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University students with special needs: Investigating factors influencing e-learning adoption

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Empirical evidence on the e-learning adoption in the field of special education is quite limited. Path modelling in particular draws attention as an important methodological gap. Therefore, a model that can provide a theoretical basis for practice in special education has the potential to make significant contributions. Accordingly, this study aimed to identify the factors influencing the intention to use e-learning systems by proposing an extended technology acceptance model for special education. The participant group consisted of 1713 university students with special needs receiving education through the e-learning systems of a state university. For analysing the data, partial least squares-structural equation modelling was used. The results showed that the model explained 76.9% of intention to use e-learning systems. Perceived ease of use and perceived usefulness had the strongest relationship in the model while that between perceived enjoyment and behavioural intention represented the strongest relationship in terms of influence on intention. In addition, hypothesis tests revealed that both social and individual-emotional factors affected intention to use e-learning, and constructs that provide intrinsic motivation and constructs of extrinsic motivation associated with performance improvement play a critical role in e-learning adoption. Accordingly, implications for research and practice are discussed.

Implications for practice or policy:
- It is critical for instructional designers, special education experts and policymakers to consider the effects of core acceptance constructs, both in terms of competence in and tendency to use e-learning systems.
- E-learning system designs that can meet the expectations arising from social norms and can contribute to strengthening the sense of belonging may have a crucial role.
- It is vital to consider the enjoyment elements in terms of ensuring quality learning through online education.

Keywords: e-learning, technology adoption, students with special needs, special education, PLS-SEM

Introduction

The ultimate goal of special education is to prepare individuals with special needs who need support in various areas throughout their lives for independence. One of the most fundamental independent living skills in adapting to living in the digital age is the ability to use technology to manage daily life (Frauenberger et al., 2011; Hasselbring & Glaser, 2000; Manzoor & Vimarlund, 2018). Individuals with special needs require technological skills in areas such as high school education, university education, job training or employment, especially in the transition from the family to independent living settings (Cullen & Alber-Morgan, 2015; Mortenson et al., 2013). Access to information, media and technology skills are emphasised as integration skills within the scope of employability skills and 21st-century learning skills for individuals with special needs (Cotton, 2008; Curtis & McKenzie, 2001). In parallel, having a command of today's technology enables individuals with special needs to exhibit many independent living skills such as social skills, working skills, self-determination skills and daily life skills and participate fully in society (Burgsthaler, 2003; Lang et al., 2014). Furthermore, technology has become an indispensable element that is mandatory in performing vital activities from time to time, beyond making life easier for individuals with special needs.

Raising individuals with special needs as individuals who can use technology will be possible by determining their needs for technology use and adaptation to technology and providing training to meet these needs (Gell et al., 2016; van Heek et al., 2018; Vereenooghe et al., 2021). Creating technological tools and applications by adapting them to individuals with special needs plays a crucial role in their technology adoption and effective (Carmien & Fischer, 2008; Goodman et al., 2002; van Heek et al., 2018). In line with this, it is crucial that while developing technology for individuals with hearing and visual impairments, user needs should be taken into account, and the compatibility and perceived usefulness of technologies should be considered (Theodorou & Meliones, 2020). Therefore, it is critical to consider the technology acceptance of these individuals in technology development (Doğan et al., 2021; van Heek et al., 2018).

E-learning systems that help students improve their learning performance independent of time and place also have considerable potential for university students with special needs. E-learning systems offer many opportunities to provide interaction between students and instructors, provide flexibility in education and stand out within the scope of young learners' preferences (Ibrahim et al., 2017). The importance of e-learning systems has increased even more due to the COVID-19 pandemic. Under the influence of the pandemic, there has been a rapid and radical digital transformation in the world, and one of the areas in which this transformation has been felt deeply is education (livari et al., 2020). The pandemic has forced institutions and instructors to switch from traditional methods to online learning environments such as e-learning and distance education (Toquero, 2020; Trust & Whalen, 2020). The education quality of university students with special needs, which is already of great importance, has become even more crucial under these special conditions. In this context, the most prominent question is the intention of university students with special needs to use e-learning systems and how effectively they can use these systems.

Research gap

The quality of online education depends considerably on the adoption and effective use of e-learning. Although investigating e-learning use of university students with special needs and identifying factors that influence the adoption of e-learning play a key role in terms of education quality, there is a lack of comprehensive and up-to-date advanced quantitative studies. In addition, according to search results in various databases (e.g., Web of Science, Scopus, ScienceDirect), there are no up-to-date path modelling studies conducted with university students with special needs, and there is no model in the field of special education that can provide a theoretical basis and guide regarding the role of factors influencing students' intention to use e-learning. Reaching a large number of participants consisting of individuals with special needs with similar characteristics is rare in the field of special education. In single-subject studies or case studies (e.g., Arsovic & Stefanovic, 2020; Kamali Arslantas et al., 2019; Valtolina et al., 2012; Vogelgesang et al., 2016), which are frequently used in the special education, the findings are evaluated within the subject and the research findings are not intended to generalise. Therefore, there is a need for empirical studies conducted with large numbers of participants, in which advanced quantitative techniques that allow the results to be generalised are employed (Gersten et al., 2005). In other words, the need for a comprehensive quantitative investigation of the factors affecting the e-learning technology use of university students with special needs indicates a crucial gap in the field. Accordingly, this study aimed to examine the factors influencing the intention to use e-learning systems of university students with special needs through an extended technology acceptance model.

