



# Examine the moderating role of mobile technology anxiety in mobile learning: a modified model of goal-directed behavior

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## Abstract

Although there are numerous mobile learning studies, limited efforts have been devoted to investigating the moderating role of mobile technology anxiety on mobile learning outcome. Accordingly, the primary purpose of this study is not only to examine the key elements that could influence desire to take mobile learning and mobile learning continuance intention, but also to explore the moderating impact of mobile technology anxiety on mobile learning outcome. 676 college students participated in this study, and the partial least squares structural equation modeling (PLS-SEM) analysis was performed to analyze the data. The study findings have demonstrated that desire to take mobile learning, attitude toward mobile learning, and perceived usefulness are positively linked to mobile learning continuance intention. Second, it has been found that attitude, positive anticipated emotion, negative anticipated emotion, and subjective norm play a key role in determining better desire to take mobile learning, whereas perceived behavioral control has no impact on desire to take mobile learning. Additionally, it has been shown that perceived usefulness, and personal learning initiative are two critical antecedents of attitude toward mobile learning. Finally, the study findings have shown that mobile technology anxiety would moderate the relationship between attitude toward mobile learning and mobile learning continuance intention.

**Keywords** Adult learning · Continuance intention · Mobile technology anxiety · Mobile learning · Model of goal-directed behavior

## Introduction

Because mobile learning has advantages and benefits, such as better flexibility and accessibility, it has gradually been viewed as a critical teaching and learning solution in our lives (Pappas et al., 2019; Wang et al., 2019). Han and Shin

(2016) have revealed that mobile learning could not only let learners have better opportunities in access to learning resources, but also facilitate them to conveniently and quickly share knowledge with other mobile learners. With particular respect to the application of mobile devices in educational settings, Shorfuzzaman et al. (2019) have indicated that mobile technology advancements could facilitate and encourage instructors to implement mobile learning. In light of this, there is a growing interest in examining key factors that improve mobile learning intention. For instance, in an early mobile learning review, Huang et al. (2014) have suggested that perceived usefulness of mobile learning, subjective norm, and self-management of mobile learning should be key antecedents of mobile learning continuance intention. In another recent study, Huang and Yu (2019) have revealed that self-management of learning and perceived flexibility advantage of mobile learning would be positively associated with mobile learning continuance intention and performance.

Although there are numerous mobile learning studies, limited efforts have been devoted to investigating the role

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of mobile technology anxiety in mobile learning achievement. Specifically, whether mobile technology anxiety, which refers to a person's anxious, uneasy, and uncomfortable feelings about using mobile devices to learn English, would have a moderating impact on mobile learning continuance intention has not yet been fully investigated in previous reports. Additionally, a growing attention has been paid to examining the key factors that could influence personal desire to act, owing probably to the close link between personal desire and behavioral intention (Lee et al., 2012; Park et al., 2017). For example, an early review by Hingle et al. (2012) has suggested that parents' desire to use vegetable parenting practices (VPP) should be one of the key of antecedents of their intention to use VPP. Another recent study by Han et al. (2018) has shown that visitors' desire to visit an environmentally responsible museum would have a positive influence on their visit intention. Nonetheless, there is still a dearth of studies examining the impact of desire to take mobile learning on mobile learning outcome. More precisely, whether desire to take mobile learning would play a key role in determining mobile learning continuance intention has not yet been fully investigated in previous reports. Accordingly, the primary purpose of this study is not only to examine the key elements that could influence desire to take mobile learning and mobile learning continuance intention, but also to explore the moderating impact of mobile technology anxiety on mobile learning outcome.

In a nutshell, the contributions and significance of this study would lie not only in exploring key elements that influence desire to take mobile learning and mobile learning continuance intention, but also in first considering the pivotal influence of desire to take mobile learning on mobile learning continuance intention. More importantly, this study further probes into the moderating impact of mobile technology anxiety on the relationship between attitude toward mobile learning and mobile learning continuance intention. The study findings would offer mobile learning researchers and practitioners theoretical and practical solutions to further enhance mobile learning outcomes.

## Literature review and hypothesis development

### Key factors that influence mobile and online learning adoption

A considerable number of studies have shown that numerous factors (Davis, 1989; Hamidi & Chavoshi, 2018; Huang et al., 2014; Karimi, 2016), such as perceived usefulness, perceived playfulness, perceived ease of use, personal innovativeness, learning style, performance expectancy, self-management of learning, and perceived flexibility

advantage, would be closely and positively associated with mobile and online learning adoption. First, in regard to the pivotal role of perceived usefulness and ease of use in technology acceptance, previous research shown that perceived usefulness and ease of uses would be two critical antecedents of mobile learning adoption (Davis, 1989). For example, Hamidi and Chavoshi (2018) have suggested that perceived ease of use should be positively linked to mobile learning adoption. Huang et al. (2014) has revealed that perceived usefulness would positively predict mobile learning continuance intention. Additionally, it has been found that self-management of learning, perceived flexibility advantage, perceived playfulness, and learning style would play pivotal roles in determining mobile learning acceptance and continuance intention. An early review by Karimi (2016) has shown that perceived playfulness and learning style should be critical determinants of mobile learning adoption in informal and formal learning. Another recent report by Huang and Yu (2019) have demonstrated that self-management of learning and perceived flexibility advantage, which refers to time and place flexibility advantage of mobile learning, would have a positive impact not only on mobile learning continuance intention, but also on mobile learning performance.

More importantly, with particular respect to the role of personal innovativeness and performance expectancy in mobile learning adoption, Karimi (2016) added that personal innovativeness, which is described as "individuals' willingness to try out any new information technology" (p. 771), would play a key role in determining mobile learning adoption in informal learning, whereas performance expectancy, which is defined as "the extent to which a person believes using m-learning would improve his/her learning performance and productivity" (p. 770), would have a positive impact on mobile learning adoption in formal learning. Although several researchers have concentrated on the key factors that could influence online learning and mobile learning adoption, there is still a shortage of studies exploring the impact of personal desire on mobile learning continuance intention. In order to close this gap in mobile learning research, consequently, the role of personal desire in the model of goal-directed behavior (MGB) in mobile learning should be worthy of further discussions in this report.

