

Analysis of Students' Ability to Accept M-Learning Technology: An Exploratory Study from High Schools in Vietnam

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Trinh Le Thi Tuyet
Dong Thap University, Dong Thap, Vietnam

Thao Phuong Thi Trinh (✉)
Thai Nguyen University of Education, Thai Nguyen, Vietnam
thaottp@tnue.edu.vn

Hang Thu Thi Nguyen
Thai Nguyen University of Agriculture and Forestry,
Thai Nguyen, Vietnam

Thanh Chi Nguyen
VNU University of Education, Vietnam National University,
Hanoi, Vietnam

Trung Tran
Vietnam Academy for Ethnic Minorities, Hanoi, Vietnam
VNU University of Education, Vietnam National University,
Hanoi, Vietnam

Abstract—Mobile phones are becoming a vital part of almost all students and teachers in the era of the Industrial Revolution 4.0. With mobile devices capable of accessing the Internet, the mobile learning method has been formed: M-learning. Many studies on this topic focused on the effectiveness of mobile technologies/applications for students to study. It is of little interest for students to use M-learning in their study and the factors affecting that decision. Based on the TAM model on technology adoption. This article analyzes and proposes factors affecting the decision to use M-learning in Vietnam - a developing country. The study used a synthesis analysis method from 238 survey samples of students. The data analysis results show that to encourage students to use M-learning, educators need to pay attention to the design of appropriate courses to save time, improve learning efficiency, increase the mobility of learners, and necessarily introduce the convenience of courses learners through many different channels.

Keywords—Technology Acceptance Model; TAM; M-learning; Vietnam; high school

1 Introduction

Nowadays, with the development of mobile phones, many educators have attempted to use these devices to improve students' learning experience. Therefore learning through mobile devices (such as smartphones and tablet PCs) called mobile learning or M-learning became popular [1]. The m-learning refers to learning and training, but the management and sharing of content and interaction are done by using mobile devices based on wireless network technology [2] [3] [4] [5] [6]. Furthermore, [7] contemplates the possibility of M-learning as a harbinger of the future of learning

Recently, many studies have been done on exploiting mobile phones' potential for pedagogical purposes in many different contexts. Studies have demonstrated that the ability to use mobile devices in learning environments effectively improves students' knowledge and learning experiences in a variety of subject areas such as science [8], [9], mathematics [10], [11] language, and art [12], [13], social science [14], engineering [15] and others. The main research directions in this topic include: (1) evaluating the effects of M-learning, (2) designing a mobile system for learning, (3) eliciting perceptions of M-learning, (4) reviewing M-learning, or (5) evaluating or exploring the factor towards M-learning. Although there have been several studies on the factors that influence learners' decision to use M-learning, most of these studies are conducted in developed countries [16], while M-learning is also at the attention of educators in developing countries recent years.

This paper is based on the TAM to study the factors affecting the students' adoption of M-learning in Vietnam - a developing country in the Asian-Pacific region. The TAM model is one of the theories in studying the application of IT innovations and new information systems [17]. However, TAM excels regarding productivity-oriented (or utilitarian) systems, but the motivators to system usage may vary greatly depending on the nature of system use [18]. The paper answers the question: What factors affect the Vietnamese students' choice of studying with M-learning?

Although M-learning has been implemented at a very early stage in other countries worldwide, M-learning still faces many difficulties [19], [20]. Education in Vietnam has also been transitioning to a learner-centered teaching model, so learners' adoption of new technologies in learning is significant in determining the exchange of new forms of learning. Results of the paper answer the questions: What factors affect the choice of studying with Vietnamese students' M-learning? From there, it is possible to make suitable recommendations for the change of education in Vietnam.

2 Literature Review

2.1 Overview of the M-learning

The existence of smartphones at low prices has led to an increase in apps for distinct aspects of life such as communication, travel, entertainment, productivity, and learning. With the support of mobile devices with Internet access functions, a mobile learning method has been established: M-learning. Keegan (2002) estimates that M-

learning will be a future learning trend. M-learning is employed using small computing mobile devices. Others simply consider M-learning as an extension of distance learning [21] or e-learning [22]. More broadly, [23] see that M-learning includes learning based on mobile devices and the learning mediated across multiple contexts using portable mobile devices.

