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Sustaining college students' continuance intention toward online learning in the post-COVID-19 era

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Abstract: Since the outbreak of the COVID-19 epidemic, universities in China have integrated online teaching, and a total of 17.75 million college students across the country have participated in these virtual learning systems. The extensive growth in online education that we have witnessed is unprecedented in the history of higher education. Based on the technology acceptance model (TAM), this study investigates the impacts of perceived enjoyment, ease of use, and usefulness on Chinese college students' continuance intention toward online learning. Our empirical findings indicated that the continuance intention of college students was affected by these perception factors and that innovativeness played a moderating role in the relationship between perceived enjoyment and continuance intention and perceived usefulness and continuance intention. These results provide theoretical and practical insights for universities and online education platforms that can be used to stimulate endogenous student motivation and sustain online learning behaviour in the post-COVID-19 era.

Keywords: online learning; online education; college students; continuance intention; innovativeness; perceived enjoyment; COVID-19; technology acceptance model; TAM.

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1 Introduction

Online education is a kind of network-based learning behaviour that can provide an efficient and convenient way for students to learn with the help of information and internet technologies. Since the outbreak of COVID-19 in 2020, the number of online learning users has undergone explosive growth in China. According to the 47th Statistical Report on Internet Development in China released by the China Internet Network Information Centre (CNNIC), the number of online learning users across the nation reached 342 million in 2020, and the online education market exceeded 480 billion yuan; however, online education is not merely a short-term response to the epidemic, but rather a revolutionary educational shift that has long-term implications. At present, the situation surrounding COVID-19 is still uncertain, and teaching administration agencies in Chinese universities should take advantage of this opportunity by initiating supportive measures that guide and encourage more students to continue participating in online learning. Specifically, they should aim to use online education to update learning concepts, optimise learning methods, improve learning quality, and promote lifelong learning.

Due to the differences in the psychological factors of online learning and the cognitive level of technology acceptance among college students, their satisfaction and learning effectiveness of online learning are also different, which will affect their willingness to accept and continuance intention toward online learning. Thus, it is important for scholars to identify and further explore the factors that might impact college students' continuance intention toward online learning. Some previous studies have already carried out relevant research. For example, Wijekumar et al. (2006) found that the effectiveness of e-learning may be affected by many factors, such as technical support, the friendliness of the network platform interface, classroom interaction, and online assessment. Maheshwari (2021) also showed that institutional support could significantly promote continuance intention toward online learning, and Joo et al. (2011) found that perceived usefulness, perceived ease of use, and perceived external

environment had significant positive effects on the willingness of students to continue engaging in online education.

Most of the existing research on this topic has focused on subjective factors, such as students' learning attention, learning satisfaction, and self-regulation abilities in online learning situations; however, few studies have investigated objective factors, such as technical support and external environment. Some studies have confirmed that perceived ease of use and perceived usefulness have direct and indirect effects on continuance intention towards online learning, but others have presented findings to the contrary. For example, Maheshwari (2021) found that perceived usefulness had no significant effect on continuous intention in online learning. More attention thus needs to be paid to the factors that affect the intrinsic motivation of students to accept and use online learning models. For example, having fun and pleasant experience could encourage students to continue participating in online learning platforms. Compared with learning in a traditional classroom, online learning should be a fun experience. Because the impact of perceived enjoyment on continuance intention in online learning is so important, it needs to be further examined.

Differences in personalities and individual motivations can also affect how willing students are to keep using online learning platforms. Students who are more innovative, for instance, are more likely to experience a sense of intrinsic motivation that encourages them to continue, while those who are less innovative are more likely to be influenced by technology ease of use and friendliness; however, research that explores the influence that personality characteristics can have on students' use intention or behaviour toward online learning is scarce, and very few empirical studies have investigated the moderating effect that these types of factors have in online learning environments.

To address this critical gap, our study uses the technology acceptance model (hereafter referred to as TAM) as the theoretical framework to empirically examine that influence that college students' perceptions and personality traits have on their online learning behavioural intention. Specifically, this study aims to answer the following questions:

Question 1 Do perceived enjoyment, perceived ease of use, and perceived usefulness impact continuance intention toward online learning?

Question 2 Does perceived enjoyment impact perceived ease of use and perceived usefulness and, in turn, affect continuance intention toward online learning?

Question 3 Does a student's personality (i.e., their sense of innovativeness) moderate the impacts of perceived enjoyment, perceived ease of use, and perceived usefulness on continuance intention?

