Unpacking mobile learning in higher vocational education during the COVID-19 pandemic

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Abstract: Mobile learning in higher education has become more popular than ever during the COVID-19 pandemic. However, the presence of mobile learning in Chinese higher vocational education is unexplored. Therefore, the aim of this research is to extend the unified theory of acceptance and use of technology (UTAUT) by incorporating three sub-dimensions of self-efficacy for measuring students' acceptance of mobile learning in Chinese higher vocational education. A total sample of 900 students from higher vocational colleges were selected to participate in this study and their responses were analysed using structural equation modelling to validate the extended UTAUT. The results provide significant evidence of the sub-dimensions of self-efficacy and confirm the validity of extended UTAUT. The results also show that students' effort and performance expectancies, social influence and facilitating condition were directly affected by their self-efficacies to use mobile learning.

Keywords: mobile learning; higher vocational education; UTAUT; structural equation modelling; self-efficacy.

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1 Introduction

With the popularisation of mobile communication technology, mobile learning is becoming an important medium of higher education which brings learners more diverse learning experiences (Aliaño et al., 2019). Mobile devices, mobile communication technology and application are the three elements of mobile learning (Pimmer et al., 2012; Isaacs et al., 2019). Access to and use of quality online resources are an additional element. Through mobile devices such as mobile phones and tablet computers, learners can obtain the learning resources they need anytime and anywhere. During the COVID-19 outbreak, mobile learning played an irreplaceable role in maintaining a normal teaching schedule and supporting students' right to receive education (Zhang et al., 2020; Demuyakor, 2020). Research also found that mobile learning can improve the experience (Biloš et al., 2017) and efficiency (Smith et al., 2021) of vocational skills training. Hence, many colleges and universities chose to implement distance education through mobile devices and technologies, thus further strengthening the importance of mobile learning in higher education (Chiodini, 2020).

Much research has proven that mobile learning has obvious advantages, such as providing more resources without restrictions of time and place (Al-Adwan et al., 2018a), helping students establish instant contact with teachers for communication of information (Hwang et al., 2018), and making the learning process more fun to stimulate students' learning motivation and responsibility (Ali and Arshad, 2016). Despite the superiority of mobile learning presented above, mobile learning in higher education institutes (HEIs) had defects such as high investment in infrastructure construction (Alshurideh et al., 2019) and lower acceptance rate (Almaiah et al., 2016). Students' acceptance is a hot topic in the sphere of mobile learning (Krull and Duart, 2017). Several pedagogical models such as the technology acceptance model (Al-Emran et al., 2018), the theory of planned behaviour (TPB) (Gómez-Ramirez et al., 2019), and the unified theory of acceptance and use of technology (UTAUT) (Almaiah et al., 2019) were used to analyse students' intention and behaviour towards mobile learning. In addition, several factors, including facilitating conditions (FCs), social influence (SI), and perceived trust were tested to have significant influence on students' intention to use mobile learning (Almaiah et al., 2019; Chao, 2019; Aliaño et al., 2019).

However, there are few studies of students in technical and vocational colleges' and their use of mobile learning (Cattaneo et al., 2015). Compared with academic higher education, technical and vocational education in China located in the short-cycle college level (ISCED level 5) with programs focusing on practical occupational skills for work force preparation (UNESCO, 2011). Its learning content and methods are quite different from the former. In China, the curriculum system of technical and vocational colleges, which contains theory courses, on-campus practice courses and workplace internships, is based on the logic of professional competence (Nylund and Virolainen, 2019). Teachers often use project-based teaching and situational teaching rather than the narrative method to help students integrate theoretical and practical knowledge (Fjellström, 2014). Students need to learn skills through observation, imitation, and repeated training to achieve a deep understanding of knowledge, skills and the workplace (McGrath and Powell, 2016). In China, public higher vocational colleges are the main providers of technical and vocational education.

What is more, Chinese students in technical and vocational colleges are of a lower socioeconomic status than students in academic HEIs (Abrassart and Wolter, 2020), and these two groups differ in learning habits, motivation and ability. Therefore, students' acceptance and intention to use mobile learning in technical and vocational colleges will be different from that in academic HEIs. It is essential to investigate the characteristics of students in technical and vocational colleges using mobile learning, especially the influencing factors and pathways connecting them. To do so, this study employed an extended UTAUT model to explain the students' acceptance of using mobile learning in Chinese technical and vocational colleges. Given the focus on students and their perceptions and acceptance of mobile learning, the issue of the quality of online resources and instructional guidance are not addressed in this paper, although those are major factors worthy of investigation (Spector, 2020).

2 Literature review

The Chinese Ministry of Education (MOE) has recently established a mobile learning platform where Chinese higher vocational colleges provide learning materials. Students

can use a mobile phone to attend courses, search for learning materials, and interact with teachers and peers. Videos, audio, flash and documents related to theoretical knowledge, demonstration of skill operation steps and technical problem solving can be obtained through specific mobile applications. The homework can also be uploaded to the platform via mobile phone.