### The model of goal-directed behavior, and desire to take mobile learning

The model of goal-directed behavior (MGB), which is developed from the theory of planned behavior (TPB), further incorporates past behaviors, positive and negative anticipated emotions into the theoretical framework of TPB, in order to increase the explanatory power of whole model (Abrams et al., 1999). In terms of predictive power of

intention, previous research has shown that MGB is better than TPB, mainly because TPB does not further explore the central influence of past behavior, motivational and affective factors on human behaviors (Lee et al., 2012; Meng & Choi, 2016; Song et al., 2014). More specifically, MGB not only posits that attitude, subjective norm, perceived behavioral control, positive and negative anticipated emotions as well as past behaviors, which refers to “frequency and recency of past behavior” (Song et al., 2014, p. 103), are critical antecedents of personal desire to act, but also suggests that personal desire would play a key mediating role in determining behavioral intention (Perugini & Bagozzi, 2001). In terms of the connections between attitude, subjective norm, perceived behavioral control, two anticipated emotions, and personal desire to act, an early review by Song et al. (2014) has shown that attitude, which refers to “a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor” (Eagly & Chaiken, 1993, p. 1), and subjective norm, which refers to social influences from important friends and people, would have a positive impact on tourists’ desire to attend the oriental medicine festival. Another truism report by Meng and Choi (2016) has found that in terms of traveling for slow tourism, perceived behavioral control, which refers to personal capability and confidence to travel for slow tourism, would positively predict personal desire to travel by slow tourism in the near future.

Second, in regard to the close connections between subjective norm, perceived behavioral control, attitude toward mobile learning, and mobile learning intention, several reports have suggested that subjective norm, perceived behavioral control, attitude toward mobile and online learning should be key determinants of online learning continuance intention and mobile learning adoption. For instance, in an early review, Lee (2010) has shown that attitude toward e-learning, subjective norm, and perceived behavioral control would be positively connected with online learning continuance intention. In another mobile learning study, Cheon et al. (2012) have indicated that attitude toward mobile learning, subjective norm, and perceived behavioral control would play a key role in determining college students’ intention to adopt mobile learning.

Third, Han et al. (2018) has revealed that positive and negative anticipated emotions, which refers to “one’s expected post-behavioral affective responses” (p. 291), should be key antecedents of personal desire to visit an environmentally responsible museum in the future. Moreover, in regard to the critical role of personal desire in previous reports, it has been suggested that personal desire, which is viewed as “the motivational state of mind to lead to behavioral intentions” (Park et al., 2017, p. 66), should be a key mediator and predictor of behavioral intention (Perugini & Bagozzi, 2001). For example, Park et al. (2017) has revealed

that desire to visit wetlands would positively predict behavioral intention to visit wetlands. Choi and Park (2017) have demonstrated that tourists’ desire to use duty-free shop would have a positive influence on their behavioral intention to use a duty-free shop. In the same vein, it is possible that college students with higher levels of attitude toward mobile learning, subjective norm, perceived behavioral control, and anticipated emotions are likely to have a stronger desire to take mobile learning, which in turn would lead to better mobile learning continuance intention, which refers to college students’ behavioral intention to continuously use mobile technology to learn English. Consequently, based on prior suggestions, this study proposes the following hypotheses.

**H1** Desire to take mobile learning will be positively linked to mobile learning continuance intention.

**H2** Attitude toward mobile learning will be positively linked to desire to take mobile learning.

**H3** Attitude toward mobile learning will be positively linked to mobile learning continuance intention.

**H4** Positive anticipated emotion will be positively linked to desire to take mobile learning.

**H5** Negative anticipated emotion will be positively linked to desire to take mobile learning.

**H6** Subjective norm will be positively linked to desire to take mobile learning.

**H7** Perceived behavioral control will be positively linked to desire to take mobile learning.

### **Perceived usefulness, and personal learning initiative**

Previous studies have revealed that perceived usefulness, which is defined as “the degree to which a person believes that using a particular system would enhance his or her job performance” (Davis, 1989, p. 320) would be one of the key determinants of attitude toward using information technology (Chung & Tan, 2004; Isiyaku et al., 2018; Padilla-Meléndez et al., 2013). More specifically, people with higher levels of perceived usefulness are likely to have better attitude toward using information technology. For example, Chung and Tan (2004) have shown that perceived usefulness could be one of the key antecedents of attitude toward using information technology. In addition, an early review by Ahn et al. (2007) has revealed that perceived usefulness

and online website would be positively associated with attitude toward using online retailing. Another recent report by Padilla-Meléndez et al. (2013) has indicated that perceived usefulness blended learning systems will have a positive impact on student attitude toward using blended learning systems. With particular respect to the positive impact of perceived usefulness on mobile learning outcome, Huang et al. (2014) has shown that perceived usefulness would be positively associated with mobile learning continuance intention. Chavoshi and Hamidi (2019) added that “especially in young people, use of wireless and mobile technologies can stimulate learning, support interests and improve the learning and development process” (p. 134).

Second, previous research has shown that personal learning initiative, which is described as “proactive, self-starting, and persisting behaviors that learners demonstrate in order to accomplish their learning goals” (Huang & Yu, 2019, p. 118), could be closely connected with personal learning outcome and individual performance. Additionally, in regard to language learning initiative, Kurhila and Kotilainen (2020) have revealed that student-initiated language learning would facilitate learners to have better learning outcomes. Although several researchers have highly concentrated on mobile learning, there is still a shortage of studies investigating the influence of personal learning initiative on attitude toward mobile learning. Specifically, the relationship between personal learning initiative and attitude toward mobile learning has not yet been fully examined in previous research. Based on previous suggestions, it is possible that the perceived usefulness and personal learning initiative will be positively connected with attitude toward mobile learning. Consequently, this study proposes the following hypotheses.