In this study, the core constructs (perceived ease of use, perceived usefulness, intention) of the technology acceptance model (TAM; Davis, 1989) formed the basis of the model proposal, and the model was extended by adding external variables. The proposed research model was formed in line with the hypotheses regarding the new constructs added, based on the relevant literature. Accordingly, the model consisted of individual, institutional, social and emotional variables in addition to the core TAM constructs. In determining the factors selected to extend the TAM, primarily the constructs that have a role in the effective use of information technologies by individuals with special needs were taken into consideration. In addition, evidence regarding the variables that affect the technology use tendency of university students with special needs in both case studies and single-subject studies were taken into account. The external variables chosen in this direction and addressed in detail in the literature section were self-efficacy, compatibility, social influence, facilitating conditions, enjoyment and anxiety.

A list of the abbreviations of the constructs is presented below:

- perceived ease of use: PEU
- perceived usefulness: PU
- behavioural intention: BI
- self-efficacy: SE
- compatibility: CMP
- social influence: SI
- facilitating conditions: FC
- perceived enjoyment: PE
- anxiety: AX.

Theoretical background

TAM

TAM, which is expressed as robust, reliable and effective model, is considered as one of the most fundamental theories on the acceptance of e-learning systems (Šumak et al., 2011; Venkatesh & Davis, 2000). TAM offers a simple structure that allows the proposed model to be extended in various ways without making it complicated (Venkatesh et al., 2003). Within the scope of TAM, PEU, PU and BI were included in the model as the core constructs. PU is expressed as an individual's belief about the increase in performance that can be achieved by using technology. PEU is defined as the degree of belief that an individual can use technology with little effort. BI is defined as an individual's intention to use technology (Davis, 1989). PU and PEU are the most crucial core constructs representing the foundations of technology adoption (Venkatesh & Davis, 2000). In parallel, PU and PEU should be considered in terms of technology development for individuals with special needs (Theodorou & Meliones, 2020). In addition, it is noteworthy that personal benefits in the context of PU, skills in the context of PEU and the effect of PU on intention are emphasised (J. Cho & Lee, 2020; Vereenooghe et al., 2021). Accordingly, the following hypotheses were proposed:

- H1. PU has a positive influence on BI.
- H2. PEU has a positive influence on (a) PU and (b) BI.

SE

SE, which refers to an individual's judgement of being able to perform a task, is expressed as a belief about the ability to perform a certain task with the use of technology (Compeau & Higgins, 1995; Strong et al., 2006). Studies have emphasised that students with a high SE level will tend to use e-learning systems, while students with a low SE level may avoid using these systems (Abdullah & Ward, 2016). In terms of TAM, SE has significant effects on the core constructs of acceptance (Abdullah & Ward, 2016). Furthermore, skills for independent use are emphasised in terms of ease of use for individuals with special needs (Vereenooghe et al., 2021). In this direction, the hypothesis below was proposed:

- H3. SE has a positive influence on (a) PEU and (b) BI.

CMP

Users perceive technologies that are compatible with their style and methods as more useful and tend to use them (Şahin et al., 2021). CMP is defined as the degree of suitability of the technology for the intended purpose (Venkatesh & Davis, 2000). The CMP of the technology with the individual's task is crucial in terms of fundamental constructs of technology adoption (Şahin et al., 2021; Şahin & Şahin, 2021). Moreover, taking into account the importance of considering user needs in terms of technologies to be developed for individuals with special needs (Theodorou & Meliones, 2020), the key role of the CMP reflects the expectations of individuals with special needs from e-learning systems, and the system's relevance to the education they will receive, becomes evident. Accordingly, the following hypothesis was proposed:

- H4. CMP has a positive influence on (a) PU and (b) BI.

SI

SI is a user's perception of the views of individuals they consider important on their using the relevant technology (Ajzen & Fishbein, 1980). SI is associated with various TAM structures and is importance in terms of technology use intention and PU (Abdullah & Ward, 2016; Venkatesh et al., 2003). However, although there are many findings regarding the relationship between the SI construct and important variables affecting technology adoption processes, the social factors and technology adoption of university students with special needs have not been adequately investigated. Thus, the hypothesis presented below was proposed:

- H5. SI has a positive influence on (a) PEU and (b) BI.

FC

FC is an individual's perception of the effects of factors that may influence performing a particular task including factors such as technical support and infrastructure (Teo, 2009; Venkatesh et al., 2003). Facilitating factors such as technical support, infrastructure, materials and training influence the attitude towards information technologies (Lai et al., 2012; Ngai et al., 2007), and FC can predict PEU and usage of e-learning systems (Agudo-Peregrina et al., 2014). FC plays a key role when considering the effects of opportunities such as technical support and training that university students with special needs have on their use of e-learning technologies. Furthermore, FC influences the knowledge and skills of students, their perceptions of the increase in performance they can achieve and their intention to use e-learning. In line with this, the hypothesis below was proposed:

- H6. FC have a positive influence on (a) PEU, (b) PU and (c) BI.