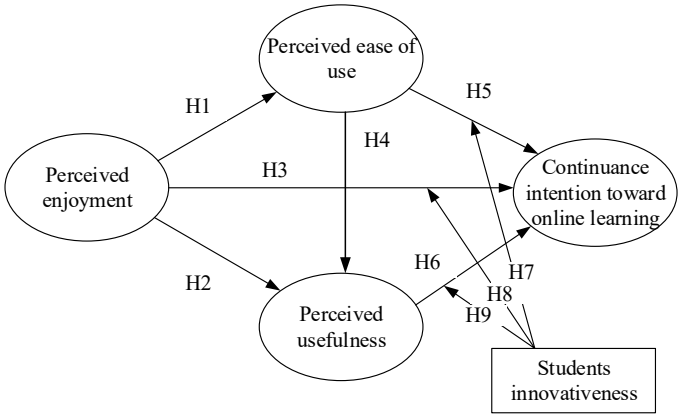
2 Theoretical foundation and hypotheses development

2.1 TAM

The TAM was the first model to explore the behaviour of technology acceptance and use based on psychological factors (Davis, 1989), and it has been widely employed in research that analyses these factors in relationship to specific innovative technologies (Pando-Garcia et al., 2016). TAM is the most common ground theory in e-learning

acceptance literature (Granić and Marangunić, 2019; Weerasinghe, 2017). The intentions that a user has toward using an e-learning technology have thus far been mainly explained using the TAM or extending it with other relevant constructs. For example, Bazelais et al. (2018) used the TAM as the research framework to empirically examine the impacts of perceived usefulness, perceived ease of use, and attitude on a person's willingness to use technology. Mailizar et al. (2021) also used the extended TAM model to empirically investigate factors that impact the behavioural intention of university students toward e-learning, as did Zhu and Zhang (2022), who used the TAM to investigate college students' degree of satisfaction and willingness to use online teaching in different disciplines. Several studies have also used the TAM to explore e-learning adoption issues at the higher education-level within the context of COVID-19. Siron et al. (2020) and Sukendro et al. (2020), for instance, applied TAM as a theoretical framework to examine factors that predict the use of e-learning during the pandemic.

Figure 1 Research model



Over the years, TAM has thus emerged as a leading scientific paradigm for investigating students and teachers' acceptance of learning technologies (Granić and Marangunić, 2019); however, there is a lack of studies that apply the TAM to examine continuance intention toward online learning in the post-pandemic era. Thus far, no studies have used perceived enjoyment and innovativeness as external factors in the TAM, particularly within the context of China and other developing countries, where online learning was not well-adopted at universities before the COVID-19 outbreak. This study applies the TAM to the context of online education as a means of investigating college students' continuance intention toward online learning. More specifically, perceived usefulness and perceived ease of use were adopted as basic variables, and intrinsic motivation (perceived enjoyment) and individual personality variables (student innovation) of students are added according to the actual characteristics of students who engage in online learning environments. The concept model of the study is shown in Figure 1. Perceived enjoyment reflects a student's subjective expectation of whether or not online learning can be fun, while perceived usefulness refers to a student's subjective cognition on whether or not online learning can effectively improve learning efficiency and enhance learning effects, and perceived ease of use is attached to a student's subjective cognition and comprehensive judgement on the difficulties and convenience of operating software and

hardware in online learning environments. Continuance intention toward online learning refers to the comprehensive attitude and judgement of college students to accept and continue using online learning, while personal innovation is the degree to which college students are willing to try new technologies.

2.2 Hypotheses development

2.2.1 Perceived enjoyment, perceived ease of use, perceived usefulness, and continuance intention toward online learning

Perceived enjoyment is a form of intrinsic motivation that can spark student interest, and many studies have suggested that it plays a role in technology acceptance and use behaviour. Perceived enjoyment often gives students intrinsic motivation to use online learning modes, as their perception of whether or not a given technology can be fun directly affects their acceptance behaviour. Several studies exploring the acceptance of network technologies in the field of education, such as Sanchez-Prieto et al. (2016), have confirmed that there is a positive correlation between perceived enjoyment and perceived ease of use. With respect to e-learning and MOOC acceptance behaviour, researchers have also demonstrated that perceived enjoyment has a significant positive impact on perceived ease of use (Siron et al., 2020; Tao et al., 2019; Teo and Noyes, 2011), as have scholars working in the field of educational technology (Matute-Vallejo and Melero-Polo, 2019). In the context of the COVID-19 epidemic, however, few studies in China have focused on the impact that perceived enjoyment of online learning has on perceived ease of use. Because previous studies have pointed out that perceived enjoyment causes learners to underestimate the difficulties associated with using technology (Sun and Zhang, 2006), we can assume that when students perceive online learning as being fun, they will view any challenges that they face as less complex, and their fear of new technologies will lessen. Therefore, we hypothesise that:

Hypothesis H1 Perceived enjoyment has a significant, positive effect on perceived ease of use.