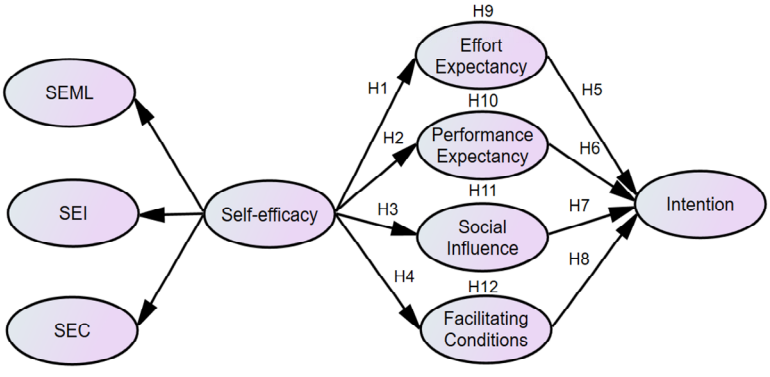
Therefore, this mobile learning platform can be regarded as a kind of online learning. According to Pachler et al. (2010, p.6), mobile learning is not simply browsing content with mobile devices, but "the processes of coming to know and being able to operate successfully in, and across, new and ever-changing contexts and learning spaces." The mobile learning platform established by MOE is not just an online learning tool but an opportunity for students to recognise and learn vocational skills in a new environment of online learning. The use of the learning platform is often independent of usual in-school programs, and this platform is becoming increasingly important to students and members of society for learning vocational skills.

However, the presence of mobile learning in Chinese higher vocational education is unexplored. As such, we have adapted the UTAUT as a theoretical framework of our study. This framework was developed based on eight prominent models of IT acceptance (Venkatesh et al., 2003) and was used to explain users' acceptance of information and communication technology (ICT) (e.g., Cimperman et al., 2016; Chao, 2019). The UTAUT model has advantages in analysing technology acceptance as it can explain roughly 70% of the variance (Min et al., 2008). The UTAUT model has been used and tested extensively in education (Guggemos et al., 2020), payment (Cao and Niu, 2019), health (Cimperman et al., 2016) and many other areas.

Although the original UTAUT model was widely used, many studies also extended the model from different perspectives so that it could better fit different research topics and produce new research results (Khalilzadeh et al., 2017). Therefore, the present study extends the UTAUT model by incorporating Bandura's (1986) social cognitive theory. Bandura (1986) introduces the concept of self-efficacy (SE) as the main element of social cognitive theory, which is becoming widespread in several areas of education (Islam et al., 2020). According to Lwoga and Komba (2015), SE is an important factor that has been added into the UTAUT model to measure one's competence in using ICT. SE was also included as a significant indicator in extending TAM (Irani et al., 2017), TRA (Jönsson et al., 2012), and developing the technology adoption and gratification (TAG) model (Islam, 2016), which has been found to have significant impact on intention, perceived usefulness (Bin et al., 2020), perceived ease of use (Abdullah et al., 2016; Bin et al., 2020), and subject norm (Chen et al., 2009) in using new technologies. However, few studies focus on mobile learning in considering SE in the UTAUT model (Almaiah et al., 2019). Recently, Shen et al. (2013) discovered six categories in online learning SE scale including, "self-efficacy to complete an online course, to interact with classmates, to interact with an instructor, to self-regulate in online learning, to handle a course management system, and to socialize with classmates." However, the mobile learning platform is a non-profit rather than mandatory learning tool which is relatively independent of the school curriculum system, and students' use of it is independent of each other. Therefore, the last three factors (to self-regulate in online learning, to handle a course management system, and to socialise with classmates) are not suitable for the mobile learning platform and process in this study. This study drew three suitable categories directly related to user behaviour of mobile learning, which include SE to use mobile learning, to interact with classmates and to interact with instructors, and to

measure students' competence in using mobile learning in HVE based on the prior research on online learning (Hung et al., 2010; Yu and Richardson, 2015).

Figure 1 The extended UTAUT model (see online version for colours)



Note: SEML = self-efficacy to use mobile learning, SEI = self-efficacy to interact with instructors and SEC = self-efficacy to interact with classmates.

In addition, mobile learning is not a completely regular and compulsory learning method in China. Considering the underdeveloped economy in some areas in mainland China, and the construction of mobile communication infrastructure is still imperfect, we assume that the actual use of mobile learning may not be vital issue, and many researchers excluded this construct from their studies (e.g., Seethamraju et al., 2017; Aliaño et al., 2019). Therefore, this study extends the UTAUT model by including three sub-dimensions of SE to measure students' intention to use mobile learning in Chinese HVE. Figure 1 shows the causal relationships of the extended UTAUT model as drawn using single headed arrows.

3 Hypotheses development for the extended UTAUT model

3.1 SE, effort expectancy and performance expectancy

SE refers to people's evaluation of their effectiveness or ability to execute a specific task (Bandura, 1986). SE was proven to be one of the most important factors in deciding acceptance of an educational system (e.g., Al-Emran et al., 2018; Almaiah et al., 2019). Venkatesh et al. (2003) define *effort expectancy* (EE) as "the degree of ease associated with the use of system", which is similar to perceived ease of use in TAM. They also define *performance expectancy* (PE) as the degree to which a person believes that the use of the technology can help him or her to succeed in his or her job performance, which is similar to perceived usefulness in TAM. Bin et al. (2020) and Islam (2016) found that teachers' perceived ease of use and usefulness were directly affected by their computer SE in new technologies. Such causal relationships were also verified in blended e-learning systems (e.g., Al-Azawei et al., 2017). For mobile learning, Wang and Xing (2019) and Zheng and Li (2020) reported that EE and PE were significantly influenced by the SE of elementary, undergraduate and postgraduate students while students receiving higher vocational education were not included in the research. Meanwhile, all the above

studies considered *SE* a single dimension instead of three sub-dimensions as the present study conceptualises it. Our first hypotheses based on the extended UTAUT model are as follows:

H1 Higher vocational college students' EE will be directly affected by their SE to use mobile learning.

