An Empirical Study on the Influencing Factors of College Students' Mobile Learning Based on TPB[*]

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Abstract. Mobile learning has become an important way to carry out teaching and learning at present, but the effectiveness of mobile learning has received a mediocre response. Based on the Theory of Plans of Behaviour (TPB) model, the study analysed 3294 bivariate variables using meta-analysis; then constructed bivariate correlation matrices using SPSS; and finally constructed a research model using Meta-Structural Equation Modeling (MASEM), to find out the correspondences between the bivariate variables and to explore the internal linkages between the influencing factors. The results of the study showed that: perceived ease of use and perceived usefulness had a significant effect on attitude; teacher preparation had a more significant effect on subjective norms than student preparation; self-efficacy had a higher effect on subjective norms than learning autonomy; and perceived behavioural control had a higher effect on behavioural intention than attitude and subjective norms.

Keywords: behavioural planning theory; meta-analysis; meta-structural equation modelling; mobile learning

1 Introduction

Mobile learning supports anytime, anywhere access to instructional materials and provides two-way learning opportunities that engage students in interaction. It provides a platform for lifelong education and personalised learning, and has become an innovative vehicle for promoting quality education[1] . Despite the high popularity of m-learning in colleges and universities, the lengthy content of its learning resources and the cluttered structure of its knowledge system may lead to poor results in students' m-learning. Teaching organisers need to explore the deep-rooted causes and influencing factors of students' poor mobile learning in order to achieve deep-rooted learning goals and develop solution strategies. Previous studies have analysed and summarized the influencing factors of mobile learning, but some of them lack data validation, and there are fewer studies on the influencing factors of mobile learning based on the behavioural planning theory in China. In this study, based on Theory of Planned Behavior (TPB)[2] , the influencing factors of mobile learning are explored in terms of attitudes (perceived usefulness, perceived ease of use), subjective norms

(student readiness, teacher readiness), and perceived behavioural control (self-efficacy, learning autonomy), in order to predict the factors that influence mobile learning.

2   Theoretical Basis and Literature Review

2.1   Behavioural Planning Theory

Behavioural planning theory is a theory that explains individual behaviour in general, assuming that individual behaviour is driven by behavioural intentions, determined by three factors: the individual's attitude towards the behaviour, subjective norms and perceived behavioural control. Behavioural planning theory can predict with high accuracy the intentions of different types of behaviour based on attitudes towards behaviour, subjective norms and perceived behavioural control, explaining the reasons for large differences in actual behaviour.

2.2   Mobile Learning

Basak et al. [3] believe that Mobile Learning (Mobile Learning) is a learning method that uses wireless devices (mobile phones, tablet computers, etc.) to deliver instructions to learners at any time and any place. Mobile devices are commonly found in college campuses, which have complete infrastructure and campus networks, and college students have diverse learning needs and strong willingness to learn, so this study mainly focuses on college students.

2.3   Literature Review

Various attempts of mobile learning have been widely used in higher education. Wang Hongyun et al. [4] studied mobile learning application cases at home and abroad and found that mobile learning has a high application rate in colleges and universities. College students can get formative evaluation and timely feedback from tutors through mobile devices. Some universities, such as Stanford University and the University of Washington, have taken the lead in mobile learning. However, the implementation of mobile learning in higher education is still challenging due to social, cultural and organisational factors. Therefore, understanding the factors that influence the use of m-learning by college students is an important step in implementing m-learning on college campuses.

3   Research Models and Assumptions

3.1   Theoretical Model

Attitudinal beliefs are derived from the Technology Acceptance Model (TAM), and there is a causal relationship between perceived ease of use, perceived usefulness, and attitudes towards the new system and behavioural intentions to use the new soft-

ware[5] , therefore, the two perceptions are used as antecedents of attitudes, and subjective norms are determined by accessible normative beliefs[6] , and normative beliefs can be decomposed into multiple reference groups , each group having a different perspective. In this study, the normative beliefs of two relevant reference groups in higher education, students and teachers, are used as antecedents of subjective norms, perceived behavior control refers to an individual's perception of his or her ability to perform a particular behaviour and is consistent with the concept of self-efficacy. [7] Learning autonomy refers to the extent to which students actively use mobile devices and exercise control over the learning process, Liaw et al. [8] confirmed that autonomy is a major factor in system acceptance, so self-efficacy and learning autonomy are important prerequisites for perceived behavior control. Accordingly, the research model is proposed as shown in Figure 1.
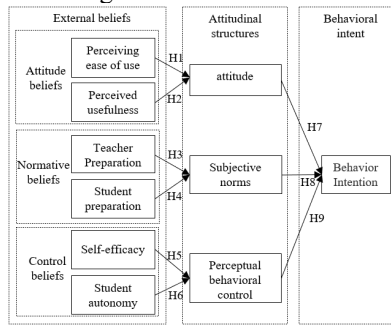