PE

Originating from intrinsic motivation, PE is explained as the level of perceiving the use of a system as enjoyable (Park et al., 2012). Studies on the acceptance and use of e-learning technologies state that regarding learning processes as enjoyable supports learning and affects the use of e-learning systems (Sumak et al., 2011) and is influential on PU, PEU and BI (Cheng, 2011). If e-learning technologies are perceived as enjoyable, students will tend to use them (Chen et al., 2013); Cheng, 2011; Şahin & Şahin, 2021); Ursavaş, 2014). The importance that university students with special needs have intrinsic motivation under the effect of the enjoyment in the context of using e-learning systems is evident. Accordingly, the following hypothesis was proposed:

- H7. PE has a positive influence on (a) PEU, (b) PU and (c) BI.

AX

AX is among the most investigated emotional factors in the acceptance and use of technologies. AX, expressed as the state of anxiety that occurs in the individual during technology use (Venkatesh et al., 2003), is addressed in relation to the constructs that influence adopting technology such as PEU, SE and BI (Şahin et al., 2021; Şahin, 2021). Furthermore, it is emphasised in the literature that it has adverse effects on the use of e-learning systems (Agudo-Peregrina et al., 2014; Park et al., 2012). It can be said that AX may cause university students with special needs to avoid using e-learning systems, which is an important factor in the adoption of e-learning systems. In this direction, the hypothesis below was proposed:

- H8. AX has a negative influence on (a) PEU and (b) BI.

The proposed model is shown in Figure 1.

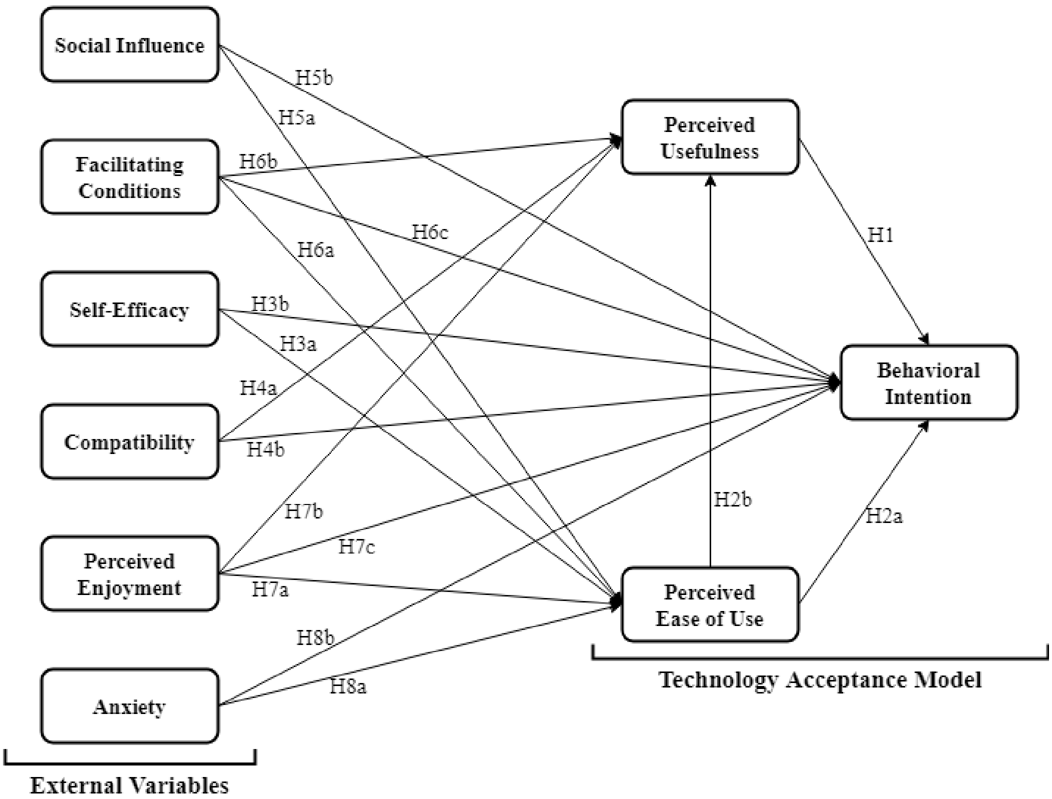

*Figure 1***.** Research model

Method

Participants

The study was carried out in the spring semester of 2021. Before data collection, the necessary approval was obtained from the university's ethics committee. The study participants consisted of 1713 university students with special needs receiving education through the e-learning systems of a state university in Turkey. Students studying in associate and bachelor's degree programmes were reached online. The data were obtained using a digital form, and it was clearly stated that participation was entirely voluntary. The demographics of the participants are presented in Table 1.

