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Understanding secondary students' continuance intention to adopt AI-powered intelligent tutoring system for English learning

Aohua Ni[1] · **Alan Cheung**[1]

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Abstract

Previous studies have demonstrated the effectiveness of intelligent tutoring systems (ITS) in facilitating English learning. However, no empirical research has been conducted on secondary students' intention to use ITSs in the language domain. This study proposes an extended technology acceptance model (TAM) to predict secondary students' continuance intention to use and actual use of ITSs for English learning. The model included fifteen hypotheses that were tested with 528 senior secondary students in China. The results of structural equation modeling showed that (1) perceived usefulness and price value had direct positive impacts on continuance intention; (2) perceived ease of use was not directly associated with students' intention but indirectly influenced intention via perceived usefulness; (3) through the mediation of perceptions, learning goal orientation and facilitating conditions were positively associated with continuance intention; (4) perceived enjoyment positively predicted and anxiety negatively predicted students' intention to use ITSs; and (5) students' continuance intention to use ITSs was significantly positively associated with their actual use of ITSs for English learning. The model showed strong explanatory power and might be implemented in future research. This study contributes to the theory and practice of ITSs in K-12 education.

Keywords Continuance intention · Actual use · Technology acceptance · Intelligent tutoring system · English learning · Motivation · Structural equation modeling

✉ Aohua Ni
niaohua@link.cuhk.edu.hk

[1] Department of Educational Administration and Policy, The Chinese University of Hong Kong, Hong Kong, China

1 Introduction

Technology advancements have fundamentally altered the educational landscape and the patterns of pedagogical adaptation. In particular, the incorporation of artificial intelligence (AI) using methods such as machine learning and deep learning has sparked global attention and become the current trend in instructional systems (Wang et al., 2021). According to previous studies, one notable use of AI in education is the intelligent tutoring system (ITS) (Mousavinasab et al., 2021). Compared to more conventional instructional approaches, ITSs, which ensure that learning is broadly available, adaptive, and personalized, have been demonstrated to be as effective as human tutoring at enhancing learning outcomes (Huang et al., 2021). With the assistance of ITSs, students can easily become more active English learners, leading to increased proficiency in language learning motivation and English competencies such as vocabulary, grammar, reading, and writing (Alhabbash et al., 2016; Parrisius et al., 2022; Wijekumar et al., 2013). ITSs have gained growing interest in Chinese secondary schools for English instruction considering the benefits of ITSs in language education (Xu et al., 2019). Consistent with the current trend of e-learning, the use of ITSs has become considerably more popular in the post pandemic era, given the flexibility in providing instruction and evaluation independent of time and space (Huang et al., 2021).

To reap the benefits of students' English learning, a prerequisite is to accept ITSs. Only if students accept ITSs will they utilize them for English learning, and only then will ITSs be able to help achieve better English learning outcomes. Previous research has applied the technology acceptance model (TAM) to understand users' ITS adoption behavior. For instance, it was found that users' continuance intention was closely related to perceived ease of use, perceived usefulness, attitude (Cao et al., 2021), social presence (Huang et al., 2021), experience, and compatibility (Wang et al., 2020). Although the findings of these studies produced some insights into the functional features of ITSs, their reach was confined to university students (Cao et al., 2021; Karacı et al., 2018), mathematics education (Huang et al., 2021), or teachers' adoption behavior (Wang et al., 2020). To the best of our knowledge, no empirical research has been conducted on secondary students' intention to implement and actual use of ITSs for language learning. In addition, the literature paid less attention to users' motivational beliefs, facilitating conditions, and price value, which are also crucial for ITS acceptance and the sustainable success of ITSs (Hatlevik et al., 2018; Venkatesh et al., 2003, 2012). Therefore, how these factors impact secondary students' behavioral intention toward ITSs is still unknown and warrants more investigation.

To address the research gaps, the study aimed to validate an extended TAM to obtain knowledge of the factors that may influence secondary students' continuance intention to use ITSs for English learning and the actual use of ITSs. Specifically, the research sought to determine the following: (1) what factors influence Chinese secondary students' continued intention to use and actual use of ITSs for English learning? (2) What are the relationships between these factors, and how do they interact to account for students' continuance behavior? This

study contributes to the existing TAM literature on ITSs by incorporating multiple factors into one study, including perceptions (e.g., perceived usefulness and perceived ease of use) (Davis, 1989), motivational beliefs (e.g., technology self-efficacy, enjoyment, and learning goal orientation) (Abdullah et al., 2016; Yi & Hwang, 2003), facilitating conditions (Venkatesh et al., 2003), and price value (Venkatesh et al., 2012).

The present study is significant in terms of the scope of ITS implementation. First, considering the effectiveness of ITSs in facilitating English learning, many Chinese K-12 students were compelled to engage in online learning for the first time with the closure of schools during the COVID-19 pandemic without sufficient preparation for learning with ITSs. Unfamiliarity with ITSs compounds additional challenges, such as lack of technology self-efficacy, insufficient interest, and more anxiety, which may hinder learning satisfaction and raise the desertion rate of ITSs (Zuo et al., 2022). Moreover, ITSs are a relatively novel technology implemented in secondary English instruction in developing countries and are expected to be promoted rapidly in the following years (Cao et al., 2021). The investigation of the potential factors will help to better elucidate secondary students' learning experiences with ITSs for those who are unprepared and promote greater language learning outcomes over the long term, with implications for researchers and practitioners seeking to integrate ITSs into secondary instruction, particularly in developing countries.

2 Literature review

2.1 Intelligent tutoring system

With the proliferation of AI in education, ITSs have experienced a renaissance as a one-to-one tutoring strategy to meet the increased need for individual learning (Alhabbash et al., 2016). Based on cognitive principles and algorithms, ITSs are adaptive data-based instructional systems that deliver real-time personalized tutoring services to learners based on their subject knowledge, abilities, emotions and learning styles without regard for time or space constraints (Han et al., 2019; Keleş et al., 2009). Previous literature has reached a consensus on the four modules of ITSs: a domain or expert module that serves as the heart of the system by providing subject knowledge, a pedagogical module that identifies learners' knowledge deficiency, a student model that tracks learners' knowledge status, and a user interface module through which learners interact with the system (Corbett et al., 1997; Freedman et al., 2000; Mousavinasab et al., 2021). The modules reflect some essential characteristics of ITSs: pedagogical, adaptive, and interactive. First, the system has integrated pedagogical and learning principles with a detailed design and integrity of content knowledge at the curriculum level. By adopting a problem-solving approach, ITSs, like human tutors, can guide learners on problem-solving activities by monitoring their learning process and performance (Corbett et al., 1997). Second, by adding intelligence to traditional computer-assisted instruction, ITSs create highly adaptive environments that emphasize the significance of student reflection based on which ITSs forecast students' learning styles, provide detailed feedback, deliver targeted lessons, and scaffold subsequent

learning behaviors (Han et al., 2019). Furthermore, interactivity is a critical component of ITSs. In addition to interacting with the user interface, ITSs interact with learners' reflections to deliver timely and customized instruction and monitor their cognitive and emotional states (Xu et al., 2019).