According to [24], [25], it is possible to show some advantages of M-learning compared to other types of learning such as In-classroom activities. It is much easier for students to use mobile devices than computers, especially in arranging classrooms. SMS messages are used to send and receive information (for example, changing class schedules, checking) between teachers and students more easily, quickly, and economically than make calls. Devices such as mobile phones, tablets, e-books are more compact and more accessible to transport than briefcases full of documents, textbooks, or even laptops. Users can record points to note directly through mobile devices such as handwriting recognition, recording. Users can use the stylus to operate directly on the screen to move web pages and links more easily. It is also favorable for task assignments and collaborative learning. Many students and teachers can work in groups through Bluetooth. It can be used to learn anytime, anywhere because it is easy to use and carry. Users can take photos directly with cameras of devices such as mobile phones or tablets. Users can easily exchange documents via Bluetooth, WIFI, and 3G. It increases interest in learning for students, especially for students with low learning motivation. It also facilitates conditions for students to improve their knowledge, encourage self-study and increase their responsibility for learning.

Today, with the development of smartphones, new interactive technologies in terms of smart mobile devices and accompanied applications (apps) attract the increasing attention of many researchers to exploit in education [26]–[29], choosing the most appropriate educational ones for children. Simultaneously, there are thousands of apps available today that are difficult and problematic for both teachers and educators [30]. Therefore, it is necessary to determine students' usage habits and technology adoption to choose the right apps.

Lim et al. (2006) say that M-learning's most significant advantage is the combination of actual interaction with learning flexibility. It creates an excellent opportunity for teachers to organize collaborative learning and learner-directed learning activities, thereby helping create self-learning and independent learning motivation. Over the past decade, studies have exploited the potential of mobile phones for educational purposes in a variety of contexts. Recent studies on mobile devices in different learning environments have shown students' ability to improve learning performance [32]–[34]. Although there have been several studies on the factors that influence learners' decision to use M-learning, most of these studies are conducted in developed countries [16], while M-learning is also attracting the attention of educators in developing countries in recent years. This paper is based on the TAM to study the factors affecting students' M-learning adoption in Vietnam - a developing country in the Asian-Pacific region.

2.2 Overview of the Technology Acceptance Model (TAM)

Acceptance of a new system and technology is the first step to the success of any system. Several theories have been presented to explore the factors that determine user acceptance of the Technology and Information System [17] to solve this problem. The technology acceptance model developed by [17] appears to be the most widely used technology acceptance model. TAM (See Fig. 1) includes the core variables of user motivation (i.e., perceived ease of use, perceived usefulness, and attitude toward technology) and outcome variables (i.e., behavioral intentions, technology use). Among these variables, perceived usefulness (PU) and perceived ease of use (PEU) are considered main variables that directly or indirectly explain the results [35].

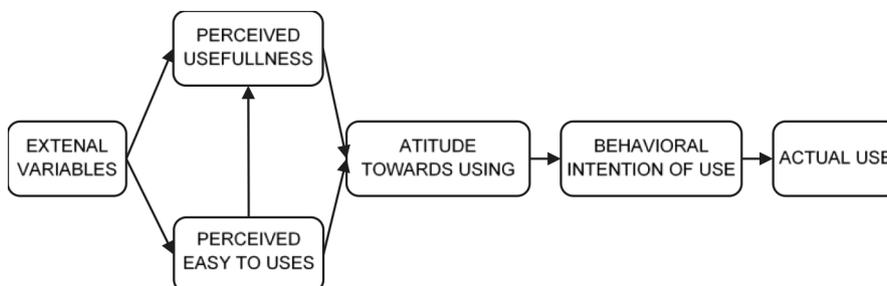


Fig. 1. TAM (Davis, 1989)

After many studies, a series of next-generation TAMs was proposed. There are at least three different versions of the TAM model made between 1986 and 2013 [35], some of which only considered USE as an outcome variable, others considered BI and USE as an ATT outcome. [36] conducted a comprehensive analysis of a TAM version containing external variables (See Fig. 2).

This model has been applied in many studies, including studies on mobile technology acceptance in education. [37] synthesized 124 correlation matrices from 114 empirical TAM studies (N = 34,357 teachers) and checked the appropriateness of TAM and its versions. Some studies include [38]: measuring users' behavioral intention who use YouTube as a learning resource and identifying the factors that influence this behavioral intention of applying YouTube as a learning resource. Another study considered the factors that influence the application and use of an instructor's Internet-based course management system. Using data from an online survey of a university lecturer (N = 191), a path analysis shows that easy system usage significantly impacts usefulness, as proposed by TAM [39]. Using the TAM, [40] has confirmed that the educational system with technology users can help them transfer and acquire knowledge.

