




Understanding college students' continuous usage intention of asynchronous online courses through extended technology acceptance model

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Abstract

Asynchronous online learning has gained great popularity in higher education, especially due to the recent COVID-19 pandemic. However, few studies have investigated how to maintain students' continuous usage intention of asynchronous online courses in the context of higher education. This study incorporated four key factors (intrinsic motivation, extrinsic motivation, perception of multiple sources, and cognitive engagement) associated with students' continuous usage intention of asynchronous online courses into technology acceptance model (TAM) to identify the influencing factors on students' continuous usage intention. A survey with 325 college students was conducted to explore their continuous usage intention of asynchronous online courses and structural equation modeling analysis was carried out to analyze the relationships between the key influencing factors and students' continuous usage intention. The results showed that cognitive engagement was the only factor that directly related to continuous usage intention. Intrinsic motivation, extrinsic motivation, and perception of multiple sources indirectly correlated with students' continuous usage intention through different pathways. The results of the study have several theoretical and practical implications. Theoretically, the study verified what key learning factors incorporated into TAM and in what way they relate to the continuous usage intention of asynchronous online courses. Practically, the present study indicated that it is required to take intrinsic motivation, extrinsic motivation, perception of multiple sources, cognitive engagement and TAM into consideration when designing and conducting asynchronous online learning courses to ensure college students' continuous usage intention of asynchronous online courses.

Keywords Asynchronous online learning · Continuous usage intention · Technology acceptance model · Intrinsic motivation · Extrinsic motivation · Perception of multiple sources · Cognitive engagement

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1 Introduction

1.1 Background

Due to the recent COVID-19 pandemic, online learning has become a necessary and irreplaceable learning format in almost all educational settings, including universities, colleges, and K-12 (Bai & Gu, 2022; Zhang et al., 2022). Among different online learning formats, asynchronous online learning (AOL) has gained increasing attention in higher education because it enables learning without limitation of geography, locations, and time (Kim et al, 2021). In the asynchronous online learning, students learn content presented in different formats (including video, audio, text, and so on) that was prepared by the instructor in advance and delivered through a specific learning management system; in addition, the interaction among learners and instructors takes place asynchronously (Kim & Kim, 2021).

When learning in asynchronous online format, students can study course content at any time they want and choose any learning strategies they want, without being disrupted by external factors. Moreover, the asynchronous interaction allows students to have more time to engage deeply and reflect thoroughly on the learning content, which is helpful to improve students' understanding of learning concepts and their higher-order thinking skills (Kim et al, 2021; Meyer, 2003). Although AOL has many advantages, it has some limitations too. For example, due to the delayed interactions with their classmates and instructors, some students often experience a sense of isolation (Hart, 2012; Moody, 2004) in AOL and are not so engaged with the learning content throughout the course (Jo et al., 2015; Kim et al, 2021). Such issues have a direct and negative effect on learning outcomes.

When learning in AOL context, students' continuous learning intention is very important even more important than their initial acceptance of AOL in order to achieve better learning outcomes in the courses. However, until now, to the best of our knowledge, the question how to maintain students' continuous learning intention in AOL in higher education remains to be answered. Without knowing students' continuous usage intention of AOL courses, it is difficult for instructors to develop asynchronous online learning courses most effectively and to find useful strategies to keep students' continuous learning interest in AOL courses. Thus, there is a great need for us to figure out what are the key factors that influence students' continuous usage intention of AOL courses and in what ways.

Due to its self-paced learning environment, asynchronous online learning puts forward higher requirements for students' learning autonomy (Kim et al., 2018). As Ushioda contended "without motivation, there is no autonomy" (1996, p. 40); therefore, there is a great link between learning autonomy and motivation (Liu, 2012). Moreover, in the asynchronous online learning courses, it is needed for students to plan and manage their own learning process independently (Broadbent & Poon, 2015), as well as to understand learning content, to complete learning tasks and so on, which needs good participation of students and their cognitive

engagement. In other words, during the asynchronous online learning process, students' cognitive engagement plays a vital role. Thus, there is a great need for us to pay close attention to students' learning motivation and cognitive engagement in the asynchronous online learning context. Furthermore, there are usually multiple learning sources in the asynchronous online learning courses. Facing the diversity of resources in the online course, students have different perceptions, and the question "whether students' perception toward the multiple learning sources would affect their continuous usage intention" still needs to be answered. To address this question, the present study will take such variable as the perception on multiple sources into account in order to investigate its influence on continuous usage intention in the asynchronous online learning context.