The use of ITSs in English learning has contributed to students' English performance in grammar, reading, and writing and enhanced their learning satisfaction (Alhabbash et al., 2016; Michaud et al., 2000). For example, in a meta-analysis, Xu et al. (2019) found that ITSs significantly impacted K-12 students' reading comprehension compared to traditional instruction. Virvou et al. (2000) demonstrated that error diagnosis in an ITS could help students understand the passive voice in English grammar in the long run. Other studies also argued that ITSs might increase language memorization, reading comprehension, analysis, and evaluation efficiency, leading to improved language learning outcomes (Graesser et al., 2017; Han et al., 2019).

2.2 TAM and previous research

Initially proposed by Davis (1986, 1989), the TAM became the most commonly used framework for understanding and predicting user behavior in education. Based on the TAM (Davis, 1989), the core variables of perceived ease of use and perceived usefulness affect users' behavioral intention, which further influences actual use behavior. Later, research extended the TAM by adding various factors to account for the influences of other environmental and motivational characteristics (Li et al., 2021; Mousavinasab et al., 2021; Sun & Gao, 2020). For example, Venkatesh et al. (2003) proposed UTAUT and identified four core constructs: effort expectancy, performance expectancy, facilitating conditions, and social norms. Then, UTAUT2 added three additional variables: hedonic motivation, price value, and habit (Venkatesh et al., 2012). These additional factors strengthen the original model for greater predictive power and adapt the TAM to a range of e-learning contexts.

Recent years have seen the emergence of research examining factors that influence students' implementation of ITSs using the extended TAM. For instance, based on 590 college students, Cao et al. (2021) found that perceived ease of use, perceived usefulness, attitude, social norms, and political influence significantly influenced students' intention to use ITSs. Huang et al. (2021) evaluated ITS use in mathematics education and reported that perceived usefulness had the largest impact on high school students' intention to use ITSs. In addition, social presence and interpersonal attraction significantly affected students' perceived usefulness and perceived ease of use, respectively. However, what is lacking in these studies is that they neglected to include multiple factors from diverse aspects of ITS adoption. In addition, no empirical research has been undertaken on Chinese secondary students' intention to embrace ITSs to learn English. Hence, it is still unknown how students' personal factors (e.g., motivational beliefs and perceptions) coupled with other contextual factors (e.g., facilitating conditions) may contribute to ITS use intention. Moreover, no previous research has examined students' actual use of ITSs. Therefore, the present study intends to provide more comprehensive information and contribute to the development of ITSs in K-12 education.

3 Conceptual framework

3.1 Traditional constructs of the TAM

In the context of ITS use, perceived usefulness reflects the extent to which students believe ITSs can enhance their English learning achievement (Davis, 1989). Perceived ease of use relates to students' perceptions of the difficulty level of ITS, for example, whether using ITS to learn English requires additional physical or mental effort (Karacı et al., 2018). Perceived usefulness was found to be the strongest predictor of students' inclination to adopt ITSs (Cao et al., 2021). Thus, the more students believe that ITSs help them learn better, the more likely they are to utilize ITSs. In addition, prior research demonstrated that perceived ease of use had a direct effect on students' perceived usefulness of ITSs (Cao et al., 2021; Huang et al., 2021) and on students' intention to continue using ITSs (Cao et al., 2021; Wang et al., 2020).

Acceptance intention describes users' psychological state before adopting an innovation (Davis, 1989). Many empirical studies have substituted intention with actual use (Wang et al., 2022). However, few have investigated the link between intention to use and actual use. Among these, Joo et al. (2014), Nikolopoulou et al. (2021), and Venkatesh et al. (2012) all stated that intention significantly impacted the actual use of mobile learning, mobile internet, and information technology. However, none of these studies focused on ITS usage in education. Based on the literature, we formulated the following hypotheses.

H1a: Perceived usefulness has a positive and direct influence on students' continuance intention of ITSs for English learning.
H1b: Perceived ease of use has a positive and direct influence on students' continuance intention of ITSs for English learning.
H1c: Perceived ease of use has a positive and direct influence on students' perceived usefulness.
H1d: Students' continuance intention of ITSs for English learning positively and directly influences their actual use of ITSs.

3.2 Motivational beliefs

Recent emphasis has been placed on incorporating motivational beliefs into the TAM (Abdullah et al., 2016; Açıkgül & Şad, 2021) since motivation significantly influences adaptation, learning, and competence and has been shown to be pivotal for e-learning adoption and success (Chen & Hu, 2020; Hatlevik et al., 2018; Li et al., 2021). Thus, it is necessary to investigate how motivational beliefs may influence students' acceptance of ITSs, which has not been previously studied related to students' intention to use ITSs. According to expectancy-value theory, students' learning intention is determined by their expectancy of achieving satisfactory outcomes (e.g., self-efficacy), subjective task values (e.g., intrinsic value), and achievement goals (e.g., goal orientation), which can predict students' desire

to engage in a learning activity (Bai et al., 2021; Wigfield, 1994). Thus, the present study integrated the four important motivational beliefs as new factors into the extended TAM.

Technology self-efficacy Self-efficacy refers to secondary students' confidence in using ITSs effectively for English learning activities (Compeau & Higgins, 1995). Previous research has indicated that self-efficacy is an important antecedent of perceived usefulness and perceived ease of use, affecting individuals' technology adoption behavior (Abdullah et al., 2016; Altalhi, 2021). For example, Zheng and Li (2020) discovered that middle school students' technology self-efficacy significantly influenced their perceived usefulness and perceived ease of use of tablet computers. We proposed the following hypotheses indicated by expectancy-value theory and the previous literature.

H2a: Technology self-efficacy has a positive and direct influence on students' perceived usefulness.
H2b: Technology self-efficacy has a positive and direct influence on students' perceived ease of use.

