers' use of technology. Considering the importance of innovativeness in education (Kılıçer & Odabaşı, 2010), and the critical role of the moderator effects of individual differences in terms of technology use by instructors (Şahin et al., 2021), it is of critical importance to examine the potential effects of the innovativeness. Additionally, the absence of up-to-date studies in education that employs innovativeness as a moderator points to a gap in the field. Thus, the innovativeness was included in the study as a moderator.

Fig. 1 Research Model



2.5.2 Gender

Studies state that the effects of moderators in technology acceptance have not been investigated adequately (Lu et al., 2019). Gender is a critical moderator that can provide valuable information, and it is important to address this variable more comprehensively (Şahin et al., 2021). Moreover, when the literature is reviewed, it is observed that gender plays an important role in terms of usage behavior toward ITs, and it's a crucial moderator in terms of acceptance, adoption, and intention (King & He, 2006; Venkatesh et al., 2003; Tarhini et al., 2014). Accordingly, gender was added to the study as moderator to shed light on the potential effects. Research model is presented in Fig. 1.

3 Method

3.1 Participant Group

Before reaching the participant group, necessary permissions were obtained from the ethics committee of the university. At the data collection stage, it was stated that participation was completely voluntary. In this context, the data collection tool was delivered to pre-service teachers studying in 10 different departments in the 2020–2021 spring semester, and 591 pre-service teachers participated in the study. The data of 58 participants containing outliers and repetitive responses were excluded from the study. The profile of pre-service teachers is summarized in Table 1.

Table 1 Profile of the participants

Pre-service Teachers		<i>f</i>	%
Department	Computer Education & Instructional Technologies	30	5.6
	Guidance and Psychological Counseling	39	7.3
	Arts and Crafts Education	25	4.7
	Primary School Mathematics Teaching	69	12.9
	Special Education Teaching	75	14.1
	Pre-school Education	45	8.4
	Primary School Education	56	10.5
	Social Studies Education	58	10.9
	French Language Teaching	35	6.6
	English Language Teaching	101	18.9
Course Year	3rd Year	243	45.6
	4th Year	290	54.4
Gender	Female	353	66.2
	Male	180	33.8

3.2 Data Collection

The data collection tool consists of two sections, including the demographic form and scale items. The first section consists of questions about personal information, and the second section comprises a 5-point likert type scale (1=*strongly disagree*; 5=*strongly agree*) consisting of 41 items. For the innovativeness, a construct consisting of 5 items was employed in the context of personal innovativeness in information technologies (Agarwal & Prasad, 1998) in order to determine how curious and willing pre-service teachers were to try new information technologies.

Two separate scales were developed to form the measurement tool of the study. While one of the scales contains the potential factors affecting the adoption of information technologies in education, the other scale focuses on the influence of emotions (enjoyment, playfulness, anxiety, and frustration) in the use of information technologies in education. The scale was developed by conducting an in-depth review of the literature and by examining the measurement tools and items created for the relevant variables in the field education. The factors of the scale were determined based on the technology acceptance model, self-determination theory and classifications of emotions framework (Beaudry & Pinsonneault, 2010; Davis, 1989; Davis et al., 1989; Ryan & Deci, 2000a; Ryan & Deci, 2000b).

Accordingly, the items of perceived ease of use (e.g. "I can use ITs effortlessly in educational activities"), perceived usefulness (e.g. "Using ITs in education increases my professional performance") and intention (e.g. "I plan to use ITs in my future lessons"), competence (e.g. "I have the ability to use ITs effectively for educational purposes"), autonomy (e.g. "I would like to choose the ITs I will use in educational activities myself") and relatedness (e.g. "Using ITs in my classes provides me with opportunities to gain professional recognition"), enjoyment (e.g. "Education with ITs is more fun"), playfulness (e.g. "Time seems to pass very quickly when ITs are involved in teaching activities"), anxiety (e.g. "The possibility of making mistakes while teaching with ITs worries me") and frustration (e.g. "I get angry when I think about my performance in using ITs for educational purposes") were created based on previous relevant studies and tools containing the same constructs developed on similar theoretical backgrounds (e.g. Baydaş 2015; Lu et al., 2019; Racero et al., 2020; Ryan & Deci, 2000; Ryan & Deci, 2020; Şahin, 2016; Şahin et al., 2021; Şahin & Şahin, 2021; Ursavaş, 2014; Ursavaş et al., 2019). Both exploratory and confirmatory factor analyzes were conducted during the scale development to determine and validate the factor structure of the tool. Fit indices of both IT adoption scale ($\chi^2/df=2.067$, SRMR=0.07, RMSEA=0.077, TLI=0.948, CFI=0.949), and IT emotion scale ($\chi^2/df=2.613$, SRMR=0.06, RMSEA=0.076, TLI=0.942, CFI=0.957) were good. The number of items and reliability coefficients of the factors in the final form of the scale were; PEU (4 items) $\alpha=0.878$, PU (5 items) $\alpha=0.868$, BI (3 items) $\alpha=0.908$, COMP (3 items) $\alpha=0.825$, AUT (3 items) $\alpha=0.661$, RLTD (5 items) $\alpha=0.807$, PI (5 items) $\alpha=0.760$, ENJ (3 items) $\alpha=0.860$, PLY (4 items) $\alpha=0.837$, ANX (3 items) $\alpha=0.858$, FRST (4 items) $\alpha=0.891$.

3.3 Data Analysis

SPSS 23 software was used for descriptive data, and SmartPLS 3.3.3 software was used for factor analysis, structural equation modeling, predictive power validation, measurement invariance, and multi-group analyses. The reason why SmartPLS was preferred instead of softwares performing factor analysis, such as Lisrel and

Table 2 Convergent validity

Constructs	Items	Loadings	α	CR	AVE
B. Intention	BI1	0.926	0.916	0.947	0.856
	BI2	0.905			
	BI3	0.944			
Perceived Usefulness	PU1	0.888	0.929	0.946	0.779
	PU2	0.914			
	PU3	0.887			
	PU4	0.829			
	PU5	0.893			
Perceived Ease of Use	PEU1	0.930	0.936	0.954	0.838
	PEU2	0.911			
	PEU3	0.930			
	PEU4	0.890			
Competence	CMPT1	0.926	0.887	0.930	0.815
	CMPT2	0.876			
	CMPT3	0.906			
Autonomy	AUT1	0.852	0.825	0.895	0.740
	AUT2	0.877			
	AUT3	0.852			
Relatedness	RLTD1	0.803	0.857	0.897	0.636
	RLTD2	0.788			
	RLTD3	0.783			
	RLTD4	0.802			
	RLTD5	0.812			
Enjoyment	ENJ1	0.938	0.924	0.952	0.869
	ENJ2	0.946			
	ENJ3	0.911			
Playfulness	PLY1	0.903	0.917	0.941	0.800
	PLY2	0.922			
	PLY3	0.874			
	PLY4	0.879			
Anxiety	ANX1	0.925	0.904	0.940	0.839
	ANX2	0.905			
	ANX3	0.918			
Frustration	FRST1	0.884	0.922	0.945	0.811
	FRST2	0.929			
	FRST3	0.911			
	FRST4	0.878			