**H8** Personal learning initiative will be positively linked to attitude toward mobile learning.

**H9** Perceived usefulness will be positively linked to attitude toward mobile learning.

**H10** Perceived usefulness will be positively linked to mobile learning continuance intention.

### Moderating impact of mobile technology anxiety

Computer anxiety, which is described as “the tendency of individuals to be uneasy, apprehensive, or fearful about current or future use of computers in general” (Igarria & Parasuraman, 1989, p. 375), has received much attention in prior reports, probably because it is negatively connected with adoptions and usages of computer technology (Cidral et al., 2018). For example, an early study by Schottenbauer

et al. (2004) revealed that negative attitude computer was positively linked to computer anxiety. Another recent review by Powell (2013) suggested that computer anxiety should be negatively related to learning outcome and intention to use. With particular respect to high-school and university students’ attitude toward the computer in Romania, Cazan et al. (2016) demonstrated that computer anxiety would have a negative impact on internet attitude.

Second, in terms of the moderating role of computer anxiety in e-commerce studies, Lee et al. (2009) found that computer anxiety would moderate the link between website information satisfaction and online purchase satisfaction. Additionally, in an early interactive marketing report, Kim and Forsythe (2008) have suggested that technology anxiety would play a moderating in determining the link between attitude toward using virtual try-on and intended use of virtual try-on technology for online apparel shopping. In another recent study, Aziz et al. (2018) indicated that technology would moderate the relationship between brand image and brand loyalty. Although there are numerous online and mobile learning studies, relatively little attention has been paid to the moderating impact of mobile technology anxiety on mobile learning outcomes. In mobile learning environments, it is possible that mobile technology anxiety, which is described as a person’s anxious, uneasy, and uncomfortable feelings about using mobile devices to learn English, will play a moderating role in determining the relationship between attitude toward mobile learning and mobile learning continuance intention. Accordingly, this study proposes the following hypothesis.

**H11** Mobile technology anxiety will moderate the relationship between attitude toward mobile learning and mobile learning continuance intention.

## Research methodology

### Demographic data for respondents

As shown in Table 1, this study had 676 college students, containing 320 males (47%), 355 females (52%), and one missing value, to successfully complete the survey. Moreover, it was found that most college students preferred to adopt mobile phone to learn English ( $n = 437$ , 65%). Third, the study findings indicated that except one missing data, 265 freshmen (39%), 250 sophomores (37%), 96 juniors (14%), and 64 seniors (9%) joined this study. Finally, it was shown that most participants were college students with business major ( $n = 292$ , 43%), and the mean age of college students was 19.4 with standard deviation 1.51.

**Table 1** Demographic data for respondents

Demographics	Items	Number	Percentage of respondents
Gender	Male	320	47
	Female	355	52
	Missing data	1	1
Age	Valid participants	671	99
	Missing data	5	1
	Mean Age	19.4	
	Standard deviation	1.51	
Mobile devices	Mobile Phone	437	65
	Tablet PC	40	6
	Notebook computer	189	28
	Missing data	10	1
College	Arts and humanities	58	9
	Business	292	43
	Engineering	166	24
	Health Sciences	154	23
	Missing data	6	1
Academic level	Freshman	265	39
	Sophomore	250	37
	Junior	96	14
	Senior	64	9
	Missing data	1	1

## Data collection and procedure

In order to collect mobile English learning data, researchers first contacted instructors who taught Business English course at different colleges and universities in Taiwan, and obtained their permission to administer the study. Second, a mobile English learning survey was given to the college students who took Business English course. More specifically, undergraduate students with mobile English learning experience were invited to finish the mobile learning survey, and the participation in this study was voluntary. The researchers successfully obtained 842 surveys from seven colleges and universities in Taiwan. This study further screened out 166 problematic surveys, not only because some participants did not have mobile English learning experience, but also because part of data were incomplete. After removing problematic surveys and questionable data, researchers finally got 676 complete surveys to analyze the data.

## Instrumentation

The survey items, which contained the constructs of attitude, subjective norm, perceived behavioral control, two anticipated emotions, as well as desire, were measured by using seven-point Likert scales, and mainly adopted from

Meng and Choi (2016). Sample items of attitude are “I think that using mobile devices to learn English is good”, and “I think that using mobile devices to learn English is valuable”. Sample items of subjective norm are “Most people who are important to me think it is okay for me to use mobile devices to learn English”, and “Most people who are important to me agree with me about using mobile devices to learn English”. Sample items of perceived behavioral control are “Whether or not I use mobile devices to learn English is completely up to me”, and “I am capable of using mobile devices to learn English”. Sample items of positive anticipated emotions are “If I can use mobile devices to learn English, I will feel excited”, and “If I can use mobile devices to learn English, I will feel glad”. Sample items of negative anticipated emotions are “If I cannot use mobile devices to learn English, I will feel unsatisfied”, and “If I cannot use mobile devices to learn English, I will feel disappointed”. Sample items of desire are “I desire to use mobile devices to learn English”, and “I want to use mobile devices to learn English.

