Undergraduate students' perceptions of using videoconferencing for EFL learning: Evidence from Tencent Meeting application

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ABSTRACT

This paper examined Chinese undergraduate students' perceptions of using videoconferencing in learning English as a foreign language (EFL) during the COVID-19 pandemic. The data were collected among 348 Chinese university students who attended sixteen-week learning of Integrated English Course through Tencent Meeting, the most widely used videoconferencing application in China. We adopted voluntary response sampling method in this cross-sectional study. Students completed an online survey on "Wenjuanxing", China's biggest online questionnaire distribution platform. A structural equation model (SEM) was constructed and analyses revealed that perceived ease of use and perceived usefulness were significant predictors of students' satisfaction and participation intention. Students' computer self-efficacy had a positive effect on their perceived ease of use, perceived usefulness, and participation intention while their frequency of using videoconferencing did not influence these variables. This study contributes to the existing literature on the acceptance of videoconferencing in the context of EFL learning and offers insights for developing up-to-date videoconferencing teaching strategies.

1. Introduction

Videoconferencing, a synchronous computer-mediated communication (SCMC) approach, provides a multimodal environment to promote interaction and allows users to communicate simultaneously with each other through audio, video, text, or their combinations [1]. In the aftermath of the COVID-19 pandemic, education institutions shifted to online teaching and resorted to digital technologies, such as Massive Open Online Courses (MOOCs), learning management systems (LMSs), and videoconferencing systems to continue delivering their educational services [2,3]. Many videoconferencing applications, such as Skype, Google Meet, Zoom, Teams, and WhatsApp, have been applied in educational contexts ranging from elementary schools to higher institutions [4]. In mainland China, with more than 20 million users by the end of 2021, Tencent Meeting has grown to be the most widely used videoconferencing application in the country [5].

A considerable number of studies on education have examined learners' willingness to accept online technologies, such as e-learning [6], mobile learning [7], learning management systems [8], and MOOCs [9]. However, few studies to date have investigated students' perceptions, attitudes and intentions to use synchronous videoconferencing technologies [2]. It has been proven that students' perceptions of using videoconferencing can influence their choice of systems and impact their success in distance learning [10,

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In the recent decade, and especially since the outbreak of the pandemic, the application of videoconferencing in foreign language teaching has been prevalent and attracted attention from L2 researchers and educators. Its multimodal affordances allow L2 learners to receive more authentic linguistic input, promote dynamic meaning-making processes, and have more opportunities to interact with language partners or native speakers in the target language [12,13]. Although abundant studies have discussed the potential and possibility of applying videoconferencing in foreign language teaching [14–16], little attention has been paid to the investigation of L2 learners' perceptions of using videoconferencing systems in their online language learning.

The lack of research on the acceptance of videoconferencing systems and the need to be better prepared for synchronous online language teaching in post-pandemic era are the motivations for this study. This study focuses on Chinese undergraduate students' perceptions of using videoconferencing for their learning of English as a foreign language (EFL). The Technology acceptance Model (TAM) is a widely applied model in understanding predictors of human behavior towards potential acceptance of technology. This study utilizes key constructs of TAM and integrates them with external variables of computer self-efficacy and frequency of using videoconferencing.

This study contributes to the existing literature on TAM by highlighting the factors influencing students' acceptance of videoconferencing in the context of EFL learning. The findings shed light on EFL students' perceptions of using Tencent Meeting and reveal students' attitudes and intentions to use videoconferencing in post-pandemic era. The study of the determinants of students' acceptance of videoconferencing offers insights for researchers, educators, and instructional designers to develop effective videoconferencing environments that support synchronous online language learning.

This study aims to explore the effect of TAM's core variables (perceived ease of use and perceived effectiveness) and external variables on students' satisfaction and intention to use Tencent Meeting in EFL learning. The study has been guided by the following research questions:

1. What factors have influenced students' intention to use Tencent Meeting in EFL learning?
2. What are the relationships among the factors that influence students' intention to use Tencent Meeting?

2. Literature review

2.1. TAM-based studies on students' perceptions of videoconferencing use

Previous studies have demonstrated the benefits of videoconferencing systems as a promising tool for online learning [13,16–18]. However, limited literature has focused on the contextual factors that affect learning outcomes through videoconferencing [4]. [19] identified positive correlations between students' motivation, tool use and academic performance in learning an economics course using web-based videoconferencing [20]. proved the efficacy and acceptability of videoconferencing in teaching through a problem identification interview of school-based behavioral consultation [21]. pointed out that students' attention to language and cultural issues are main factors influencing their attitudes towards their videoconferencing L2 learning.

Until recently, scholars began to integrate TAM into the investigation of student perceptions of videoconferencing systems. As the key internal variables of TAM, students' perceived ease of use has affected perceived usefulness and the latter predicted the intention to use videoconferencing systems [10,22]. As for the influence of external factors, educational institution's facilitating conditions have been found to have a positive effect on students' perceived ease of use of videoconferencing program and effort expectancy significantly anticipated performance expectancy [2,23]. Other external variables, such as subject norm and computer playfulness had a significant impact on most TAM constructs in their using of videoconferencing for distance learning [24]. The above studies on students' acceptance of videoconferencing systems have been conducted based on TAM or a combined framework of TAM, Self-determination Theory (SDT) and Unified Theory of Acceptance (UTAUT).

The limitation of existing TAM-based studies on students' perceptions of videoconferencing use can be summarized in two aspects. First, these studies mainly focus on the general context of distance learning or online learning and there lacks an in-depth investigation of students' attitudes towards videoconferencing systems in specific contexts or disciplines. Second, most factors analyzed in these studies are restricted to key constructs of TAM-related theories and more variables should be incorporated into the investigation of students' perceptions of videoconferencing use.