Perceived enjoyment Enjoyment is defined as the joyful experience of using ITSs for English learning, which excludes any academic performance repercussions associated with system usage (Venkatesh et al., 2003). Previous research has indicated that perceived enjoyment is a principal intrinsic motivator for adopting e-learning technologies (Abdullah & Ward, 2016). According to expectancy-value theory, students are intrinsically motivated to employ a technology when they experience delight and enjoyment throughout the usage process (Bai et al., 2021). Prior studies have provided evidence of the strong impact of perceived enjoyment on students' perceived usefulness and perceived ease of use of e-learning, as well as their continuance intention to employ e-learning (Gunasinghe et al., 2019; Li et al., 2021). Therefore, we propose the following hypotheses.

H3a: Perceived enjoyment has a positive and direct influence on students' perceived usefulness.
H3b: Perceived enjoyment has a positive and direct influence on students' perceived ease of use.

Technology anxiety Technology anxiety describes students' unpleasant emotional reactions to ITSs (Venkatesh et al., 2003). Using ITSs may not always result in joyful emotions but can also result in technology-related negative emotions. When students feel anxious about ITSs or have concerns about their performance, they are more hesitant to adopt ITSs for learning. Previous empirical research has established a negative association between technology anxiety, perceived usefulness (Purnomo & Lee, 2013; Zheng & Li 2020), and perceived ease of use (Bai et al., 2021; Jiang

et al., 2021). In agreement with the previous literature, we proposed the following hypotheses.

H4a: Technology anxiety has a positive and direct influence on students' perceived usefulness.
H4b: Technology anxiety has a positive and direct influence on students' perceived ease of use.

Learning goal orientation Goal orientation is a critical motivational belief that determines learners' academic performance and choice of different learning activities (Chatzoglou et al., 2009; Wigfield, 1994), which has attracted increasing interest in technology acceptance research (Yi & Hwang, 2003). Goal-oriented students tend to participate in an adaptive response pattern that involves perseverance, increased efforts, and self-instruction. The challenging level of a task is regarded as an opportunity for competence development (Yi & Hwang, 2003). In the context of ITSs, students with learning goals might perceive the challenge of learning new technological features as an opportunity to build self-confidence and competence, resulting in a greater tendency to embrace new technologies. Many studies have found that learning goal orientations positively influence the perceived ease of use, which further contributes to technology adoption (Chatzoglou et al., 2009; Loraas & Diaz, 2009). In this study, we also evaluated the possibility of a direct link between students' learning goal orientation and their continued intention to adopt ITSs. The following hypotheses were proposed.

H5a: Learning goal orientation has a positive and direct influence on students' perceived ease of use.
H5b: Learning goal orientation has a positive and direct influence on students' continuance intention of ITSs for English learning.

3.3 Facilitating conditions

Facilitating conditions (Venkatesh et al., 2003) are critical environmental characteristics that students perceive to receive from schools that may lead to more successful usage of ITSs, such as instruction, services, and technical infrastructure (Faqih & Jaradat, 2021). The determinant of facilitating conditions has been widely addressed in technology acceptance studies across diverse educational technologies, such as e-learning and mobile learning (Al-Nuaimi & Al-Emran, 2021; Bai et al., 2021). These studies have offered convincing evidence of the significance of facilitating conditions in making technology easy to use and, therefore, enhancing its adoption (Gyamfi, 2021). In the present study, the first time that the participating secondary students used ITSs for English learning was examined. Thus, students might face many technical difficulties and need assistance, such as instruction and services from the school and teachers. The degree of perceived facilitating support might

play an important role in their intention behavior. Thus, we propose the following hypothesis.

H6a: Facilitating conditions have a positive and direct influence on students' perceived ease of use.

3.4 Price value

Price value refers to individuals' perceived trade-off between the benefits and cost of using a technology (Venkatesh et al., 2012). Price value is linked to students' technology adoption behavior by making a cost−benefit judgment (Faqih & Jaradat, 2021). Bower et al. (2020) argued that the high cost might be a factor for the lack of deployment of some emerging technologies in teaching and learning, such as virtual reality. In ITS use, the perceived advantages and quality of ITSs compared to the price is another critical factor in understanding students' behavioral intentions. In the present study, we regarded that secondary students' cost−benefit judgment was an important determinant of their adoption intention. ITSs are a relatively new innovation in Chinese secondary schools. Bosom and Smart Learning (BLS) was presented to the research participants for the first time. After the free-use period, students need to decide whether they want to pay to continue using the system to facilitate English learning. Under these circumstances, the monetary value of the system becomes crucial. The choice and intention of students will be heavily impacted by their perceptions of the system's advantages relative to its monetary cost. When the perceived benefits outweigh the monetary cost, the price value is positive. As a result, students may regard ITSs as beneficial and are more likely to accept the system. Previous research has brought attention to the significant positive influence price value has on perceived usefulness (Mehta et al., 2019) and students' adoption behavior for mobile learning and e-learning (Alghazi et al., 2021; Gyamfi, 2021). Thus, we established the following hypotheses.

H7a: Price value has a positive and direct influence on students' perceived usefulness.
H7b: Price value has a positive and direct influence on students' continuance intention of ITSs for English learning.

3.5 Proposed model

Drawing on the extant literature, we proposed an extended TAM model (see Fig. 1) to provide more important information to understand the determinants affecting secondary students' intention to use and actual use of ITSs for English learning in the Chinese context. When applied to different subjects and contexts, the initial TAM is somewhat insufficient (Wang et al., 2022); thus, an extended TAM is necessary for the present study on ITSs. The proposed model is strong in predicting students' user behavior of ITSs from the individual (e.g., perceptions, motivation) and contextual (e.g., facilitating conditions, price value) perspectives and thus might be implemented in future research and diverse domains.

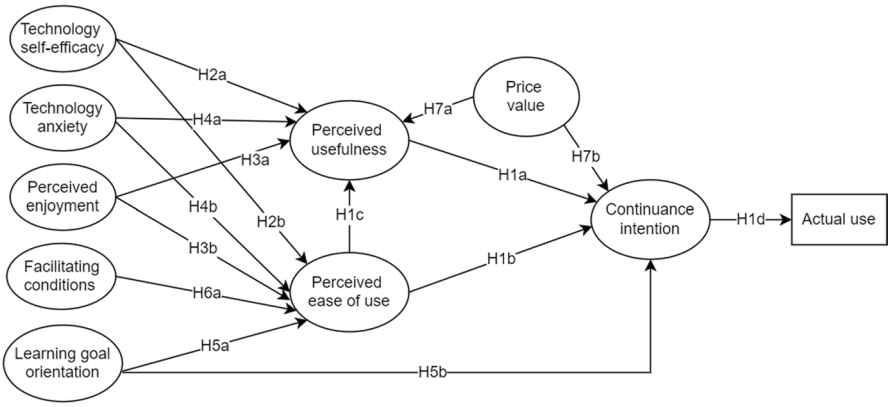

Fig. 1 The proposed model

4 Methods

4.1 Participants and data collection

The study used a convenience sampling method to collect data through a web-based online questionnaire survey. The invited participants were students at a suburban public senior secondary school in central China. Students in the school had no previous experience using ITSs for English learning. The study obtained ethical approval from the corresponding author's institution.