Table 1
Demographics of the participants

		f	%
Disability	Hearing impairment	252	14.7
	Visual impairment	448	26.1
	Physical disability	258	15.1
	Other (multiple disabilities, chronic diseases)	755	44.1
Department type	Four-year program	789	46.1
	Two-year program	924	53.9
Graduation degree	High school	646	39.4
	Undergraduate	944	55.1
	Master	80	4.7
	PhD	13	0.8
Gender	Female	612	35.7
	Male	1101	64.3

E-learning in the institution is provided through a system (a combination of an e-learning system and a distance education platform) that offers live lectures; course recordings; summary videos; question-solution videos; and various written, visual, and audio learning materials (e.g., textbooks, audiobooks, unit summaries and tests consisting of multiple-choice and open-ended questions). In this context, the system offers a wide variety of instructional settings, both synchronously and asynchronously, and has a structure that allows methods such as full online education, and blended and flipped learning.

Data collection

The first part of the data collection instrument collected the participants' demographic information, and the second part contained the scale items. The second part consisted of 9 constructs: PEU, PU, BI, CMP, SI, FC, SE, PE and AX, consisting of thirty-five 5-point Likert-type items (1 = *completely disagree*, 5 = *completely agree*). The items of the instrument were adapted from an information technology acceptance scale we developed within the scope of another model development study. Although the necessary tests regarding the construct validity, reliability and model fit performed with the partial least squares (PLS) method in the context of model evaluation (Tables 2, 3 & 4), we conducted a pilot study using both covariance-based AMOS and variance-based PLS in order to double-check.

Before the main data collection phase of the study, a separate data collection process was carried out, and the reliability and factorial validity of the scale was tested with confirmatory factor analysis (pilot study). The goodness fit of the measurement tool was evaluated using AMOS through the fit indices ($\chi2$/df; standardised root-mean-square residual – SRMR; root-mean-square error of approximation – RMSEA; normed fit index – NFI; Tucker-Lewis index – TLI; and comparative fit index – CFI). The validity and reliability of the scale were evaluated using PLS through convergent validity (item loadings; Cronbach's alpha; composite reliability – CR; and average variance extracted – AVE) and discriminant validity (Fornell-Larcker & Heterotrait-Monotrait Ratio – HTMT). As a result of the tests, we concluded that all of the factors diverged clearly from each other and that the factors were able to consistently measure the constructs they were designed to measure. We determined that the factor structure of the scale was confirmed and the fit of the measurement model was good. Thus, we established the adaptation of the scale for university students with special needs, and in the next stage, we carried out the main data collection phase of the study.

Data analysis

SPSS version 23 was used for the descriptive analysis, and the SmartPLS software was used for structural equation modelling. At the modelling stage, the PLS path modelling method was employed. The fact that PLS is recommended for complex and explanatory models was influential in preferring variance-based PLS instead of covariance-based methods (Hair et al., 2017; Hair et al., 2011). The second stage was conducted with testing the convergent and discriminant validity within the scope of measurement model assessment and performing PLS and bootstrapping analyses within the scope of structural model assessment, respectively.

Results

Measurement model assessment

As seen from the Table 2 item loadings, Cronbach's alpha, CR and AVE were examined first. Item loadings showed that the values were in the range of 0.838–0.940 (> 0.7). Accordingly, reliability at the item level was established. Cronbach's alpha and CR results revealed that all values were higher than .7. Furthermore, the AVE values were in the range of 0.772–0.864 (> 0.5). Based on these values, convergent validity was established (Hair et al., 2017).

Table 2
Convergent validity

Constructs	Item	Loading	α	CR	AVE
BI	BI1	0.924	.920	.949	.862
	BI2	0.938			
	BI3	0.922			
PU	PU1	0.906	.939	.956	.846
	PU2	0.934			
	PU3	0.926			
	PU4	0.913			
PEU	PEU1	0.894	.905	.933	.778
	PEU2	0.903			
	PEU3	0.838			
	PEU4	0.892			
SI	SI1	0.846	.902	.931	.772
	SI2	0.880			
	SI3	0.904			
	SI4	0.884			
SE	SE1	0.923	.949	.963	.867
	SE2	0.939			
	SE3	0.940			
	SE4	0.923			
FC	FC1	0.912	.937	.955	.840
	FC2	0.929			
	FC3	0.920			
	FC4	0.904			
CMP	CMP1	0.907	.930	.950	.826
	CMP2	0.916			
	CMP3	0.919			
	CMP4	0.893			
PE	PE1	0.923	.947	.962	.864
	PE2	0.935			
	PE3	0.934			
	PE4	0.924			
AX	AX1	0.908	.920	.940	.796
	AX2	0.896			
	AX3	0.882			
	AX4	0.882			

Discriminant validity was tested based on the Fornell-Larcker criterion and HTMT ratio. The results concerning the Fornell-Larcker criterion revealed that all of the square root values of the AVEs of the constructs were greater than the inter-structure correlations, and the criterion was met. Moreover, HTMT ratio results demonstrate that almost all of the indices between the constructs were compatible for $HTMT_{90}$. The fact that PE-CMP (0.903) and FC-SE (0.904) indices were marginal and the results of the Fornell-Larcker criterion presenting appropriate values showed that PE-CMP and FC-SE did not pose any problem in terms of discriminant validity. Thus, discriminant validity (Tables 3 & 4) was established (Fornell & Larcker, 1981; Hair et al., 2017).