During the COVID-19 pandemic, many colleges and universities in China utilised online teaching with the help of platforms such as Tencent Conference, Dingding.com, and MOOC, which have the advantages of strong interactivity, convenience, flexibility, rich learning resources, and multimedia technical support. While these benefits have a pragmatic value, entertainment (e.g., enjoyment) may also affect student learning activities. In fact, some platforms are also designed to create an enjoyable experience for student users. For example, the new Tencent conference platform offers entertainment functions, such as interactive annotations and doodles. Previous studies have shown that the more pleasurable the technology is, the more useful it is. For instance, researchers studying online business simulation games have found a positive relationship between perceived enjoyment and perceived usefulness (Matute-Vallejo and Melero-Polo, 2019; Siron et al., 2020). The reason for this connection is that when learners enjoy their interaction with the technology, they are not aware that their work or study becomes more efficient (Agarwal and Karahanna, 2000). In the context of online education, students may not realise they are learning if they have a fun and entertaining interaction with online technologies. Therefore, we hypothesise the following:

Hypothesis H2 Perceived enjoyment has a significant positive effect on perceived usefulness.

Previous studies have also found that perceived enjoyment has a significant positive impact on a user's acceptance of and willingness to use technology (Matute-Vallejo and Melero-Polo, 2019). If a student has a pleasant experience while interacting with a new technology, they are more likely to keep using it. In the field of online education and MOOC research, scholars have confirmed the positive relationship between perceived enjoyment and behavioural intention. For example, Lim (2001) found that there was a positive correlation between a learner's perceived enjoyment and their willingness to participate in future online courses. Tao et al. (2019) also demonstrated that users were more likely to use MOOCs if they think that participating in them is a pleasurable experience. A recent study in the field of online learning also confirmed that perceived enjoyment positively affects a student's continuance intention toward online learning (Maheshwari, 2021; Siron et al., 2020). Therefore, we put forward the following hypothesise:

Hypothesis H3 Perceived enjoyment has a significant positive impact on continuance intention toward online learning.

2.2.2 Perceived ease of use, perceived usefulness and continuance intention toward online learning

In the TAM model, perceived ease of use is defined as "the user's perception of the ease of using a particular system" (Davis, 1989) and the positive relationship between perceived ease of use and perceived usefulness is verified in the TAM model. In addition, the relationship between perceived ease of use and perceived usefulness has been verified in previous studies on hybrid teaching, e-learning, mobile learning, and MOOC. For example, Wu and Liu (2013) found that perceived ease of use was an important determinant for predicting perceived usefulness, and Li et al. (2021) confirmed that perceived ease of use had a significant positive impact on perceived usefulness in e-learning environments. Tao et al. (2019) also found that perceived ease of use had a significant positive impact on perceived usefulness in MOOC environments. Evidently, when students can easily accomplish required learning tasks through using online learning platforms, they have a stronger perceived ease of use and are more likely to recognise the benefits of online education; so, we hypothesised the following:

Hypothesis H4 Perceived ease of use has a significant, positive impact on perceived usefulness.

Similarly, the positive impact of perceived ease of use on learners' continuance intention has also been verified in a variety of different fields. For example, in the field of MOOC research, extant studies have confirmed that perceived ease of use had a significant positive impact on continuous learning intention (Jung and Lee, 2018; Li et al., 2021), and in the field of e-learning, Yeung and Jordan (2007) demonstrated that perceived ease of use effectively enhanced continuance intention. Previous research on hybrid learning also found that perceived ease of use had an indirect and significant positive impact on

acceptance intention through attitude (Wingo et al., 2017), and similar results that confirmed this connection have also emerged from the field of online learning (Farahat, 2012; Joo et al., 2011; Siron et al., 2020; Zhu and Zhang, 2022). Therefore, we put forward the following hypothesis:

Hypothesis H5 Perceived ease of use has a significant positive impact on continuance intention toward online learning.

2.2.3 Perceived usefulness and continuance intention toward online learning

Perceived usefulness is defined as "the extent to which users believe that using a particular system will improve their performance" (Davis, 1989). Previous studies found that perceived usefulness was positively correlated with a users' willingness to use technology (Venkatesh and Morris, 2000). The perceived usefulness of online learning is considered to be related to intrinsic factors, and prior research has demonstrated that perceived usefulness directly affects a learner's willingness to use technology (Yi and Hwang, 2003). In online learning environments, perceived usefulness enables students to recognise the benefits and practical values of these types of educational platforms and methodologies, which in turn stimulates their interest in online courses and makes them engage more with the material. Therefore, perceived usefulness can enhance learners' continuance intention toward online learning. Previous studies in the field of education have also confirmed that perceived usefulness had a significant, positive impact on learners' willingness to use specific learning patterns (Farahat, 2012; Joo et al., 2011; Jung and Lee, 2018; Siron et al., 2020; Wingo et al., 2017; Zhu and Zhang, 2022). Therefore, we hypothesise the following:

Hypothesis H6 Perceived usefulness has a significant positive impact on continuance intention toward online learning.