H2 Higher vocational college students' PE will be directly affected by their SE to use mobile learning.

3.2 SE, SI and FC

SI refers to the degree of influence an important person has when suggesting new technologies or systems. SI was represented as a subjective norm in the TPB proposed by Ajzen (1991). FC was defined as the extent to which an individual believes that an organisation or hardware environment supports his or her use of a new technology or system. This is equivalent to perceived behavioural control in TPB (Venkatesh et al., 2003). Few studies have focused on the effect of SE on SI/subject norm and FC/perceived behavioural control, especially in the sphere of mobile learning and among higher vocational college students. Yeap et al. (2016) found that SE has a positive effect on perceived behavioural control in m-learning, and this relationship has also been confirmed by Zolait (2014) in customs' adoption of internet banking. In the extended UTAUT model, Chen and Hwang (2019) regard SE and effort as the second-order factors of motivation, and their study proved that motivation had a positive effect on SI in online learning behavioural intention of college students. Teo and Zhou (2014) hypothesised that SE is interrelated with social norms and FCs. Therefore, this study hypothesises that:

H3 Higher vocational college students' SI will be directly affected by their SE to use mobile learning.

H4 Higher vocational college students' FC will be directly affected by their SE to use mobile learning.

3.3 Mobile learning intention, EE and PE

In the TAM and TAG models, perceived ease of use and usefulness has been verified as valid antecedents of intention for individuals to use new technologies or systems (Chen et al., 2020; Bin et al., 2020). The UTAUT model also identified the above relationships using the different name of the exogenous variables such as effort and performance expectancies (Venkatesh et al., 2003; Ali and Arshad, 2016; Dwivedi et al., 2017). In mobile learning, researchers claimed that individuals' effort and performance expectancies significantly influence their intentions (Al-Adwan et al., 2018b; Ho et al., 2010), and these relationships can be mediated by attitude (Thomas et al., 2013) and satisfaction (Chao, 2019) or moderated by experience, gender and age (Ali and Arshad, 2016). These mixed results led us to construct the following hypotheses:

H5 Higher vocational college students' intention to use mobile learning will be directly affected by their EE.

H6 Higher vocational college students' intention to use mobile learning will be directly affected by their PE.

3.4 Mobile learning Intention, SI and FC

In regard to TPB (Ajzen, 1991), subject norm and perceived behavioural control significantly influenced intention to use. This effect has been proven in the extended UTAUT model in web-based learning (Lwoga and Komba, 2015), e-learning (Mahande and Malago, 2019), and teacher professional learning (Dunn et al., 2018). Some studies using UTAUT to test students' acceptance towards mobile-learning had the same results (Yeap et al., 2016; Hsia, 2016; Wang et al., 2009). However, Hao et al. (2017) and Alasmari and Zhang (2019) found no relationship between subject norm and intention. Therefore, the following hypotheses were proposed:

H7 Higher vocational college students' intention to use mobile learning will be directly affected by their SI.

H8 Higher vocational college students' intention to use mobile learning will be directly affected by their FC.

3.5 Mediating effect between SE and intention in mobile learning

Studies using the extended TAM or UTAUT model found a significant relationship between SE and intention in consumer demand analysis (Irani et al., 2017) and e-learning for university students (Mahdi, 2014). However, this relationship was recently mediated by some variables such as perceived usefulness (Jiang et al., 2021; Bin et al., 2020) and perceived ease of use (Jiang et al., 2021; Bao et al., 2013). As for mobile learning, Zheng and Li (2020) found that intention was indirectly affected by SE, while Mohammadi (2015) and Hutcheson (2015) found a direct relationship between these two factors. These contradictory results indicated that more studies are needed to explore the relationships between SE and intention mediated by EE, PE, SI and FC to use mobile learning in HVE. Thus, this research predicts that:

H9 Higher vocational college students' intention to use mobile learning will be indirectly affected by their SE mediated by EE.

H10 Higher vocational college students' intention to use mobile learning will be indirectly affected by their SE mediated by PE.

H11 Higher vocational college students' intention to use mobile learning will be indirectly affected by their SE mediated by SI.

H12 Higher vocational college students' intention to use mobile learning will be indirectly affected by their SE mediated by FC.

4 Methodology

4.1 Participants

According to Hair et al. (2010), each item in the questionnaire should have a minimum of five respondents. Therefore, a total sample of 900 Chinese students from higher vocational colleges was selected to participate in this study. The students' details are presented in Table 1. The sample consisted of 393 (43.67%) males and 507 (56.33%)

females. Participants aged 18–19 accounted for 37.22%, those aged 20–21 accounted for 38.33%, and those aged 22–23 accounted for 4.45%. The percentages by year in college are as follows: freshman year (38.00%), sophomore year (38.33%) and junior year (23.67%). On the types of networks used for mobile learning, the majority of students used 4G network (79%), followed by WiFi outside campus (11.44%), WiFi inside campus (7.67%), 5G network (1.44%) and 3G network (0.44%). In terms of mobile operating systems, 83.56% of participants used Android powered by Google, 9.11% used IOS powered by Apple, 1.22% used the Windows phone system powered by Microsoft, and 0.11% used the Symbian system powered by Nokia. 6% of participants used other mobile systems such as BlackBerry OS, Web OS. 37.33%, 31.22%, 14.67% and 16.78% of the participants had 0–1 year, 1–2 years, 2–3 years and more than three years' experience in using mobile learning, respectively. During the COVID-19 outbreak, 48% of the participants lived in rural area, 25.26% lived in a village or town, and 26.44% lived in a city.