Moreover, four survey items, which examined the construct of perceived usefulness, were taken from Huang et al. (2014). Sample items of perceived usefulness are “Using mobile technology to learn English could improve my learning performance”, and “Using mobile technology to learn English could enhance my learning effectiveness”. Six survey items, which evaluated the construct of personal learning initiative, were selected from Huang and Yu (2019). Sample items of personal learning initiative are “I actively deal with problems encountered in learning”, and “Whenever learning goes wrong, I search for a solution immediately”. Additionally, five survey items, which measured the construct of mobile learning continuance intention, were adopted from Huang and Yu (2019). Sample items of mobile learning continuance intention are “I will continue to use mobile devices to learn English in the future”, and “I intend to regularly use mobile devices to learn English”. Finally, three survey items, which measured the construct of mobile technology anxiety, were taken from Cidral et al. (2018). Sample items of mobile technology anxiety are “Using mobile technology to learn English would make me very nervous”, and “Using mobile technology to learn English makes me feel uncomfortable”.

## Data analysis and results

The partial least squares structural equation modeling (PLS-SEM) analysis was performed not only to examine the key elements that could have positive impacts on desire to take mobile learning, but also to explore the moderating impact of mobile technology anxiety on the relationship between attitude toward mobile learning and mobile learning continuance intention. According to Fornell and Larcker (1981), two measures, containing composite reliability (CR) and factor



loading, should be adopted to examine the reliability and the internal consistency of mobile learning survey. In three different models (full model, high mobile technology anxiety model, and low mobile technology anxiety model), it was found that CR in different constructs was all greater than 0.90, and factor loadings in different variables were higher than the suggested criteria (0.70) (Fornell & Larcker, 1981). Moreover, in order to examine whether the convergent and discriminant validity were satisfactory, two measures, the average variance extracted (AVE) and square root of AVE, should be utilized to analyze the data. In Tables 2 and 3, study findings, in three different models, demonstrated that the values of AVE, in different constructs, were all larger than 0.50. More importantly, the square root of AVE on the diagonal was greater than off-diagonal values in the correlation matrix (Fornell & Larcker, 1981). Hence, the study findings demonstrated that three measurement models were all adequate (Fig. 1).

Second, the researchers adopted several measures, containing path coefficients, R-square values, and t-values, to test hypotheses and structural model in this study. In Fig. 2, the study results, in full model, revealed that although the perceived behavioral control (H7;  $\beta = 0.024$ ;  $t = 0.774$ ) was not supported by study findings, other hypotheses, including H1, H2, H3, H4, H5, H6, H8, H9 and H10, were all buttressed by study findings. Specifically, it was demonstrated that desire to take mobile learning (H1,  $\beta = 0.410$ ,  $t = 9.834$ ), attitude toward mobile learning (H3;  $\beta = 0.213$ ;  $t = 5.020$ ), and perceived usefulness (H10;  $\beta = 0.288$ ;  $t = 6.332$ ), which explained a total of 61.7% of variance in mobile learning continuance intention, would positively predict college students' mobile learning outcome. Additionally, attitude toward mobile learning (H2;  $\beta = 0.195$ ;  $t = 4.524$ ), positive anticipated emotion (H4;  $\beta = 0.438$ ;  $t = 9.470$ ), negative anticipated emotion (H5;  $\beta = 0.140$ ;  $t = 3.447$ ), and subjective norm (H6;  $\beta = 0.089$ ;  $t = 2.309$ ), which accounted for a total of 48.9% of variance in desire to take mobile learning, would positively predict college students' desire to take mobile learning. More importantly, it was shown that personal learning initiative (H8;  $\beta = 0.189$ ;  $t = 4.771$ ), and perceived usefulness (H9;  $\beta = 0.550$ ;  $t = 15.321$ ), which explained a total of 42.5% of variance in attitude toward mobile learning, would be two critical antecedents of attitude toward mobile learning.

Third, in order to examine the moderating impact of mobile technology anxiety on the link between attitude toward mobile learning and mobile learning continuance intention, this study adopted the median of mobile technology anxiety to categorize 676 participants into two different groups: high mobile technology anxiety group ( $N1 = 341$ ) and low mobile technology anxiety group ( $N2 = 335$ ). According to the suggestions by Keil et al. (2000), the analysis of path coefficient comparison was performed to

examine the moderating role of mobile technology anxiety in the relationship between attitude toward mobile learning and mobile learning continuance intention. The procedures were as follows:

$$\text{Spooled} \sqrt{\frac{(N_h - 1) \times SE_h^2 + (N_l - 1) \times SE_l^2}{(N_h + N_l - 2)}}$$

$$t = \frac{(PCh - PCl)}{\frac{\text{Spooled}}{\sqrt{\frac{1}{N_h} + \frac{1}{N_l}}}}$$

Spooled = pooled estimator for the variance.

$t$  =  $t$ -statistic with  $(N_h + N_l - 2)$  degrees of freedom.

$N_h$  = sample size of high mobile technology anxiety group;

$N_l$  = sample size of low mobile technology anxiety group.

PCh = path coefficient in structural model of high mobile technology anxiety.

PCl = path coefficient in structural model of low mobile technology anxiety.

SE<sub>h</sub> = standard error of path in structural model for high mobile technology anxiety.

SE<sub>l</sub> = standard error of path in structural model for low mobile technology anxiety.

In Table 4 and Fig. 3, the study findings indicated that mobile technology anxiety would moderate the relationship between attitude toward mobile learning and mobile learning continuance intention ( $t = -35.46$ ,  $p < 0.001$ ). More precisely, mobile technology anxiety would lessen the link between attitude toward mobile learning and mobile learning continuance intention.