2.2. Videoconferencing for foreign language learning purposes

In recent years, the application of videoconferencing for foreign language learning purposes has been growing in popularity. A large number of studies have been conducted to examine the effect of videoconferencing teaching on promoting L2 learners' language proficiency, motivation, confidence and cultural awareness. Firstly, videoconferencing is effective in promoting learners' foreign language proficiency. About two decades ago [25,26], discussed the possibility and potential of using videoconferencing as a communication tool in foreign language teaching. Subsequent studies found that synchronous videoconferencing interaction was beneficial for the development of learner's vocabulary knowledge, English writing skills, and speaking abilities [27–30]. As widely used tools for videoconferencing, Skype and Zoom have played an important role in cultivating students' interest in learning and improving their English learning ability [14,31,32]. Secondly, videoconferencing helps to support teacher-student communication through multimodal interactions [33]. showed that L2 students had a stronger sense of "teaching presence" and "social presence" in the simultaneous videoconferencing scenario. The multimodal affordances of videoconferencing systems can support learners'

communication from a sociocultural and a semiotic perspective [31] and foster a sense of community [15]. Thirdly, videoconferencing can enhance L2 learners' intercultural awareness and competence. Scholars have explored the capability of using videoconferencing for cross-cultural communication and found that L2 learners' use of videoconferencing deepened their understanding of target-language culture [34,35].

2.3. L2 learners' perceptions of using videoconferencing in language learning

Despite extensive studies into videoconferencing use in foreign language teaching, there is limited literature on L2 learners' perceptions of videoconferencing systems [36]. observed that L2 learners experienced similar levels of speaking anxiety in both videoconferencing and face-to-face tests. L2 learners experienced difficulties when attending speaking and listening lectures in videoconferencing settings [37,38]. Therefore, there is an urgent need to examine L2 learners' experience in using videoconferencing and especially the factors that influence their perceptions of different videoconferencing systems.

Due to the widespread use of Zoom in education, its immersive and easy-to-use functions of Zoom can facilitate communicative language learning [14]. In Ref. [15]'s survey, over 60 % of university students expressed a satisfaction with their online communication through writing or speaking using Zoom. Other scholars found that students using Zoom may also experience technical problems such as unreliable Internet connections and inadequate speakers or microphones [39,40]. [41]'s study was the first to use TAM to investigate students' attitudes and intentions to use Zoom for their EFL learning. They have found positive correlations between computer self-efficacy, attitudes, intention and actual use. This study paved the way for the explorations of EFL students' attitudes towards other videoconferencing systems.

With the largest number of EFL learners in the world, China has launched a transition to online language learning threatened by the emergency triggered by the COVID-19 pandemic [42]. However, the current literature on China's online language education lacks empirical studies into L2 learners' attitudes to use videoconferencing systems for their EFL learning. This study bridges this gap by exploring the factors that influence Chinese undergraduate students' perceptions of using Tencent Meeting, the most widely used videoconferencing system in China.

3. Theoretical framework and hypothesis development

Among the various theoretical models related to the acceptance and use of technology, the Technology Acceptance Model (TAM) is most widely used to determine the significant factors contributing to the acceptance of technologies [43]. Drawing on the model of Theory of Reasoned Action (TRA) proposed by Refs. [44,45] introduced and developed the Technology Acceptance Model (TAM), providing a theoretical explanation of the relationship of attitudes-intention-behavior. It is now applied to the investigation of L2 learners' understandings of emergent technologies and tools, such as e-learning of online English courses [46], Augmented Reality for English reading [47] and mobile assisted language learning [48,49].

In this study, we adopt TAM as our research framework to examine Chinese undergraduate students' perceptions of using Tencent Meeting for EFL learning. The basic TAM consists of five variables. The three core variables are perceived ease of use (PEU), perceived effectiveness (PU) and attitude. The two outcome variables are behavioral intention (BI) and actual use (AU). This paper studies four of these variables (PEU, PU, BI and AU) and integrates the variable of satisfaction from the Expectation Confirmation Model (ECM) as our five internal variables. ECM focuses on the links between perceived usefulness, confirmation, satisfaction, and ultimately continuance intention to use [50]. According to ECM, users' satisfaction is the most significant factor that influences continuance intention to use. In this study, satisfaction is used as the third core variable of TAM considering students' positive attitude bring more benefits to learning [3,51].
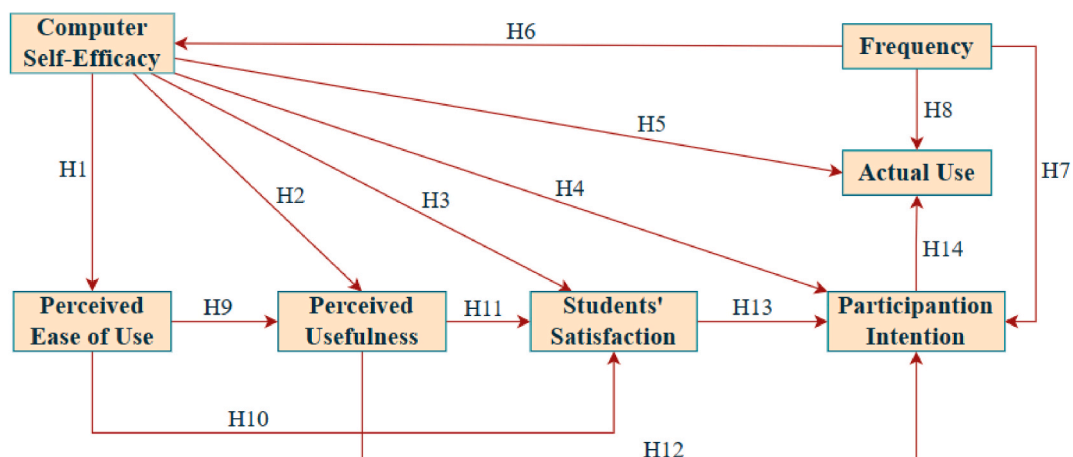

Fig. 1. Research model and hypotheses.