α =Cronbach's
CR=Composite
AVE=Average
extracted

alpha,
reliability,
variance

AMOS, was the partial least squares structural equation modeling (PLS-SEM) technique coming to the fore with its applicability to explanatory models and its ability to work effectively for models with complex structures (Hair et al., 2011, 2017). At first, the reliability and validity analyses were performed using SmartPLS, and convergent and discriminant validity were examined. At the following stage, structural equation modeling was performed, and the hypotheses were tested. After structural equation modeling, the predictive power was examined and validated with PLSpredict. PLSpredict allows to determine the consistency and predictive power of out-of-sample estimates of the model. At the final stage, the measurement invariance of the model was first checked, and multi-group analyses were conducted.

4 Results

4.1 Measurement model

For convergent validity, reliability at the item level, cronbach's alpha (α), composite reliability (CR), and average variance extracted (AVE) were examined. The results revealed that the item loadings varied between 0.783 and 0.946. Accordingly, reliability at the item level was established (Hair et al., 2010). Cronbach's alpha (α) and composite reliability (CR) examined within the scope of convergent validity were above 0.70. Moreover, it was determined that all of AVE values were greater than 0.5 (Hair et al., 2017). In line with this, convergent validity was established (Table 2).

The Fornell-Larcker and HTMT were used for discriminant validity. According to the results, it was observed that the square roots of AVE for all constructs were higher than the correlations with other constructs and the Fornell-Larcker criterion was met. In the context of the HTMT ratio, it was revealed that most of the values were below 0.90 (Fornell & Larcker, 1981; Hair et al., 2017). However, the good results for the Fornell-Larcker criterion of the constructs with values over 0.90 within the scope of HTMT indicate that there is no significant problem regarding discriminant validity. Accordingly, discriminant validity was established (Tables 3 and 4). Finally, the variance inflation factor (VIF) values were investigated, and VIF values between the

Table 3 Discriminant validity (Fornell-Larcker)

Constructs	ANX	CMPT	ENJ	FRST	BI	AUT	PEU	PLY	PU	RLTD
ANX	0.916									
CMPT	-0.768	0.903								
ENJ	-0.691	0.725	0.932							
FRST	0.858	-0.766	-0.716	0.901						
BI	-0.694	0.732	0.839	-0.746	0.925					
AUT	-0.594	0.671	0.708	-0.644	0.746	0.860				
PEU	-0.777	0.899	0.729	-0.782	0.758	0.649	0.916			
PLY	-0.703	0.744	0.851	-0.720	0.773	0.690	0.720	0.895		
PU	-0.663	0.720	0.839	-0.711	0.824	0.710	0.734	0.813	0.883	
RLTD	-0.478	0.583	0.687	-0.537	0.663	0.613	0.566	0.728	0.738	0.798

constructs were observed in the range of 2.276–6.207. Accordingly, it was concluded that there was no significant problem in the context of linearity ($VIF < 10$). Moreover, standardized root mean square residual (SRMR) revealed that the model fit was good.

4.2 Structural model

According to structural equation modeling, the model explains 78.7% of PU, 83.2% of PEU, and 79.8% of BI (Fig. 2). Furthermore, 13 of the proposed 17 hypotheses were supported (Table 5). Among BI-related hypotheses, those with competence, relatedness, playfulness, and anxiety were not significant, while those established with usefulness, ease of use, autonomy, enjoyment, and frustration were significant. In terms of usefulness, all hypotheses were supported, and the relationships between ease of use, autonomy, relatedness, enjoyment, and playfulness were found significant. In addition to these, all of the hypotheses proposed in ease of use context were supported, and competence, anxiety, and frustration relationships were significant. In addition, Competence->Perceived Ease of Use was the strongest relationship in the model.

The 10-fold prediction cross-validation process was carried out with 10 repetitions in order to evaluate the predictive power. In interpreting the predictive power, firstly, the target variable (BI) was determined. Afterwards, it was checked whether the prediction error distributions were symmetrical or not in order to determine the prediction statistics (root mean squared error - RMSE, or mean absolute error - MAE)

Table 4 Discriminant validity (HTMT)

Constructs	ANX	CMPT	ENJ	FRST	BI	AUT	PEU	PLY	PU	RLTD
ANX										
CMPT	0.857									
ENJ	0.755	0.795								
FRST	0.909	0.844	0.775							
BI	0.763	0.807	0.810	0.812						
AUT	0.683	0.777	0.809	0.736	0.855					
PEU	0.844	0.923	0.783	0.841	0.817	0.734				
PLY	0.770	0.820	0.917	0.779	0.836	0.783	0.774			
PU	0.723	0.789	0.906	0.767	0.892	0.807	0.786	0.874		
RLTD	0.541	0.665	0.767	0.600	0.742	0.721	0.628	0.816	0.823	

Fig. 2 Partial Least Squares Structural Equation Modeling

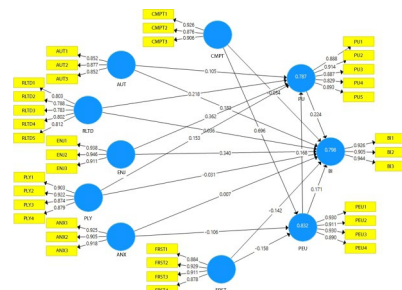


Table 5 Hypothesis testing

Path	Coefficient	t-Value	p-Value	VIF	Results
PU -> BI	0.225	4.876***	.000	4.754	Supported
PEU -> BI	0.174	3.311***	.001	6.207	Supported
PEU -> PU	0.169	5.036***	.000	2.433	Supported
CMPT -> BI	-0.055	1.077 ^(ns)	.000	6.095	Not Supported
CMPT -> PEU	0.696	18.843***	.000	2.727	Supported
AUT -> BI	0.183	5.417***	.000	2.446	Supported
AUT -> PU	0.105	2.986**	.003	2.306	Supported
RLTD -> BI	0.036	1.066 ^(ns)	.287	2.579	Not Supported
RLTD -> PU	0.219	5.362***	.000	2.276	Supported
ENJ -> BI	0.340	6.020***	.000	5.021	Supported
ENJ -> PU	0.362	6.538***	.000	4.364	Supported
PLY -> BI	-0.032	0.632 ^(ns)	.528	5.004	Not Supported
PLY -> PU	0.152	3.270**	.001	4.538	Supported
ANX -> BI	0.007	0.152 ^(ns)	.879	4.525	Not Supported
ANX -> PEU	-0.106	2.521**	.012	4.274	Supported
FRST -> BI	-0.142	2.891**	.004	4.728	Supported
FRST -> PEU	-0.158	3.846***	.000	4.229	Supported

p: ns ≥ 0.05; * < 0.05; ** < 0.01, *** < 0.001

to be taken as basis for evaluating the degree of prediction error. The results showed that the prediction error distributions is symmetrical. Hence, the examination of the prediction error was carried out on the basis of the RMSE (Shmueli et al., 2016; Shmueli et al., 2019).