Table 1 Participants' detailed information

Participants	*Categories*	*Frequency*	*Percentage*
Gender	Male	393	43.67%
	Female	507	56.33%
Age	18–19	335	37.22%
	20–21	525	58.33%
	22–23	40	4.45%
Grade	Freshman year	342	38.00%
	Sophomore year	345	38.33%
	Junior year	213	23.67%
Region	Eastern China	300	33.33%
	Central China	300	33.33%
	Western China	300	33.33%
Network	3G network	4	0.44%
	4G network	711	79.00%
	5G network	13	1.44%
	WiFi inside campus	69	7.67%
	WiFi outside campus	103	11.44%
Operation system	Android powered by Google	752	83.56%
	IOS powered by Apple	82	9.11%
	Windows phone system powered by Microsoft	1	0.11%
	Symbian system powered by Nokia	11	1.22%
	Others	54	6.00%

Table 1 Participants' detailed information (continued)

Participants	*Categories*	*Frequency*	*Percentage*
Mobile learning experience	0–1 year	336	37.33%
	1–2 year	281	31.22%
	2–3 year	132	14.67%
	3 year and more	151	16.78%
Living place during COVID-19 outbreak	Rural area	432	48.00%
	Village and town	230	25.56%
	City	238	26.44%

4.2 Measures

Six constructs in the extended UTAUT model including EE, PE, SE, SI, FCs and intention to use were measured by 54 modified items as adapted from prior studies to suit the present research. Among them, eight items of measuring students' EE referred to Chao (2019) and Chen et al.'s (2020) scale. An example item is 'Learning how to use a mobile learning platform is easy for me'. PE was measured by ten items to identify participants' performance in using mobile learning (Chao, 2019; Chen et al., 2020). An example item is, 'Using the mobile learning platform would allow me to accomplish learning tasks more productively'. Using 14 items, we measured three sub-dimensions of SE such as SE to use mobile learning, SE to interact with instructors and SE to interact with classmates (Shen et al., 2013; Hung et al., 2010; Yu and Richardson, 2015). Example items are, 'I feel confident in my knowledge and skills of how to manage apps for mobile learning', 'I feel confident to ask my instructor questions through mobile apps', and 'I feel confident in initiating social interaction with classmates during mobile learning'. SI was measured by seven items (Almaiah et al., 2019; Thomas et al., 2013) such as 'Friends who are important to me think I should use a mobile learning platform'. To assess students' perceived beliefs on the organisation or hardware environment supports for using mobile learning (FCs), seven items, partly drawn from Chaka and Govender (2017) and Thomas et al. (2013) were used. An example item is 'I have the resources necessary to use mobile a learning platform'. Finally, intention to use mobile learning platforms was measured by eight items (Almaiah et al., 2019; Chen et al., 2020; Abu-Al-Aish and Love, 2013) such as, 'I will use a mobile learning platform to carry out my learning activities'. Since all these items were presented in English, in order to ensure that participants could accurately understand the meaning of items, we invited three researchers with overseas learning experience in English-speaking countries to translate the items.

There are significant differences in infrastructure construction, especially that of mobile communications, among the eastern, central and western parts of China (Ministry of Industry and Information Technology of PRC, 2019). Therefore, we selected three higher vocational colleges from the eastern, central and western regions of China with the third highest comprehensive rank in these regions. 300 students in each higher vocational college were selected in the survey. The questionnaires were distributed via office of educational administration in three colleges, and participants were asked to indicate their agreement with each item on a six-point Likert scale with response options ranging from 1 (strongly disagree) to 6 (strongly agree).

Table 2 Interrelationships and square roots of AVE

	CR	*AVE*	*SI*	*EE*	*SE*	*PE*	*FC*	*INT*
SI	0.967	0.882	*0.939*					
EE	0.917	0.736	0.729	*0.858*				
SE	0.957	0.881	0.864	0.834	*0.938*			
PE	0.965	0.874	0.805	0.754	0.865	*0.935*		
FC	0.955	0.810	0.846	0.784	0.897	0.798	*0.900*	
INT	0.974	0.881	0.850	0.726	0.871	0.838	0.879	*0.939*