2.2.4 Moderating role of students' innovativeness

Student innovation is a factor that also affects a user's willingness to continue using online learning technologies. Broadly speaking, innovativeness refers to "the willingness of individuals to adopt new products or ideas within the scope of their personal experience" or, to put it a different way, the degree to which individuals are willing to experiment with new technologies within a particular context. If an individual has a high level of innovativeness, they are more likely to embrace new things at a quicker pace than others. Previous research on this topic has mainly been conducted in the field of information systems. These studies found that personal innovativeness affected a user's willingness to accept information technology in the form of online shopping and location services. Other studies have investigated the moderating effect of individual innovativeness. For example, Citrin et al. (2000) examined the moderating effect of customer innovativeness on online shopping, and Jeong et al. (2009) validated the moderating effect of individual innovativeness on perceived need and purchase intention. In the field of education, researchers have investigated the moderating effect of student innovativeness. For instance, Matute-Vallejo and Melero-Polo (2019) found that individual innovativeness had a negative moderating effect on the relationship between perceived ease of use and attitude toward online business simulation games. Therefore, it can be inferred that highly innovative students do not worry about online learning's ease

of use and are willing to try online learning models and related technologies no matter how complex and unreliable they seem. In other words, if a student's innovation level is high, the impact of perceived ease of use on their willingness to continue engaging with online learning will be weakened. Students who are more inclined to seek novelty and are open to new experiences find online learning and related technologies more stimulating and challenging and have higher expectations that the this type of educational model will improve learning efficiency and enhance learning effectiveness; so, if a student's level of innovativeness is high, perceived enjoyment and perceived usefulness have a stronger impact on their willingness to accept and continue using online learning. Therefore, we put forward the following hypotheses:

Hypothesis H7 Student innovativeness negatively moderates the positive correlation between perceived ease of use and continuance intention toward online learning.

Hypothesis H8 Student innovativeness positively moderates the positive correlation between perceived enjoyment and continuance intention toward online learning.

Hypothesis H9 Student innovativeness positively moderates the positive correlation between perceived usefulness and continuance intention toward online learning.

3 Research design

3.1 Data collection and measurement development

The data for this study was collected by distributing questionnaires to college students at the university where the authors worked. 412 questionnaires were collected, and 334 valid responses were retained after deleting data items with missing values. The questionnaire consisted of two main parts. The first part asked for the participants' basic information. Among the students that we surveyed, 147 (44%) were male and 187 (56%) were female. 153 (45.8%) students were majoring in liberal arts, 181 (54.2%) were majoring in science and engineering (including medicine). 102 students (30.53%) spent more than half an hour online each week. The second part of the questionnaire consisted of a cognitive measurement of influencing factors of continuance intention toward online learning. To achieve the purpose of the study, all of the measurement items of latent variables were adapted from prior research and modified in combination with the actual research. Finally, 16 measurement items were identified for the constructs of the study: perceived enjoyment (three items), perceived ease of use (three items), perceived usefulness (four items), continuance intention toward online learning (three items), student innovativeness (three items). A five-point Likert scale was used to test the items of each potential variable (1 means strongly agree, 3 means uncertain, and 5 means strongly disagree). Specific measurement items of each construct are listed in Table 1.

Table 1 Measurement items

Name of construct	*Measurement items*	*References*
Perceived enjoyment (PE)	I find participating in online learning interesting.	Sun and Zhang (2006)
	I enjoy participating in online learning.	
	Participating in online learning makes me happy.	
Perceived ease of use (PEOU)	Online learning is easy to use.	Davis et al. (1992), Venkatesh and Morris (2000)
	It was easy for me to learn how to operate online.	
	I think I will soon learn how to do it online.	
Perceived usefulness (PU)	Participating in online learning can improve my learning efficiency.	Davis et al. (1992), Venkatesh and Morris (2000)
	Participating in online learning can improve my academic performance.	
	Participating in online learning enriches my college experience.	
	Participating in online learning can improve my learning ability.	
Students' innovativeness (SPI)	If I hear about a new technology, I find a way to experience it.	Agarwal and Karahanna (2000)
	Among my peers, I am always the first to try new technologies.	
	I like to try new learning patterns and related technologies.	
Continuance intention toward online learning (CUI)	All things considered, I expect to continue using online learning.	Zhu and Zhang (2022)
	All things considered, I expect to use online learning methods frequently.	
	I would recommend online learning to my family, friends, and classmates.	

3.2 Statistics tool

SPSS 24.0 software was used to conduct exploratory factor analysis on data to verify whether there was a common method bias, and then. Then SmartPLS 3.0 software was used to test reliability and validity and analyse the coefficients of each hypothesised path.