The results showed that all of Q^2 values were positive. This result indicates that the model does not show any inadequacy in terms of predictive power. In the next

Table 6 PLS-SEM prediction errors

Item	RMSE	MAE	MAPE	Q^2_{predict}
BI1	0.452	0.358	9.503	0.678
BI2	0.522	0.384	11.365	0.582
BI3	0.491	0.378	11.286	0.717

step, RMSE values of PLS-SEM and linear regression model (LM) were compared in order to examine the degree of predictive power in detail. According to the results, it was determined that RMSE prediction errors of all indicators of BI for PLS-SEM are lower than LM. These findings indicate that the model has high predictive power (Shmueli, 2010; Shmueli et al., 2019). The results regarding the evaluation of the predictive power are summarized in Tables 6 and 7.

4.2.1 Moderators

Multi-group analysis employed is a non-parametric test of significance used to determine differences between groups, based on the results of bootstrapping (Henseler et al., 2009). According to the analysis, ENJ->PU and ANX->BI relationships differ significantly between gender groups. This relationship is stronger for female pre-service teachers. With regard to PI, the results showed that AUT->PU, ENJ->BI, and PLY->BI relationships were stronger for pre-service teachers with high innovativeness. The results are summarized in Table 8.

Table 7 LM prediction errors

Item	RMSE	MAE	MAPE	Q ² _{predict}
BI1	0.457	0.348	9.162	0.685
BI2	0.537	0.397	11.723	0.559
BI3	0.494	0.382	11.191	0.714

Table 8 Gender and innovativeness - Multi-group analysis

Path	Female vs. Male		H. PI vs. L. PI	
	t-Value	p-Value	t-Value	p-Value
PU -> BI	0.495 ^(ns)	.621	0.111 ^(ns)	.912
PEU -> BI	0.172 ^(ns)	.863	0.174 ^(ns)	.862
PEU -> PU	0.740 ^(ns)	.460	1.069 ^(ns)	.286
CMPT -> BI	1.229 ^(ns)	.220	1.197 ^(ns)	.232
CMPT -> PEU	1.454 ^(ns)	.147	0.447 ^(ns)	.655
AUT -> BI	0.843 ^(ns)	.399	0.915 ^(ns)	.361
AUT -> PU	0.866 ^(ns)	.387	2.926 ^{**}	.004
RLTD -> BI	0.086 ^(ns)	.932	1.364 ^(ns)	.173
RLTD -> PU	0.064 ^(ns)	.949	0.844 ^(ns)	.399
ENJ -> BI	0.113 ^(ns)	.910	2.347 [*]	.019
ENJ -> PU	2.432 [*]	.015	1.386 ^(ns)	.167
PLY -> BI	0.071 ^(ns)	.944	2.723 ^{**}	.007
PLY -> PU	1.605 ^(ns)	.109	0.350 ^(ns)	.727
ANX -> BI	2.296 [*]	.022	0.019 ^(ns)	.985
ANX -> PEU	1.064 ^(ns)	.288	0.356 ^(ns)	.722
FRST -> BI	1.596 ^(ns)	.111	0.424 ^(ns)	.672
FRST -> PEU	0.195 ^(ns)	.845	1.571 ^(ns)	.117

p: ns ≥ .05; * < .05; ** < .01

5 Discussion

This study examined the factors influencing the intention to use technology of pre-service teachers from 10 different departments. Based on a motivational approach, basic psychological needs (self-determination theory) and four emotions (classification of emotions) were included in the technology acceptance model and a model proposal was presented.

Thirteen of the 17 hypotheses were supported. Furthermore, it was determined that the model explained the output variables with a high percentage (PU=78.7%, PEU=83.2% & BI=79.8%). These results suggest that the robust, flexible, and effective structure of TAM are also supported in this study (Şahin et al., 2021). The predictive power was also evaluated. All indicators related to the target variable showed results indicating high predictive power (Shmueli, 2010; Shmueli et al., 2019). From this point of view, the predictive power of the model was also validated. The results showed that the proposed model would provide accurate and consistent results for the out-of-sample predictions, and revealed that the theoretical basis provided for the field of education is also of high practical relevance. In this context, it can be deduced that the model has a high potential to be a roadmap and guide for studies in education. In parallel, it can be stated that model development studies have a critical role in not ignoring the evaluations regarding the predictive power.

The results regarding intention showed that the relationships with usefulness, ease of use, autonomy, enjoyment, and frustration were significant. In line with this, all of the relationships between the core TAM constructs are significant. According to the literature, substantially similar results were achieved in the field of education (e.g. Baydaş & Göktaş, 2017; Bin et al., 2020; Fathali & Okada, 2018; Joo et al., 2018; Parkman et al., 2018; Ursavaş, 2014). Findings on PU and PEU, which are expressed as the most significant determinants in terms of the acceptance and use of technology (Venkatesh & Davis, 2000) and emphasized to play important roles in the context of motivation for technology use (Şahin et al., 2021), indicate the support of previous studies. However, when studies are addressed from the point of the pandemic, there are studies reporting different results in terms of influence of PU and PEU on intention for university students and instructors (Şahin & Şahin, 2021; Şahin et al., 2021).

In the field of education, it is stated that the influence of ease of use and usefulness on intention may vary depending on whether the technology use is a choice or not. It is emphasized that the use of technology in education, becoming mandatory rather than a choice, as experienced during the pandemic, may weaken the effect of motivational variables. However, different results were obtained in this study, which was carried out with students receiving education in three semesters within the scope of mandatory online education. A possible explanation for these differences can be made in terms of e-learning system and the institutional resources provided. Contradictory results indicate that potential factors are shaped by the ease of use of e-learning systems and distance education platforms providing online education, their compatibility for courses, and the ability to meet students' expectations. Furthermore, it suggests that facilitating conditions such as training, technical support, and access provided by the university play an essential role. In this context, it can be stated that the quality of the e-learning platform, the facilitating conditions and

the success of the institutional resources owned can function in a way that balances the motivation of pre-service teachers where the technology use is mandatory. These findings provide valuable information that can improve teacher education during the pandemic to meet expectations.