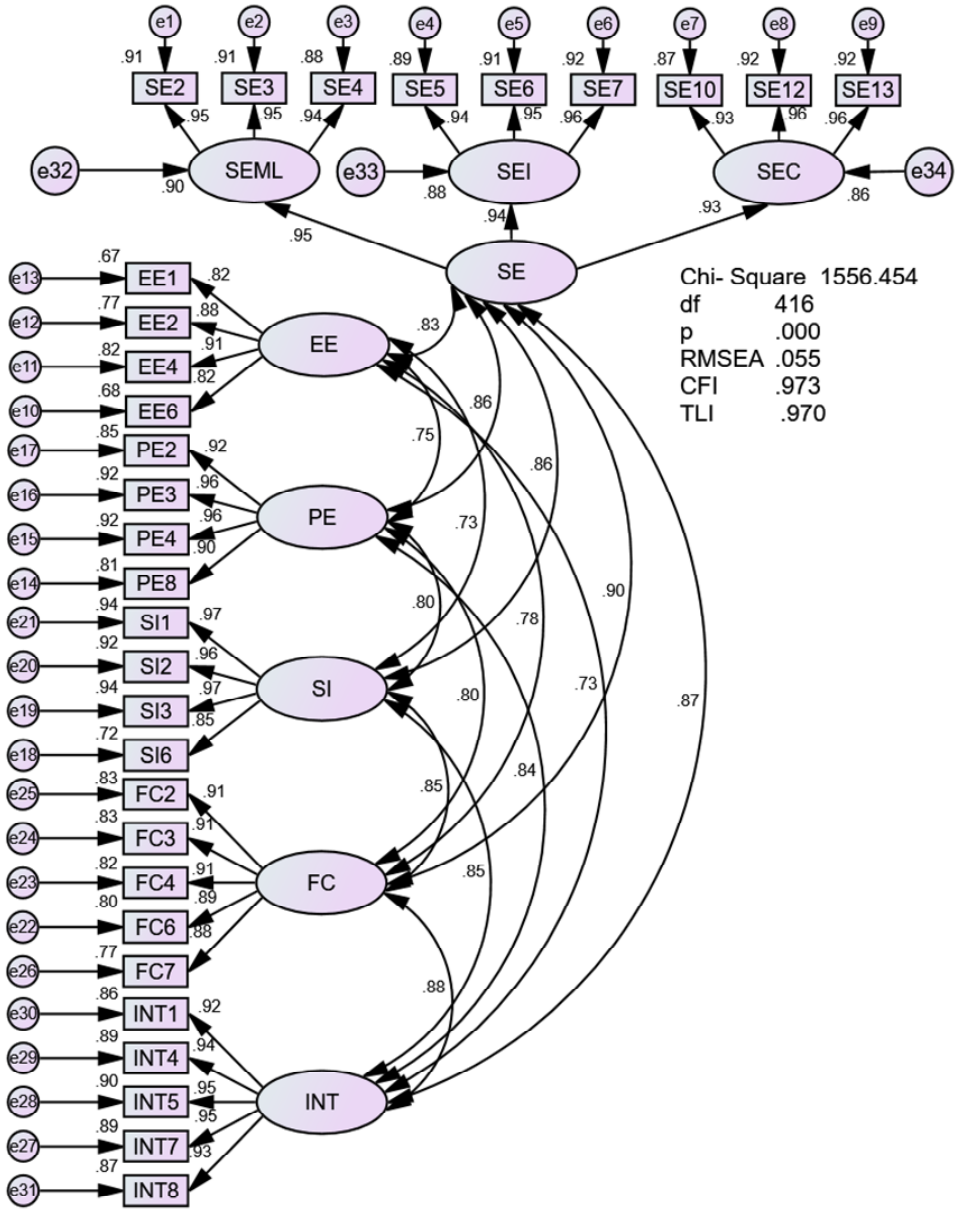
Note: Diagonal values characterised in italics are square roots of AVE.

5 Findings

The validity and reliability of the questionnaire were tested via SPSS 21.0. Exploratory factor analysis (EFA) was used to test the validity of the scale, which includes 54 items measuring the six constructs of SE, EE, PE, SI, FC and intention (INT). The validity of the constructs, excluding SE, was tested, and a total of 40 valid items accounted for 84.661% of the total variance. The factor loadings for 40 valid items of five components ranged from 0.529 to 0.797, and the KMO was 0.984 (Bartlett's test of sphericity, p = 0.000). The validity of the scale measuring SE was tested separately due to its sub-dimensions. After excluding the two cross-loaded items, a total of 12 items belonged to three sub-factors which accounted for 91.129% of the total variance with a factor loading range of 0.545 to 0.801. The KMO was 0.970 (bartlett's test of sphericity: p = 0.000).

Initially, we validated three first-order factors and second-order factor of SE with 12 valid items of EFA using confirmatory factor analysis (CFA). We then interrelated the second-order factor of SE with the remaining factors of EE, PE, SI, FC and INT for examining convergent and discriminant validity. The measurement models were evaluated based on Hu and Bentler's (1999) suggested few fit indices of chi-square (χ^2)/degree of freedom (< 5) along with the root mean square error of approximation (RMSEA < .080), the Tucker-Lewis index (TLI > .90), and the comparative fit index (CFI > .90). The results of the revised three first-order factors and second-order factor of SE confirmed that the models fitted the data by the following the fit indices, χ^2 = 77.013, df = 24, p = .000, RMSEA = .050, CFI = .996, TLI = .994 and χ^2 = 77.013, df = 24, p = .000, RMSEA = .050, CFI = .996 and TLI = .994, respectively. Later, our revised six-factor measurement model of SE, EE, PE, SI, FC and INT also fitted the data well by the following the fit indices, χ^2 = 1,556.454, df = 416, p = .000, RMSEA = .055, CFI = .973 and TLI = .970 (see Figure 2). This six-factor revised model was finally tested based on Hair et al.'s (2010) criterion of composite reliability (CR > .70) and average variance extracted (AVE > .50) and Fornell and Lacker's (1981) recommendation that the square root of AVEs should be greater than covariances. Table 2 contains the findings of convergent (CR > .917 and AVE > .736) and discriminant validity (the square root of AVEs are greater than covariances), which are the evidence for testing the structural model for this study.