Fig. 1. Theoretical model

3.2   Formulation of Hypotheses

The following hypotheses are proposed based on the research model:

H1: Students' perceived ease of use of m-learning has a positive effect on their attitudes towards using m-learning;

H2: Students' perceived usefulness of m-learning has a positive effect on their attitude towards using m-learning;

H3: Mobile learning perceived teacher readiness has a positive effect on subjective norms of mobile learning;

H4: Mobile learning perceived learning readiness has a positive effect on mobile learning subjective norms;

H5: Students' mobile learning self-efficacy has a positive effect on their perceived behavioural control of mobile learning;

H6: Students' m-learning learning autonomy has a positive effect on their m-learning perceived behavioural control;

H7: Students' m-learning attitudes have a positive effect on their m-learning behavioural intentions;

H8: Students' subjective norms of m-learning have a positive effect on their m-learning behavioural intentions;

H9: Students' perceived behavioural control of m-learning has a positive effect on their intention to engage in m-learning behaviour.

4   Research Design

4.1   Research Methodology

The study explores the factors influencing mobile learning based on behavioural planning theory using Meta-analytic Structural Equation Modeling [9] (MASEM). In conducting the study using MASEM, the bivariate correlation matrix across the studies was first synthesised using meta-analytic techniques, then the bivariate correlation matrix obtained through meta-analysis was used using structural equation modelling, and finally the results of the two were integrated to arrive at a conclusion.

4.2   Literature Search and Screening

This study conducted a comprehensive search of the literature in both English and Chinese. The CNKI database was searched with the keywords "Theory of Planned Behaviour", "Mobile Learning", "Empirical Research". The keywords "Theory of Planned Behavior", "TPB", "Mobile Learning" were used to search the CNKI database. Science Direct, Elsevier, and Google Scholar. In order to avoid omissions, the references of the review and related articles were manually searched, and then the literature was screened according to the following screening criteria:(1) The study must be conducted by undergraduate students. (2) The study must be quantitative with sufficient data information. (3) The study must use behavioural planning theory to study mobile learning. (4) The study must contain three dimensions of attitudinal beliefs, normative beliefs, and control beliefs, each of which contains at least one and more relevant dimensions. (5) The study needs to have coefficients of correlations between variables.

5   Data Analysis

5.1   Bivariate Correlation Analysis

The final inclusion of 30 literatures for meta-analysis through screening resulted in a bivariate correlation analysis table, as shown in Table 1. The total number of literature on attitude to behavioural intention was 28, with a total sample size of 19,828, and r=0.625>0.5, indicating that the relationship between attitude and behavioural intention is stronger. The standard error is 0.058, indicating that the sample statistic is closer to the overall parameter and the sample is more representative of the overall. The upper and lower limits do not contain 0, indicating that the relationship between attitude and behavioural intention is significant. Heterogeneity is greater than 0.75, indicating that the study is highly heterogeneous. The fail-safe coefficient of 2825 >

100 indicates that there is less publication bias, the sample is more complete, and the literature included in the analysis is more representative.