Alongside the development and extension of TAM, external variables including subjective norm, motivation, experience, computer self-efficacy and other personal traits have been incorporated to broaden the framework of TAM. Focusing on Chinese undergraduate students' use of videoconferencing, this study attaches more importance to Chinese students' familiarity and experience with internet and videoconferencing system than their subjective and personal traits. Existing literature have emphasized the vital role played by computer self-efficacy in fostering EFL teachers' capacity [52,53]. However, little attention has been paid to students' computer self-efficacy in their online L2 learning. While researchers believe that students' previous learning experience with computers has a tremendous influence on their participation in online learning [54,55], few studies have taken learners' prior experience in technology use into consideration when L2 learners' acceptance of technology is concerned. Significant positive correlations between computer self-efficacy and computer experience have been found [56–58] and specific types of computer experience had different impact on users' computer self-efficacy [59]. However, users' experience of using videoconferencing and their computer self-efficacy in online language learning remain largely unknown. Therefore, we incorporate computer self-efficacy and frequency of using videoconferencing as our two external variables, with the intent to see if they affect the five internal factors in EFL learners' use of Tencent Meeting. Fig. 1 shows this research model and hypotheses.

3.1. Computer self-efficacy (CSE)

As a subcategory of self-efficacy, computer self-efficacy refers to individuals' beliefs about their abilities to competently use computers [60]. CSE has been recognized as an important determinant of perceived ease of use and perceived effectiveness in using internet, e-learning and virtual reality systems [61–63]. Other studies reported that CSE significantly influence users' PEU and PU in mobile-based learning and Web 2.0 technologies for language learning [8,64]. In this study, we propose Hypothesis 1-2 to examine the effect of EFL students' computer self-efficacy on their PEU and PU in videoconferencing use.

Hypothesis 1. Computer Self-Efficacy positively affects perceived ease of use.

Hypothesis 2. Computer Self-Efficacy positively affects perceived usefulness.

Previous studies revealed that CSE had a positive effect on satisfaction and is positively related to behavioral intention to use new technologies [65,66]. [67]'s study emphasized that EFL students' behavioral intention to use automated writing evaluation and practical use are directly determined by CSE. We thereby propose Hypothesis 3-5 to examine the influence of EFL students' computer self-efficacy on satisfaction, intention and actual use of videoconferencing.

Hypothesis 3. Computer Self-Efficacy positively affects students' satisfaction.

Hypothesis 4. Computer Self-Efficacy positively affects participation intention.

Hypothesis 5. Computer Self-Efficacy positively affects actual use.

3.2. Frequency of videoconferencing use

[68] added experience as a moderating factor of individual variables in an extended TAM model [69]. study proved that learners' frequency of using computer is positively associated with computer self-efficacy [70]. found that users' experience of the website played a moderating role in their web acceptance. Other studies have considered internet experience as an external variable of TAM and found its positive influence on intention and ability to use technologies [71–73];. In this study, we use "frequency of videoconferencing use" to represent students' past experience of using Tencent Meeting. Students' frequency of using Tencent Meeting in the last six months includes online learning of university courses for four months and self-voluntary use for two months during holidays. This study hypothesizes that EFL students' frequency of using videoconferencing influences their satisfaction, participation intention, and actual use as an external variable.

Hypothesis 6. Frequency of using videoconferencing positively affects computer self-efficacy.

Hypothesis 7. Frequency of using videoconferencing positively affects participation intention.

Hypothesis 8. Frequency of using videoconferencing positively affects actual use.

3.3. Perceived ease of use (PEU)

[45] described PEU as "the degree to which someone believes that using a particular system with little effort." PEU has been recognized as a significant determinant in shaping users' attitudes towards using e-learning and mobile technologies [7,74]. Many previous studies have testified the effect of perceived ease of use on perceived usefulness, confirmation and attitudes in the assessment of their perceptions of videoconferencing for distance learning [1,75]. In this study, PEU refers to the degree to which L2 learners believe Tencent Meeting is easy to use and will enhance their EFL learning efficiency. We propose two hypotheses to see how perceived ease of use affects perceived usefulness and students' satisfaction.

Hypothesis 9. Perceived ease of use positively affects perceived usefulness.

Hypothesis 10.   Perceived ease of use positively affects students' satisfaction.

3.4. Perceived usefulness (PU)

PU is defined as "the degree to which a person believes that using a particular technology will enhance his or her job performance" [45]. Previous empirical studies pointed out that PU is the most significant construct in TAM [76,77]. Other studies demonstrated evidence for the link between users' attitudes and PU in e-learning [78], and PU is a significant predictor of both user satisfaction and behavior intention [79]. In this study, PU is described as the degree to which an L2 learner believes that using Tencent Meeting can improve their learning effectiveness in EFL learning. We propose two hypotheses to examine the effect of perceived usefulness on students' satisfaction and participation intention.

Hypothesis 11.   Perceived usefulness positively affects students' satisfaction.

Hypothesis 12.   Perceived usefulness positively affects participation intention.

3.5. Students' satisfaction (SS)

[45] put forward "attitude toward use" as "an individual's overall affective reaction to the use of the system." Students' satisfaction (SS) refers to students' positive attitudes and perceptions of how well the system has satisfied their expectations and met their demands [80]. [3] made the observation that users' satisfaction and perceived usefulness are the top two strong predictors of their acceptance of videoconferencing. Other studies have found that user satisfaction has a significant impact on users' intention and actual use of e-learning system [8]. In this study, we use students' satisfaction to represent the degree to which L2 learners are happy and satisfied with their use of Tencent Meeting. We propose one hypothesis to explore the effect of students' satisfaction on participation intention.