Figure 2 The revised measurement model (see online version for colours)



Note: SEML = self-efficacy to use mobile learning, SEI = self-efficacy to interact with instructors and SEC = self-efficacy to interact with classmates.

Table 3 Items and summary of the results of CFA

Constructs		*Items*	*Loadings*	*M*	*SD*	α
EE	EE1	Learning how to use a mobile learning platform is easy for me.	.82	4.54	1.075	.916
	EE2	My interaction with a mobile learning platform is clear and understandable.	.88	4.41	1.103	
	EE4	I find it easy to get the mobile learning platform to do what I want it to do.	.91	4.41	1.093	
	EE6	I find it easy to access the mobile learning platform to help me take the courses.	.82	4.40	1.091	
PE	PE2	Using a mobile learning platform increases my chances of learning things that are important to me.	.92	4.24	1.026	.964
	PE3	Using the mobile learning platform allows me to accomplish learning tasks more productively.	.96	4.22	1.055	
	PE4	Using the mobile learning platform enhances my effectiveness in learning.	.96	4.19	1.076	
	PE8	Using the mobile learning platform improves the quality of my study.	.90	4.22	1.053	
SE (SEML)	SE2	I am confident in my knowledge and skills of how to use mobile learning apps.	.95	4.37	.999	.964
	SE3	I am confident in using mobile learning to collect relevant information for learning.	.95	4.40	.990	
	SE4	I am competent at integrating mobile technologies into my learning activities.	.94	4.35	.981	
SE (SEI)	SE5	I am confident in asking my instructor questions through mobile apps.	.94	4.29	1.039	.966
	SE6	I am confident in initiating discussions with the instructor through mobile apps.	.95	4.28	1.047	
	SE7	I am confident in seeking help from my instructor through mobile apps when needed.	.96	4.32	1.028	
SE (SEC)	SE10	I am confident in developing friendship with my classmates through mobile learning.	.93	4.38	1.040	.964
	SE12	I am confident in applying different social interaction skills depending on the situation during mobile learning.	.96	4.43	.994	
	SE13	I am confident in initiating social interaction with classmates during mobile learning.	.96	4.43	.993	
SI	SI1	Friends who are important to me think I should use a mobile learning platform.	.97	4.27	1.027	.966
	SI2	Friends who I value their opinion will prefer that I use a mobile learning platform.	.96	4.25	1.038	
	SI3	Friends who have an impact on me think I should use a mobile learning platform.	.97	4.25	1.042	
	SI6	My higher vocational college teachers are supportive of the use of a mobile learning platform.	.85	4.36	.989	
FC	FC2	I have the resources necessary to use a mobile learning platform.	.91	4.42	.987	.955
	FC3	Support from an individual or service is available when I encounter problems with mobile learning technologies.	.91	4.31	1.036	
	FC4	The availability of mobile devices and their associated applications to me will facilitate my decision to accept the use of a mobile learning platform.	.91	4.41	.998	
	FC6	My university campus has technical support for mobile learning.	.89	4.37	.985	
	FC7	I have sufficient facilities in my home that support the use of a mobile learning platform.	.88	4.40	.986	
INT	INT1	I intend to use a mobile learning platform in the future.	.92	4.33	1.013	.974
	INT4	I will use a mobile learning platform to update my knowledge and information pertaining to my study.	.94	4.35	.994	
	INT5	I intend to use a mobile learning platform to upgrade my learning capacity.	.95	4.38	.982	
	INT7	I will enjoy using a mobile learning platform.	.95	4.32	1.018	
	INT8	I have intention to recommend that others use a mobile learning platform.	.93	4.33	1.018	

Table 3 reports all the items of the revised measurement model and its loadings, mean (*M*), standard deviation (*SD*) and Cronbach's alpha (α) for certifying the validity and reliability of the instrument.

6 Evaluation of the extended UTAUT model

Figure 3 shows the extended UTAUT model for SE, EE, PE, SI, FC and INT with standardised regression weights. The extended UTAUT model fitted the data well, with χ^2 = 1,636.619, df = 423, p = .000, RMSEA = .056, CFI = .971 and TLI = .969. In the extended UTAUT path diagram, most of the correlations among exogenous, endogenous and mediating variables develop in the desired direction and support the hypothetical causal structure at a 95% confidence interval. Our first (H1) and second (H2) hypotheses were supported; that is, Chinese higher vocational college students' EE (β = .84, p = .000, CR = 27.108) and PE (β = .88, p = .000, CR = 33.706) were directly affected by their SE to use mobile learning. The results showed a highly significant direct influence of SE on SI (β = .88, p = .000, CR = 30.959) and FC (β = .91, p = .000, CR = 35.215), thus supporting H3 and H4. The results also exhibited a highly significant direct influence of PE (β = .30, p = .000, CR = 9.862), SI (β = .26, p = .000, CR = 8.657) and FC (β = .46, p = .000, CR = 13.204) on INT, which provide support for H6, H7 and H8, respectively. However, the direct influence of EE (β = –.04, p = .126, CR = –1.529) on INT (H5) was not significant. On the other hand, the results obtained by the Sobel (1982) test showed that SE had significant indirect influences on INT through PE (chi-square, χ^2 = 9.546, p = 0.0), SI (chi-square, χ^2 = 8.252, p = 0.0) and FC (chi-square, χ^2 = 12.390, p = 0.0); that is, H10, H11 and H12 were proven while H9 was rejected.