Table 3
Fornell-Larcker criterion (discriminant validity)

Constructs	AX	BI	CMP	SE	FC	PE	PEU	PU	SI
AX	**0.892**								
BI	0.147	**0.928**							
CMP	0.172	0.831	**0.909**						
SE	0.127	0.750	0.821	**0.931**					
FC	0.178	0.738	0.802	0.852	**0.917**				
PE	0.191	0.831	0.886	0.753	0.759	**0.929**			
PEU	0.139	0.728	0.776	0.776	0.795	0.764	**0.882**		
PU	0.131	0.752	0.792	0.706	0.749	0.798	0.829	**0.920**	
SI	0.323	0.779	0.789	0.712	0.709	0.775	0.683	0.680	**0.879**

Note. Numbers in bold represent the square root of the AVE.

Table 4
HTMT ratio (discriminant validity)

Constructs	AX	BI	CMP	SE	FC	PE	PEU	PU	SI
AX									
BI	0.144								
CMP	0.168	0.899							
SE	0.123	0.802	0.875						
FC	0.175	0.795	0.860	0.904					
PE	0.184	0.890	0.903	0.794	0.806				
PEU	0.137	0.796	0.843	0.836	0.862	0.824			
PU	0.124	0.810	0.846	0.747	0.799	0.846	0.897		
SI	0.342	0.855	0.861	0.769	0.770	0.838	0.754	0.739	

Structural model assessment

Before the structural model, firstly, we examined whether there was a problem in terms of multicollinearity using the variance inflation factor (VIF). The fact that the VIF of the 17 proposed hypotheses were within acceptable ranges (VIF < 10) indicated that there was no significant problem between the constructs in the context of multicollinearity. In the context of the structural model, PLS path modelling and bootstrapping analyses were performed. According to the results, the proposed model explained 70.8% of PEU, 75.9% of PU and 76.9% of BI. These values for the output variables suggested that the model has high explanatory power.

The bootstrapping analysis conducted to test the hypotheses revealed that 13 out of 17 hypotheses were supported (Table 5). The relationships of PU -> BI, SE -> BI, CMP -> BI, SI -> BI, PE -> BI, and AX -> BI concerning BI were significant. Hence, H1, H3b, H4b, H5b, H7c and H8b were supported. In terms of PU, PEU -> PU, CMP -> PU and PE -> PU hypotheses (H2a, H4a, and H7b) were supported. Finally, the results concerning PEU showed that SE -> PEU, SI -> PEU, FC -> PEU and PE -> PEU relationships were significant. Thus, H3a, H5a, H6a, and H7a were supported. Four hypotheses (H2b, H6b, H6c and H8a) were not supported: PEU -> BI, FC -> PU, FC -> BI, and AX -> PEU. In addition, the strongest relationship in the model is between PEU and PU, while the most robust relationship in terms of external variables is between FC and PEU.

Discussion

In this study, TAM was extended by adding six external variables (SI, CMP, FC, SE, PE, AX) to three core TAM constructs (PEU, PU and BI) and validated. The model proposal explained 70.8% of PEU, 75.9% of PU and 76.9% of BI. Based on these results, it can be stated that the model further strengthens the findings regarding the flexibility and robustness of TAM.

Table 5
Structural modelling results

Hypothesis	Path	Coefficient	*t* value	*p* value	VIF	Results
H1	PU -> BI	0.116	3.594***	0.000	4.219	Supported
H2a	PEU -> PU	0.462	12.420***	0.000	3.317	Supported
H2b	PEU -> BI	0.004	0.119(ns)	0.905	4.401	Not supported
H3a	SE -> PEU	0.221	4.857***	0.000	4.227	Supported
H3b	SE -> BI	0.097	2.526**	0.012	4.835	Supported
H4a	CMP -> PU	0.144	2.948**	0.003	5.822	Supported
H4b	CMP -> BI	0.191	3.942***	0.000	5.926	Supported
H5a	SI -> PEU	0.064	2.118*	0.034	3.083	Supported
H5b	SI -> BI	0.259	7.386***	0.000	3.261	Supported
H6a	FC -> PEU	0.344	7.428***	0.000	4.217	Supported
H6b	FC -> PU	0.060	1.687(ns)	0.092	3.562	Not supported
H6c	FC -> BI	0.021	0.527(ns)	0.598	4.740	Not supported
H7a	PE -> PEU	0.292	7.610***	0.000	3.344	Supported
H7b	PE -> PU	0.271	6.551***	0.000	5.011	Supported
H7c	PE -> BI	0.287	7.049***	0.000	5.591	Supported
H8a	AX -> PEU	-0.027	1.841(ns)	0.066	1.148	Not supported
H8b	AX -> BI	-0.056	4.351***	0.000	1.158	Supported

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

In terms of BI, PU -> BI, SE -> BI, SI -> BI, PE -> BI, CMP -> BI, and AX -> BI were supported. The PU -> BI result indicated that the perceptions of university students with special needs about the performance increase that they could obtain from e-learning systems affected their intention to use. Accordingly, it can be stated that students will tend to use the e-learning system if they find it useful. In parallel, studies have demonstrated that students with special needs intend to use e-learning systems if they are designed in accordance with their disabilities and are usable and accessible (J. D. Cho, 2021; Lee et al., 2015; Okur & Demir, 2019; Yusril, 2020). Additionally, the fact that individuals with special needs emphasise that they want to use user-friendly and functional instructional technologies (Schrepp et al., 2017; Rosa & Valentim, 2020; Pal et al., 2017) suggests that the tendency to use instructional technology will increase if students find it useful.