4 Data analysis and findings

4.1 Common method bias

Three methods were used to control for common method bias. First, before taking the questionnaire survey, students were told that the information they provided would be confidential and anonymous so as to dispel their concerns about information disclosure and ensure that the answers were authentic. Second, the order of measurement items of each variable in the questionnaire was randomly set to avoid students inferring a causal relationship between variables. Finally, SPSS was used for exploratory factor analysis, and the principal component method was adopted to extract factors. The results show that

the variance explanation rate of the first factor is 27.53%, far less than 50%, so the common method bias is acceptable.

4.2 Reliability and validity test

Reliability analysis was conducted by checking whether indicator loadings (> 0.5), Cronbach's α coefficient (> 0.7), composite reliability (> 0.7), AVE value (> 0.5) met their respective thresholds. The results show that the relevant test values of all measurement items and latent variables of the study meet the threshold requirements (see Table 2), indicating that the data has a high reliability.

Table 2 Reliability analysis results

Variable	*Item*	*Loading*	*Cronbach's α*	*CR*	*AVE*
PE	PE1	0.865	0.838	0.903	0.756
	PE2	0.857			
	PE3	0.885			
PEOU	PEOU1	0.792	0.774	0.869	0.689
	PEOU2	0.84			
	PEOU3	0.857			
PU	PU1	0.844	0.857	0.903	0.7
	PU2	0.834			
	PU3	0.831			
	PU4	0.839			

Table 3 Cross-loading

	CUI	*PE*	*PEOU*	*PU*	*SPI*
PEOU1	0.32	0.253	*0.792*	0.282	–0.561
PEOU2	0.369	0.241	*0.84*	0.345	–0.534
PEOU3	0.363	0.24	*0.857*	0.397	–0.596
PU1	0.669	0.473	0.337	*0.844*	–0.359
PU2	0.666	0.356	0.322	*0.834*	–0.348
PU3	0.66	0.403	0.344	*0.831*	–0.311
PU4	0.644	0.366	0.385	*0.839*	–0.275
PE1	0.493	*0.865*	0.276	0.441	–0.31
PE2	0.49	*0.857*	0.223	0.389	–0.362
PE3	0.459	*0.885*	0.264	0.416	–0.347
SPI1	–0.436	–0.356	–0.624	–0.343	*0.904*
SPI2	–0.374	–0.311	–0.582	–0.282	*0.868*
SPI3	–0.474	–0.364	–0.599	–0.391	*0.887*
CUI1	*0.85*	0.487	0.377	0.621	–0.417
CUI2	*0.884*	0.472	0.354	0.704	–0.43
CUI3	*0.889*	0.493	0.381	0.738	–0.431

Table 4 Fornell-Larcker criterion

	CUI	*PE*	*PEOU*	*PU*	*SPI*
CUI	*0.874*				
PE	0.553	*0.869*			
PEOU	0.424	0.294	*0.83*		
PU	0.789	0.479	0.415	*0.837*	
SPI	–0.487	–0.39	–0.679	–0.387	*0.886*

Notes: The italic values represent the square root of AVE; other values below the diagonal indicate correlations between latent variables.

According to the statistical viewpoint, there are two main methods for discriminating validity. One method involves judging whether the loads on related latent variables are greater than all the loads on other latent variables. The other method is Fornell-Larcker criterion, that is, judging if the AVE square root of a latent variable is greater than the correlation coefficient between the latent variable and other latent variables. SmartPLS3.0 was used to conduct discriminant validity statistics on the samples, and the results showed that both cross loading (see Table 3) and Fornell-Larcker standard (see Table 4) meet the above standards, indicating that the sample data had good validity.

Table 5 Hypotheses test results

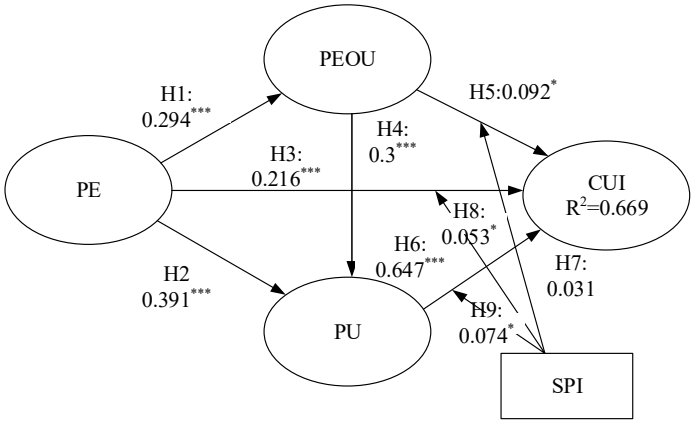
Main effects	β	*T value*	*Result*
H1: Perceived enjoyment → Perceived ease of use	0.294	4.957***	Supported
H2: Perceived enjoyment → Perceived usefulness	0.391	7.003***	Supported
H3: Perceived enjoyment → Continuance intention	0.216	5.02***	Supported
H4: Perceived ease of use → Perceived usefulness	0.3	6.032***	Supported
H5: Perceived ease of use → Continuance intention	0.092	2.326*	Supported
H6: Perceived usefulness → Continuance intention	0.647	15.408***	Supported
Moderating effect			
H7: Students' innovativeness × perceived ease of use → Continuance intention	0.031	1.126	Not supported
H8: Students' innovativeness × perceived enjoyment → Continuance intention	0.053	2.097*	Supported
H9: Students' innovativeness × perceived usefulness → Continuance intention	0.074	2.398*	Supported