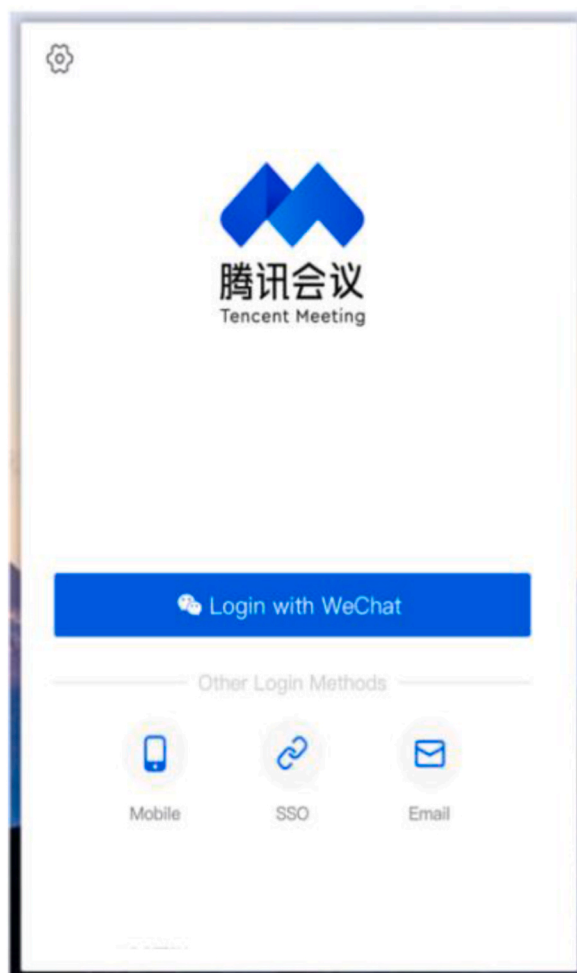**Hypothesis 13**.   Students' satisfaction positively affects participation intention.

Fig. 2. Login page of Tencent Meeting.

3.6. Participation intention (PI)

What TAM and TRA have in common is that intention is the direct factor that determines users' behavior. In TAM, behavioral intention to use (BI) refers to an individual's desire to carry out a specific action [81]. Users' behavior or utilization intention was found to be the most effective predictor of their use of videoconferencing for distance learning [82]. It is also observed that users' continuance intention is the most essential component of users' acceptance of videoconferencing for online teaching in the future [3]. To highlight student's intention to participate in videoconferencing use in this study, we change "behavioral intention" to "participation intention". We also consider participation intention as the most important outcome variable in our hypotheses, aiming to reveal the effects of two external variables and three core variables on participation intention. This study also proposes the hypothesis that participation intention has a positive effect on actual use.

Hypothesis 14.   Participation intention positively affects actual use.

3.7. Actual use of videoconferencing (AU)

Previous studies attached more importance to users' behavior intention than actual use concerning videoconferencing use in online education [19]. proved that students' technology use and participation intention were significantly correlated with each other and with exam scores. To better understand how learners perceive their learning outcomes using videoconferencing, this study integrates the actual use of videoconferencing into the research construct as an outcome variable. This study proposes some hypotheses to see if the two external variables and participation intention have a positive effect on actual use.

4. Methodology

4.1. Tencent meeting application features

In the past three years, Tencent Meeting has stood out among Chinese SCMC systems in expanding its application in higher education due to its multi-functions for education. It supports different platforms, including Windows, macOS, tablets, mobile phones, etc. It allows synchronous interactions between 300 users at the same time. Students can log in or register their accounts through mobile phone numbers or WeChat accounts. To arrange an online lecture, teachers can create an online classroom and generate an ID number to allow students to join the class. After joining the class, students can create their user's name before turning on or off the audio and camera as required by the class. They can also choose a virtual environment to enhance their social presence in the online lecture (Fig. 2).

During online learning through Tencent Meeting, teachers can design and implement a series of learning-related activities. For example, screen sharing enables all the students to clearly see the content of courseware and other materials. By Unlocking the real-time voice function, students can participate in class and answer questions immediately by turning on the microphone and webcam to ensure effective interaction between teachers and students. The teacher can also export the historical precipitation or cloud meeting record and playback it for a future check. After teachers upload teaching resources for students in class, students can download courseware after class for preview and review.
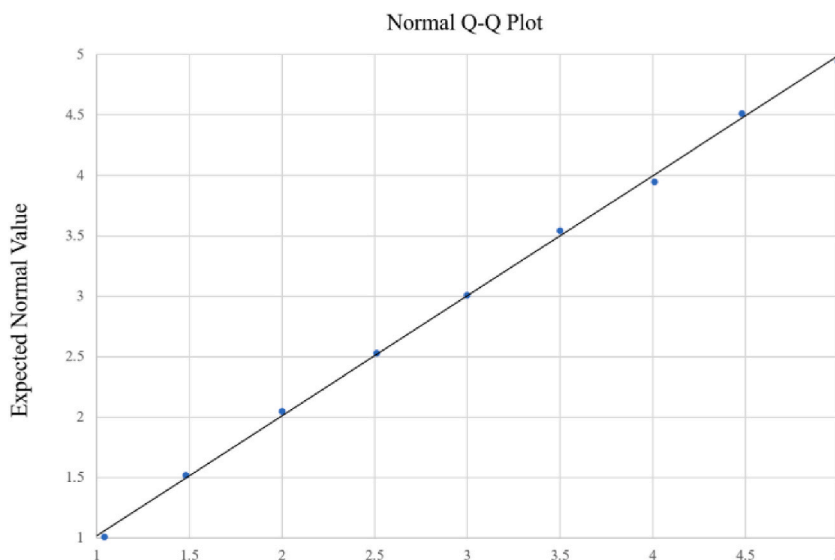

Fig. 3. The results of Q-Q plot.

4.2. Research design

This study followed a cross-sectional survey research design using the adapted TAM framework to measure levels of perceived ease of use, perceived usefulness, students' satisfaction, participation intention, and actual use. A cross-sectional research design involves obtaining data at a specific point in time. The time for our survey in this study was the second semester of 2020 after the outbreak of the COVID-19.

Our participants are English majors in a southern university in China (n = 348). Our participants attended a 2-h online class of an Integrated English Course through Tencent Meeting twice a week for 16 weeks. We distributed a questionnaire survey on "wen-juanxing" platform asking for students' anonymous comments on the use of videoconferencing for EFL learning. All the invited students knew the purpose of our study and had the possibility to drop out of this experiment at any time. The number of valid questionnaires was 304, and the effective rate of this questionnaire survey was 87.3 %. In order to verify that the sample size is sufficient, the quantile-quantitative (Q-Q) plot was used to test the distribution of sample data, and the results are shown in Fig. 3, indicating that the data are normally distributed and meet the research requirements. The investigation of our six latent variables (CSE, PEU, PU, SS, PI, and AU) and one observed variable (frequency of using Tencent Meeting) is designed through a set of items in the questionnaire. This study was approved by the university's ethics committee. Written informed consent was obtained from all the participants prior to this questionnaire survey (Table 1).