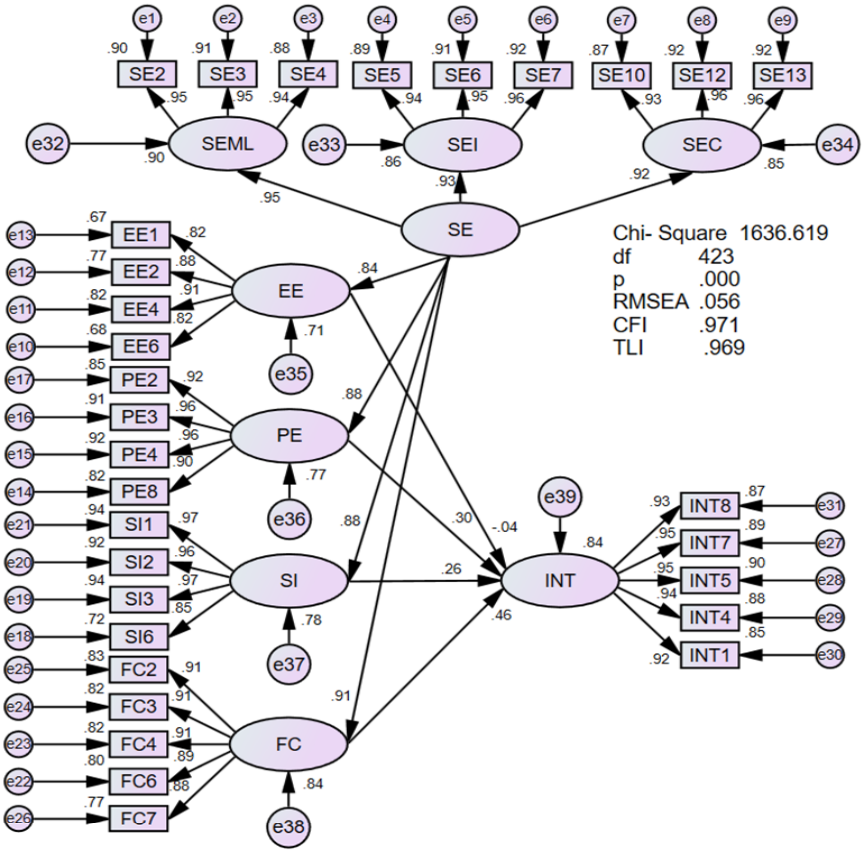
We summarise the results of hypotheses of extended UTAUT model in Table 4 where the variances of the model are reported as well.

Table 4 The results of hypotheses of extended UTAUT model

Hypotheses		β	*CR (p)/χ^2 (p)*	*Standardised effect size*	*Variances*	*Results*
H1	SE → EE	.84	27.108 (.000)	.842	71%	Accepted
H2	SE → PE	.88	33.706 (.000)	.879	77%	Accepted
H3	SE → SI	.88	30.959 (.000)	.884	78%	Accepted
H4	SE → FC	.91	35.215 (.000)	.914	84%	Accepted
H5	EE → INT	–.04	–1.529 (.126)	–.044	84%	Rejected
H6	PE → INT	.30	9.862 (.000)	.297		Accepted
H7	SI → INT	.26	8.657 (.000)	.262		Accepted
H8	FC → INT	.46	13.204 (.000)	.460		Accepted
H9	SE → EE → INT	–.033 (≤.080)	–1.513 (.065)	.877		Rejected
H10	SE → PE → INT	.264 (≥.080)	9.546 (0.0)			Accepted
H11	SE → SI → INT	.228 (≥.080)	8.252 (0.0)			Accepted
H12	SE → FC → INT	.418 (≥.080)	12.390 (0.0)			Accepted

Note: β = path coefficient, CR = critical ratio and χ^2 = chi-square.

Figure 3 The extended UTAUT model (see online version for colours)



7 Discussion

This research explored students' drivers of acceptance of mobile learning during the COVID-19 pandemic in Chinese higher vocational colleges based on the extended UTAUT model. According to the original UTAUT model, EE and PE have significant influence on intention to use mobile learning, and these relationships have been confirmed in many studies (Chen et al., 2020; Ali and Arshad, 2016). However, this study only proved significant relationships among PE, SI and intention. This indicates that Chinese higher vocational college students' EE cannot significantly improve their intention to use mobile learning. This finding is consistent with Hutcheson's (2015) results, which shows that EE has far less influence on mobile technology acceptance in learning than what previous studies and models have shown. Caffaro et al. (2020) attributed this result to the fact that perceived ease of use (similar to EE) generally tests internal factors for the use of new skills, and it is unlikely to capture the external control issues that hinder the use of the technology. Therefore, one possible explanation is that mobile phone use costs less for higher vocational students to learn. At present, 86.5% of Chinese primary and secondary school students own a variety of electronic products,

among which the ownership rate of smart phones is 68.1% (Sun and Zhang, 2018). As a result, many Chinese students already are relatively skilled at smartphone operation and use of APPs before entering higher vocational colleges. As such, the results showed that the simplicity of mobile learning cannot improve students' intention to use. Accordingly, this finding proves that the key to enhancing students' mobile learning intention is to improve the PE or usefulness of mobile learning in higher vocational colleges. In addition to having relevant content to learn vocational skills through traditional video and text, mobile learning platforms should introduce a variety of forms such as interactive animation (Holzinger et al., 2005). The purpose of introducing a variety of forms is to improve the matching between mobile learning and vocational skills learning and allow students to experience the advantages of mobile learning compared with traditional classroom teaching.