The classical theoretical technology acceptance model (TAM) (Davis, 1989) has been adopted in previous studies to test users' intentions to use technology continuously (Hsu & Lin, 2022; Oyman et al., 2022). However, existing constructs of TAM and extended versions of the model in earlier studies were insufficient to identify students' continuous usage intentions in the context of asynchronous online learning context. From this aspect, it is important and necessary to incorporate the key factors that influence students' continuous usage intention of asynchronous online learning into TAM in the higher education context and to identify the relationship between these key influencing factors.

1.2 Research purpose

Based on the above analysis of existing studies, the research purposes of the present study are to:

- (1) Review related theories to propose a structural research model to understand students' continuous usage intention of asynchronous online courses in higher education based on TAM.
- (2) Investigate the relationships between the key variables of the proposed structural research model of students' continuous usage intention of asynchronous online courses in higher education.

2 Theoretical framework and hypotheses development

2.1 Theoretical framework

In this study, the classical TAM (Davis, 1989) was used as the theoretical framework. This TAM framework was used to predict users' acceptance of a new technology, and the acceptance is defined by the degree to which they intend to use or continue to use the new technology. TAM has been well-recognized and validated to analyze students' and instructors' behaviors relating to the use of new technologies in various educational contexts, including students' continuous intention to engage in the mobile-assisted language learning context (Hsu & Lin, 2022), teachers'

intention to use a digital game (Yeo et al., 2022), students' intention to use virtual reality (Fussell & Truong, 2022) and so on.

The TAM framework consisted of four key variables, including perceived ease of use, perceived usefulness, attitude toward using, and intention to use technology. *Perceived ease of use* is defined as “the degree to which a person believes that using a particular system would be free of effort” (Davis, 1989, p. 320). *Perceived usefulness* is defined as “the degree to which a person believes that using a particular system would enhance his or her job performance” (Davis, 1989, p. 320). *Attitude toward using* refers to “an individual's positive or negative feelings about performing the target behavior” (Davis et al., 1989, p. 984). *Intention to use* is defined as “a measure of the strength of one's intention to perform a specified behavior” (Davis et al., 1989, p. 984).

This study extended the TAM by incorporating several key learning factors (including intrinsic motivation, extrinsic motivation, perception of multiple sources and cognitive engagement) related to asynchronous online learning. We aimed to create a theoretical framework that can predict key learning factors that impact college students' continuous usage intention of asynchronous online courses.

2.2 Learning motivation and TAM

Learning motivation is a crucial factor in learning process, and it has been paid much attention to in the field of educational psychology (Lu et al., 2022; Lu et al., 2021a, b; Ryan & Deci, 2000; Sun & Gao, 2020). Learning motivation refers to the process whereby goal-directed activity is instigated and sustained (Pintrich et al., 1991). There are two main types of learning motivation, including intrinsic and extrinsic motivation. Intrinsic motivation is defined as “the degree to which the student perceives herself to be participating in a task for reasons such as challenge, curiosity, mastery” (Pintrich et al., 1991, p9), while extrinsic motivation complements intrinsic motivation and it refers to “the degree to which the student perceives herself to be participating in a task for reasons such as grade, rewards, performance, evaluation by others, and competition” (Pintrich et al., 1991, p10). In other words, students with intrinsic learning motivation tend to satisfy their inner thirst for knowledge, while those with extrinsic learning motivation tend to satisfy their need for good learning performance or learning outcome (Ryan & Deci, 2000).

Referring to the relationship between learning motivation and the key factors of TAM, previous studies found that intrinsic motivation had significant influence both on perceived ease of use and perceived usefulness in different e-learning environments. For example, Sun and Gao (2020) found that students' intrinsic motivation was positively related to students' perceived usefulness of mobile devices. Hsu and Lin (2022) found that in mobile-assisted language learning, both students' perceived ease of use and perceived usefulness positively correlated with intrinsic motivation. As scholars stated, students with intrinsic motivation tended to spend more time on learning tasks, which resulted in more productive work and higher cognitive processing (Fagan et al., 2008). Thus, in the asynchronous online courses, we believe students with greater degree of intrinsic motivation may tend to engage in

the learning activities more and underestimate the difficulty of using asynchronous online courses (Hsu & Lin, 2022).