Note: * indicates $p < 0.05$, ** indicates $p < 0.01$, *** indicates $p < 0.001$.

4.3 Structural model analysis

As Figure 2 illustrates, variables in the research model explained 31.1% variation of perceived usefulness ($R^2 = 0.311$) and 66.9% variation of continuance intention toward online learning ($R^2 = 0.669$), which were statistically significant and thus indicate good explanatory power of the model. The path coefficient analysis results show that all the six hypotheses of the study are supported.

Figure 2 Structural model analysis result



Path coefficients in the model are shown in Figure 2. In terms of the main effect, the relationship between independent variables and dependent variables shows a positive and direct impact, and each path coefficient presents a strong significance; so, hypotheses H1–H6 are supported. According to the standardised impact analysis, the impact of perceived enjoyment on perceived usefulness (β = 0.391) is greater than that of perceived ease of use (β = 0.294), indicating that while students enjoy using online learning tools, they can not only improve the operation skills of online learning, but also enhance the learning value and improve the learning effect. The total effects on continuance intention toward online learning were as follows: perceived usefulness (β = 0.647) > perceived enjoyment (β = 0.216) > perceived ease of use (β = 0.092). Compared with perceived usefulness and perceived enjoyment, perceived ease of use had a weaker impact on the continuance intention. One reason for this may be that college students have comparative advantages in terms of their ability to use the internet and information technologies, so they can easily operate online teaching skills and are more concerned about usefulness and how much they enjoy using a particular online learning platform.

The results of moderating effect analysis showed that the higher a student's level of individual innovativeness, the more their perceived enjoyment (β = 0.053; T = 2.097) and perceived usefulness (β = 0.074; T = 2.398) has a stronger positive effect on continuance intention; however, the moderating effect (β = 0.031; T = 1.126) of a student's level of individual innovativeness on the path between perceived ease of use and continuance intention was insignificant. One possible reason for this is that the operability of online learning technology plays a limited role in enhancing the willingness of students with high levels of innovativeness to continue engaging in these types of systems. Because they have rich experience in operating various information technologies, using complex hardware or software in an online learning environment will not influence their continuance intention.

Furthermore, four mediation paths were built into the research model: perceived enjoyment → perceived ease of use → continuance intention (PE → PEU → CUI, perceived enjoyment → perceived usefulness → continuance intention (PE → PU → CUI), perceived enjoyment → perceived ease of use → perceived usefulness → continuance intention (PEU → PEU → PU → CUI), and perceived ease of use → perceived usefulness→ continuance intention (PEU → PU → CUI). The mediating effect

test showed that perceived enjoyment had an indirect and significant positive effect on continuance intention through perceived ease of use and perceived usefulness, and perceived ease of use had an indirect and significant positive effect on continuance intention through perceived usefulness (see Table 6).

Table 6 Mediation test results (bootstrap = 5,000)

Mediation path	*β*	*Bootstrap SE*	*Bootstrap confidence interval*	*Significance*
PE→PEU→CUI	0.084	0	[0.045, 0.134]	$p < 0.001$
PE→PU→CUI	0.326	0	[0.244, 0.412]	$p < 0.001$
PEU→PEU→PU→CUI	0.338	–0.001	[0.255, 0.420]	$p < 0.001$
PEU→PU→CUI	0.308	0.001	[0.218, 0.393]	$p < 0.001$

5 Discussion

Through empirical analysis, this study investigated the impacts of perceived enjoyment, perceived ease of use, and perceived usefulness on continuance intention toward online learning and examined the moderating role of student innovativeness. The results confirm that perceived enjoyment, perceived ease of use, and perceived usefulness have a significant positive effect on college students' continuance intention toward online learning, and a student's level of innovativeness has a significant positive moderating effect on the paths between perceived enjoyment, perceived usefulness, and continuance intention, respectively. Most of the hypotheses in the proposed research model were empirically supported.