The significant Autonomy->B.Intention relationship indicates that the fact that pre-service teachers can choose the technologies they will use, their ability to make choices, and to use initiatives will help them to perceive their teaching activities as more meaningful tasks and that their tendency to use technology will strengthen. However, the relative neglect of Autonomy->B.Intention relationship in similar studies (Fathali & Okada, 2018; Lee et al., 2015; Nikou & Economides, 2017; Racero et al., 2020) draws attention as an important gap. Nevertheless, the emphasis on the vital role of AUT support in terms of quality and success of educational settings (Ryan & Deci, 2020) suggests that the result is supported and reveals a need for more frequent investigation of this relationship.

The results in terms of Enjoyment->B.Intention suggest that pre-service teachers will be more enthusiastic about the intention to use, as the use of technology in education is perceived as enjoyable. On the other hand, the Frustration->B.Intention relationship indicates that when pre-service teachers experience a situation that prevents or stops the achievement of their goals for educational purposes or a failure regarding digital technologies in their teaching processes, their intention to use information technologies will weaken. Although there are many studies presenting similar findings regarding Enjoyment->B.Intention relationship (e.g. Chang et al., 2017; Lee et al., 2015; Ursavaş, 2014), no study presenting any up-to-date empirical finding for FRST->BI relationship has been found. It is noteworthy that the constructs for negative emotions employed only consist of anxiety. In line with this, the current situation indicates that studies present a relatively narrow and insufficient framework for the effect of emotions (Ding & Chai, 2015). Considering the close relationship of the effective use of information technologies with experience and competence in teaching activities for instructors, it is obvious that the acquisition of the necessary knowledge and skills that can successfully integrate education with technology is a challenging process. The fact that this challenging process is mostly intertwined with trial and error, making errors and correcting them suggests that frustration, which is formed by failures and a feeling of frustration toward the use of technology, may play a crucial role.

All of the relationships of usefulness with ease of use, autonomy, relatedness, enjoyment, and playfulness were significant. Perceived Ease of Use->Perceived Usefulness relationship showed a result largely overlapping with the literature (e.g. Baydaş 2015; Fathali & Okada, 2018; Teo et al., 2019; Ursavaş et al., 2019). The results obtained in this direction suggest that pre-service teachers' perceptions of effort to be required in the use of technology for educational purposes affect their perceptions of the performance they will achieve. This finding indicates that it is important in terms of motivation to see the benefit to be gained by using technology at a scale that can justify the level of effort required.

All hypotheses of the self-determination theory constructs regarding usefulness were supported. The results in terms of autonomy suggest that if pre-service teachers have the freedom of choice regarding the technology to be used, their percep-

tion of the increase in performance to be obtained from technology will be more positive. Findings coinciding with the literature (Fathali & Okada, 2018; Nikou & Economides, 2017; Racero et al., 2020) demonstrate that pre-service teachers' ability to take the initiative toward technology use (Ryan & Deci, 2020) and their perceptions that they have a certain control for this process (Fathali & Okada, 2018) also positively affect their perceptions of the benefit they will gain. The results regarding relatedness suggest that pre-service teachers' being in an environment that will support their sense of belonging and connection will reflect positively on their perceptions of the performance increase they can achieve using technology. Accordingly, Relatedness->Perceived Usefulness relationship suggests that instructors who have professional settings where respect and care are intense (Ryan & Deci, 2020) will be more motivated in terms of technology use, and their opinions that they can benefit from technology better will be more dominant. In addition, the significant Relatedness->Perceived Usefulness relationship supports previous studies conducted in education (Fathali & Okada, 2018; Lee et al., 2015; Nikou & Economides, 2017; Racero et al., 2020).

Enjoyment->Perceived Usefulness and Playfulness->Perceived Usefulness hypotheses were supported. Accordingly, the findings indicate that it is important for pre-service teachers to perceive technology as fun. In addition, these findings suggest that technology will be perceived as more useful if technology attracts the attention of pre-service teachers, stimulates use and provides flow experience. Previous studies have reported similar results on Enjoyment->Perceived Usefulness and Playfulness->Perceived Usefulness relationship (Chang et al., 2017; Padilla-Meléndez et al., 2013; Sánchez-Prieto et al., 2019; Şahin et al., 2021; Teo & Noyes, 2011; Ursavaş, 2014). In line with this, considering the critical role of enjoyment and playfulness in providing intrinsic motivation (Deci & Ryan, 2000), it can be stated that the findings indicating that the perception that technology is beneficial will become stronger if the pre-service teachers perceive the use of technology as a fun activity that provide flow experience.

All the hypotheses proposed in the context of PEU were supported. Moreover, the Competence->Perceived Ease of Use relationship represents the strongest relationship. The study results both overlap with the literature (Fathali & Okada, 2018; Nikou & Economides, 2017) and contradict it (Racero et al., 2020). Furthermore, the results show that the perceived ease of use which is expressed as one of the most dominant factors (Venkatesh & Davis, 2000), is affected at the highest level by pre-service teachers' perceptions of their competence in using technology. In other words, the findings suggest that pre-service teachers' self-confidence, and belief in their skills and knowledge in using technology is the most determining factor in their perception of the level of effort required to use technology effectively. Accordingly, it can be said that the fact that pre-service teachers see themselves as competent in the use of technology helps them to perceive the effort required for effective use of technology to be much lower.

The significant relationship of anxiety and frustration with ease of use indicates that anxiety and frustration about technology use adversely affect pre-service teachers' perceptions of the ease of use. The negative impact of anxiety on technology use is intensively emphasized (e.g. Şahin et al., 2021; Ursavaş, 2014). Considering frus-

tration that emerges in relation to a failure regarding digital technologies (Hadlington & Scase, 2018) when there is a situation that prevents or stops the realization of a goal (Lazar et al., 2006), it can be interpreted that the negative relationships of anxiety and frustration with ease of use present expected results. These results for anxiety and frustration, which are connected in terms of emotion classification, demonstrate that pre-service teachers' anxiety about the technology and the feeling of frustration that emerges together with the feeling of loss of control over the use of technology cause pre-service teachers to perceive the technologies as more difficult.

5.1 Moderator variables

The results showed that Enjoyment->Perceived Usefulness and Anxiety->B.Intention relationships differed with regard to gender, while Enjoyment->B.Intention, Playfulness->B.Intention, Autonomy->Perceived Usefulness differed in terms of innovativeness. Enjoyment->Perceived Usefulness and Anxiety->B.Intention relationships were stronger for female pre-service teachers, and Autonomy->Perceived Usefulness, Enjoyment->B.Intention, and Playfulness->B.Intention were stronger for pre-service teachers with high innovativeness.