The school introduced BSL to all students for a 2-month free trial at the beginning of the autumn semester of 2021–2022. After the trial, students need to pay a subsidized rate to continue using it. Students could voluntarily decide whether they wanted to pay the price to continue using the system. This study distributed questionnaires during November and December 2021, immediately after the completion of the trial, to understand students' perceptions of the system and their continuance intention. After sending invitations, 544 students from Grades 10 and 11 agreed to participate in the survey. After data screening, 16 unengaged respondents were removed, and 528 submissions were deemed effective. The participants comprised 250 male students (47.3%) and 278 female students (52.7%), with an average age of 16.7 years old.

4.2 The BLS tutoring system

Each week, students attended ten 45-minute English classes in school. BLS aims to provide English instruction and tutoring services for students after class. BLS is a mobile-based ITS that students can access through their pads, tablets, or smartphones. The BLS is designed to facilitate secondary students' English learning in three aspects: homework, examination, and self-directed exercises. Figure 2 shows the features of the system.

For vocabulary-related homework, BLS provides students with a list of vocabulary and a detailed explanation of each word after each English session. BLS assigns basic

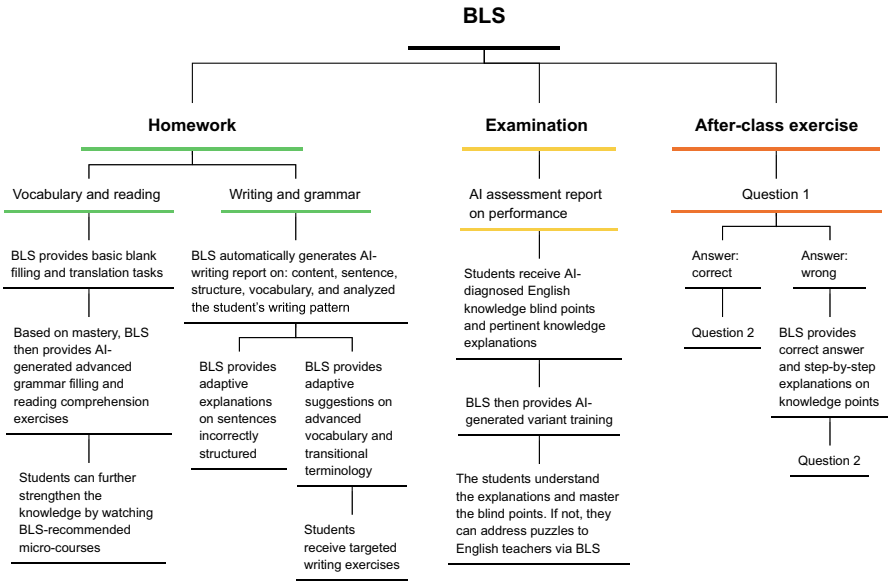

Fig. 2 BLS features

tasks, such as translation and grammar filling, to strengthen memory following this process. Then, based on students' vocabulary mastery, BLS uses the AI algorithm to generate advanced grammar filling and reading comprehension exercises focusing on unfamiliar words to further enhance vocabulary. For writing homework, BLS provides an AI report with detailed comments for each English composition on five dimensions: content, vocabulary, grammar, sentence, and structure. Incorrect grammar and sentences are highlighted to give explanations and remedies. The BLS also provides advanced vocabulary and transitional terminology choices depending on students' writing patterns. Later, students receive recommendations on targeted writing micro courses and exercises.

In terms of examinations, BLS integrates intelligent tutoring with online English examinations. After the exam, teachers can assess online papers using BLS. When students get their grades back, they receive the AI assessment report, which will help identify English knowledge blind spots and provide pertinent knowledge explanation and AI-generated variant training to assure mastery. After this AI-assisted learning process, students may understand the key knowledge points. They can address anything that is puzzling with their English teachers if they still have questions.

For self-directed exercises, the BLS provides an extensive electronic English exercise database in which students may review previously covered knowledge points, self-study new content, and assess their level of knowledge mastery. The system interacts with students by posing questions and providing textual instructions and intelligent voices to clarify answers and knowledge points. If students choose the correct answer, it will proceed to the following question. If they respond erroneously, BLS gives detailed, step-by-step explanations of the correct answer to help students better comprehend the material before moving on to the next question.

4.3 Measures

To better understand students' experiences with BLS, the present study involved 42 items on perceptions, motivational beliefs, facilitating conditions, price value, and continuance intention. Nine items were adapted from Davis (1989) and Huang et al. (2021) to measure perceived ease of use (e.g., I find it easy to use ITSs to facilitate my English learning) and perceived usefulness (e.g., using ITSs would improve my English performance). The four-item scale of continuance intention (e.g., I plan to continue using ITSs for my English learning) was drawn from Davis (1989) and modified to fit the context of ITSs for English learning. The Cronbach's α values of perceived ease of use, perceived usefulness, and continuance intention were 0.935, 0.969, and 0.940, respectively. The actual use of ITSs was measured in terms of time spent by students every day using ITSs for English learning. The options vary from "1 = never" to "2 = rarely (1–15 minutes)" to "3 = a few times (16–30 minutes)" to "4 = sometimes (31–45 minutes)" to "5 = often (46–60 minutes)"to "6 = frequently (more than 60 minutes)".