First, perceived enjoyment, perceived ease of use, and perceived usefulness all had significant positive impacts on the continuance intention of college students toward online learning (path coefficients were 0.216, 0.092, and 0.647, respectively), and perceived ease of use had indirect impacts on continuance intention through perceived usefulness. In terms of standardised path coefficients, perceived usefulness had the greatest direct impact on continuance intention, which is consistent with the findings from prior research (Wingo et al., 2017). This indicates that students pay more attention to the practical value of online learning. Hence, universities and online learning platforms should collaborate in order to optimise online learning environments, improve the quality of online teaching, and make students feel that online learning improves learning effectiveness.

Perceived enjoyment also had a significant positive effect on continuance intention toward online learning, which is consistent with what previous studies have found (Balog and Pribeanu, 2010; Maheshwari, 2021). This result indicates that college students are more concerned about whether online learning be more fun than traditional, in-person approaches. For this reason, online learning platforms should focus on improving their entertainment features. For instance, they could embed personalised interactive tools that allow students to entertain themselves while learning and improve their overall educational experience, which would meet the expectations that students have for online learning and enhance their continuance intention.

Compared with the impacts of perceived usefulness and perceived enjoyment on continuance intention, the impact of perceived ease of use on continuance intention is less

significant. One possible reason for this finding is that college students have grown up using the internet and are more familiar with operating computers and network technologies. They thus have a strong affinity for adapting to and accepting online learning and working independently. In addition, perceived ease of use has a greater indirect impact ($\beta = 0.308$, $T = 6.909$) on continuance intention through perceived usefulness, which indicates that perceived usefulness mediates the path between perceived ease of use and continuance intention.

Second, perceived enjoyment had a significant positive impact on perceived ease of use ($\beta = 0.294$, $T = 4.957$) and perceived usefulness ($\beta = 0.391$, $T = 7.003$). The effect of perceived enjoyment on perceived usefulness was greater than the influence of perceived ease of use, which is consistent with what previous studies have found (Matute-Vallejo and Melero-Polo, 2019) and confirms that perceived enjoyment is a determinant of perceived ease of use and perceived usefulness in online learning environments. Moreover, perceived enjoyment had a significant indirect positive effect on continuance intention through perceived ease of use and perceived usefulness ($\beta = 0.084$, $T = 3.816$; $\beta = 0.326$, $T = 7.628$). When students enjoy the process of engaging with online learning, they have a strong perception of its practical effects. Consequently, students will be less likely to become frustrated with any operational difficulties that may arise, and they will be less fearful or reluctant to use new technologies, which will help sustain their willingness to continue using these types of educational tools. These results indicate that if online learning platforms add some interesting elements or entertainment functions, students will be more likely to continue engaging with online learning and develop their independent learning abilities. For instance, developing interactive modules and incorporating contests and other opportunities for social engagement would help maintain student interest. In fact, there are many factors that can influence continuance intention. Besides perceived enjoyment, perceived usefulness, and perceived ease of use, some of 'soft environment' factors, such as teaching methods, technical operations and classroom teaching, and some of the 'hardware conditions', such as curriculum resources, teaching support, and technical services, may affect continuance intention (Joo et al., 2011); however, when considering various decision-making variables, group characteristics of contemporary college students, such as sense of belonging, should be taken into account.

Third, student innovativeness positively moderated the relationship between perceived enjoyment and continuance intention ($\beta = 0.053$, $T = 2.097$) as well as the relationship between perceived usefulness and continuance intention ($\beta = 0.053$, $T = 2.398$); however, the negative moderating effect of student innovativeness on the relationship between perceived ease of use and continuance intention was insignificant ($\beta = 0.031$, $T = 1.126$). This finding indicates that the continuance intention of students who are innovative depends more on their subjective perception of online learning enjoyment and their comprehensive judgement of its practical value. On the other hand, for students who do not have high levels of innovativeness, continuance intention was less affected by perceived enjoyment and perceived usefulness. One possible reason for this result is that students with low levels of innovativeness seldom learn using the internet and computers because they are not confident in their ability to engage with online learning. As a result, they are unsure of whether online learning can be fun or if it can achieve a better result than traditional classroom methodologies. Therefore, for students who do not have an innovative spirit, it is important to provide them with strong

guidance and encouragement while helping them become familiar with the operations of online learning.

6 Conclusions, implications, and future directions

6.1 Conclusions

Universities and online learning platforms in China must identify the factors that affect college students' continuance intention toward online learning in order to promote more active engagement in the post-COVID-19 era. This study integrated perceived enjoyment and student innovativeness into the TAM to establish an expended the model as a means of examining continuance intention toward online learning in universities. The results indicated that perceived enjoyment, perceived ease of use, and perceived usefulness all had significant positive impacts on the continuance intention of college students and that perceived enjoyment and perceived ease of use affected continuance intention indirectly. In addition, empirical evidence demonstrated that a college student's level of innovativeness played a positive moderating role in the relationship between perceived enjoyment and continuance intention and the relationship between perceived usefulness and continuance intention. These findings will help universities, education authorities, and online education platforms design policies and strategies to sustain college students' continuance intention toward online learning and promote the sustainable development of life-long learning and continuing education.