## Discussions and implications

### Summary of findings

The primary purpose of this study is not only to examine the key elements that could influence desire to take mobile learning and mobile learning continuance intention, but also to explore the moderating impact of mobile technology anxiety on mobile learning outcome. First, the study results have indicated that desire to take mobile learning, attitude toward mobile learning, and perceived usefulness would be positively connected with mobile learning continuance intention. Second, the study findings have demonstrated that attitude, positive anticipated emotion, negative anticipated emotion, and subjective norm would play a key role in determining desire to take mobile learning, whereas perceived behavioral control has no impact on desire to take mobile learning. Additionally, it has been found that perceived usefulness,

**Table 2** Confirmatory factor analysis of each model

Items	FM	$\alpha$	CR	AVE	HMTA	$\alpha$	CR	AVE	LMTA	$\alpha$	CR	AVE
AT1	0.93				0.92				0.93			
AT2	0.92				0.91				0.93			
AT3	0.92				0.90				0.92			
AT4	0.81				0.84				0.80			
AT		0.92	0.94	0.81		0.91	0.94	0.80		0.91	0.94	0.81
MLCI1	0.82				0.93				0.74			
MLCI2	0.93				0.93				0.93			
MLCI3	0.90				0.90				0.90			
MLCI4	0.93				0.93				0.94			
MLCI5	0.92				0.92				0.91			
MLCI		0.94	0.95	0.82		0.95	0.96	0.85		0.93	0.94	0.79
DR1	0.94				0.93				0.94			
DR2	0.95				0.95				0.96			
DR3	0.94				0.94				0.95			
DR4	0.93				0.93				0.94			
DR		0.96	0.97	0.89		0.95	0.97	0.87		0.96	0.97	0.90
NAE1	0.95				0.94				0.96			
NAE2	0.96				0.95				0.97			
NAE3	0.93				0.94				0.93			
NAE4	0.92				0.90				0.92			
NAE		0.96	0.97	0.89		0.95	0.96	0.87		0.96	0.97	0.90
PAE1	0.94				0.93				0.95			
PAE2	0.97				0.97				0.96			
PAE3	0.93				0.93				0.94			
PAE4	0.96				0.97				0.96			
PAE		0.97	0.98	0.91		0.96	0.97	0.90		0.97	0.98	0.91
PCB1	0.83				0.82				0.77			
PCB2	0.93				0.93				0.92			
PCB3	0.93				0.92				0.92			
PCB		0.88	0.93	0.81		0.87	0.92	0.80		0.85	0.90	0.76
PLI1	0.86				0.87				0.84			
PLI2	0.87				0.87				0.85			
PLI3	0.86				0.86				0.86			
PLI4	0.87				0.87				0.86			
PLI5	0.85				0.84				0.86			
PLI6	0.81				0.84				0.79			
PLI		0.92	0.94	0.73		0.93	0.94	0.74		0.92	0.94	0.71
PU1	0.91				0.85				0.93			
PU2	0.93				0.92				0.93			
PU3	0.91				0.89				0.91			
PU4	0.92				0.92				0.92			
PU		0.93	0.95	0.84		0.92	0.94	0.80		0.94	0.96	0.85
SN1	0.93				0.93				0.92			
SN2	0.96				0.96				0.95			
SN3	0.92				0.94				0.91			
SN		0.93	0.96	0.88		0.94	0.96	0.90		0.92	0.95	0.86

FM full model; HMTA high mobile technology anxiety; LMTA low mobile technology anxiety; AT attitude; MLCI mobile learning continuance intention; DS desire; NAE negative anticipated emotion; PAE positive anticipated emotion; PCB perceived behavioral control; PLI personal learning initiative; PU perceived usefulness; SN subjective norm; CR composite reliability; AVE average variance extracted;  $\alpha$  cronbach's alpha

**Table 3** The correlations of each construct in different models

Construct	<i>M</i>	<i>SD</i>	<i>AT</i>	<i>MLCI</i>	<i>DS</i>	<i>NAE</i>	<i>PAE</i>	<i>PCB</i>	<i>PLI</i>	<i>PU</i>	<i>SN</i>
Full model											
<i>AT</i>	5.45	1.09	0.90								
<i>MLCI</i>	4.90	1.12	0.61	0.90							
<i>DS</i>	4.35	1.15	0.53	0.70	0.94						
<i>NAE</i>	3.47	1.34	0.26	0.28	0.38	0.94					
<i>PAE</i>	4.62	1.17	0.53	0.57	0.64	0.38	0.95				
<i>PCB</i>	5.94	0.98	0.51	0.41	0.30	0.04	0.31	0.90			
<i>PLI</i>	5.01	0.94	0.42	0.42	0.35	0.14	0.35	0.43	0.85		
<i>PU</i>	5.04	1.00	0.63	0.68	0.64	0.20	0.49	0.45	0.42	0.91	
<i>SN</i>	4.88	1.26	0.58	0.52	0.46	0.22	0.50	0.35	0.33	0.50	0.94
<i>HMTA</i>											
<i>AT</i>	5.18	1.03	0.90								
<i>MLCI</i>	4.61	0.95	0.50	0.92							
<i>DS</i>	4.20	0.97	0.48	0.69	0.94						
<i>NAE</i>	3.65	1.06	0.30	0.37	0.43	0.94					
<i>PAE</i>	4.48	1.08	0.54	0.59	0.64	0.45	0.95				
<i>PCB</i>	5.56	1.02	0.45	0.32	0.23	0.08	0.31	0.89			
<i>PLI</i>	4.87	0.92	0.42	0.33	0.26	0.21	0.36	0.47	0.86		
<i>PU</i>	4.76	0.85	0.54	0.64	0.61	0.28	0.50	0.36	0.39	0.90	
<i>SN</i>	4.64	1.21	0.62	0.49	0.45	0.32	0.52	0.32	0.35	0.50	0.95
<i>LMTA</i>											
<i>AT</i>	5.71	1.09	0.90								
<i>MLCI</i>	5.19	1.21	0.66	0.88							
<i>DS</i>	4.49	1.30	0.55	0.72	0.95						
<i>NAE</i>	3.28	1.56	0.32	0.32	0.39	0.95					
<i>PAE</i>	4.77	1.24	0.51	0.55	0.65	0.39	0.95				
<i>PCB</i>	6.32	0.77	0.50	0.43	0.34	0.12	0.29	0.88			
<i>PLI</i>	5.15	0.94	0.39	0.46	0.40	0.15	0.33	0.35	0.84		
<i>PU</i>	5.33	1.06	0.65	0.67	0.66	0.24	0.46	0.44	0.41	0.92	
<i>SN</i>	5.13	1.26	0.51	0.51	0.46	0.22	0.47	0.29	0.27	0.47	0.93