For motivational beliefs, the factors of ITS anxiety (e.g., I feel apprehensive about using ITSs in learning) and ITS enjoyment (e.g., ITSs make learning more enjoyable) were revised by Abdullah et al. (2016) and Bai et al. (2021) to fit in with the current context. The five-item self-efficacy scale was drawn from Compeau and Higgins's (1995) computer self-efficacy scale and then modified (e.g., I can use ITSs in my learning even if there is one around to show me how to do it). The five items measuring learning goal orientation were drawn from the Yi and Hwang (2003) scale (e.g., in the process of using ITSs, I am willing to select a challenging task). The Cronbach's α values of ITS anxiety, enjoyment, self-efficacy and learning goal orientation were 0.951, 0.953, 0.936, and 0.887, respectively. The following scales and items were adapted from Thompson et al. (1991) and Venkatesh et al. (2003, 2012) and were modified to fit with the use of ITSs: facilitating conditions (e.g., I can turn to a specific person (group) for assistance with ITS difficulties) and price value (e.g., ITSs are good value for the money). The Cronbach's α values of facilitating conditions and price value were 0.857 and 0.917, respectively. In the questionnaire, each item was scored on a 6-point Likert scale from "1" (strongly disagree) to "6" (strongly agree). All items on the scale were initially translated into Chinese and then back translated into English by the authors. After that, two experts in English education and three secondary students were invited to assess the content validity of the questionnaire to verify that expressions were readable and clear. A full list of the constructs can be found in Appendix 1.

4.4 Data analysis

SPSS 25.0 was first used for descriptive and bivariate correlation analyses. Second, confirmatory factor analysis (CFA) was used to evaluate the measurement model with Mplus 7.4. After checking the construct reliability, validity, and measurement model fit, we performed a structural equation model (SEM) to test the hypotheses above. Multiple fit indices were used for the model fitness, including the chi-square value per degree of

freedom ($\chi 2$/df), the comparative fit index (CFI), the Tucker−Lewis index (TLI), the root mean square error of approximation (RMSEA), and the standardized root means square residual (SRMR). According to previous literature, the model fit is acceptable (excellent) when CFI and TLI are more than 0.90 (0.95) (Hu & Bentler, 1999), RMSEA less than 0.08 (0.06) (Schreiber et al., 2006), SRMR less than 0.08 (0.05) (Bollen & Long, 1993), and $\chi 2$/df less than 5.00 (3.00) (Kline, 2015; Marsh & Hocevar, 1985).

5 Results

5.1 Descriptive results

Table 1 presents the descriptive statistics for the variables measured in the study. All constructs had skewness and kurtosis values of less than one. According to Kline (2015), data can be considered normally distributed when the skewness and kurtosis values are less than |3.00| and |8.00|, respectively. Thus, all the measurement constructs are continuous and normally distributed, providing a foundation for further SEM analysis. As shown in Table 2, all the factors were significantly associated with students' continuance intention to adopt ITSs in the correlation analysis. Perceived usefulness was most associated with continuance intention ($r = 0.774$), followed by price influence ($r = 0.668$) and perceived ease of use ($r = 0.648$).

5.2 The measurement model

CFA was used to evaluate the measurement model. All variables in the nine-factor measurement model were freely connected with one another. The measurement model fit was excellent: $\chi 2/df = 1.852$ ($p < 0.01$), CFI = 0.954, TLI = 0.949, RMSEA = 0.040,

Table 1 Descriptive data of the constructs

Constructs	Mean	Std. Deviation	Skewness	Kurtosis
TSE	4.584	0.970	-0.504	0.122
ANX	4.084	1.421	-0.658	-0.507
ENJ	4.681	0.931	-0.721	0.936
FC	4.323	0.980	-0.273	0.113
PV	4.034	1.092	-0.199	0.053
LG	4.975	0.751	-0.393	-0.234
PEU	4.205	1.083	-0.361	0.089
PU	4.348	1.016	-0.430	0.412
CI	4.373	0.977	-0.434	0.373
AU	3.800	1.384	-0.060	-0.840

TSE, technology self-efficacy; *ANX*, technology anxiety; *ENJ*, perceived enjoyment; *FC*, facilitating conditions; *PV*, price value; *LG*, learning goal orientation; *PE*U, perceived ease of use; *PU*, perceived usefulness; *CI*, continuance intention; *AU*, actual use

Table 2 Discriminant validity of the constructs

	TSE	ANX	ENJ	FC	PV	LG	PEU	PU	CI
TSE	**0.864**								
ANX	-0.161**	**0.892**							
ENJ	0.541**	-0.054	**0.898**						
FC	0.450**	-0.183**	0.627**	**0.776**					
PV	0.366**	-0.264**	0.575**	0.610**	**0.833**				
LG	0.398**	-0.113**	0.478**	0.369**	0.372**	**0.787**			
PEU	0.409**	-0.259**	0.498**	0.545**	0.623**	0.377**	**0.888**		
PU	0.429**	-0.293**	0.630**	0.566**	0.665**	0.423**	0.763**	**0.928**	
CI	0.399**	-0.226**	0.579**	0.551**	0.668**	0.408**	0.648**	0.774**	**0.902**

*$p<0.05$, **$p<0.01$

The diagonal items represent the discriminant index

SRMR = 0.038. As presented in Table 3, the factor loadings of the nine constructs ranged from 0.692 to 0.949. All factor loadings were above the recommended threshold value of 0.5 (Hair et al., 2009). We checked the composite reliability (CR) and AVE values for convergent validity. Table 3 shows that all CR and AVE values were well above the minimal values of 0.7 and 0.5, respectively (Fornell & Larcker, 1981), indicating that the measurement model had sufficient convergent validity. The results also demonstrated good discriminant validity (see Table 2). We concluded that the measurement model had a satisfactory fit based on the criteria.

5.3 Structural model

After confirming the reliability and validity, we developed a structural model using the measured variables and the accompanying items. The results suggested a satisfactory structural model fit: $\chi 2/df = 2.686$ ($p<0.01$), CFI = 0.939, TLI = 0.934, RMSEA = 0.057, SRMR = 0.046. Thus, the extended TAM of ITSs is well suited to the data. The findings supported 10 out of the 15 hypothesized paths. Figure 3 shows the links among the variables in the structural model.

Regarding the hypotheses on perceptions, the results showed that facilitating conditions (H6a, $\beta = 0.434$, $p<0.001$) and learning goal orientation (H5a, $\beta = 0.127$, $p<0.05$) were positively associated with perceived ease of use, while technology anxiety (H4b, $\beta = -0.154$, $p<0.001$) was negatively correlated with perceived ease of use. For perceived usefulness, perceived ease of use (H1c, $\beta = 0.494$, $p<0.001$), technology anxiety (H4a, $\beta = -0.103$, $p<0.001$), enjoyment (H3a, $\beta = 0.271$, $p<0.001$), and price influence (H7a, $\beta = 0.211$, $p<0.001$) all significantly predicted perceived usefulness. Thus, Hypotheses H1c, H3a, H4a, H4b, H5a, H6a, and H7a were supported. However, no association was found between enjoyment and perceived ease of use (H3b, $\beta = 0.085$). Neither perceived usefulness nor perceived ease of use was significantly influenced by technology self-efficacy. Higher self-efficacy in their abilities to perform ITSs did not lead to greater technology acceptance. Therefore, Hypotheses H2a, H2b, and H3b were rejected.