The application of TAM to m-learning has also been studied by many authors on different subjects of undergraduate and graduate students at two universities in Taiwan [41] and medical students at Coimbra University [42]; Bachelor of Primary Education at the University [43]. These studies all use the extended TAM. One

common point of these studies is that users maintain a positive attitude towards M-learning and consider M-learning an effective tool. It can be seen that the studies focused on clarifying factors influencing the decision to use M-learning of undergraduate and graduate students. There is no study for high school students. This article will clarify the factors influencing high school student's decision to use M-learning in Vietnam and compare these factors with other subjects previously studied.

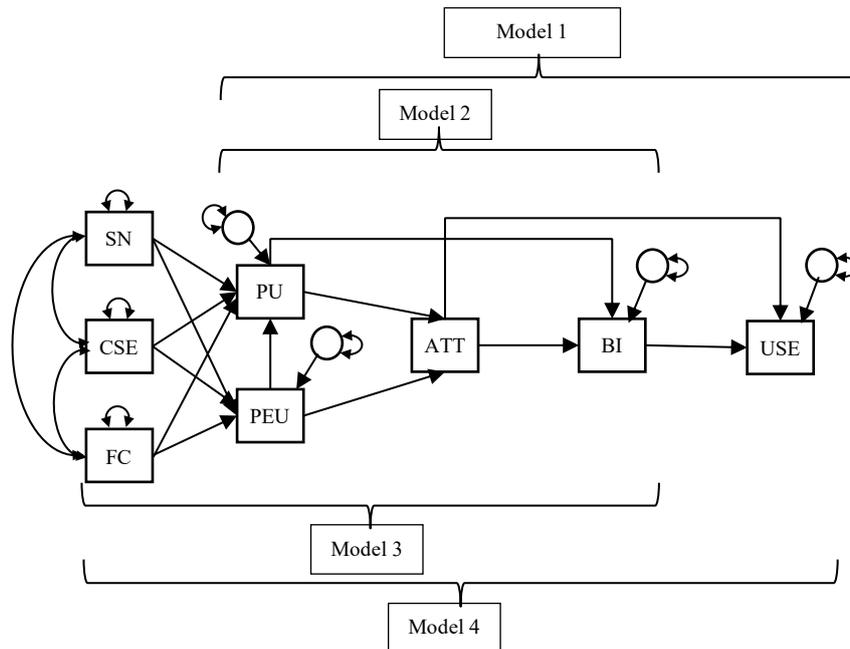


Fig. 2. Models describing teachers' technology acceptance with and without external variables.

3 Methods

With this exploratory study, we want to determine the factors influencing high school student's decision to use M-learning. It can be seen that a students' attitude towards accepting and using M-learning will improve the effectiveness of participating in activities through mobile technology in learning support. Based on previous studies, the items of each work in the research model have been adapted [17], [36], we select factors from the model, which can influence the choice of using M-learning in Vietnam. Specifically, Davis (1989) measured the Perceived usefulness (PU) (three items) and Perceived ease of use (PE) (three items). The self-efficacy (CSE) consisted of three items, facilitating conditions (FC) consisted of two items adapted from Abdullah & Ward (2016). Scales were adapted from Abdullah & Ward (2016) to measure subjective norms (SN)-the influence of others on the user's decision to use or not to use the technology (three items) and Attitude (ATT) (two items).

Behavioral intention (BI) (four items) was based on Abdullah & Ward (2016). We build a research model with relationships between factors, as shown in Fig. 3.

With the above model, we have conducted a study to evaluate the following hypotheses:

3.1 Hypotheses

- H1: Perceived usefulness has a positive effect on attitude.
- H2: Perceived ease of use has a positive effect on attitude.
- H3: Self-efficacy positively has a positive effect on behavioral intention.
- H4: Subjective norms have a positive effect on behavioral intention.
- H5: Mobility and convenience have a positive effect on behavioral intention.
- H6: Attitude has a positive effect on behavioral intention.