Furthermore, previous studies also found that extrinsic motivation was positively related to perceived usefulness and perceived ease of use. For example, Moon and Kim (2001) found that it is needed to reflect students' extrinsic motivation in designing user interface, which is the key to increase the usability of world-wide-web. Fagan et al. (2008) found that extrinsic motivation was positively related to perceived ease of use when investigating students' intention to use computers. Based on the self-determination theory, intrinsic motivation was related to users' persistence behavior toward interest-driven tasks, while extrinsic motivation was correlated with users' persistence behavior toward effort-driven tasks (Gagné & Deci, 2005). In the asynchronous online courses, learning tasks may not always be of interest to students; thus, students' extrinsic motivation plays an important role in their continuous usage intention of asynchronous online courses as in other technology-enhanced learning contexts.

Based on the above mentioned analyses of the literature, we hypothesized the following:

Hypothesis1 (H1): Students' intrinsic motivation is positively related to perceived usefulness of asynchronous online learning courses in higher education.

Hypothesis2 (H2): Students' intrinsic motivation is positively related to perceived ease of use of asynchronous online learning courses in higher education.

Hypothesis3 (H3): Students' extrinsic motivation is positively related to perceived usefulness of asynchronous online learning courses in higher education.

Hypothesis4 (H4): Students' extrinsic motivation is positively related to perceived ease of use of asynchronous online learning courses in higher education.

2.3 Perception of multiple sources and TAM

In asynchronous online learning courses, there are usually multiple learning resources in different formats (e.g. video, audio, figures and so on) provided to students. Students' perception of multiple sources in asynchronous online learning context refers to the extent by which they perceive online asynchronous learning courses provide opportunities for accessing multiple learning sources (MacLeod, et al., 2018; Tsai et al., 2012).

When it comes to the relationship between perception of multiple sources and TAM, previous studies had investigated the relationship between perception of multiple sources and perceived usefulness. For example, Anyim (2020) examined the relationship between students' perception of electronic resources and their usefulness in the distance learning context. Scholars found that electronic resources were useful, since electronic resources could provide unlimited information from different sources. Caffaro et al. (2020) investigated the relationship between formal and informal sources of information and their perceived usefulness. The research result showed that both formal and informal information had significant influence

on perceived usefulness in the context of smart farming technologies. Formal information was positively related to perceived usefulness whereas informal information was negatively related to perceived usefulness. In asynchronous online learning courses, most of the learning sources are formal, thus we hypothesized that:

Hypothesis5: (H5): Students' perception of multiple sources is positively related to perceived usefulness in the asynchronous online learning context in higher education.

2.4 Cognitive engagement and TAM

Cognitive engagement refers to the extent of effort in learning with strategic and self-regulated learning (Fredricks et al., 2004). In asynchronous online learning courses, learners are required to plan and manage their own learning process independently and use self-regulated strategies (Broadbent & Poon, 2015), as well as to understand the learning content, to complete learning tasks and so on. All of this needs good students' participation and cognitive engagement. Thus, it is very important to examine the relationship between cognitive engagement and TAM in the asynchronous online learning context.

When investigating the relationship between cognitive engagement and TAM, existing research had examined the relationship between different factors of TAM and cognitive engagement. For example, Liang et al. (2014) found that there was a significant positive relationship between cognitive engagement and students' perceived usefulness in the Massive Open Online Courses (MOOCs) context. Jung and Lee (2018) also verified that students' learning engagement was positively related to perceived usefulness in MOOCs context. Moreover, Saadé and Bahli (2005) found that students' cognitive absorption was shown to be positively related to both perceived usefulness and perceived ease of use when study with the help of Internet-based learning systems. Agarwal and Karahanna (2000) also found that students' absorption was positively correlated with both perceived usefulness and perceived ease of use in the world wide web context. In the asynchronous online courses, we need to pay great cognitive efforts when students learn complex and difficult knowledge and content. When asynchronous online courses are easy to use and are of practical use to students, students will spend less time on how to use the course and more time focusing on the course content itself. Thus, we believe that their cognitive engagement can increase.

Referring to the relationship between cognitive engagement and continuous usage intention, previous studies found that cognitive engagement was correlated with positive experiences (Hollebeek et al., 2014), which motivated the usage of mobile services (Holbrook, 2006). This finding was also verified by previous studies in the MOOC context (Breslow et al., 2013; Pursel et al., 2016). For example, Breslow et al. (2013) found that most students who received a certificate in MOOC were

actively engaged in the course forums. In other words, active engagement in MOOC was positively related to continuous usage. What is more, MOOC is one type of asynchronous online courses; thus, it can be inferred that there was a positive relationship between cognitive engagement and continuous usage intention in the asynchronous online learning context.