Table 3 Results of the measurement model

Construct	Items	Loading	CR	AVE
Perceived ease of use	PEU1	0.794	0.937	0.789
	PEU2	0.905		
	PEU3	0.939		
	PEU4	0.909		
Perceived usefulness	PU1	0.915	0.969	0.861
	PU2	0.930		
	PU3	0.942		
	PU4	0.926		
	PU5	0.926		
Technology anxiety	ANX1	0.938	0.951	0.795
	ANX2	0.941		
	ANX3	0.827		
	ANX4	0.859		
	ANX5	0.889		
Technology self-efficacy	SE1	0.825	0.936	0.747
	SE2	0.837		
	SE3	0.917		
	SE4	0.874		
	SE5	0.865		
Enjoyment	ENJ1	0.852	0.954	0.807
	ENJ2	0.936		
	ENJ3	0.949		
	ENJ4	0.888		
	ENJ5	0.862		
Facilitating conditions	FC1	0.802	0.857	0.602
	FC2	0.860		
	FC3	0.739		
	FC4	0.692		
Price value	PV1	0.799	0.919	0.694
	PV2	0.849		
	PV3	0.852		
	PV4	0.816		
	PV5	0.847		
Learning goal orientation	LG1	0.827	0.890	0.619
	LG2	0.783		
	LG3	0.805		
	LG4	0.806		
	LG5	0.709		
Continuance intention	CI1	0.897	0.946	0.814
	CI2	0.881		
	CI3	0.920		
	CI4	0.911		

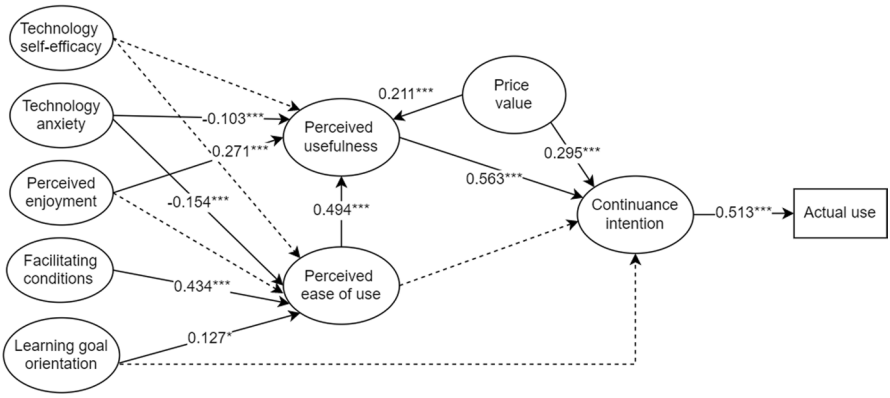

Fig. 3 Results of the final model

Concerning the impact on continuance behavior, perceived usefulness (H1a, $\beta = 0.563$, $p < 0.001$) and price value (H7b, $\beta = 0.295$, $p < 0.001$) positively influenced students' intention to continue using ITSs for English learning. However, the findings revealed that the direct path from perceived ease of use to continuance intention was insignificant (H1b, $\beta = 0.026$, $p = 0.715$). We found that the indirect effect size for perceived ease of use and continuance intention was 0.278. Thus, perceived usefulness fully mediated the effects between perceived ease of use and students' intention. Learning goal orientation (H5b, $\beta = 0.060$, $p = 0.106$) likewise fell short of the significance threshold but exerted an indirect influence on continuance intention via the mediating effects of perceived ease of use and perceived usefulness. Thus, Hypotheses H1a and H7b were supported. In terms of actual use, a direct and significant association was found between continuance intention and actual use (H1d, $\beta = 0.513$, $p < 0.001$), supporting Hypothesis H1d. A summary of the hypothesis results is presented in Table 4.

Table 5 summarizes the direct and indirect effects of the measured variables on secondary students' continuance intention to adopt ITSs for English learning. The model explained 43.3% of the variance in perceived ease of use, 71.2% of perceived usefulness, 69.6% of the total variance in students' intention to continue using ITSs, and 26.3% in students' actual use of ITSs for English learning.

6 Discussion

Based on an extended TAM model, this study aimed to investigate the effects of multiple factors, perceptions, motivational beliefs, facilitating conditions, and price value on Chinese secondary students' continuance intention, as well as their actual use of ITSs for English learning. Overall, most hypotheses supported the general portrayal of the model. Two determinants, perceived usefulness and price value, were found to directly affect students' intention to use ITSs for English learning. Students' perceptions mediated the relationships between facilitating conditions, motivational beliefs,

Table 4 Results of the hypotheses

Hypothesis	Path	β-value	Result
H1a	PU → CI	0.563***	Supported
H1b	PEU → CI	0.026	Not supported
H1c	PEU → PU	0.494***	Supported
H1d	CI → AU	0.513***	Supported
H2a	TSE → PU	-0.006	Not supported
H2b	TSE → PEU	0.079	Not supported
H3a	ENJ → PU	0.271***	Supported
H3b	ENJ → PEU	0.085	Not supported
H4a	ANX → PU	-0.103***	Supported
H4b	ANX → PEU	-0.154***	Supported
H5a	LG → PEU	0.127*	Supported
H5b	LG → CI	0.060	Not supported
H6a	FC → PEU	0.434***	Supported
H7a	PV → PU	0.211***	Supported
H7b	ANX → CI	0.295***	Supported

*$p<0.05$, **$p<0.01$, ***$p<0.001$

and continuance intention. In addition, students' continuance intention was found to be positively associated with their actual usage behavior of ITSs.

In accordance with TAM theory, this study confirmed that both perceived usefulness and perceived ease of use positively influenced secondary students' continuance intention to use ITSs for English learning. Perceived usefulness was found to have the greatest direct impact on intention ($\beta=0.563$, $p<0.001$). Chinese secondary students are under great English learning pressures because they must take the national English examination for college admission. Chinese schools and students welcome innovative techniques such as ITSs if they believe that employing new approaches will enhance their English performance. In this study, the BLS system uses the AI algorithm to analyze students' learning patterns and English levels. It provides personalized instructions to students in homework, examination evaluation, and after-class exercises, which may enhance students' learning effectiveness and efficiency, thereby increasing their continuance intention to use the system.