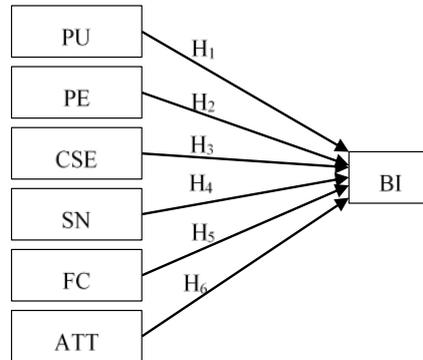


Fig. 3. Proposal for six factors model

Before conducting the official survey, we conducted a pilot survey with 50 students, the number of students of three high schools representing the North, Central, and South of Vietnam, to test the significance and understandability of the questionnaire. After receiving the results from the pilot test, we reviewed and adjusted to achieve a final questionnaire with 19 items (see Table 1.).

3.2 Materials

The questionnaire consists of 19 questions according to a 5-point Likert scale with five levels of strongly disagree, disagree, neither agree nor disagree, agree, and strongly agree for each opinion.

In the official survey, we use the online survey choice to collect data. The time for conducting the survey and data collection is half a month (from April 12th, 2019 to May 30th, 2019).

3.3 Participants

Experimental data used in this study was collected through a survey of high school students on their participation in M-learning. The survey was sent to 10 high schools in Vietnam (N = 400): 02 specialized high schools and eight other public high schools. The survey of all schools was not feasible at that time due to time and resource constraints, so high schools were selected based on their representation in education (Specialized and public high schools); number of years of establishment (newly opened and long-standing school); scale (large and small schools); geographical location (north, central and south of Vietnam);

3.4 Procedure

The experiment took place with high school students in Thai Nguyen, Hanoi, Dong Thap, and An Giang provinces. When the questionnaire link was sent, the participants completed the questionnaire with written instructions sent to the educational institutions. On average, each student takes about 15-20 minutes to complete the questionnaire given by the study.

Table 1. Coding factors of the study model

Variable	Description	Type	Items	Questionnaires
PU	Perceived usefulness	Independent	3	(PU1) The use of M-learning will save me much time (PU2) M-learning will improve my learning efficiency (PU3) Overall, I find M-learning useful
PE	Perceived ease of use	Independent	3	(PE1) The use of M-learning will not require much of my effort (PE2) Interaction with M-learning is easy for me to understand (PE3) I think M-learning is easy to use
CSE	Self-efficacy	Independent	3	(CSE1) I know I can use mobile technologies even if I have not used them in an educational environment yet. (CSE2) I can design educational activities using mobile devices (CSE3) I can use a mobile device in class even if no one is helping me
FC	Facilitating conditions	Independent	2	(FC1) It is convenient to access M-learning anytime and anywhere (FC2) Mobility is an outstanding advantage of M-learning
SN	Subjective norms	Independent	3	(SN1) I use M-learning because my friends also use this type of learning (SN2) Teachers introduced us to use M-learning (SN3) I use M-learning because I find that celebrities also participate in this type of learning
ATT	Attitude	Independent	2	(ATT1) I want to use M-learning (ATT2) I have a positive opinion of M-learning
BI	Behavioral intention	Dependent	3	(BI1) I plan to use M-learning when available (BI2) If I were asked to express my opinion on M-learning, I intended to say something favorable (BI3) In the future, I plan to use M-learning regularly

3.5 Design and analyses

We use multivariate regression analysis to analyze and evaluate the proposed hypotheses. The collected questionnaire was into SPSS software to conduct the data analysis. The missing data values were checked and processed by using the frequency command in SPSS version 20 to filter invalid input values in addition to conventional values and checking the original questionnaire to adjust the data correctly. After the data set was cleaned, data analysis was conducted to verify the scale. We used Cronbach's Alpha composite reliability coefficients to evaluate the reliability of each scale. If these are greater than 0.6, the constructs are reliable. In this study, we used exploratory factor analysis (EFA) to evaluate the value of the scale of elements in the model. The convergent value and the discriminant value of the scale create more significant factors from the assessment of the convergent value. If the factor loadings on items in the constructs are larger than 0.5, the constructs in the model achieve convergence validity. We used the 95% confidence intervals of the correlation coefficients between constructs in the model regarding discriminant validity. If the 95% confidence intervals of the correlation coefficients do not contain one value, the constructs in the model reach discriminant validity. After analyzing the exploratory factor, we put the new factor table into a multivariate regression analysis to consider the impact of the factors in the model, thereby testing the proposed hypothesis with statistical significance at level 5%.