What is more, in the TAM model, students' perceived ease of use is positively related to perceived usefulness. This result has been verified in different contexts, including mobile-assisted language learning context (Hsu & Lin, 2022), K-MOOCs context (Joo et al., 2018), learning management system context (Erслан & Kutlu, 2019), and so on. In this study, we also inferred that perceived ease of use is positively related to perceived usefulness in the asynchronous online learning context.

Based on the analysis of the literature, we hypothesized that:

Hypothesis6 (H6): Students' perceived ease of use is positively related to perceived usefulness of asynchronous online learning courses in higher education.

Hypothesis7 (H7): Students' perceived usefulness is positively related to cognitive engagement in the asynchronous online learning courses in higher education.

Hypothesis8 (H8): Students' perceived ease of use is positively related to cognitive engagement in the asynchronous online learning courses in higher education.

Hypothesis9 (H9): Students' cognitive engagement is positively related to continuous usage intention in the asynchronous online learning courses in higher education.

The research model of this study was proposed. As can be seen in Fig. 1, the assumptive relationships between each variable were also presented.

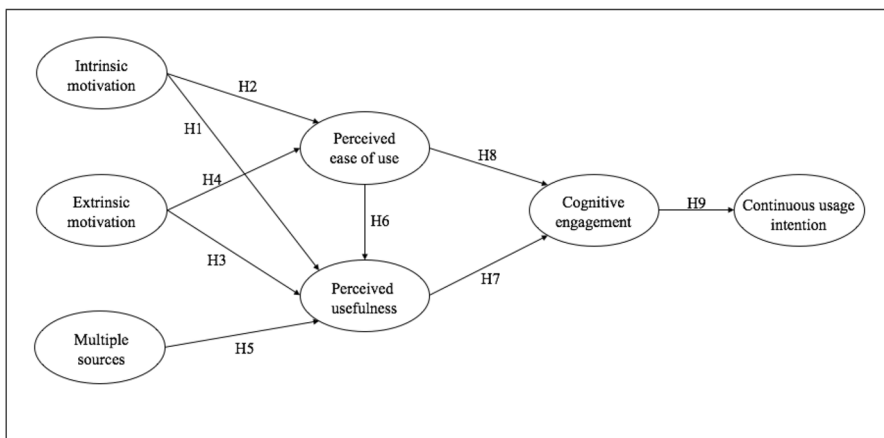


Fig. 1 The research model

3 Methodology

3.1 Research design

This study adopted a mixed methods research design to explore students' intrinsic motivation, extrinsic motivation, perception of multiple sources, perceived usefulness, perceived ease of use, cognitive engagement, and continuous usage intention as well as to investigate the relationship between these key variables and students' continuous usage intention of asynchronous online courses. In this study, we sought to use questionnaires to collect the data and then to use a statistical method to study the relationship among research variables.

3.2 Participants

A total of 325 students from higher education who had asynchronous online learning experiences participated in this study. Nine individuals' responses were removed from data analysis because they were incomplete. Thus, the valid response rate was 97.2%. Among the 316 participants, 133 were men (42.09%) and 183 were women (57.91%). 133 participants (42.09%) majored in liberal arts and 180 (57.91%) in science.

Because of the COVID-19 pandemic, college students in China had to study online. Participants ranged from freshmen to second-year master degree students. The online survey was administered in the Spring of 2022. The participants had asynchronous online learning experiences for at least one semester.

During the asynchronous online learning process, first, the related learning objectives, learning materials, learning tasks and course tests of one specific course were introduced to students by the instructor in the pre-agreed learning platform step by step. Students could learn these materials according to their own pace. But, they were required to submit the homework, complete the assignments and tests before the deadline. When they encountered problems in the learning process, students could post these problems in the discussion board of the platform or send private messages to their classmates or instructors. Their classmates and instructors would respond to them when they log into the platform. At last, when students finished all the learning assignments, the platform would give students a grade, which was given according to their academic performance in the learning process. It included the completion of learning assignments, homework, interaction with classmates and instructors and so on.

3.3 Instruments

The questionnaire survey consisted of two parts. The first part was used to collect participants' demographic data. The second part was used to measure students' perceptions of the key variables of the proposed research model, i.e.

intrinsic motivation, extrinsic motivation, perception of multiple sources, perceived usefulness, perceived ease of use, cognitive engagement, and continuous usage intention.