The SI -> BI relationship, which represented one of the strongest relationships in terms of influence on BI, indicated that the opinions of peers, friends and instructors, whom students considered important, regarding the use of the e-learning systems were the primary factors in the tendency to use e-learning. The effects of SI on university students' acceptance of information and communication technology have been reported in various studies (Abdullah & Ward, 2016; Chang et al., 2017); SI is one of the most crucial factors in ensuring the tendency to use information technologies (Şahin, 2016). In addition, studies have shown that approval and social acceptance were effective in the education of students with special needs, and that social supports affected learning motivation positively (Arslan-Ari & İnan, 2010; Forouzan et al., 2013; Milic-Babic & Dowling, 2015; Rothman & Cosden, 1995). Considering the consequences of students being isolated from society and labelled due to their disabilities and being behind their peers, it is important for e-learning systems to be designed for students with special needs to have an operationally effective and flexible design for students to fulfill the expectations that arise from social norms.

The SE -> BI result indicated that the beliefs of students in their knowledge and skills about e-learning systems affected their intention to use these systems. Accordingly, SE -> BI suggested that if students consider themselves competent, their tendency to use e-learning systems will be higher. SE -> BI indicated that adapting instructional technologies in line with user needs would enable them to be more competent in technology use and to have higher beliefs in their skills. The findings suggest that SE, which represents the belief in the ability to perform a certain task with the use of technology (Compeau & Higgins, 1995), can strengthen the tendency of students with special needs to use e-learning systems.

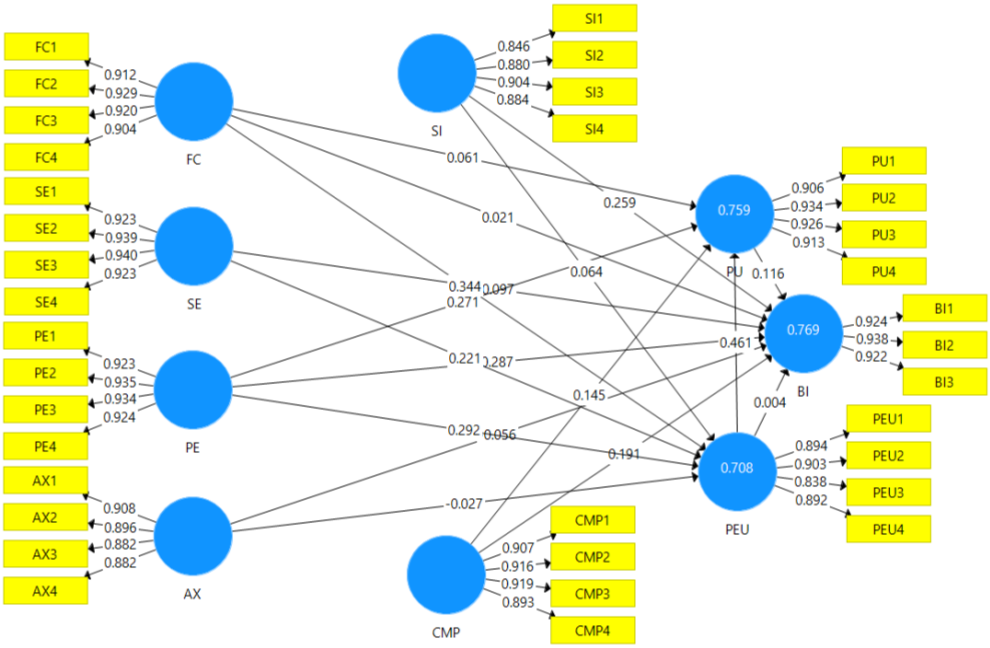

Figure 2. PLS-SEM results

CMP -> BI revealed that the CMP of the e-learning system influenced the intention. This result indicated that the system's ability to respond to students' educational expectations is a determining factor. Thus, the accessibility of courses is an element that increases the participation of students in the course and, therefore, the use of the system. It is possible to meet the expectations of students regarding the education they receive through the e-learning systems if the education is accessible (Cooper et al., 2007; Fichten et al., 2009; Lee et al., 2015; Okur & Demir, 2019).

PE -> BI and AX -> BI revealed that perceiving the system as enjoyable or anxiety-provoking affected the intention to use it. Accordingly, students will have a stronger tendency to use the e-learning system if they perceive it as enjoyable, and they will avoid using it if they perceive it as a technology that causes anxiety and frustration. Studies have indicated that enjoyment influences the use of the e-learning system and the perceiving the system as enjoyable positively affects the user experience (Alahoul et al., 2016; Şahin & Şahin, 2021). On the other hand, perceived user satisfaction is affected by anxiety (Liaw & Huang, 2013), and anxiety about learning in e-learning systems adversely affects students' intention to continue using (Oh & Lee, 2016).