4.3. Instrument

A questionnaire was used as the instrument in this study, which consisted of two parts. The first part asked for students' de-mographic information, including their age, gender and grade in university. The second part consisted of nineteen items about six constructs, which were all derived or adapted from the existing literature to ensure content validity (see Table 2). These constructs measured in the questionnaire included computer self-efficacy (CSE; 3 items; adapted [60]), perceived ease of use (PEU; 3 items; adapted from Ref. [45]), perceived effectiveness (PU; 3 items; adapted from Ref. [45]), students' satisfaction (SS; 3 items; adapted from Ref. [83]), participation intention (PI; 4 items; adapted from Ref. [45]) and actual use (AU; 3 items; adapted from Ref. [41]). All of the items were measured using a 5-point Likert scale (ranging from 1 = strongly disagree to 5 = strongly agree). Table 2 shows scales and references. Considering that Chinese university students' English proficiency may not be sufficient to understand the items originally in English, four bilingual (Chinese and English) research assistants translated the questionnaire to make sure Chinese students can understand the meaning of each item. In the second part, since frequency is an observed variable, we used multiple choice questions to determine the number of times students used Tencent Meeting in the past six months. Before the formal survey, we selected 60 valid questionnaires for a pre-test. In the pre-test, the CA of each constructs, including AU, CSEF, PEU, PU, PI, and SS, are greater than 0.7. CR are greater than 0.8, and AVE are greater than 0.7. The results indicate that the questionnaire was suitable for this study.

In this study, structural equation modeling (SEM) was used to examine the hypothesized relationships between internal and external variables of the TAM. The data were then analyzed using the Statistical Product and Service Solution 26.0 (SPSS 26.0) and SmartPLS3.0 to validate the measurement model's validity, reliability, the structural model's predictive accuracy and relevance.

5. Results

5.1. Measurement model assessment

In this study, confirmatory factor analysis (CFA) was used as the measurement method to confirm the six-factor structure of the questionnaire. The effective sample size of this study is 304, 10 times more than the number of analysis items, so the sample size is appropriate. The averages of CSEF, PEU, PU, SS, AU and PI were 1.778, 1.864, 2.451, 2.366, 2.395, and 2.381, indicating a good level of all variables (Table 3). AVE (Average Variance Extracted) and CR (Composite Reliability) are used for convergent validity analysis. The AVE values of the six factors are all greater than 0.5, indicating high aggregation validity. The AVE square root value of each question is 0.645, which is greater than the maximum absolute value of the correlation coefficient among factors, so the discriminant

Table 1
Demographic profiles of the participants.

Participants	Item	Quantity
Gender	Male	51
	Female	297
Age	18–19	118
	19–20	158
	20–21	72
Grade in university	Sophomore	172
	Junior	176
Frequency of using videoconferencing in the past 6 months	32 times (only having class)	69
	sometimes in addition to class	78
	often in addition to class	119
	always in addition to class	82

Table 2
Survey instrument.

Latent Variable	Measurement Items	References
Computer Self-Efficacy	1. I can log in and exit Tencent Meeting without any problems. 2. I can solve the problems encountered in using Tencent Meeting in time. 3. I can use Tencent Meeting to attend an English class successfully.	[60]
Perceived Ease of Use	1. I can learn to use Tencent Meeting easily. 2. I can easily find the meeting room in Tencent Meeting for English learning. 3.I find it easy to understand and use the functions of Tencent Meeting.	[45]
Perceived Usefulness	1. The use of Tencent Meetings has promoted the enthusiasm of online learning. 2. The audio and the video in Tencent Meeting add to the authenticity of learning. 3. The use of Tencent Meeting is advantageous for English learning.	[45]
Students' Satisfaction	1. It is easy for me to become skillful at using Tencent Meeting for English learning. 2. I feel pleased with the experience of using Tencent Meeting for English learning. 3. I am satisfied with the learning outcomes I gain from using Tencent Meeting.	[83]
Participation Intention	1. The learning experience of Tencent meeting met my expectations. 2. I feel comfortable using Tencent Meeting to improve my English. 3. I believe Tencent Meeting is useful for English learning in my future study. 4. I think Tencent Meeting should be used in the future for English learning.	[45]
Actual Use	1. I believe Tencent Meeting helps me cooperate with my teacher and classmates. 2. I believe the sharing screen function of Tencent Meeting helps improve my knowledge of English. 3. I believe real-time interaction function of Tencent Meeting helps me improve my oral English proficiency.	[41]

validity of the measurement model is appropriate. Table 3 also shows that CR values are all greater than 0.8, indicating that the analyzed data have good convergent validity. In Table 4, Cronbach's Alpha coefficient of each variable is greater than 0.7, which indicates that the reliability of the research data is high [84]. According to the Fornell-Larcker criterion, Table 4 confirms that the square root of AVE of latent variables has the largest value compared with their correlation coefficient with other variables. In addition, the heterotrait-monotrait ratio of correlations (HTMT) is a new criterion for assessing the validity of the discriminant, and its value should be less than 1 [85]. The values of HTMT in Table 5 again verify that the discriminant validity of the model is appropriate.

In order to establish discriminant validity with cross-loadings, the outer loading of each item on its associated construct should be greater than the loading of item on other constructs [86]. Table 6 shows that the correlation coefficient between each measured variable and its latent variable is more significant than the correlation coefficient with other latent variables, which proves good convergent and discriminative validity of the measurement model. Furthermore, Table 7 shows the outer weight to assess the importance and explanatory degree of the observed variable for the latent variable. According to Ref. [87], the outer weight of this study suggests that construct validity is good.

VIF (variance inflation factor) value is a tool for measuring and quantifying the degree of variance exaggeration, which can reveal whether there is a problem of collinearity. Table 8 shows that all VIF values do not exceed the critical level value of 8, indicating no multicollinearity problem. The estimation results of the model are relatively stable.