4 Results

4.1 Descriptive statistic

After the process of missing (responses were rejected because they did not answer all the items in the survey, their data was not included in the analysis), the study collected responses from 238 high school students, including 150 male and 88 female students (completion rate of valid questionnaires was 59.5% of participants). The age of surveyed students is from 16 to 18 years (equivalent to grade 10 to 12), of which the number of 10th graders responding to the questionnaire accounts for 153/238 (64.3%) (see Table 2.).

Especially with the question "The mobile devices you are using," 94.1% of the students answered that they use a mobile phone, and the time spent more than three years accounts for 132/238 (55.5%). However, when asked "Your experience with M-learning," the number of students who answered "I know what M-learning is and have used it before" only accounts for 21/238 (8.8%) (Table 2.).

Table 2. Personal Information Description of the surveyed samples

		Count	Column N %
Sex	Male	150	63.0%
	Female	88	37.0%
	Total	238	100.0%
Class	Grade 10	153	
	Grade 11	32	
	Grade 12	53	
TB1_MTCT	No	0	0.0%
	Yes	238	100.0%
TB2_TBCT	No	98	41.2%
	Yes	140	58.8%
TB3_MTB	No	163	68.5%
	Yes	75	31.5%
TB4_DTDD	No	14	5.9%
	Yes	224	94.1%
	Total	238	100.0%
Used time	Less than one year	37	
	From 1 to 3 years	69	
	More than three years	132	
Frequency of use	Less than 1 hour	10	
	From 1 to 3 hours	107	
	Over 3 hours	121	
Experience	No answer	69	
	Unknown and unused	73	
	Know but have not used	75	
	Already known and used	21	

4.2 Testing factors and measuring scales

Evaluating the reliability of Cronbach's Alpha scale with the data set collected, we have Table 3.

Table 3. Reliability estimates

Factors	Observed variables	Cronbach's α	Corrected item-total correlation
PU	PU1, PU2, PU3	0.773	> 0.3
PE	PE1, PE2, PE3	0.866	> 0.3
CES	CES1, CES2, CES3	0.644	> 0.3
FC	FC1, FC2	0.602	> 0.3
SN	SN1, SN2, SN3	0.801	> 0.3
ATT	ATT1, ATT2	0.775	> 0.3

According to Table 3, the Cronbach's alpha reliability coefficient of factors is from 0.602 to 0.866, which satisfies the reliability requirements (≥ 0.6), and the corrected item-total correlation is greater than 0.3. This proves that the observed variables in the factors are highly consistent, and the measuring scale of factors is sufficiently reliable.

4.3 Testing the factors affecting the decision to use M - learning

The exploratory factor analysis - EFA is used to test the factors that affect students' decision to use M - learning. According to the initial hypothesis, there are six factors (16 observed variables). The results of factor analysis in Tables 2 and 3 indicate that:

- The KMO coefficient is used to evaluate the conformity of the exploratory factor analysis, reaching a value of 0.778, which satisfies the condition of $0.5 \leq KMO \leq 1$. This indicates that the exploratory factor analysis is accepted with the studied data set.
- Sig Barlett's Test is used to evaluate whether observed variables in a factor are correlated and whether the exploratory factor analysis is significant or not. According to Table 3, sig = 0.000 < 0.05 shows that the exploratory factor analysis is suitable for the variables under consideration.
- Through the rotated component matrix table, 16 observed variables will be converted to 5 factors, and the position of 16 variables has been revised, specifically as in 0

Table 4. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.778
Bartlett's Test of Sphericity	Approx. Chi-Square	1499.844
	df	120
	Sig.	.000

Table 5. Rotated Component Matrix

	Component				
	1	2	3	4	5
ATT1	.835				
SN3	.823				
SN2	.822				
ATT2	.821				
SN1	.733				
PE1		.873			
PE3		.866			
PE2		.865			
PU1			.829		
PU3			.819		
PU2			.793		
CES1				.861	
CES3				.824	
CES2				.526	
FC1					.826
FC2					.762