Learning motivation Students' intrinsic and extrinsic motivation were respectively measured by three items adapted from Wang and Chen (2010). Each item was scored on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). "In asynchronous online learning courses, I prefer course material that arouses my curiosity, even if it is difficult to learn" is one representative sample item to measure intrinsic motivation. "Getting a good grade in asynchronous online learning courses is the most satisfying thing to me" is one representative sample item to measure extrinsic motivation.

Perception of multiple sources Students' perception of multiple sources was measured by three items adapted from MacLeod et al. (2018). Each item was scored on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). One representative sample item to measure perception of multiple sources is "In asynchronous online learning courses, various information sources were permitted to be explored during learning."

Perceived usefulness and perceived ease of use Students' perceived usefulness and perceived ease of use were respectively measured by three items adapted from MacLeod et al. (2018), because this scale was closer to the characteristics of asynchronous online courses of the present study. Each item was graded on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). "Asynchronous online learning courses can benefit my learning experience" is one representative sample item to measure perceived usefulness. "In asynchronous online learning courses, I can use technology which is easy to navigate" is one representative sample item to measure perceived ease of use.

Cognitive engagement Students' cognitive engagement was measured by three items from the scale developed by Fredricks et al. (2004; 2005) which was later modified by Sun and Rueda (2012). Each item was graded on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). "When I read the asynchronous online learning course materials, I ask myself questions to make sure I understand what it is about" is one representative sample item to measure cognitive engagement.

Continuous usage intention Students' continuous usage intention was measured by three items adapted from Lv et al. (2022). Each item was graded on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). "I will continue to use asynchronous online learning, not calling for anyone's help" is one representative sample item to measure continuous usage intention.

3.4 Data collection and analysis

To collect the data, an online survey was conducted between April 8, 2022 and April 18, 2022 at two universities in Mainland China. Before the survey, all the students were told that their questionnaire results would not affect their academic achievement. The participants completed the survey voluntarily and anonymously. The online questionnaire platform (<https://www.wjx.cn>) was used to collect the data. This platform is popular in China and is widely used in academic settings such as universities. Approximately 8–10 minutes was needed to complete the questionnaire. All responses were entered into SPSS 21.0 and AMOS 21.0 for data analysis. The structural equation modeling analysis was conducted to analyze the relationships between the key influencing factors and students' continuous usage intention.

4 Results

4.1 Confirming the measurement model

In this part, the research model of the present study was estimated via the structural equation modeling analysis. Before analyzing the relationships between the key variables in the research model, it is needed to evaluate the overall fit of the model (Ullman & Bentler, 2012), that is confirming the measurement model. Only the overall fit of the model was within the acceptable range, so the correlation analysis between each variable in the research model could be effective.

The measurement model was assessed by goodness-of-fit, construct reliability, construct validity, and discriminant validity. Goodness-of-fit was determined based on GFI, CFI, TLI, RMSEA and SRMR. As presented in Table 1, all model fit statistics were within the acceptable ranges (Hair et al., 2010). The value of χ^2/df was 1.579, i.e. it was less than 3, which was within the acceptable range. The value of GFI, CFI, TLI were 0.925, 0.976, and 0.971 respectively, i.e. all values were over 0.90. While the value of RMSEA and SRMR were 0.043 and 0.072 respectively, i.e. they both were less than 0.08. This demonstrates that the measurement model exhibits satisfactory values.

Convergent validity is the extent to which a measure correlates positively with alternative measures of the same construct (Hair et al., 2021). It was determined through average variance extracted (AVE). Reliability refers to the consistency of a measurement procedure, and indices of reliability describe the extent to which the scores produced by the measurement procedure are reproducible (John & Benet-Martínez, 2000). Construct reliability of the model were determined through composite reliability (CR) and Cronbach's alpha (Hair et al., 2010). As presented in Table 2, the results of average

Table 1 Results of goodness-of-fit

	χ^2	Df	χ^2/df	GFI	CFI	TLI	RMSEA	SRMR
Model	279.418	177.000	1.579	0.925	0.976	0.971	0.043	0.072
Acceptable range			< 3	>= 0.90	>= 0.90	>= 0.90	<= 0.08	<= 0.08