*FM* full model; *HMTA* high mobile technology anxiety; *LMTA* low mobile technology anxiety; *M* mean; *SD* standard deviation; *AT* attitude; *MLCI* mobile learning continuance intention; *DS* desire; *NAE* negative anticipated emotion; *PAE* positive anticipated emotion; *PCB* perceived behavioral control; *PLI* personal learning initiative; *PU* perceived usefulness; *SN* subjective norm; Diagonal elements are the square root of average variance extracted

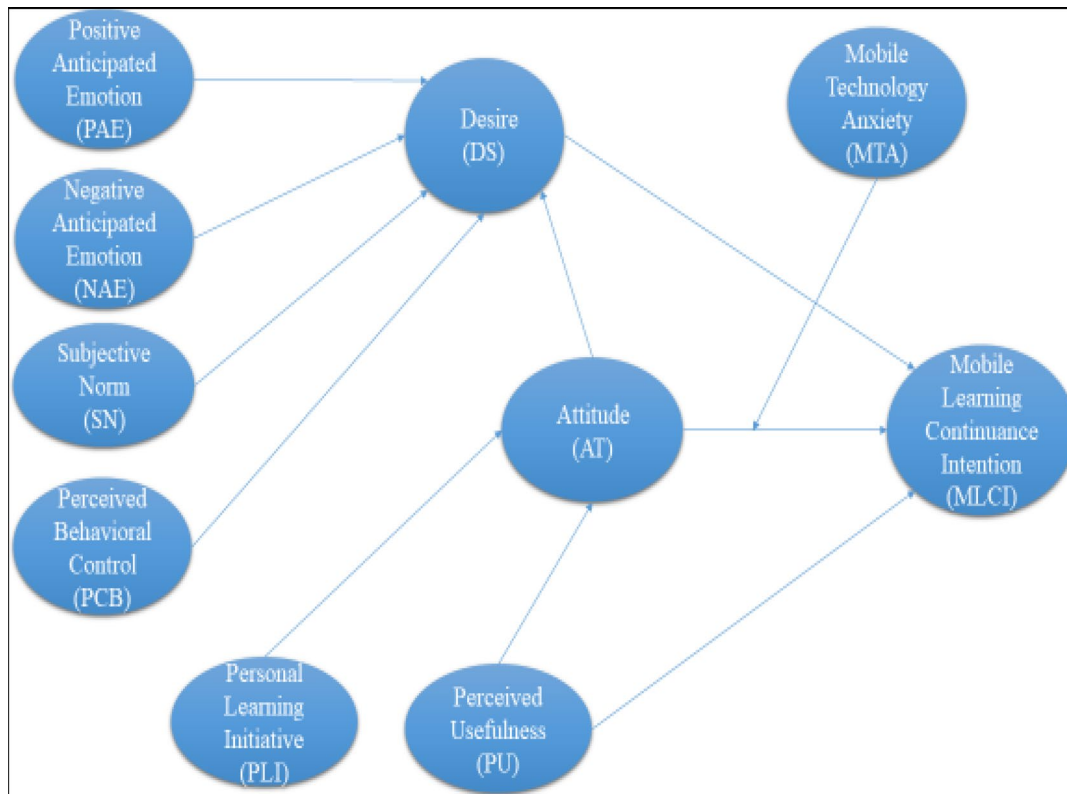
and personal learning initiative would be two critical antecedents of attitude toward mobile learning. Finally, the study findings have shown that mobile technology anxiety would moderate the relationship between attitude toward mobile learning and mobile learning continuance intention.

### Theoretical and practical implications

First, in regard to H1, H3, and H10, the study findings are congruent with previous suggestions (Ahn et al., 2007; Han et al., 2018; Padilla-Meléndez et al., 2013; Park et al., 2017; Perugini & Bagozzi, 2001), which reveal that desire to take mobile learning, attitude toward mobile learning, and perceived usefulness are key antecedents of mobile learning continuance intention. Specifically, as learners have higher

levels of desire to take mobile learning, attitude toward mobile learning, and perceived usefulness, it is likely that they will have better mobile learning continuance intention. In order to enhance mobile learning outcome, it is critical that more attention should be paid to enhancing college students' desire to take mobile learning, as well as improving their attitude toward mobile learning and perceived usefulness of mobile learning. (Ahn et al., 2007; Han et al., 2018; Padilla-Meléndez et al., 2013; Park et al., 2017; Perugini & Bagozzi, 2001). More importantly, the study findings contribute to the body of knowledge in the mobile learning filed not only by adding attitude toward mobile learning and perceived usefulness to the mobile learning model, but also by first considering the key impact of desire to take mobile learning on mobile learning continuance intention.





**Fig. 1** Research framework of the study

Second, in terms of H2, H4, H5, H6, and H7, the study results, in line with previous suggestions (Han et al., 2018; Lee et al., 2012; Meng & Choi, 2016; Park et al., 2017; Perugini & Bagozzi, 2001), have shown that attitude, subjective norm, positive anticipated emotion, and negative anticipated emotion, would have positive influences on desire to take mobile learning. In other words, attitude toward mobile learning, opinions from critical friends and people, as well as positive and negative anticipated emotions would play key roles in desire to take mobile learning. It is hinted that more efforts should be devoted to improving learners' attitude toward mobile learning, subjective norm, positive and negative anticipated emotions to improve their desire to take mobile learning. For example, it is critical that learning institutions and organizations should provide learners with timely information about mobile learning, positive feedbacks, opinions, and suggestions to help learners enhance their desire to take mobile learning (Han et al., 2018; Lee et al., 2012; Meng & Choi, 2016; Park et al., 2017; Perugini & Bagozzi, 2001).