Table 6. Revised factors and variables

Factors	Observed variables	Variable types
X1 (PU)	PU1, PU2, PU3	Independent
X2 (pe)	PE1, PE2, PE3	Independent
X3 (ces)	CES1, CES2, CES3	Independent
X4 (FC)	FC1, FC2	Independent
X5 (new)	SN1, SN2, SN3, ATT1, ATT2	Independent
Y (BI)	BI1, BI2, BI3	Dependent

4.4 Multiple regression analysis

The metric to assess the conformity of a standard linear model is the adjusted coefficient R² (Adjusted R Square), which reflects the explanatory degree for dependent variables of independent variables in the regression model. Table 5 shows that R²_a = 0.516, indicating that the independent variables X1, X2, X3, X4, X5 explain 51.6% of the change in the dependent variable Y, the remaining 48.4% of the change in Y will be due to variables other than the studied model.

0 shows that the sig value of the F test is used to test the conformity of the regression model. The statistic F = 51.614 with the probability of rejection has a sig value = 0.000, sufficient to conclude that the value of R²_a is accepted. The model uses multiple linear regression, consistent with the collected data set.

Table 7. Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.726 ^a	.527	.516	.539	2.178

Table 8. ANOVA^a

Model	Sum of Squares	df	Mean Square	F	Sig.	
1	Regression	75.097	5	15.019	51.614	.000b
	Residual	67.510	232	.291		
	Total	142.607	237			

Multicollinearity is the phenomenon of independent variables with close correlation to each other (linear relationship), and it is invalid to explain the change of dependent variables in the regression model. This means that the occurrence of multicollinearity will cause difficulties in analyzing the effects of each independent variable on dependent variables.

According to the reference materials, if the variance inflation factor -VIF is less than 10 (actually less than 2), there will be no collinearity. With the results obtained in Table 7. , the independent variables have VIF <2, indicating that variables in the model are independent of each other, there is no multicollinearity.

According to Table 4. , we have a new analytical model as follows:

$$Y = f(X1, X2, X3, X4, X5).$$

These new factors are quantified by the average of observed variables in that factor. Using SPSS, we have regression results as shown in Table 9.

Table 9. Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
Constant	-1.574	.328		-4.797	.000		
pu	.510	.066	.369	7.766	.000	.904	1.106
pe	.154	.044	.173	3.526	.001	.848	1.179
ces	.168	.055	.150	3.042	.003	.838	1.193
fc	.232	.042	.274	5.468	.000	.813	1.230
new	.296	.045	.323	6.625	.000	.859	1.165

Sig value. of the t-test (testing the significance of Beta regression coefficient) in Fig. 4 of factors X1 (PU), X2 (pe), X3 (ces), X4 (fc), X5 (new) are all less than 0.05. Therefore, we conclude that these independent variables impact the dependent variable Y (BI). The impact level of variables depends on the standard regression coefficient.

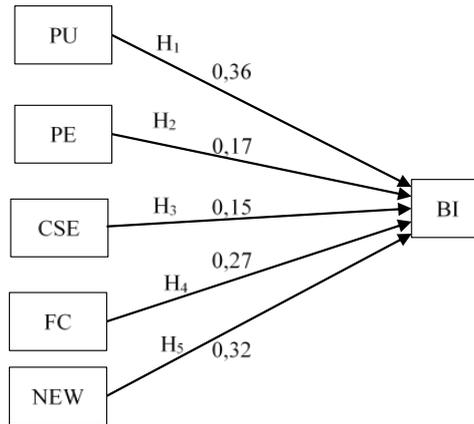


Fig. 4. Model of performance levels of the independent variables to the dependent variables

Standardized regression equation:

$$Y = 0.369*X1 + 0.173*X2 + 0.150*X3 + 0.274*X4 + 0.323*X5$$

Thus, the independent variables X1 (PU), X5 (new) have the most influence on the dependent variable Y, the variable X3 (ces) has the least influence.

5 Discussion and Conclusion

According to the initial theoretical model with six hypotheses, the six factors affecting the decision to use M-learning by high school students: Perceived usefulness, Perceived ease of use, Self-efficacy, Subjective norms, mobility, convenience, attitude. However, through SPSS for analyzing and processing actual survey data, there are only five basic factors X1 (PU), X2 (pe), X3 (ces), X4 (fc), X5 (new), affecting the decision to use M-learning by high school students.