PEU -> PU, PE -> PU, and CMP -> PU were supported. In line with this, it can be stated that the perceptions of students regarding the effort required for the effective use of the system and the perception of the e-learning as enjoyable influence their perceptions of the potential increase in performance. Moreover, the fact that PEU -> PU, the strongest relationship in the model indicated that the perception of the level of effort required for effective use of the system in the context of extrinsic motivation for performance increase was regarded as the top priority by students. Finally, the results suggested that meeting students' expectations from the e-learning system regarding the quality of education served as a determinant for their perceptions of the benefit they would obtain from the system. Findings indicated that making e-learning systems functional and accessible by adapting them according to individual characteristics positively affects students' perceptions of the benefits provided by e-learning systems are parallel with this study (Alahoul et al., 2016; Schrepp et al., 2017; Zongozzi, 2020). Therefore, adaptability to individual characteristics and accessibility are crucial in e-learning adoption.

For PEU, the SI -> PEU, SE -> PEU, FC -> PEU, and PE -> PEU relationships were significant. These findings indicated that the opinions of people whom university students considered important about e-learning systems, their perceptions of their knowledge and skills, the existence of resources such as software, hardware and technical support, and the degree to which the e-learning system was perceived as enjoyable influenced their perceptions of the level of effort that were required to use these systems effectively. The results suggested that the opinions of people whom students considered important such as friends and peers that the effective use of e-learning systems would not require much effort were influential in terms of ease of use. On the other hand, it could be stated that students' belief in their skills and the presence of resources such as technical support, software and hardware help them perceive the use of these technologies as easier. Finally, the results revealed that the intrinsic motivation that would emerge when e-learning systems were perceived as enjoyable strengthens students’ opinions that the use of the e-learning system would not require much effort. Thus, adapting the e-learning system according to students with special needs, in other words, the presence of facilitating factors (Fichten et al., 2009; Lee et al., 2015; Okur & Demir, 2019; Yusril, 2020) and the e-learning system being enjoyable (Alahoul et al., 2016) can act as a factor that motivates students and strengthens their intention to use. Therefore, enjoyment elements play a significant role in the perception of the effort required to use e-learning systems effectively and the tendency of students to make an effort.

PEU -> BI, FC -> BI, FC -> PU, and AX -> PEU relationships were not supported. The results in terms of BI indicated that the perceptions of students concerning the level of effort required to use e-learning systems and the resources they have, such as software, hardware and technical support, did not directly affect their e-learning usage intentions. The other unsupported hypotheses suggested that FC for e-learning systems did not affect the perception of the increase in performance and students' anxiety regarding the use of e-learning systems did not affect their perceptions of ease of use. These unexpected findings on FC indicated the need for further research on this construct. Another unexpected finding was that anxiety had no direct effect on ease of use. This result, which contradicts the findings of studies conducted both during the pandemic (Şahin & Şahin, 2021; Şahin, 2021) and before the pandemic (Abdullah & Ward, 2016) is significant. The relationship between AX and PEU, which was not significant, suggested that anxiety about e-learning systems might not affect the perception of the level of effort required to use these technologies effectively. Although this unexpected finding revealed a positive result, it could be stated that it is not possible to make a clear judgement on the relationship between AX and PEU. At this point, additional studies focusing on specific disability types will help to result in more in-depth and clear conclusions.

Conclusion and implications

Although a wide variety of studies have been carried out in the context of online education, the empirical findings within the scope of potential variables influential on technology use intentions and adoption processes of students with special needs are quite limited. This study addressed this issue where the crucial role of online education has become much more evident with the impact of the COVID-19 pandemic. The results showed the model provides an effective framework for university students with special needs and further strengthens the findings on the flexibility and robustness of TAM, as the proposed model explained 70.8% of PEU, 75.9% of PU and 76.9% of BI.

The results showed that PU had an effect on BI, but not PEU. This result regarding ease of use is somewhat unexpected under normal conditions. However, the findings indicate that the motivational effects of core TAM constructs may weaken during the pandemic as the use of information technologies is mandatory (Şahin et al., 2021; Şahin et al., 2022; Şahin & Şahin, 2021). Therefore, the influence of extrinsic motivation-oriented technology acceptance factors may differ according to the characteristics of the educational environment for students with special needs. From this point of view, for e-learning systems to be successful, it is important for instructional technology experts, program designers, special education experts and policymakers to consider the effects of these constructs both in terms of competence and tendency.

The strongest influence on the intention to use e-learning was the SI. The diagnosis of students with special needs causes them to be labelled and isolated from society and and to fall behind their peers in education. This issue results in students’ efforts to fully participate in society and integrate with society throughout their lives (Green, 2007; Klotz, 2004). Social norms may play a critical role in e-learning adoption. From this point of view, the primary goal can be expressed as an e-learning system design that can be used by students with special needs to meet the expectations arising from social norms and can contribute to strengthening the sense of belonging. In addition, online social networks can be established on e-learning systems to create social support, and communication platforms can be designed where students with and without disabilities can interact. The fact that the intrinsic motivation and sense of efficacy in individuals with special needs depend on the positive reactions they will receive from outside and social acceptance, regulations based on social interaction will also support SE.