Third, with respect to H7, it has been found that perceived behavioral control is not linked to desire to take mobile learning. Although the study result is contradictory to previous suggestions (Meng & Choi, 2016; Perugini & Bagozzi, 2001), it is consistent with study findings by

Lee et al. (2012), Park et al. (2017), Song et al. (2012), and Song et al. (2014). One possible explanation for this inconsistent result could be associated with learners' interest in foreign language learning. That is, learners' interest in foreign language learning is likely to play a more important role in determining their desire to take mobile learning (Chavoshi & Hamidi, 2019). Nonetheless, in order to verify study findings and further examine the relationship between perceived behavioral control, and desire to take mobile learning, it is implied that future studies should further incorporate different factors such as perceived control and self-efficacy into the construct of perceived behavioral control (Song et al., 2012).

More importantly, with specific respect to H8 and H9, the study findings are in line with previous reports (Chung & Tan, 2004; Huang & Yu, 2019; Padilla-Meléndez et al., 2013), which suggest that perceived usefulness and personal learning initiative would be key antecedents of attitude toward mobile learning. That is, as learners have better perceived usefulness of mobile learning and personal learning initiative, it is possible that they will have stronger attitude toward mobile learning. In order to enhance desire to take mobile learning, it is hinted that more efforts should be devoted not only to improving

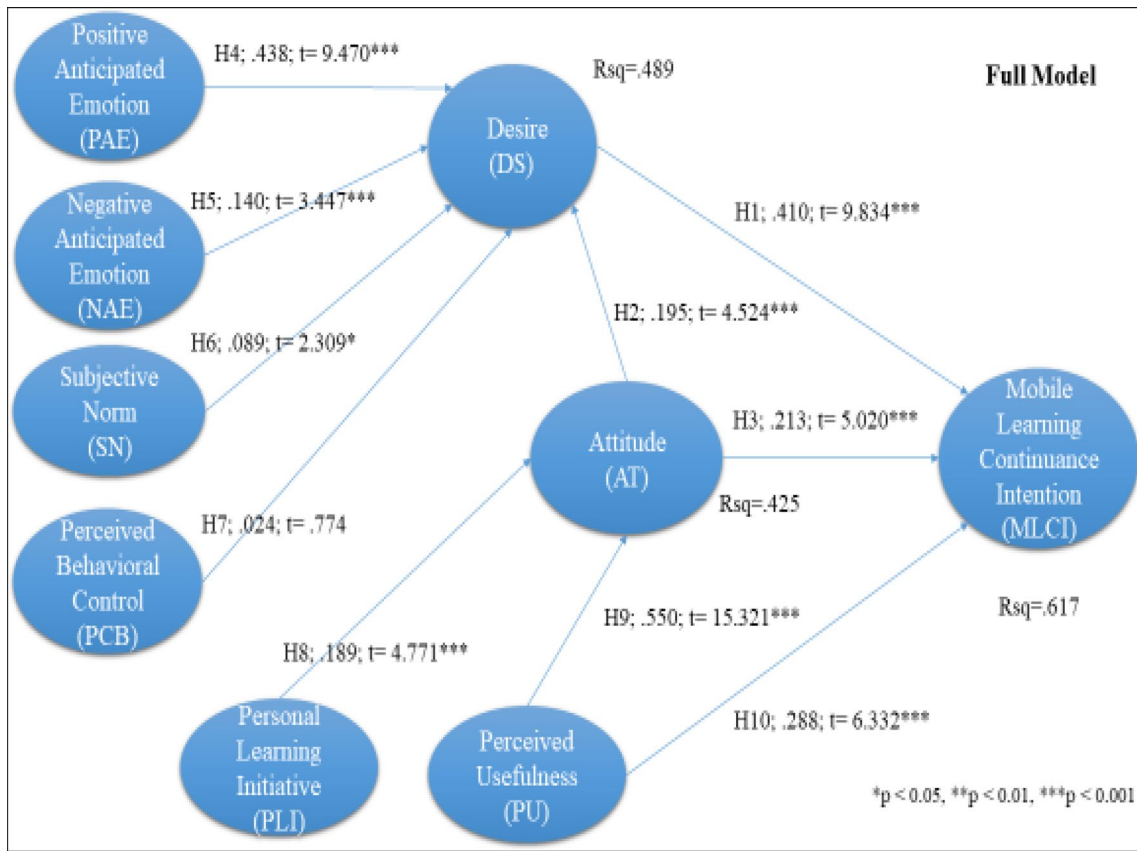


Fig. 2 The path coefficient of full model

Table 4 The moderating effect of mobile technology anxiety

Hypothesis	Path	HMTA (N1 = 341)		LMTA (N2 = 335)		Comparison
		Path coefficient	SE	Path coefficient	SE	
H11	AT → MLCI	0.126	0.050	0.281	0.063	- 35.46***

FM full model; HMTA high mobile technology anxiety; LMTA low mobile technology anxiety; AT attitude; MLCI mobile learning continuance intention; \*p < 0.05, \*\*p < 0.01, \*\*\*p < 0.001

learners’ perceived usefulness of mobile learning, but also to enhancing their personal learning initiative.

Additionally, in terms of H11, the study findings, with specific regard to the moderating impact of mobile technology anxiety on mobile learning, are consistent with previous suggestions (Aziz et al., 2018; Lee et al., 2009), which indicate that mobile technology anxiety would moderate the link between attitude toward mobile learning and mobile learning continuance intention. Specifically, college students with higher levels of mobile technology anxiety are likely to have a weaker relationship between attitude toward mobile learning and mobile learning continuance intention than those with lower levels of mobile technology anxiety. It is hinted that more attention should be paid to minimizing learners’ mobile technology anxiety, mainly because mobile technology anxiety would reduce the positive relationship

between attitude toward mobile learning and mobile learning continuance intention. For example, in order to minimize learners’ mobile technology anxiety, it is important that more attention should be devoted to offering learners training supports and timely suggestions, such as online tutoring services (Aziz et al., 2018; Cidral et al., 2018; Lee et al., 2009).