6.2 Theoretical and practical implications

From a theoretical perspective, the study validates the applicability of the TAM to the research framework. Relevant findings have answered the initial questions of this study and achieved the expected effect, which demonstrates the use of extending the TAM to study learning behaviour and willingness to use in network environments. This study extends the TAM by proposing a variable related to students' intrinsic motivation (that is, perceived enjoyment) and a individual personality variables (that is, a student's level of innovativeness) and validating direct and indirect impacts of perceived enjoyment on continuance intention as well as the moderating effect of students' innovativeness, thereby demonstrating that the TAM remains effective and useful in the current research environment.

The results of this study also have several important practical implications. First, importance should be given to the enjoyment of online learning. Online learning platforms should prioritise integrating fun elements into their platform design and course development. It is necessary for universities and online learning platforms to carry out extensive research on the needs of college students and design content and activities that are suitable for their diverse needs and preferences. Doing so would improve their learning experience and truly achieve 'edutainment', For example, creative tools, such as emotional expressions, mini-games, and fun quizzes, can be embedded into online learning platforms to provide students with an amusing and interactive experience. When students experience the pleasure of online learning, they may not feel anxious about using it. In fact, they may grow to believe that using online learning is easy and has practical value. With the help of these kinds of design approaches, students can develop a serious

interest in online education, which could, in turn, affect their perception of ease of use and usefulness, stimulate their curiosity of college, and continuously enhance their intention to use online learning.

Second, attention should be paid to the ease of use and usefulness of online learning. Our findings demonstrated that both perceived ease of use and perceived usefulness had a significant positive impact on continuance intention toward online learning and that perceived ease of use had a significant positive impact on perceived usefulness. Therefore, colleges and universities should carry out operation training related to online learning software among college students. Only when college students perceive online learning as easy to operate will they become aware of its benefits and advantages. At the same time, universities should take the new normal of online learning triggered by the epidemic as an opportunity to promote the shift from 'teacher-centred' to 'student-centred' education and urge teachers to strengthen classroom design, transform learning content into resources conducive to independent learning, guide students to carry out inquiry-based and personalised learning, encourage active utilisation of innovative online and offline blended teaching practices, and embrace a 'flipped classroom' approach that combines ease of use and usefulness.

Third, we should pay attention to the diversity of college students' personality characteristics. The empirical findings showed that if a student has a high level of innovativeness, the impact of perceived enjoyment and perceived usefulness on their continuance intention will be greater, though the impact of perceived ease of use on a student's continuance intention is not significantly affected by innovativeness. Therefore, college teachers should pay attention to the personality diversity and heterogeneity of college students and implement differentiated and personalised teaching strategies. For example, for students with high innovativeness, we should strengthen the publicity of the novelty and practical value of online learning platform to target their interest in new technology. For students who lack an innovative spirit, it is important to make them feel that online learning is easier to use. Teachers need to encourage and guide students in order to strengthen their confidence while using online learning platforms and cultivate their ability to work independently.

Finally, we should promote the steady improvement of students' willingness to use online learning and encourage the sustainable development of online education. Online learning provides teachers and students with great flexibility, and it can complement traditional classroom approaches in powerful ways. During the COVID-19 epidemic, China organised the largest online learning operation in the history of education in a very short period of time, which fully reflects the organisational skill and planning abilities of China's higher education sector; however, this does not mean that we have gained the endogenous impetus for the comprehensive development of online learning. In order to motivate students to engage in online learning, universities should work with online education platforms, adhere to the basic concept of student-oriented education, arouse students' curiosity, and ignite interest in learning with the support of technology, for example, by designing an online learning warning system (Li and Zhou, 2021), and make students' participation in online learning become a daily habit and conscious action. To this end, the Ministry of Education and China's other five departments should recognise that the practice of using mass online education during the COVID-19 epidemic is an approach that needs to be maintained and developed and work to create a collaborative mechanism that ensures the availability of online learning resources.

6.3 Limitations and future directions

Based on the TAM theory, this study established a research model to empirically analyse the influencing factors of college students' continuance intention toward online learning, but there are limitations to this research. First, the data was collected from only one university, so the generalisability of our findings needs to be further verified. Future studies can further expand the scope of investigation, collect sample data from national or regional college students for testing, or conduct testing based on existing panel data to make the research results more objective and rigorous. Second, the study validated the moderating effect of students' personality characteristics (such as their level of innovativeness), indicating that continuance intention toward online learning is affected by individual characteristics. Future studies can further analyse other personality characteristics that may influence a student's willingness to use computers, such as self-efficacy, neuroticism, interaction needs, etc.

Data availability

Data was collected from college students through questionnaires, and readers can access the data supporting the conclusions of the study if necessary.

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