Table 2 Results of construct reliability and validity

	Convergent validity AVE	Reliability	
		CR	Cronbach's alpha
IM	0.728	0.889	0.887
MS	0.749	0.900	0.900
EM	0.756	0.903	0.903
PU	0.651	0.848	0.849
EU	0.612	0.825	0.823
CE	0.717	0.883	0.883
CU	0.699	0.874	0.874
Criteria	> 0.50	> 0.70	> 0.70

EM=Extrinsic motivation; MS=Perception of multiple sources; IM=Intrinsic motivation; EU=Perceived ease of use; PU=Perceived usefulness; CE=Cognitive engagement; CU=Continuous usage intention

variance extracted (AVE) ranged from 0.612 to 0.756, the values were greater than 0.5, which was satisfactory (Segars, 1997). The composite reliability (CR) values ranged from 0.825 to 0.903; that is, all values were over 0.7 demonstrating satisfactory reliability (Nunnally & Bernstein, 1994). The Cronbach's alpha value swas in a range between 0.874 and 0.903; the values were over 0.70, i.e. they were within the acceptable limits (Fornell & Larcker, 1981).

Discriminant validity is the extent to which a construct is truly distinct from other constructs by empirical standards. Thus, establishing discriminant validity implies that a construct is unique and captures phenomena not represented by other constructs in the model (Hair et al., 2021). To evaluate the discriminant validity, the square roots of AVE were compared to correlations among latent variables (Fornell & Larcker, 1981). As shown in Table 3, all latent correlations were less than the corresponding AVE square roots, which was satisfactory. Overall, these results indicate that the proposed research model has a good fit.

Table 3 Results of discriminant validity

	IM	MS	EM	EU	PU	CE	CU
IM	0.853						
MS	0.319	0.866					
EM	0.228	0.352	0.869				
EU	0.396	0.235	0.459	0.782			
PU	0.313	0.523	0.396	0.545	0.807		
CE	0.185	0.211	0.224	0.392	0.425	0.847	
CU	0.149	0.170	0.180	0.315	0.342	0.805	0.836

Bold numbers represent square roots of the AVE. EM=Extrinsic motivation; MS=Perception of multiple sources; IM=Intrinsic motivation; EU=Perceived ease of use; PU=Perceived usefulness; CE=Cognitive engagement; CU=Continuous usage intention

4.2 The structural model and hypothesis test

To test the hypotheses, a structural model was conducted. A structural model was used to presented the results of the structural equation modeling analysis. Usually, the solid line between every two variables represented this hypothesis was supported, while the dashed line represented this hypothesis was unsupported. As shown in Fig. 2, the structural model was adjusted based on the research model, presented with the path coefficients marked by standardized regression weights (β value) and t-values to show the relationships between the key influencing factors and students’ continuous usage intention.

Table 4 presents the results of the test. The results show that some hypotheses (i.e. H2, H4, H5, H6, H7, H8 and H9) were supported, while others (i.e. H1 and H3) were not supported. Intrinsic motivation ($\beta=0.224, p<0.001$) and

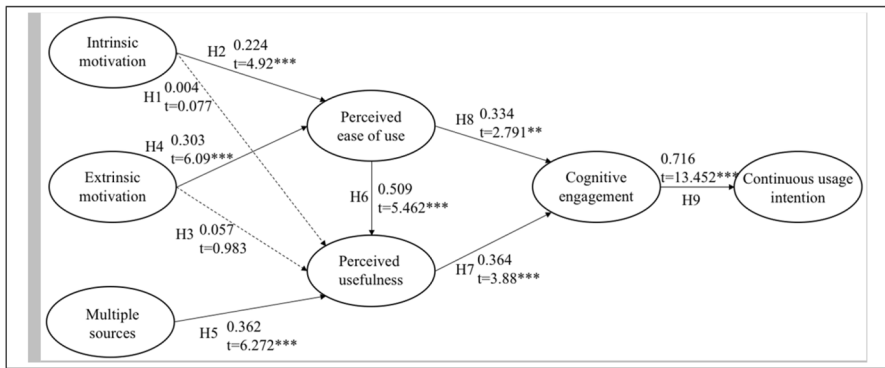


Fig. 2 Model estimation results. Note: *solid line* - supported hypothesis; *dashed line* - unsupported hypothesis