Last but not least, this study did not examine the moderating role of mobile technology anxiety in the link between perceived usefulness and mobile learning continuance intention, as well as the relationship between perceived usefulness and attitude toward mobile learning. Nonetheless, it has been shown that mobile technology anxiety is likely to play a moderating role in determining the connection between perceived usefulness and mobile learning continuance intention, as well as the relationship between perceived

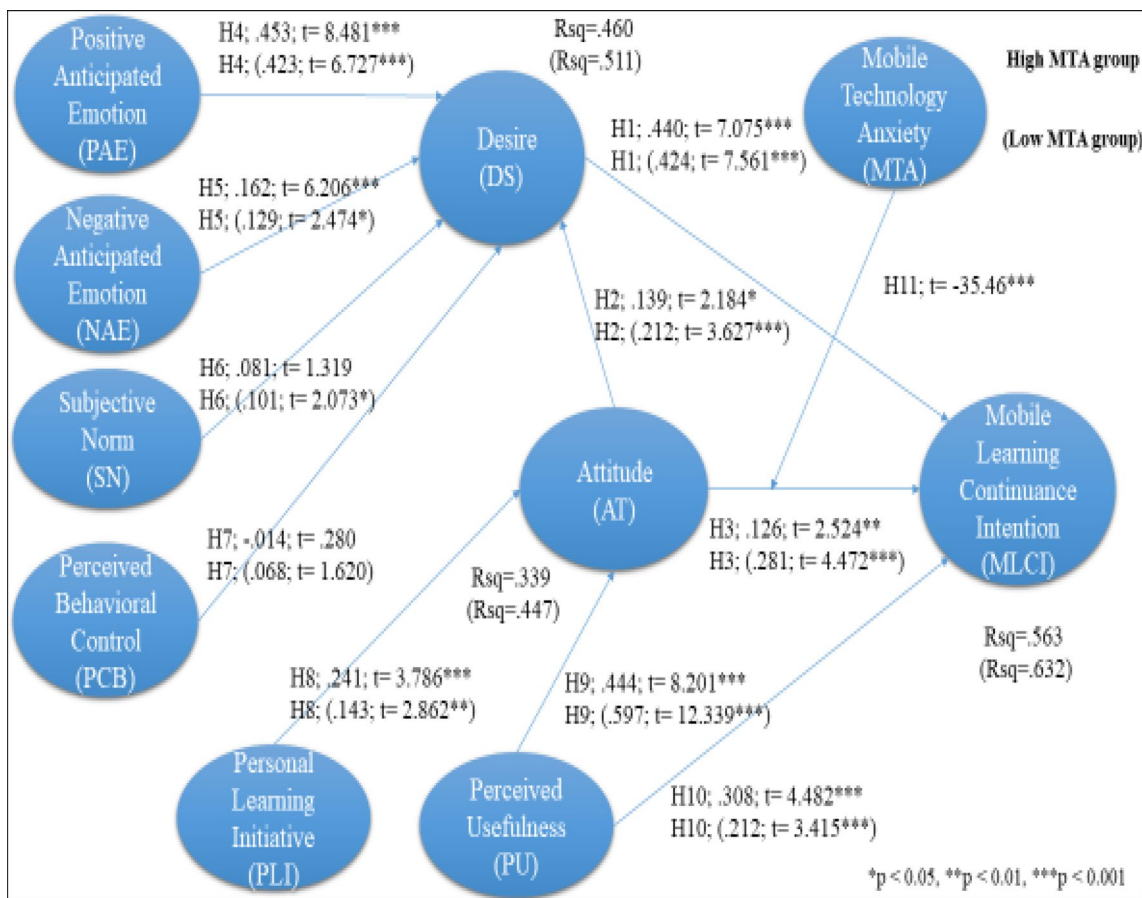


Fig. 3 PLS solution for different models

usefulness and attitude toward mobile learning. In order to increase mobile learning continuance intention with particular respect to more anxious groups, it is suggested that more studies should be needed to further clarify the moderating impact of mobile technology anxiety on the connections between perceived usefulness, attitude toward mobile learning, and mobile learning continuance intention.

### Limitations and suggestions

There are several noteworthy limitations in this report. First, because this study only collected data from college students in Taiwan, the study findings should be interpreted very carefully. It is suggested that future studies should gather mobile learning data from the different countries and populations in order to verify the study results. Second, the role of age variable was neglected in this study, mainly because the participants were all college students. Hence, it is suggested that more studies should be needed to verify the role of age in attitude toward mobile learning and mobile learning continuance intention. Third, this study only probed into the impacts of perceived usefulness and personal learning

initiative on attitude toward mobile learning, it is important that more attention should be paid to the key elements that have positive impacts on attitude toward mobile learning in order to improve mobile learning continuance intention. Additionally, it is considerable and meaningful that a longitudinal study should be carried out to examine the impact of time variable on desire to take mobile learning and mobile learning continuance intention. Finally, the impact of formal and informal learning on mobile learning outcomes was neglected in this study. It is suggested that future studies should focus more on the roles of formal and informal learning in mobile learning continuance intention.

### Conclusions

In conclusion, the study findings have contributed to the body of knowledge in mobile learning not only by examining key elements that influence desire to take mobile learning and mobile learning continuance intention, but also by investigating the moderating impact of mobile technology anxiety on the relationship between attitude toward mobile

learning and mobile learning continuance intention. The study results would provide researchers and practitioners in the mobile learning field with theoretical and practical solutions to continuously improve mobile learning effectiveness and efficiency.

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