The finding that perceived ease of use strongly impacted perceived usefulness also echoed previous research (Davis, 1989; Wang et al., 2021), demonstrating that students adept at using ITSs tend to value the system's advantages for English learning. In contrast to some studies that found both direct and indirect effects of perceived ease of use (Abdullah et al., 2016; Cao et al., 2021), our results showed that perceived ease of use exerted only indirect effects on students' continuance intention. This insignificant effect of perceived ease of use on behavioral intention in our study was consistent with Bai et al. (2021) and Huang et al. (2021). One potential explanation may be that Chinese secondary students may not opt to use ITSs merely because it is effortless. Chinese secondary students may place a higher value on the advantages of ITSs than on the simplicity of use to achieve greater English academic gains (Zheng & Li, 2020). Thus, students may still choose to adopt ITSs even if they

Table 5 Results of the structural model

	Perceived ease of use		Perceived usefulness			Continuance intention		
	Direct effects	Indirect effects	Direct effects	Indirect effects	Total effects	Direct effects	Indirect effects	Total effects
Technology anxiety	-0.154***	–	-0.103***	-0.076**	-0.179***	–	-0.105***	-0.105***
Technology self-efficacy	0.079	–	-0.006	0.039	0.033	–	0.021	0.021
Perceived enjoyment	0.085	–	0.271***	0.042	0.313***	–	0.179***	0.179***
Facilitating conditions	0.434***	–	–	0.215***	0.215***	–	0.132***	0.132***
Learning goal orientation	0.127*	–	–	0.063*	0.063*	0.060	0.039*	0.098**
Price value	–	–	0.211***	–	0.211***	0.295***	0.119**	0.413***
Perceived ease of use	–	–	0.494***	–	0.494***	0.026	0.278***	0.305***
Perceived usefulness	–	–	–	–	–	0.563***	–	0.569***
R^2	0.433***	–	0.712***	–	–	0.696***	–	–

*$p<0.05$, **$p<0.01$, ***$p<0.001$

find the systems difficult to use as long as they believe that using them will improve their English proficiency.

Among the four motivational beliefs, technology anxiety was found to have a direct negative association with both perceived usefulness and perceived ease of use. This finding was in line with most past studies (Venkatesh et al., 2003; Zheng & Li 2020). This was the first time that secondary students had used ITSs for English studies. It is plausible that students might have been unfamiliar with the system and felt apprehensive about using it. The anxiety might make have made ITSs more challenging for students and prevented them from making full use of the system. Enjoyment was found to have a significant direct impact on perceived usefulness. Students who enjoy using ITSs are more likely to recognize the benefits of using the system for English learning (Li et al., 2021; Sun & Gao, 2020). However, no significant correlation was found between perceived enjoyment and perceived ease of use. This nonsignificant impact on enjoyment did not come as a surprise, given that earlier research reported that greater enjoyment in e-learning would not lead to increased perceived ease of use (Jiang et al., 2021; Mehta et al., 2019). In addition, as hypothesized, learning goal orientation positively and directly predicted students' perceived ease of use of ITSs. When students view the process of using ITSs as a learning opportunity and embrace challenges as growth possibilities, they are more inclined to find the systems easy to use. This finding was in line with most prior studies (Chatzoglou et al., 2009; Loraas & Diaz, 2009).

Moreover, this study discovered that the mediation of perceptions, anxiety, enjoyment and learning goal orientation indirectly affected students' intention to continue using ITSs for English learning. The findings verified enjoyment as a positive predictor and anxiety as a negative predictor in interpreting students' intention (Bai et al., 2021; Li et al., 2021). These relationships need to be given greater attention in an effort to understand the significance of students' emotional states on their ITS adoption behavior. In addition, learning goal orientation, which received little attention in previous ITS studies, is an influential predictor in understanding adoption behavior. Hence, it merits further investigation in future research.

While technology self-efficacy has been identified as a critical predictor in some prior research (Bai et al., 2021; Venkatesh et al., 2012; Zheng & Li, 2020), our results demonstrated no significant impact of self-efficacy on either perceived ease of use or perceived usefulness. This finding was consistent with some recent e-learning-related studies, such as Jiang et al. (2021). Secondary students' confidence in their abilities to use ITSs may not affect their perceptions of whether ITSs are beneficial or simple. There might be some possible explanations. For example, in a meta-analysis, Abdullah & Ward (2016) identified self-efficacy as one of the five most commonly used predictors in the TAM model. However, 17 out of the 27 reviewed studies (63%) revealed a lack of significant correlation between self-efficacy and perceived ease of use. In addition, Chinese secondary students in the present study received weekly computer classes and additional instruction on utilizing ITSs to facilitate their English learning process. Therefore, technology self-efficacy might not be a major predictor of students' perceptions and behavioral intention when every student has received training and developed technological competence. More empirical research may be needed to reconsider the role of self-efficacy in the current information era when students are considered digital natives (Lee et al., 2020).

Aligned with previous research (Faqih & Jaradat, 2021; Gyamfi, 2021), this study confirmed that facilitating conditions positively influenced students' perceived ease of use of ITSs. Via the mediation of perceived ease of use, facilitating conditions significantly predicted students' continuance intention. The findings highlighted the significance of technical infrastructure and organizational support in increasing students' inclination to adopt ITSs for English learning. Because ITS is a relatively new technology implemented in Chinese secondary schools, students may find challenges using the system for English learning. Students' acceptance of ITSs may be impeded if there is a lack of resources and guidance available to them. Our findings emphasize that schools need to provide technological resources, staff assistance, and other support to decrease obstacles and promote the implementation of ITSs.

Moreover, price value was proposed as a direct determinant of secondary students' perceived usefulness and continuance intention of ITSs for English learning, consistent with previous research on e-learning (Alghazi et al., 2021; Mehta et al., 2019). In reality, not all schools in China have enough budgets to implement well-designed ITSs to facilitate learning. As was the case in the present study, students still need to pay for continuous use of the system, notwithstanding school subsidies. Consequently, students intend to continue using ITSs based on an appraisal of the system's financial cost and the potential academic benefits. Despite its significance, price value's role has received scant attention in ITS-related research. This study highlighted the importance of price influence and the necessity for schools and governments to provide additional financial support for students.

Finally, regarding actual usage behavior, the continuance intention to use ITSs significantly affected students' actual use of ITSs for English learning ($\beta = 0.513$, $p < 0.001$), which supports the TAM (Davis, 1989) and empirical studies by Anthony et al. (2021) and Joo et al. (2014). The actual use of ITSs was measured by students' use time in this study. Thus, the results suggested that the more Chinese secondary students intend to use ITSs for English learning, the more often they use the system. As students' continuance intention was influenced by their perceptions of the benefits and usability of the system, their perceived anxiety and enjoyment toward ITSs, their learning goal orientation, outside facilitating conditions, and the price of ITSs, schools should examine these precursors to increase the usage level of ITSs among secondary students.