Table 4 Results of the hypotheses

Hypothesis	Relationship	β	S.E.	T	Result
H1	IM→PU	0.004	0.052	0.077	Not supported
H2	IM→EU	0.224	0.046	4.92***	Supported
H3	EM→PU	0.057	0.058	0.983	Not supported
H4	EM→EU	0.303	0.05	6.09***	Supported
H5	MS→PU	0.362	0.058	6.272***	Supported
H6	EU→PU	0.509	0.093	5.462***	Supported
H7	PU→CE	0.364	0.094	3.88***	Supported
H8	EU→CE	0.334	0.12	2.791**	Supported
H9	CE→CU	0.716	0.053	13.452***	Supported

EM=Extrinsic motivation; MS=Perception of multiple sources; IM=Intrinsic motivation; EU=Perceived ease of use; PU=Perceived usefulness; CE=Cognitive engagement; CU=Continuous usage intention; ** $p<0.01$; *** $p<0.001$

extrinsic motivation ($\beta=0.303$, $p<0.001$) were positively related to perceived ease of use. Multiple sources ($\beta=0.362$, $p<0.001$) and perceived ease of use ($\beta=0.509$, $p<0.001$) were positively related to perceived usefulness. Moreover, perceived ease of use ($\beta=0.334$, $p<0.01$) and perceived usefulness ($\beta=0.364$, $p<0.001$) were positively related to cognitive engagement. Finally, cognitive engagement ($\beta=0.716$, $p<0.001$) was positively related to continuous usage intention.

Moreover, the indirect effects among the key variables were analyzed. As shown in Table 4 and Fig. 2, both intrinsic motivation and extrinsic motivation were indirectly related to perceived usefulness through perceived ease of use. What is more, cognitive engagement was indirectly influenced by intrinsic motivation, extrinsic motivation and multiple sources. Intrinsic motivation and extrinsic motivation were indirectly correlated with cognitive engagement not only through perceived ease of use, but also through the combination of perceived ease of use and perceived usefulness. While multiple sources variable was indirectly correlated with cognitive engagement through perceived usefulness. Furthermore, students' continuous usage intention was indirectly affected by all the key independent factors in this study. Both intrinsic motivation and extrinsic motivation were indirectly related to continuous usage intention through two pathways, respectively are the combination of perceived ease of use and cognitive engagement and the combination of perceived ease of use, perceived usefulness and cognitive engagement. Multiple sources variable was indirectly related to continuous usage intention through the combination of perceived usefulness and cognitive engagement. Finally, both perceived ease of use and perceived usefulness were indirectly related to continuous usage intention through cognitive engagement.

5 Discussion and conclusion

5.1 Contribution of the present study

To the best of our knowledge, very few empirical studies have examined the predicting variables of college students' continuous usage intention of asynchronous online learning courses by incorporating the key influencing factors into TAM. This study filled this gap in the literature by undergoing two steps. First, a research model was proposed to explain and predict the key factors' that influence college students' continuous usage intention. Second, and more importantly, the key factors' effects on college students' continuous usage intention were identified and analyzed. The results of this study are significant because they add important information to the existing literature regarding college students' continuous usage intention of asynchronous online courses through extended technology acceptance model.

Moreover, the results of the study can help the instructors better understand students' psychological attitudes toward asynchronous online courses and design learning tasks to meet their needs. Finally, the findings of this study can be used as reference for developers to design and adjust asynchronous online learning platforms and asynchronous online courses.

5.2 Discussion of the results

In the present study, we found both direct and indirect relationship between all the key learning factors (i.e. intrinsic motivation, extrinsic motivation, multiple sources, and cognitive engagement) and students' continuous usage intention in the research model. Indirect relationship refers to the relationship in which there is no direct effect relationship between variables, but indirect effect relationship can be generated through other mediating variables.

Among the four key learning factors (i.e. intrinsic motivation, extrinsic motivation, multiple sources, and cognitive engagement) included in the study, cognitive engagement was the only factor that directly related to continuous usage intention. This finding is consistent with those reported in previous studies (Hepola et al., 2016; Hollebeek et al., 2014). This may be explained by the reason that in the asynchronous online learning courses, it is needed for students to plan and manage their own learning process independently (Broadbent & Poon, 2015), as well as to understand learning content, to complete learning tasks and so on. All of these need great participation from students, particularly, their cognitive engagement. Other learning perceptions of students, e.g. perceptions of the asynchronous online learning course, including intrinsic motivation, extrinsic motivation, multiple sources, perceived ease of use and perceived usefulness all had influence on asynchronous online learning process. Thus, all these learning factors would affect students' continuous usage intention via their cognitive engagement.