5.2. Structural model assessment

To validate the hypotheses of this study, we use SmartPLS 3.0 to construct structural equation model (also known as path analysis) and bootstrapping with 5000 sub-samples to analyze the significance of the path coefficient. Table 9 summarizes the final results that the significance level of ten of the fourteen hypotheses has been confirmed ($p < 0.05$ and T-value>1.96), except for the H3, H5, H6 and H7 ($p > 0.05$ or T-value<1.96). Therefore, the research model we proposed was verified for Chinese undergraduate students' use of Tencent Meeting. Furthermore, the 95 % confidence intervals showed that the parameter values for all significant pathways were estimated accurately, which increased confidence in the interpretation of the results. In other words, the effect value for each hypothetical path falls within the confidence interval, indicating a significant effect.

According to Fig. 4, CSE has a positive impact on PEU, PU and PI but does not affect SS and AU. PEU has a positive effect on PU and PI. PU also has a positive link with SS and PI. In addition, the positive impact of SS on PI is noticeably significant based on the path coefficient. PI has a strong influence on AU since the path coefficient between the two is 0.724. SS serves as the critical indicator that affects PI and AU. Frequency only positively affects AU but does not influence CSE.

The R-Square values and Q-Square values are used as the criteria for prediction accuracy and prediction relevance, respectively. As

Table 3
Mean, AVE, CR and Cronbach's Alpha of the model.

	Mean	SD	Cronbach's Alpha (CA)	Composite Reliability(CR)	Average Variance Extracted (AVE)
CSEF	1.778	0.536	0.725	0.845	0.645
PEU	1.864	0.353	0.759	0.859	0.671
PU	2.451	0.465	0.756	0.860	0.672
SS	2.365	0.470	0.890	0.924	0.752
PI	2.395	0.479	0.892	0.925	0.756
AU	2.381	0.441	0.744	0.854	0.661

Table 4
Fornell-Larcker test of discriminant validity.

	AU	CSEF	PEU	PI	PU	SS
AU	0.813					
CSEF	0.470	0.803				
PEU	0.426	0.596	0.819			
PI	0.653	0.474	0.505	0.870		
PU	0.620	0.342	0.312	0.722	0.820	
SS	0.632	0.467	0.578	0.796	0.635	0.867

Table 5
The HTMT values.

	AU	CSEF	PEU	PI	PU	SS
AU						
CSEF	0.627					
EU	0.544	0.792				
PI	0.797	0.583	0.601			
PU	0.821	0.456	0.389	0.870		
SS	0.770	0.576	0.677	0.891	0.766	

Table 6
The cross loading values.

	AU	CSEF	PEU	PI	PU	SS
AU1	0.865					
AU2	0.776					
AU3	0.796					
CSEF1		0.787				
CSEF2		0.793				
CSEF3		0.828				
PEU1			0.831			
PEU2			0.764			
PEU3			0.859			
PI1				0.860		
PI2				0.874		
PI3				0.896		
PI4				0.848		
PU1					0.772	
PU2					0.822	
PU3					0.863	
SS1						0.865
SS2						0.863
SS3						0.891
SS4						0.851

shown in Table 10, the R-Square of AU, PU, SS are moderate, which is between (0.33 and 0.67) [88]. The R-square value of PI ($R^2 =$ 0.730) is greater than 0.67, which could be substantially and directly explained by CSEF, PU and SS. The research model uses the Stone-Geisser's Q^2 value to verify the predictive relevance of endogenous structure. The structural model provides a high level of predictive accuracy because the Q^2 value for AU, PI, PU and SS are greater than 0.35 [89].

In addition, to verify the model fit, we calculated the values of SRMR, NFI, and Theta using the PLS algorithm. Table 11 shows that the model fit is good, as it is indicated by SRMR <0.8, NFI >0.9, and Theta <0.12, which meet the fit indexes.

5.3. Mediation of participation intention

Based on above analysis, it is necessary to take a closer look at the mediation relationship between computer self-efficacy, perceived ease of use, perceived usefulness, students' satisfaction, and participation intention. A stepwise test of Bootstrapping with 5000 sub-samples is employed to test the mediating effects between variables. In Table 12, students' satisfaction is the main intermediate variable. SS not only maintains the existing influence on other variables, but also demonstrates some insignificant influence among certain variables. For instance, it can partially mediate the positive effect of PU, PEU, and CSE on PI. Additionally, the impact of PEU on SS is partially mediated by PU.

Table 7
The outer weight.

	AU	CSEF	PEU	PI	PU	SS
AU1	0.457					
AU2	0.356					
AU3	0.413					
CSEF1		0.426				
CSEF2		0.373				
CSEF3		0.446				
PEU1			0.475			
PEU2			0.310			
PEU3			0.428			
PI1				0.286		
PI2				0.279		
PI3				0.295		
PI4				0.290		
PU1					0.371	
PU2					0.376	
PU3					0.468	
SS1						0.266
SS2						0.292
SS3						0.291
SS4						0.305

Table 8
VIF value.

	Satisfaction	Participation Intention	Actual Use
Computer Self-Efficacy	2.045	2.049	2.059
Perceived Usefulness	2.764	2.776	2.900
Perceived Ease of Use	2.592	2.660	2.687
Participation Satisfaction		2.134	3.231
Participation Intention	2.149		3.254
Actual Use	2.431	2.152	
Frequency	1.012	1.006	1.012

Table 9
Result of structural model examination.