Table 1. Bivariate correlation analysis table

hypothetical relationship	Number of papers	Master Sample	weighted average correlation		95 per cent confidence interval		heterogeneity	publication bias
	K	N	r	standard error	lower limit	limit	I^2	Fail-safe factor
H1: ATT to UF	10	5078	0.648	0.080	0.525	0.744	97.659	6023.000
H2: ATT to EOU	11	5843	0.621	0.081	0.492	0.722	97.939	6668.000
H3: SN to IR	3	1409	0.601	0.209	0.217	0.824	98.429	539.000
H4: SN to SR	4	1852	0.491	0.247	0.007	0.789	99.161	619.000
H5: PBC to SE	8	4303	0.627	0.082	0.499	0.728	97.014	4232.000
H6: PBC to LA	3	1409	0.727	0.117	0.560	0.838	95.773	906.000
H7: ATT to BI	28	13328	0.625	0.058	0.537	0.699	98.751	2825.000
H8: SN to BI	30	15037	0.482	0.039	0.415	0.544	97.138	7024.000
H9: PBC to BI	28	14372	0.520	0.053	0.431	0.599	98.439	943.000

Note: BI: Behavior Intentions; ATT: Attitudes; SN: Subjective Norms; PBC: Perceived Behavioural Control; EOU: Perceived Usefulness; UF: Perceived Ease of Use; IR: Instructor Readiness; SR: Student Readiness; SE: Self-Efficacy; LA: Learning Autonomy

Using the HARMEAN () function, the reconciliation mean was calculated to be 3294, resulting in a bivariate correlation matrix, as shown in Table 2:

Table 2. Bivariate correlation matrix

	ATT	SN	PBC	BI	EOU	UF	IR	SR	SE	LA
ATT	1									
SN	.543	1								
PBC	.461	.523	1							
BI	.624	.488	.543	1						
EOU	.621	.356	.405	.404	1					
UF	.648	.495	.575	.446	.359	1				
IR	.270	.601	.298	.671	.263	.295	1			
SR	.461	.491	.402	.582	.556	.315	.495	1		
SE	.455	.460	.627	.444	.377	.416	.451	.463	1	
LA	.202	.461	.727	.415	.376	.317	.464	.559	.600	1

5.2   Modelled Data Analysis

The model was constructed using the correlation matrix, with N being the reconciled mean of 3294, and the variables were standardised to set the mean to 0 and the variance to 1. The model is shown in Figure 2.
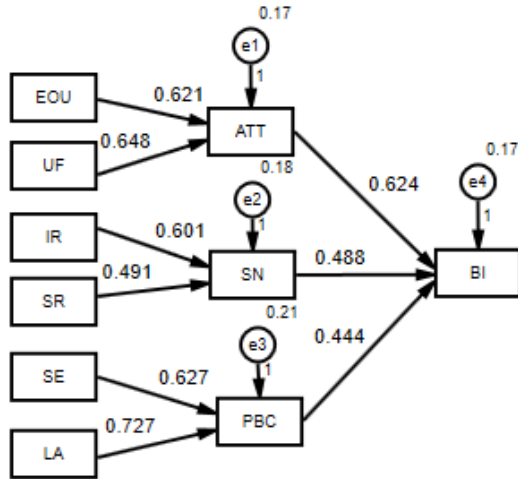
Fig. 2. Research model

Table 3. Table of model fit coefficients

norm	modelled value	adaptation requirement	Model fit judgement
CMIN/DF	1.646	<3 (better)	be
RMR	0.033	<0.08 (good); <0.05 (better)	be
GFI	0.986	>0.9 (good)	be
AGFI	0.863	>0.9 (good)	be
TLI	0.862	>0.9 (good) >0.95 (better)	be
CFI	0.977	>0.9 (good) >0.95 (better)	be
RMSEA	0.358	<0.08 (better)	clogged
CN	139	>75 (sufficient sample)	be

The fit of the research model was validated in AMOS and the validation results are shown in Table 3. The model fit metric is the ratio of the chi-square to the degrees of freedom, with a ratio of less than 3 being most desirable. As shown in Table 3, all the fit metrics except the root mean square of approximation error (RMSEA) meet the fit requirements, indicating a good model fit.

As shown in Table 4, the p-values are all less than 0.05, indicating that the research hypotheses are all valid. $p<0.001$ indicates that there is a significant difference in the studies, and the standardised factor loadings are greater than 0.6, indicating that the hypotheses are substantively significant. Perceived ease of use (0.911) had a greater effect on attitudes; teacher preparation (0.804) had a more significant effect on subjective norms; self-efficacy (0.914) had a greater effect on perceived behavioural control; and the greatest effect on behavioural intentions was perceived behavioural control (0.903).