Enjoyment->Perceived Usefulness result indicates that the perception of the benefit that can be obtained from the use of technology, which is perceived as fun, is stronger for the female group. On the other hand, Anxiety->B.Intention result suggests that the influence of anxiety on intention is stronger for female pre-service teachers. The findings indicating that enjoyment is regarded more important for female instructors (Şahin et al., 2021) are in line with the results on female pre-service teachers' perceptions of enjoyment and potential performance increase. In terms of anxiety, the fact that the factors of competence and ease of use are more determinant for female users (Tarhini et al., 2014; Venkatesh et al., 2003) indicates that female pre-service teachers may be more prone to anxiety and suggests that the result that the anxiety-intention relationship is stronger for females is supported.

The results showed that Autonomy->Perceived Usefulness, Enjoyment->B.Intention, and Playfulness->B.Intention were stronger for pre-service teachers with high innovativeness. Autonomy->Perceived Usefulness result suggests that if innovative pre-service teachers have the sense of control and have the freedom to take initiative, their perception of the usefulness will be more positive and strong. The facts that innovativeness manifests itself as curiosity toward ITs and willingness to use them (Agarwal & Prasad, 1998), pre-service teachers with a high level of innovativeness are pioneers in technology adoption (Şahin, 2016), and their innovativeness create motivation in users in direct relation to the tendencies to experience ITs indicate the critical role of autonomy. It can be stated that with the support of pre-service teachers in terms of autonomy, freedom of choice regarding the technologies and a sense of control over the technology (Fathali & Okada, 2018; Ryan & Deci, 2020) will help them create stronger perceptions of their performance increase and productivity they will gain with technology. Accordingly, Autonomy->Perceived Usefulness relationship should be considered for education processes both during and after the pandemic.

Enjoyment->B.Intention and Playfulness->B.Intention relationships are stronger for pre-service teachers with high innovativeness. These results indicate that the influence of emotional constructs such as enjoyment, interest, and flow experience on intention toward technology use are stronger for innovative pre-service teachers. Considering the curiosity towards information technologies, willingness to experiment, being a pioneer and innovativeness that serve as a source of motivation (Agarwal & Prasad, 1998; İçer & Odabaşı, 2010; Şahin 2016), and the emotions that can create motivation by providing flow experience in the use of technology such as enjoyment and playfulness, it can be stated that the results obtained regarding intention are supported.

6 Conclusion and implications

In this study, data were collected from 591 pre-service teachers from 10 different programs, receiving online education for three semesters, and influencing variables on pre-service teachers' intention to use information technologies were examined from a motivational perspective. A model proposal based on the technology acceptance model, self-determination theory, and a framework for the classification of emotions was tested. The results demonstrated that the model explains 79.8% of the behavioural intention to use technology. The validation process of predictive power (Shmueli, 2010; Shmueli et al., 2019) showed that the model would provide accurate and consistent results for the out-of-sample predictions, and revealed that the theoretical basis provided for the field of education is also of high practical relevance. Thus, it can be stated that the model contributes to the field both theoretically and practically.

Thirteen of the 17 hypotheses proposed were supported. Addressing emotions' effect on the use of technology in education from a motivational perspective, including the emotions whose roles are emphasized in the literature (Beaudry & Pinsonneault, 2010; Şahin et al., 2021) but which have not been studied comprehensively, is among the valuable contributions of the study. Another important contribution of the study to the emerging body of literature is that it provides detailed and up-to-date information on the moderator roles of individual differences, especially innovativeness, which have not been studied as a moderator in education. In line with this, investigating the role of emotions and the variables related to the satisfaction of needs in the context of motivational factors theoretically and addressing them more in studies should be taken into consideration to strengthen the theoretical background of the field. Furthermore, focusing on emotions and variables related to the satisfaction of needs in terms of pre-service teachers, teachers, and instructors should be regarded important for acquisitions that are targeted to be obtained from the technology in education.

Among the relationships in the model, Competence->Perceived Ease of Use represents the strongest one. This finding, reflecting pre-service teachers' beliefs in their knowledge and skills in using technology, and their self-confidence in performing tasks in teaching activities, indicates the key role of pre-service teachers' regarding themselves as experts (Ryan & Deci, 2020) in perceiving the effective use of technology as an easy job. Based on this, it can be inferred that training pre-service teachers

as competent instructors with a sense of achievement and development plays a vital role for them to become instructors who can fully utilize the potential of technology and train productive students with the necessary skills, especially in mandatory online education during the pandemic. Future studies focusing on competence in more detail and improving the quality of pre-service education and in-service training opportunities in practice can make significant contributions to the field of education, both theoretically and practically.

All of the hypotheses regarding autonomy and frustration were significant. The results regarding the autonomy revealed that pre-service teachers' perceptions of the performance increase they can gain from technology and their intention to use technology can be strengthened with the support of freedom of choice and control. On the other hand, it was observed that frustration (Hadlington & Scase, 2018), which manifests itself with a failure regarding digital technologies in connection with a factor that prevents or stops the realization of a goal or task to be achieved by the use of technology (Lazar et al., 2006), adversely affects the perception of the ease of use, affects the perception of use as more difficult than it is and weakens the intention to use technology. Accordingly, the role of autonomy, which is expressed to be critical for the quality and success of educational settings (Ryan & Deci, 2020), in allowing for instructors' selecting the technology to be used especially for education during the pandemic to correspond to their teaching styles and expectations from teaching activities should be taken into account, or at least customizability of technology should not be ignored. Furthermore, it should be aimed to overcome the obstacles and problems faced by instructors and to prevent the emergence of the sense of frustration by providing instructors with technical support, activities such as in-service training and personnel who assume a moderator role for problem-solving and providing information to assist the teaching processes. In other words, it comes to the fore as a need for designers of instructional technologies, educational program designers and policymakers to pay attention to the importance of instructors' motivation to maintain the quality of education, and, for this motivation, compatibility of technologies with courses, control over the technologies in online education, their ability to take initiative and possession of resources that will support the elimination of the obstacles they encounter during the pandemic.

According to multi-group analyses, gender and innovativeness had various effects on the relationships. In light of the in-depth findings, the frequent and detailed consideration of moderator analyses in future studies (Şahin et al., 2021) has the potential to make valuable contributions to the emerging body of literature. In this context, it is particularly noteworthy that there are no recent studies investigating the moderator role of innovativeness in the field of education. An in-depth examination of the moderator effects of innovativeness, whose effects on both basic psychological needs and emotional relationships has been determined, has valuable potential in this respect. Findings that autonomy is determinant in terms of the perception of the benefit that technology can provide for innovative pre-service teachers and that enjoyment-playfulness elements are prioritized within the scope of IT usage intention provide important information. These findings suggest that innovativeness may have a critical role as a moderator. In this context, studies aimed at determining the adopter categories (laggards, late majority, early majority, early adopters & innovators) of

instructors in terms of innovativeness and obtaining more detailed information on innovativeness characteristics have the potential to make valuable contributions in practice. This potential indicates that an assessment of the categories and characteristics of the instructors before employing education policies and conducting integration studies can provide a solid guide and a roadmap.