Hypotheses	Path	Beta values (β)	Standard Deviation	T-values	P-values	Confidence intervals		Remarks
						0.025	0.975	
H1	CSEF→PEU	0.596	0.050	11.650	0.000	0.492	0.691	Supported
H2	CSEF→PU	0.242	0.093	2.566	0.010	0.055	0.420	Supported
H3	CSEF→SS	0.071	0.062	1.114	0.257	0.053	0.190	Unsupported
H4	CSEF→PI	0.120	0.051	2.352	0.018	0.019	0.218	Supported
H5	CSEF→AU	0.203	0.069	0.915	0.124	0.068	0.344	Unsupported
H6	Fre→CSEF	0.054	0.079	0.680	0.497	0.100	0.202	Unsupported
H7	Fre→PI	0.095	0.040	1.471	0.705	0.171	0.018	Unsupported
H8	Fre→AU	0.064	0.062	3.387	0.005	0.100	0.147	Supported
H9	PEU→PU	0.668	0.100	6.656	0.000	0.032	0.365	Supported
H10	PEU→SS	0.383	0.069	5.486	0.000	0.246	0.517	Supported
H11	PU→SS	0.491	0.058	8.406	0.000	0.375	0.600	Supported
H12	PU→PI	0.355	0.067	5.306	0.000	0.223	0.487	Supported
H13	SS→PI	0.509	0.061	8.393	0.000	0.391	0.627	Supported
H14	PI→AU	0.560	0.070	8.016	0.000	0.410	0.694	Supported

6. Discussion and implications

6.1. Result discussion

The purpose of this research is to explore whether undergraduate students are willing to accept the use of videoconferencing for their EFL learning. In this study, we developed the extended TAM with two external factors: computer self-efficacy and frequency of using videoconferencing to understand students' acceptance of Tencent Meeting as a tool for their EFL learning.

Firstly, computer self-efficacy was a significant predictor of students' intention to use videoconferencing for EFL learning. The results suggest that computer self-efficacy positively affects perceived ease of use, perceived usefulness and participation intention
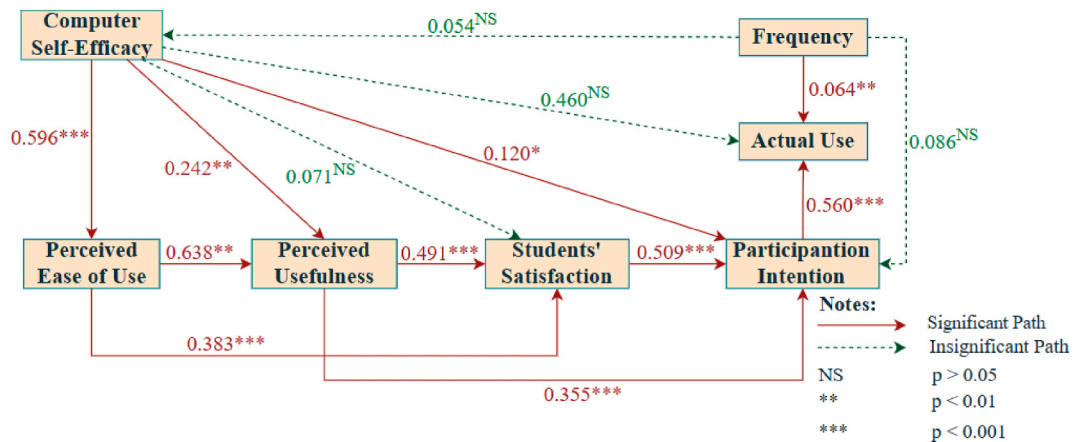
Fig. 4. Result of structural model examination.

Table 10
Predictive accuracy and predictive relevance.

Endogenous constructs	R Square	Q Square
AU	0.460	0.483
PI	0.730	0.538
PU	0.435	0.479
SS	0.567	0.413

Table 11
Model fit.

Fit Summary	Saturated Model
SRMR	0.068
NFI	0.964
rms Theta	0.113

Table 12
Summary of mediating effect size results.

	Indirect effects	T-values	Direct effects	T-values	P Values	Total effects	VAF	Remarks
PU→SS→PI	0.250	0.252	0.355	5.266	0.000	0.605	41.31 %	partial mediation
CSE→PU→SS	0.195	0.194	0.071	1.138	0.255	0.266	62.60 %	partial mediation
PEU→PU→SS	0.282	0.285	0.383	1.994	0.011	0.665	44.99 %	partial mediation
CSE→PU→PI	0.336	0.236	0.120	2.105	0.035	0.456	41.72 %	partial mediation

(H1, H2, and H4 respectively). The findings echo the "digital natives" concept proposed by Ref. [90], suggesting that young students growing up with Internet technology are usually very familiar with technologies. It is also consistent with studies which support the belief that if students perceived they are competent or effective in performing internet-related tasks, they feel more likely to perceive these tasks as effortless [74,91]. Despite the positive influence computer self-efficacy had on participation intention, it did not directly influence students' self-reported actual use. After the outbreak of the COVID-19 pandemic, students' actual use of Tencent Meeting was limited to basic functions of listening to EFL lectures, communicating in chat box and sharing resources, which did not require an advanced level of computer self-efficacy at that time [92]. also found that even though the EFL students today are digital natives, they still lack digital knowledge and skills. In our study, students have not fully realized the necessity of digital literacy for their videoconferencing-based EFL learning.

Secondly, students' frequency of using videoconferencing positively affected their self-reported actual use (H8) but did not affect students' satisfaction or participation intention. This is somewhat inconsistent with [41] findings that students' past experience of using Zoom positively correlated with their behavioral intention. However [67],'s study found that high levels of usage may mitigate learners' satisfaction with videoconferencing systems. In China, it was not until the outbreak of the COVID-19 pandemic that Chinese universities began to transform to various online teaching forms, such as live broadcast, videoconferencing, etc. Students' familiarity with Tencent Meeting at that time was largely restricted to the requirement of courses and lectures. There was no distinctive individual

difference between students' frequency of using Tencent Meeting in their daily study. Therefore, their perceptions of the ease of use, the usefulness of the system, as well as their computer self-efficacy had a far more significant influence on their satisfaction and participation intention than other external factors. Their frequency of using Tencent Meeting have a significant impact on their satisfaction or intention to use the system for EFL learning.

Thirdly, the results showed that students' perceived ease of use significantly affects their perceived usefulness and satisfaction (H9 and H10 respectively). It indirectly affected students' participation intention and actual use through the mediated effect of students' satisfaction. Perceived ease of use is therefore one of the key factors affecting participation intention. These results echo the findings from other studies suggesting that students' PEU with Zoom strongly affected learners' PU and AU [10,41]. Simultaneously, students' perceived usefulness significantly affected their satisfaction and participation intention (H11 and H12 respectively). It partly mediated the impact of computer self-efficacy on satisfaction and intention, as well as their perceived ease of use on satisfaction. Therefore, perceived usefulness is an important factor influencing participation intention, which supported the findings of previous studies concerning other videoconferencing systems [1,41]. In other studies, perceived ease of use also has a positive effect on perceived effectiveness and usefulness in L2 learners' perceptions of ICT and online English courses [46,93].