While intrinsic motivation, extrinsic motivation, and multiple sources were found to be indirectly correlated with students' continuous usage intention through different pathways, they all went through the cognitive engagement variable. Both intrinsic motivation and extrinsic motivation had the same functional pathways toward continuous usage intention, i.e. through the combination of perceived ease of use and cognitive engagement and the combination of perceived ease of use, perceived usefulness, and cognitive engagement respectively. Moreover, multiple sources variable was indirectly related to continuous usage intention through the combination of perceived usefulness and cognitive engagement. This finding reflected that it is needed to concern these four factors in asynchronous online learning context to sustain students' continuous learning intention.

Among all the functional pathways, intrinsic motivation and extrinsic motivation were found to be directly related to perceived ease of use. This finding is consistent with those reported in previous studies (Fagan et al., 2008; Hsu & Lin, 2022). However, these variables were not found to have direct relationship with perceived usefulness. This finding is inconsistent with previous studies (Moon & Kim, 2001; Sun & Gao, 2020). The possible reason is that students who have strong motivation to learn (no matter it is intrinsic motivation or extrinsic motivation) are more willing to explore and use technologies, resources, and learning material proactively in the asynchronous online learning context. They find asynchronous online courses easier to use. While the usefulness of asynchronous online courses was determined primarily by its practical aid to students, and students who learned in the asynchronous

online learning courses tend to be self-directed, they tend to evaluate the asynchronous online courses objectively.

Moreover, perception of multiple sources and perceived ease of use were verified to be directed positively related to perceived usefulness. This finding is in line with those reported elsewhere (Anyim, 2020; Caffaro et al., 2020; Hsu & Lin, 2022). The result indicated that in order to improve students' perception of usefulness in the asynchronous online learning contexts, one possible way is to increase the diversities of learning resources, material and technologies. The other possible way is to enhance the ease of use of technical tools in the asynchronous online learning courses.

What is more, perceived ease of use and perceived usefulness were found to be directly related to cognitive engagement, and cognitive engagement was found to be directly correlated with continuous usage intention. This result echoes those from previous studies (Agarwal & Karahanna, 2000; Hepola et al., 2016; Liang et al., 2014). Our findings indicated that enhancing the ease of use and usefulness of the technologies in the asynchronous online learning courses is useful for improving students' cognitive engagement and for sustaining their continuous usage intention.

5.3 Theoretical and pedagogical value

This study is one of the first to investigate college students' continuous usage intention by incorporating the key learning factors into the extended TAM for asynchronous online learning. Results of the study have several theoretical and practical implications. Theoretically, this study verified that incorporating the key learning factors into the extended TAM can explain the continuous usage intention of asynchronous online learning courses. Findings of the study provided a more integrative perspective on how to improve students' continuous usage intention of asynchronous online learning courses.

Findings of the present study also had some implications for pedagogical practice. First, in terms of the learning environment, while ensuring the ease of use and usefulness of the asynchronous online learning environment, it is also needed to increase the diversity of learning resources, materials, and learning technologies. The reason is because a stable and comfortable learning environment is the basis for continuous learning. Second, in terms of the course designing, there is a great need to choose the topics and contents that are interesting, significant and practical to attract students' learning attention and learning interest, which is beneficial to increase students' intrinsic motivation. Moreover, formative and summative evaluations and appropriate rewards in the courses are also required to continuously stimulate students' extrinsic motivation. Furthermore, some collaborative learning activities and discussions are suggested to be added to help students increase cognitive conflict, which is beneficial to improve their cognitive engagement and then to sustain their continuous learning intention in the asynchronous online courses.

5.4 Limitations and future research directions

Despite the present study has important implications, several limitations should be noted. First, data used in the study was self-reported, which was subjective. Some other objective evidence, like learning behavior observations and analyses may be considered in the future studies to triangulate findings with self-reported data. Second, it should be noticed that we have incorporated four important factors into TAM to examine their relationship with students' continuous usage intention in asynchronous online learning context. Some other relevant factors, e.g. peer interaction, self-efficiency, and emotional engagement, can be also considered in future studies. Finally, participants from only two universities in China participated in the study. Future research can involve participants from other universities in China or abroad to ensure diversity and increase the generalizability of the findings.

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Data availability The datasets generated and analyzed during the current study are not publicly available but will be provided by the corresponding author on reasonable request.

Declarations

Conflict of interest None.

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