Disability is a factor that can cause an individual to be excluded from society. In this context, strengthening the social interactions of students with special needs is one of the main aims of special education. E-learning systems are online environments where students with special needs can come together and interact from anywhere at any time. By turning this situation into a learning opportunity, e-learning systems should be designed with communication and interaction structures to support the social skills of individuals with special needs. In other words, it is important that e-learning systems lay the groundwork for social interaction beyond being accessible. In line with the results of this research, chat settings and group conversations should be added to e-learning systems to be designed for students with special needs, and online activities should be organised.

The significant influence of SE and PEU on BI suggests that competence and self-confidence are determinants of perception of effort and tendency to use e-learning. However, due to social exclusion, students with special needs regard themselves as inadequate to perform many actions in the use of e-learning systems and have self-confidence problems. When the technology is not compatible with the students, competence decreases significantly. Therefore, adaptations that take into account individual characteristics play a key role in enabling individuals with special needs to use e-learning systems effectively and to feel competent. Designing the content, environment, learning materials, user interface and communication channels in line with the individual learning characteristics of students with special needs will improve self-confidence and perception of competence. At this point, it should be a state policy to employ flexible and adaptable universal design principles that take into account individualisation and consideration of individual differences while developing e-learning systems. All stakeholders providing services in the domain of special education should also customise their e-learning technologies according to the needs of the users, just like other special education processes.

Enjoyment influenced all of the core acceptance constructs (PEU, PU and BI). The fact that students with special needs lag behind their typically developing peers may cause their motivation to use technology to decrease. The reinforcement process increases motivation by enabling individuals with special needs to have fun and be happy in different ways. Similarly, students' perception of using the e-learning system as fun will increase their intention to use it by providing motivation. However, the enjoyment perceived by disability groups in terms of technology use may differ. Further studies investigating which features were perceived as fun for which type of disability in the use of e-learning systems could provide important information. For example, the use of entertaining animations, videos or game-based educational content supported with auditory elements for students with visual impairment as well as visual and textual elements for students with hearing impairment can create highly reinforcing experiences that will increase the use of e-learning systems. Therefore, it is vital for policymakers and practitioners involved in the design of e-learning systems to consider the enjoyment elements in terms of ensuring permanent learning through online education.

The results suggested that student expectations and systems features have an important role in e-learning adoption. The expectations of students in e-learning is that the benefit they get from distance education is at the closest level to the face-to-face education managed by special education processes. This can be possible only if the e-learning system is flexible, individualised and has the qualifications to meet special needs. Learning characteristics of individuals with special needs are unique to them, and they have different needs in line with their disabilities. Therefore, we recommend developing learner-oriented designs so that the student can adapt to online education better. Student expectations can be met by employing the policies to identify the needs of students with special needs in terms of system designs. Course content and learning materials that appeal to the sense of sight should be developed for students with hearing impairment. Similarly, audio-intensive content should be developed for students with visual impairments, and visual content should be supported by large font use and additional software such as screen readers and voice-overs. In addition, providing assistive tools for those with physical disabilities will increase the level of SE and turn e-learning systems into effective learning tools. Another important point is the evaluation stage for all disability groups. It is critical that adaptations such as changes in the exam format and additional time support offered in face-to-face education are transferred to the e-learning process. Consideration of the aforementioned recommendations by both policymakers and instructors working in the field has a key role in designing e-learning systems that meet the expectations of students with special needs.

Based on what has been learned within the scope of this study, we anticipate that there are important points for future studies to focus on to progress the current study. In this context, extending the model proposed in this study with new constructs or testing TAM with different external variables has the potential for valuable contributions to the field. In terms of external variables, focusing on the role of emotional constructs in technology adoption can provide valuable information. Considering that the variables addressed in the context of emotions in this study are relatively limited, covering one positive and one negative emotion (enjoyment and anxiety), it is crucial to test models that deal with emotions from both positive and negative aspects in a multidimensional way in future studies. In addition, beyond this approach, the development of an integrated model by adding different models or frameworks to TAM may provide an effective method. In the context of e-learning, integrating self-determination theory (Ryan & Deci, 2000), which has an important place in the field of special education, into TAM would provide important findings on the role of motivation in the adoption and competent use of instructional technologies.

Another method in the context of using technology in learning for future research could be placing a different technology as the the focus of the model. In this direction, mobile technologies, which have great potential in terms of contribution to learning, can be given as an example. In a model proposal that deals with mobile technologies in special education, integrating a theory such as the uses and gratifications theory (Katz & Blumber, 1974; Ruggiero, 2000) into TAMs can provide valuable findings. In this way, information can be obtained about why and how students seek certain media to satisfy their specific needs, and this information can provide crucial benefits in promoting mobile learning. As another potential approach, employing other widely accepted models in the field of education, such as the unified theory of acceptance and use of technology (Venkatesh et al., 2003), the theory of planned behaviour (Ajzen, 1991) and the theory of reasoned action (Fishbein & Ajzen, 1975) as the core of the proposed models, instead of TAM, which was the basis of the proposed model of this study, has a great potential to make valuable theoretical contributions. In this direction, the findings to be obtained by testing comprehensive model proposals would provide in-depth information and further support filling the gap in the field.

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