Lastly, results showed that students' satisfaction positively affects participation intention (H13) and the latter directly influences their actual use of videoconferencing in EFL learning (H14). This supports the core beliefs of ECM that users' satisfaction is the most significant factor that influences continuance intention to use technologies. Satisfaction has been recognized as a significant emotional factor influencing users' continued use of social networks and learning platforms [94,95]. [96]'s study also reported that L2 learners perceived a moderately high level of satisfaction in technology-assisted language learning. Relevant studies revealed that students' satisfaction has played the mediating role between perceived usefulness and participation intention [97,98]. In our study, students' participation intention of Tencent Meeting was influenced by personal satisfaction under the comprehensive impact of external and internal factors.

In sum, this study broadened the research scope of TAM and proved that it is a credible model for assessing the deployment of various technologies in higher education. The study revealed the factors that influence EFL students' intention to use Tencent Meeting in foreign language learning. The extended TAM integrating two external variables (computer self-efficacy and frequency of using videoconferencing) and satisfaction enriched the classical TAM and shed light on the underexplored relationship between technology-related variables and EFL learners' satisfaction with videoconferencing. The current extended TAM discovered new relationships between EFL learners' ability and experience in using technologies and traditional core variables in TAM. It provided a new perspective for us to understand how EFL students perceive videoconferencing as a new channel of online language learning. The results suggested that students' computer self-efficacy, perceived ease of use and perceived usefulness were significant predictors of students' satisfaction and participation intentions to use Tencent Meeting for EFL learning. This extended TAM model enhanced the explanatory power beyond the original TAM. Through our analysis, we observed a good coefficient of determination (R2) in our new model, indicating that our model explains a larger proportion of the variance in students' perceptions of using videoconferencing for EFL learning. The findings of the structural equation modeling demonstrated highly significant effects among key constructs in theoretical frameworks of the TAM and ECM.

6.2. Pedagogical implications

Videoconferencing systems are an effective tool in language teaching and help teachers and students to adapt to multimodal environments [13]. This study concluded that TAM had an effect on university students' intention to use Tencent Meeting as an EFL learning tool. There is great potential for its practical application in foreign language learning in higher education.

The primary contribution of the study is to provide evidence from students' perspective for the acceptance of videoconferencing systems for EFL learning in the post-pandemic era. Therefore, educational stakeholders should consider how to improve the acceptability of videoconferencing systems in L2 teaching and learning. Since computer self-efficacy, perceived ease of use and perceived usefulness positively affect students' intention to use Tencent Meeting, universities should provide training programs to familiarize students with the features and functions of the videoconferencing platform to maximize their acceptance. More active measures should be taken to eliminate students' psychological barriers in using videoconferencing for EFL learning. EFL teachers should provide humanized support to help students feel comfortable and confident in the use of videoconferencing easily. The learning support from teachers and peer L2 learners will give students a sense of pleasure and fulfillment, which will improve their satisfaction in using videoconferencing for EFL learning.

To further increase perceived usefulness of Tencent Meeting for EFL learning, L2 teachers should incorporate videoconferencing features into specific L2 learning activities. Many functions of Tencent Meeting, such as online document collaboration, real-time screen sharing, and instant text, are helpful for online learning but are not particularly designed for language learning. In the design of EFL courses through videoconferencing, teachers should launch a series of communication-related activities, such as greeting, L2 oral report, questions and answers and group discussion. Students should be encouraged to participate in these activities using L2 to improve their oral proficiency. Material-sharing functions allow teachers to upload high-quality L2 learning resources and homework assignments, and for students to download relevant materials and answers. To improve students' participation in classroom interactions, teachers should encourage them to use slides, whiteboard and chat box to communicate with one another in L2. In one word, teachers should design more interesting language-related activities to raise L2 students' enthusiasm and motivation.

7. Conclusion and limitations

This paper used the extended TAM to examine the relationships among the factors that affect students' participation intention in using Tencent Meeting application for their EFL learning during the COVID-19 pandemic. The SEM analyses showed that students' computer self-efficacy, perceived ease of use, and perceived usefulness positively affected their satisfaction and participation intention. Their frequency of using videoconferencing affected actual use but not participation intention. This study raises teachers' awareness to evaluate students' acceptance of technologies using empirical studies to explore their technology adoption behaviors. Even in its infancy, Tencent Meeting should improve its service quality and provide effective technological support to help students and teachers better adapt to videoconferencing environments.

There are some limitations in this study. First, the sample size of this study is not big enough, which may limit the scope of empirical research. In future studies, appropriately expanding the sample size may improve the accuracy of the model. Second, future studies on videoconferencing use in higher education can go further to investigate more external variables such as subjective norm, perceived interaction, or joyfulness in TAM-based models. Third, the results of this study are based on the analysis of self-reported data. Future studies should develop and confirm these initial findings by using mixed-method data collections (e.g., classroom observations, focus individual and group interviews). Researchers can also consider alternative technology adoption models to understand students' perceptions of videoconferencing systems from other perspectives. It is hoped that this study will provide a preliminary insight in understanding EFL students' acceptance of videoconferencing systems and we call more studies to deepen and broaden the studies in this direction.

Ethics statement

This study was approved by the Ethics Committee of School of International Studies, Hangzhou Normal University. Informed consent was obtained from the participants. The authors report that this is an original research and no AI technology has been used in writing the paper.

Funding information

Data availability statement

Data in this study will be made available on request.

CRediT authorship contribution statement

Rong Luo: Writing – original draft, Project administration, Funding acquisition, Conceptualization. **Jingli Wang:** Writing – review & editing, Methodology, Formal analysis. **Yijin Wang:** Writing – review & editing, Methodology, Investigation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e22993.

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