Table 4. Table of regression coefficients

research hypothesis	path factor				Significance test results
	Estimate	S.E.	C.R.(Z)	P	
H1: UF to ATT	.911	.030	6.914	***	set up
H2: EOU to ATT	.871	.056	5.500	***	set up
H3: IR to SN	.804	.035	3.494	***	set up
H4: SR to SN	.765	.044	5.686	***	set up
H5: SE to PBC	.914	.072	7.736	***	set up
H6: LA to PBC	.884	.071	2.406	.016	set up
H7: ATT to BI	.891	.338	9.108	***	set up
H8: SN to BI	.839	.083	9.540	***	set up
H9: PBC to BI	.903	.031	5.333	***	set up

Note: When p<0.001, p-values are indicated by "***"

6   Conclusions and Insights

6.1   Conclusion

(1) Effects of perceived usefulness and perceived ease of use on attitudes

Perceived ease of use (0.911) and perceived usefulness (0.871) had a significant effect on attitudes, indicating that college students are more likely to adopt mobile devices that are easy to use and useful to them for learning in the classroom. However, since most college students already own mobile devices and are more proficient in their use, the technical limitations of mobile devices, such as small screens, slow internet speeds, and limited access, should be considered. The ease of use of mobile devices affects students' attitudes towards using mobile learning in the classroom, and the usefulness of mobile devices in the classroom can be key to college students' use of mobile learning.

(2) Effects of teacher preparation and student preparation on subjective norms

Teacher preparation (0.804) has a more significant effect on subjective norms, rich learning experience can reduce the psychological obstacles for students to use mobile learning, and teachers are more prepared before using mobile devices for teaching, which can likewise reduce students' resistance and unfamiliarity with mobile devices. It means that the importance of the teacher's role should be realised when using mobile devices for teaching, to achieve the dual-line teaching of online mobile learning and offline teachers' timely guidance and answering questions. There is also a significant relationship between students' preparation (0.765) and subjective norms, where students' adequate preparation prior to m-learning leads to a positive attitude towards m-learning. This implies that students should give full play to their subjective initiative when using m-learning in order to produce better learning results.

(3) The effect of self-efficacy and learning autonomy on perceived behavioural control

Research has shown that college students' perceived behavioural control over m-learning is a key factor in its use, with self-efficacy and learning autonomy being

important antecedents. Enhancing students' perceived behavioural control can help to increase autonomy towards mobile learning, and instructional designers should design mobile learning components based on students' comfort. Meanwhile the relationship between subjective norms (0.839) and behavioural intention was lower than that between perceived behavioural control (0.903) and attitude (0.891), and there was a significant relationship between subjective norms and behavioural intention (p<0.001). Higher education administrators can improve students' attitudes by providing mobile devices and developing e-learning platforms to enhance students' perceptions of control over mobile learning. After familiarising themselves with the mobile environment, students can adapt the mobile learning classroom by adopting strategies such as independent production and sharing.

6.2   Discussion

The study explored the factors influencing college students' use of m-learning based on the Theory of Plans of Behaviour (TPB). Among them, perceived ease of use (0.910) and perceived usefulness (0.920) have a significant effect on attitude; teacher preparation (0.910) and student preparation (0.923) have a significant relationship with subjective norms; self-efficacy (0.831) and learning autonomy (0.854) have an effect on perceived behavioural control. Resource designers need to improve the usability design of mobile learning resources, ensure the quality of resource content, and create high-quality mobile learning resources; optimise the structure of the knowledge system to ensure that learning resources are useful and easy to use. In addition, it is also necessary to improve user acceptance of mobile learning and enhance the sense of user experience, so that users can easily access the learning website through mobile devices. Students should give full play to their subjective initiative, enhance their learning consciousness, increase learning exchanges, and realise two-way interaction with teachers. Teachers should improve their own requirements, skilled in the use of mobile devices; efforts to provide channels of communication and interaction with students, so that both parties are involved in the implementation of the teaching programme. Colleges and universities should set mobile teaching goals, put forward corresponding requirements for teachers, and then formulate mobile learning programmes, such as study plans and study guides, according to the current level of students, to ensure that teaching and learning are carried out properly. The excellence of the learning plan can be assessed according to the three factors of attitude, subjective norms, and perceived behavioural control in the behavioural plan theory. Mobile learning involves the coordination of students, teachers, schools, and learning resource designers, and each participant should play his or her own role to build a new system of mobile learning and achieve deep teaching goals.

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