Accordingly, obtaining more detailed information about complex relationships in technology acceptance and understanding these processes better can significantly contribute to the field of education in both theoretical and practical senses, and online teacher education during the pandemic can be kept at the same level with conventional education or elevated to higher levels. In addition, obtaining as much information as possible about online teacher education for teacher education programs requiring intensive practice, such as Computer Education and Instructional Technologies, and face-to-face interaction, such as Pre-school Education and Special Education, and ensuring that pre-service teachers who are trained during the pandemic to educate future generations can step into the profession as competent teachers are of vital importance for the education during and after the pandemic.

Although the most chaotic times of the pandemic seem to have passed, the continuous emergence of more dangerous new variants such as Omicron indicates that the post-pandemic educational environments will not be exactly the same as before. It can be predicted that learning methods such as e-learning, mobile learning and both synchronous and asynchronous electronic education environments such as distance education platforms will constitute a larger part of education compared to the pre-pandemic era. From this point of view, the factors that shape education during the pandemic may also be valid to some extent for the post-pandemic period. In this direction, improving the quality of pre-service education and in-service training opportunities is one of the priorities for post-pandemic in the context of technology-education. This priority is especially important in terms of teaching styles and expectations from teaching activities. On the other hand, considering the psychological needs in the educational settings and evaluating the role of both positive and negative emotions regarding instructors' teaching experiences are important points to focus on after the pandemic.

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Conflict of interest The authors state that they have no conflicts of interest.

References

- Agarwal, R., & Karahanna, E. (2000). Time flies when you're having fun: Cognitive absorption and beliefs about information technology usage. *MIS quarterly*, 24(4), 665–694. <https://doi.org/10.2307/3250951>

- Agarwal, R., & Prasad, J. (1998). A conceptual and operational definition of personal innovativeness in the domain of information technology. *Information systems research*, 9(2), 204–215. <https://doi.org/10.1287/isre.9.2.204>
- Al-alak, B. A., & Alnawas, I. A. (2011). Measuring the acceptance and adoption of e-learning by academic staff. *Knowledge Management & E-Learning: An International Journal*, 3(2), 201–221. <https://doi.org/10.34105/j.kmel.2011.03.016>
- Ali, I. (2019). Personality traits, individual innovativeness and satisfaction with life. *Journal of Innovation & Knowledge*, 4(1), 38–46. <https://doi.org/10.1016/j.jik.2017.11.002>
- Baydaş, Ö. (2015). *Öğretmen Adaylarının Gelecekteki Derslerinde Bilişim Teknolojilerini Kullanma Niyetlerini Belirlemeye Yönelik Bir Model Önerisi* (Unpublished doctoral dissertation). Atatürk Üniversitesi, Erzurum
- Baydas, O., & Goktas, Y. (2016). Influential factors on preservice teachers' intentions to use ICT in future lessons. *Computers in Human Behavior*, 56, 170–178. <https://doi.org/10.1016/j.chb.2015.11.030>
- Baydas, O., & Goktas, Y. (2017). A model for preservice teachers' intentions to use ICT in future lessons. *Interactive Learning Environments*, 25(7), 930–945. <https://doi.org/10.1080/10494820.2016.1232277>
- Baydas, O., & Yilmaz, R. M. (2018). Pre-service teachers' intention to adopt mobile learning: A motivational model. *British Journal of Educational Technology*, 49(1), 137–152. <https://doi.org/10.1111/bjet.12521>
- Beaudry, A., & Pinsonneault, A. (2010). The other side of acceptance: Studying the direct and indirect effects of emotions on information technology use. *MIS Quarterly*, 34(4), 689–710. <https://doi.org/10.2307/25750701>
- Bhattacherjee, A. (2001). Understanding information systems continuance: An expectation-confirmation model. *MIS quarterly*, 25(3), 351–370. <https://doi.org/10.2307/3250921>
- Bin, E., Islam, A. A., Gu, X., Spector, J. M., & Wang, F. (2020). A study of Chinese technical and vocational college teachers' adoption and gratification in new technologies. *British Journal of Educational Technology*, 51(6), 2359–2375. <https://doi.org/10.1111/bjet.12915>
- Chang, C. T., Hajiyev, J., & Su, C. R. (2017). Examining the students' behavioral intention to use e-learning in Azerbaijan? The general extended technology acceptance model for e-learning approach. *Computers & Education*, 111, 128–143. <https://doi.org/10.1016/j.compedu.2017.04.010>
- Csikszentmihalyi, M., & Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience* (1990 vol.). Harper & Row
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 13(3), 319–340. <https://doi.org/10.2307/249008>
- Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science*, 35(8), 982–1003. <https://doi.org/10.1287/mnsc.35.8.982>
- Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, 11(4), 227–268. https://doi.org/10.1207/S15327965PLI1104_01
- Ding, Y., & Chai, K. H. (2015). Emotions and continued usage of mobile applications. *Industrial Management & Data Systems*, 115(5), 833–852
- El Alfy, S., Gómez, J. M., & Ivanov, D. (2017). Exploring instructors' technology readiness, attitudes and behavioral intentions towards e-learning technologies in Egypt and United Arab Emirates. *Education and Information Technologies*, 22(5), 2605–2627. <https://doi.org/10.1007/s10639-016-9562-1>
- Fathali, S., & Okada, T. (2018). Technology acceptance model in technology-enhanced OCLL contexts: A self-determination theory approach. *Australasian Journal of Educational Technology*, 34(4), <https://doi.org/10.14742/ajet.3629>
- Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18(1), 39–50. <https://doi.org/10.1177/002224378101800104>
- Garone, A., Pynoo, B., Tondeur, J., Cocquyt, C., Vanslambrouck, S., Bruggeman, B., & Struyven, K. (2019). Clustering university teaching staff through UTAUT: Implications for the acceptance of a new learning management system. *British Journal of Educational Technology*, 50(5), 2466–2483. <https://doi.org/10.1111/bjet.12867>
- Gelbrich, K., & Sattler, B. (2014). Anxiety, crowding, and time pressure in public self-service technology acceptance. *Journal of Services Marketing*. <https://doi.org/10.1108/JSM-02-2012-0051>