In addition, this study also confirmed the influence of peers and teachers, which was consistent with results based on the UTAUT (Lwoga and Komba, 2015; Yeap et al., 2016). It indicated that teachers should create opportunities for students and teachers to have in-depth discussions around the problems in the use of mobile learning. In particular, students who have successfully used mobile learning to improve academic performance can be invited to share their experiences and create an atmosphere that encourages the use of mobile learning in classes and on campus.

In addition to the relationships among effort and performance expectancies, SI and intention to use mobile learning, we also tested the relationship between FC and intention, which was consistent with Hsia (2016) who proved that students' beliefs about technical equipment and support had significantly influence on their intentions to use mobile learning. A FC in mobile learning involves network signal quality, mobile operating speed and external technical support. Although China is now vigorously developing 5G technology, the popularity rate of 4G is still lagging behind that of developed countries such as Japan and South Korea (Statista, 2020), and the quality of 4G signal will vary according to region. In some rural areas in western China, there is still room for improvement in the popularity of 4G network, signal quality and technical support. Considering that 4G is currently the most important network for Chinese higher vocational students to use mobile learning, the government should strive to improve the popularity rate and technical support level of 4G network and reduce the cost of 4G network and home broadband in order to improve network accessibility. Higher vocational colleges should also improve the coverage and speed of Wi-Fi on campus to enhance students' intention to use mobile devices for learning.

The present research incorporated SE into the UTAUT model and found that SE has significant influence on effort and performance expectancies, SI and FC. Part of these results were consistent with the studies based on the TAG model (Islam, 2016; Bin et al., 2020) and extended TAM (Teo and Zhou, 2014) where researchers identified the relationships among SE, perceived ease of use and usefulness. Meanwhile, the mediating effects of PE, SI, and FC were found between SE and intention to use mobile learning. However, studies found that perceived usefulness (Jiang et al., 2021; Bin et al., 2020) and perceived ease of use (Jiang et al., 2021; Bao et al., 2013; Bin et al., 2020) were the valid mediating variables of establishing a relationship between SE and intention to use. On the other hand, this study found a non-significant mediating effect of EE in assessing the indirect relationship between SE and intention to use mobile learning. These results mean that students receiving higher vocational education who believe they are more capable of using mobile learning are better able to follow the advice regarding using mobile learning

given by significant others and to pay more attention to, discover and utilise mobile learning resources. Thus, they are more willing to use mobile learning. Therefore, improving students' SE in using mobile learning should be regarded as an important measure for improving their intentions. For this study, SE includes three sub-aspects based on prior studies such as SE to use mobile learning, SE to interact with instructors and SE to interact with classmates. The designers and developers of mobile learning platforms should pay attention to the matching of content and students' courses, strengthen the guidance of using methods of mobile learning platforms, and promote the development of a good teacher-student relationship and peer relationship based on mobile learning platforms.

As shown in the results, students' SE was an important predictor in predicting acceptance of mobile learning (Hutcheson, 2015). This research extended the UTAUT model using three sub-dimensions of SE, which all contribute to fully predicting students' SE in using mobile learning. Future studies using UTAUT as the research model should include SE as a crucial indicator for predicting one's acceptance of new technology.

8 Conclusions

This study uses an extended UTAUT model to explain the students' acceptance of using mobile learning in Chinese technical and vocational colleges. Our findings show that the use of mobile learning has three primary determinants: PE, SI and FC. Higher vocational college students' intention to use mobile learning was indirectly predicted by their SE which was mediated by PE, SI and FC. Higher vocational college students' SE of using mobile learning was measured using three important sub-dimensions of SE: SE to use mobile learning, SE to interact with instructors and SE to interact with classmates. The UTAUT model was successfully applied to the mobile learning research of students in higher vocational colleges in China, which contributes to the expansion of the research object in this field and improves the UTAUT model. Meanwhile, this study provides suggestions for the government, higher vocational colleges and learning platform development enterprises to enhance students' acceptance of mobile learning. It especially calls for developers to pay attention to the content quality of mobile learning platforms, and the government and schools should optimise the environment of mobile learning in terms of both hardware and publicity.

However, we only focused on three higher vocational colleges in China, and some moderating factors were not considered in our model. Meanwhile, substantial research still needs to be done to investigate the relationship between SE and intention of using new technology. Future studies can focus on the moderating effect in the UTAUT model in the sphere of mobile learning, comparing students' acceptance of mobile learning from higher vocational colleges and academic higher education institutions to discover the deep mechanism involved in deciding to use mobile learning in the context of the coronavirus pandemic.

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