7 Conclusion and implication

This study proposed a model to investigate secondary students' behavioral intention to use ITSs for English learning. The model investigated the determinants of perceptions (perceived usefulness and perceived ease of use), motivational beliefs (technology self-efficacy, perceived enjoyment, anxiety, and learning goal orientation), facilitating conditions, and price value on students' continuance intention to use and actual use of ITSs for English learning. The extended TAM model had good predictive power by explaining 69.6% of the total variance.

This study has both theoretical and practical implications. Theoretically, since no empirical research has been conducted on students' intention to implement ITSs and

their actual use of ITSs in the specific language learning domain, it contributes to a deeper understanding of secondary students' use behaviors of ITSs for English studies in China and even beyond. Second, although the TAM has been extensively used as a robust model for explaining technology acceptance, the current tendency in research is to expand the model by adding more predictors to improve its predictive power (Abdullah & Ward, 2016; Venkatesh et al., 2003). This study is an important endeavor to expand the literature by incorporating multiple factors into TAM to examine the impact of motivational beliefs and contextual factors on students' continuance intention. Factors such as anxiety, learning goal orientation, facilitating conditions, and price value are new factors that have not been previously explored in ITS-related research. This extended TAM was empirically validated and showed good predictive power, which may provide some theoretical implications for future technology adoption studies.

Practically, the study has important implications for schools, teachers, and system developers to improve students' learning experiences with ITSs, hence promoting ITS adoption. First, the study confirmed the significant impact of perceived usefulness and perceived ease of use. Therefore, schools and system developers should publicize the advantages of ITSs for English learning. In addition, students should be provided with an intuitive and user-friendly system interface to facilitate efficient and effective learning, hence increasing their intention to adopt ITSs. Second, the study highlighted the importance of motivational beliefs on perceptions and intention. To increase students' enjoyment, it is essential to design ITSs with more engaging features and interesting tasks. In addition, greater attention should be given to students' emotional states. To reduce anxiety, the way forward is to educate students so that they are well prepared and aware of the benefits of adopting ITSs to boost learning. It is of paramount importance for schools and teachers to encourage students to embrace new tasks and challenges and develop a learning goal orientation to accept the use of an innovative system. The utilization of ITSs is not predetermined but can be improved with practice. Third, given the powerful influence of facilitating conditions, system developers need to provide communicative means of responding to students' inquiries. Moreover, schools and teachers must provide prompt support to students who fail to successfully implement the system. With greater assistance and resources, students will be more inclined to embrace ITSs. Fourth, the study confirmed that price value directly influenced perceived usefulness and continuance intention. Given the benefits of ITSs in facilitating English learning (Xu et al., 2019), schools may consider investing more in introducing ITSs to students. Governments at different levels need to support schools financially by introducing ITSs, especially those with low SES. These actions will increase the adoption rate of ITSs among students by enhancing their cost−benefit estimation.

The present study has a number of limitations. First, the study is constrained by the lack of representativeness of the sample since all participants came from one school. Future research may use extensive sampling to extend the frontiers of investigation to increase generalizability. Second, the data collected were cross-sectional. In the future, longitudinal data may be collected to help explain the causality. Third, students' intention does not equal their actual usage behavior. The study incorporated an outcome variable on the actual use of ITSs. The data were based on students' self-reported use frequency, which might lack accuracy and introduce self-reported bias. More research is needed to gather data such as system log files to investigate students' actual usage

of ITSs to provide more interesting findings. Finally, although the study attempted to explore how multiple factors affected students' adoption behavior of ITSs, we must acknowledge that other variables, such as teacher support, may also play a role but were not included in the study. Future research may consider elaborating on the critical factors regarding students' adoption of ITSs.

Appendix 1 Constructs and items

Perceived ease of use

1 I find ITSs to be flexible to interact with for my English learning
2 It would be easy for me to become skillful at using ITSs for English learning
3 I find it easy to use ITSs to facilitate my English learning
4 Learning how to operate ITSs for English learning is easy for me

Perceived usefulness

1 Using ITSs would improve my English performance
2 Using ITSs would enhance my effectiveness in English learning
3 Using ITSs would increase my productivity in English learning
4 Using ITSs would allow me to accomplish English learning tasks more quickly
5 Using ITSs would improve the quality of English tasks I do

Continuance intention

1 I plan to continue using ITSs for my English learning
2 I will pay for ITSs to assist my English learning in the future
3 I plan to use ITSs more frequently for my English learning
4 I think ITSs should be used more in English classes

Technology self-efficacy
I can use ITSs in my learning,

1 even if there is no one around to show me how to do it
2 even if I have never used it before
3 even if I have only the software manuals for reference
4 even if I have just the built-in help facility for assistance
5 even if I have only seen someone else using it before trying it myself

Perceived enjoyment

1 I am interested in ITSs
2 The actual process of using ITSs is fun
3 ITSs make learning more enjoyable

4 ITSs make learning entertaining
5 I prefer using ITSs while learning

Anxiety

1 I feel apprehensive about ITSs in learning
2 Using ITSs is intimidating for me
3 ITSs make me feel uncomfortable
4 I am easily to get frustrated in using ITSs
5 I hesitate to use ITSs for fear of making mistakes that I cannot correct

Learning goal orientation
In the process of using ITSs,

1 I am willing to select a challenging task
2 I look for opportunities to develop myself
3 I enjoy challenging and difficult
4 I like developing my work ability
5 I prefer to work in situations

Facilitating conditions

1 I have resources necessary to use ITSs for learning
2 I can turn to a specific person (group) for assistance with ITSs difficulties
3 Specialized instructions concerning ITSs are always available to me
4 There is always support when I need help using ITSs

Price value

1 ITSs are affordable
2 ITSs are reasonably priced
3 ITSs are good value for the money
4 I am willing to pay additional prices for more advanced ITSs services
5 I think the cost for ITSs are worthy considering the good value delivering

Data availability We make sure that all data complies with field standards. Information on data generation and analysis is included in the paper and supplementary materials.

Declarations

Conflict of interest The authors report no conflict of interest.

Ethical approval The study followed the guidelines for Survey and Behavioral Research Ethics (SBRE) and obtained ethical approval from the Chinese University of Hong Kong.

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