- Hadlington, L., & Scase, M. O. (2018). End-user frustrations and failures in digital technology: exploring the role of Fear of Missing Out, Internet addiction and personality. *Heliyon*, 4(11), e00872. <https://doi.org/10.1016/j.heliyon.2018.e00872>
- Hair, J. F., Black, W., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis: A global perspective*. Pearson
- Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2017). *A primer on partial least squares structural equation modeling (PLS-SEM)* (2nd. ed.). Sage.
- Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. *Journal of Marketing Theory and Practice*, 19(2), 139–151. <https://doi.org/10.2753/MTP1069-6679190202>
- Hashim, K. F., Tan, F. B., & Rashid, A. (2015). Adult learners' intention to adopt mobile learning: A motivational perspective. *British Journal of Educational Technology*, 46(2), 381–390. <https://doi.org/10.1111/bjet.12148>
- Henseler, J., Ringle, C. M., & Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing. *New challenges to international marketing*. Emerald Group Publishing Limited. [https://doi.org/10.1108/S1474-7979\(2009\)0000020014](https://doi.org/10.1108/S1474-7979(2009)0000020014)
- Huang, R. T., Jang, S. J., Machtmes, K., & Deggs, D. (2012). Investigating the roles of perceived playfulness, resistance to change and self-management of learning in mobile English learning outcome. *British journal of educational technology*, 43(6), 1004–1015. <https://doi.org/10.1111/j.1467-8535.2011.01239.x>
- International Association of Universities (2020). Covid-19: Higher education challenges and responses. International Association of Universities. <https://www.iau-aiu.net/Covid-19-Higher-Education-challenges-and-responses>
- Jokinen, J. P. (2015). Emotional user experience: Traits, events, and states☆. *International Journal of Human-Computer Studies*, 76, 67–77. <https://doi.org/10.1016/j.ijhcs.2014.12.006>
- Joo, Y. J., Park, S., & Lim, E. (2018). Factors influencing preservice teachers' intention to use technology: TPACK, teacher self-efficacy, and technology acceptance model. *Journal of Educational Technology & Society*, 21(3), 48–59
- Kılıçer, K., & Odabaşı, H. F. (2010). Bireysel Yenilikçilik Ölçeği (BYÖ): Türkçeye Uyarlama, Geçerlik Ve Güvenirlik Çalışması. Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 38 (38), 150–164. Retrieved from <https://dergipark.org.tr/en/pub/hunefd/issue/7798/102155>
- Kim, H. W., Chan, H. C., & Chan, Y. P. (2007). A balanced thinking–feelings model of information systems continuance. *International Journal of Human-Computer Studies*, 65(6), 511–525. <https://doi.org/10.1016/j.ijhcs.2006.11.009>
- Kim, J., & Lennon, S. J. (2013). Effects of reputation and website quality on online consumers' emotion, perceived risk and purchase intention. *Journal of Research in Interactive Marketing*, 7(1), 33–56. <https://doi.org/10.1108/17505931311316734>
- King, W. R., & He, J. (2006). A meta-analysis of the technology acceptance model. *Information & Management*, 43(6), 740–755. <https://doi.org/10.1016/j.im.2006.05.003>
- Lazar, J., Jones, A., & Schneiderman, B. (2006). Workplace user frustration with computers: An exploratory investigation of the causes and severity. *Behaviour & Information Technology*, 25(03), 239–251. <https://doi.org/10.1080/01449290500196963>
- Lee, Y., Lee, J., & Hwang, Y. (2015). Relating motivation to information and communication technology acceptance: Self-determination theory perspective. *Computers in Human Behavior*, 51, 418–428. <https://doi.org/10.1016/j.chb.2015.05.021>
- Lin, P. H., & Yeh, S. C. (2019). How motion-control influences a VR-supported technology for mental rotation learning: from the perspectives of playfulness, gender difference and technology acceptance model. *International Journal of Human-Computer Interaction*, 35(18), 1736–1746. <https://doi.org/10.1080/10447318.2019.1571784>
- Lu, Y., Papagiannidis, S., & Alamanos, E. (2019). Exploring the emotional antecedents and outcomes of technology acceptance. *Computers in Human Behavior*, 90, 153–169. <https://doi.org/10.1016/j.chb.2018.08.056>
- Marangunić, N., & Granić, A. (2015). Technology acceptance model: a literature review from 1986 to 2013. *Universal access in the information society*, 14(1), 81–95. <https://doi.org/10.1007/s10209-014-0348-1>
- Moon, J. W., & Kim, Y. G. (2001). Extending the TAM for a World-Wide-Web context. *Information & management*, 38(4), 217–230. [https://doi.org/10.1016/S0378-7206\(00\)00061-6](https://doi.org/10.1016/S0378-7206(00)00061-6)
- Nikou, S. A., & Economides, A. A. (2017). Mobile-Based Assessment: Integrating acceptance and motivational factors into a combined model of Self-Determination Theory and Technology Acceptance. *Computers in Human Behavior*, 68, 83–95. <https://doi.org/10.1016/j.chb.2016.11.020>

- Padilla-Meléndez, A., del Aguila-Obra, A. R., & Garrido-Moreno, A. (2013). Perceived playfulness, gender differences and technology acceptance model in a blended learning scenario. *Computers & Education*, *63*, 306–317. <https://doi.org/10.1016/j.compedu.2012.12.014>
- Park, Y., Son, H., & Kim, C. (2012). Investigating the determinants of construction professionals' acceptance of web-based training: An extension of the technology acceptance model. *Automation in Construction*, *22*, 377–386. <https://doi.org/10.1016/j.autcon.2011.09.016>
- Parkman, S., Litz, D., & Gromik, N. (2018). Examining pre-service teachers' acceptance of technology-rich learning environments: A UAE case study. *Education and Information Technologies*, *23*(3), 1253–1275. <https://doi.org/10.1007/s10639-017-9665-3>
- Racero, F. J., Bueno, S., & Gallego, M. D. (2020). Predicting Students' Behavioral Intention to Use Open Source Software: A Combined View of the Technology Acceptance Model and Self-Determination Theory. *Applied Sciences*, *10*(8), 2711. <https://doi.org/10.3390/app10082711>
- Rogers, E. M., & Shoemaker, F. F. (1971). *Communication of Innovations; A Cross-Cultural Approach*. Free Press
- Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary educational psychology*, *25*(1), 54–67. <https://doi.org/10.1006/ceps.1999.1020>
- Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American psychologist*, *55*(1), 68
- Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology*, *61*, 101860. <https://doi.org/10.1016/j.cedpsych.2020.101860>
- Ryan, R. M., Soenens, B., & Vansteenkiste, M. (2019). Reflections on self-determination theory as an organizing framework for personality psychology: Interfaces, integrations, issues, and unfinished business. *Journal of personality*, *87*(1), 115–145. <https://doi.org/10.1111/jopy.12440>
- Saariluoma, P., & Jokinen, J. P. (2014). Emotional dimensions of user experience: A user psychological analysis. *International Journal of Human-Computer Interaction*, *30*(4), 303–320. <https://doi.org/10.1080/10447318.2013.858460>
- Şahin, F. (2016). *Öğretmen adaylarının bilişim teknolojileri kabul düzeyleri ile bireysel yenilikçilik düzeyleri arasındaki ilişkinin incelenmesi* (Unpublished master's thesis). Anadolu Üniversitesi, Eskişehir
- Şahin, F., Doğan, E., İlic, U., & Şahin, Y. L. (2021). Factors influencing instructors' intentions to use information technologies in higher education amid the pandemic. *Education and Information Technologies*, *26*(4), 4795 - 4820. <https://doi.org/10.1007/s10639-021-10497-0>
- Şahin, F., & Şahin, Y. L. (2021). Examining the acceptance of e-learning systems during the pandemic: The role of compatibility, enjoyment and anxiety. *International Technology and Education Journal*, *5*(1), 1–10
- Şahin, F. (2021). *Öğretmen adaylarının bilişim teknolojileri kullanım niyetlerinde duyguların ve temel psikolojik ihtiyaçların rolü: Teknolojinin kabulüne motivasyonel bir yaklaşım* [Unpublished doctoral dissertation]. Anadolu University, Eskişehir
- Şahin, F., Doğan, E., Okur, M. R., & Şahin, Y. L. (2022). Emotional outcomes of e-learning adoption during compulsory online education. *Education and Information Technologies*, 1–23. <https://doi.org/10.1007/s10639-022-10930-y>
- Sánchez-Prieto, J. C., Hernández-García, Á., García-Peñalvo, F. J., Chaparro-Peláez, J., & Olmos-Migueláñez, S. (2019). Break the walls! Second-Order barriers and the acceptance of mLearning by first-year pre-service teachers. *Computers in Human Behavior*, *95*, 158–167. <https://doi.org/10.1016/j.chb.2019.01.019>
- Sánchez-Prieto, J. C., Olmos-Migueláñez, S., & García-Peñalvo, F. J. (2017). MLearning and pre-service teachers: An assessment of the behavioral intention using an expanded TAM model. *Computers in Human Behavior*, *72*, 644–654. <https://doi.org/10.1016/j.chb.2016.09.061>
- Scherer, R., Siddiq, F., & Tondeur, J. (2020). All the same or different? Revisiting measures of teachers' technology acceptance. *Computers & Education*, *143*, 103656. <https://doi.org/10.1016/j.compedu.2019.103656>
- Shmueli, G. (2010). To explain or to predict? *Statistical Science*, *25*(3), 289–310. <https://doi.org/10.1214/10-STS330>
- Shmueli, G., Ray, S., Velasquez Estrada, J. M., & Chatla, S. B. (2016). The elephant in the room: evaluating the predictive performance of PLS models. *Journal of Business Research*, *69*(10), 4552–4564. <https://doi.org/10.1016/j.jbusres.2016.03.049>

- Shmueli, G., Sarstedt, M., Hair, J. F., Cheah, J. H., Ting, H., Vaithilingam, S., & Ringle, C. M. (2019). Predictive model assessment in PLS-SEM: guidelines for using PLSpredict. *European Journal of Marketing*, 53(11), 2322–2347. <https://doi.org/10.1108/EJM-02-2019-0189>
- Tarhini, A., Hone, K., & Liu, X. (2014). The effects of individual differences on e-learning users' behaviour in developing countries: A structural equation model. *Computers in Human Behavior*, 41, 153–163. <https://doi.org/10.1016/j.chb.2014.09.020>
- Teo, T., & Noyes, J. (2011). An assessment of the influence of perceived enjoyment and attitude on the intention to use technology among pre-service teachers: A structural equation modeling approach. *Computers & Education*, 57(2), 1645–1653. <https://doi.org/10.1016/j.compedu.2011.03.002>
- Teo, T. (2009). The impact of subjective norm and facilitating conditions on pre-service teachers' attitude toward computer use: A structural equation modeling of an extended technology acceptance model. *Journal of Educational Computing Research*, 40(1), 89–109. <https://doi.org/10.2190/EC.40.1.d>
- Teo, T., Lee, C. B., & Chai, C. S. (2008). Understanding pre-service teachers' computer attitudes: Applying and extending the technology acceptance model. *Journal of Computer Assisted Learning*, 24(2), 128–143. <https://doi.org/10.1111/j.1365-2729.2007.00247.x>
- Teo, T., Sang, G., Mei, B., & Hoi, C. K. W. (2019). Investigating pre-service teachers' acceptance of Web 2.0 technologies in their future teaching: a Chinese perspective. *Interactive Learning Environments*, 27(4), 530–546. <https://doi.org/10.1080/10494820.2018.1489290>
- Toquero, C. M. (2020). Challenges and Opportunities for Higher Education Amid the COVID-19 Pandemic: The Philippine Context. *Pedagogical Research*, 5(4), 1–5
- Trust, T., & Whalen, J. (2020). Should teachers be trained in emergency remote teaching? Lessons learned from the COVID-19 Pandemic. *Journal of Technology and Teacher Education*, 28(2), 189–199
- Ursavaş, Ö. F. (2014). *Öğretmenlerin Bilişim Teknolojilerini Kullanmaya Yönelik Davranışlarının Modellemesi* (Unpublished doctoral dissertation). Gazi Üniversitesi, Ankara
- Ursavaş, Ö. F., Yalçın, Y., & Bakır, E. (2019). The effect of subjective norms on preservice and in-service teachers' behavioural intentions to use technology: A multigroup multimodel study. *British Journal of Educational Technology*, 50(5), 2501–2519. <https://doi.org/10.1111/bjet.12834>
- Valtonen, T., Kukkonen, J., Kontkanen, S., Sormunen, K., Dillon, P., & Sointu, E. (2015). The impact of authentic learning experiences with ICT on pre-service teachers' intentions to use ICT for teaching and learning. *Computers & Education*, 81, 49–58. <https://doi.org/10.1016/j.compedu.2014.09.008>
- Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision Sciences*, 39(2), 273–315. <https://doi.org/10.1111/j.1540-5915.2008.00192.x>
- Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science*, 46(2), 186–204. <https://doi.org/10.1287/mnsc.46.2.186.11926>
- Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), 425–478. <https://doi.org/10.2307/30036540>
- Wong, K. T., Teo, T., & Russo, S. (2012). Influence of gender and computer teaching efficacy on computer acceptance among Malaysian student teachers: An extended technology acceptance model. *Australasian Journal of Educational Technology*, 28(7), <https://doi.org/10.14742/ajet.796>
- Zhang, P., & Li, N. (2005). The importance of affective quality. *Communications of the ACM*, 48(9), 105–108

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