Factor X1 presents three basic issues: saving much time, improving learning efficiency, and bringing usefulness. In the standardized regression equation, the factor X1 has the highest Beta coefficient (Beta = 0.369), showing that X1 influences students' decision to use M-learning. This result is consistent with previous studies [41]. The results indicate that users know that users' usefulness is the most important in expressing their attitudes when using M-learning.

The factor X5 (new) presents two main issues: the attitude of learners and the impact of the objects that affect M-learning. In the standardized regression equation, the factor X5 has the second-highest Beta coefficient (Beta = 0.323), which shows that the influence of X2 on learning outcomes is only behind the influence of usefulness. These findings were aligned with previous studies where students' self-learning ability were found to challenging for using M-learning [19].

The factor X4 (fc) presents mobility and convenience when using M-learning. In the standardized regression equation, the factor X4 also has a relatively high Beta coefficient (Beta = 0.274), which shows that X4 is also a factor that significantly influences the decision to use M-learning by high school students.

The two factors X2 (ces) and X3 (pe) are self-efficacy factors for mobile technology and ease of use. In the standardized regression equation, the factors X2, X3 have a Beta coefficient of 0.173 and 0.150, respectively, which shows that the two factors' influence on learning outcomes is nearly equal. At the same time, we can see that these two factors have the most minor influence on using M-learning among the factors measured. The mobile phone skills of students can explain it; students seemed to adopt the ability to use mobile phones quickly [44].

This study aims to determine the factors that influence the decision to use M-learning by high school students in Vietnam. The conclusions of this study have some implications for suppliers and researchers interested in M-learning. Firstly, this study shows that perceived usefulness (PU), attitudes of learners, and the impact of different objects (SN, ATT) are the main factors that determine the user's perception of M-learning. However, PU has more influence than SN and ATT.

The above study results show that the most important thing to encourage students to choose M-learning in their studying is that the educators should pay attention to the design of appropriate courses to save time, improve learning outcomes for students, and increase the mobility of learners. Besides, it is also necessary to introduce the convenience of courses to learners through many different channels.

6 Recommendations

Based on the research on the application of M-learning and the factors affecting the decisions to use M-learning in students' learning, further research is needed to implement M-learning as effective [45-47].

Firstly, it is necessary to research, design, and edit m-learning materials to support students in learning to exploit the advantages of M-learning and prove the connection with the curriculum, content, and teaching purposes.

Secondly, it is necessary to identify the appropriate forms to exploit several mobile phone applications in learning activities under experimental conditions.

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8 Authors

Trinh Le Thi Tuyet is a Ph.D. in Mathematics Education and works as a Lecturer at Dong Thap University, Vietnam. Her main research interests include mathematics education, evaluation, and assessment in education and innovation of teaching and learning methods in high school. Email: letrinh1282@gmail.com; ORCID: <https://orcid.org/0000-0003-3970-9773>

Thao Phuong Thi Trinh is an Associate Professor, Doctor of Education, and a senior lecturer at the Thai Nguyen University of Education, Vietnam. Associate Professor Trinh Thi Phuong Thao has published many articles in prestigious scientific journals in ISI, Scopus. The main research interests of Associate Professor Trinh Thi Phuong Thao include mathematics education, information, and communication technology application in education, teacher training, and fostering and ethnic education. email: trinhphuongthao@dhsptn.edu.vn; ORCID: <https://orcid.org/0000-0001-6277-4907>

Hang Thu Thi Nguyen is working at the Faculty of Basic Sciences at Thai Nguyen University of Agriculture and Forestry. She is a Ph.D. student at the Thai Nguyen University of Education. Her main research direction is to innovate teaching and assessment methods towards developing learners' capacity. Besides, she has a scientific research orientation in the context of industrial revolution 4.0. email: nguyenhang@tuaf.edu.vn; ORCID: <https://orcid.org/0000-0003-2737-833X>

Thanh Chi Nguyen is an Associate Professor of Education Studies, graduated with a Ph.D. in Didactic Mathematics at Grenoble I University (French Republic), currently a lecturer at the University of Education, Hanoi National University. The main research areas are Didactic Math; Application of Information Technology in teaching and learning Maths; Professional development of math teachers; Developing school curriculum in Maths; STEM education; Mathematical and Computer Thinking in general teaching. Email: thanhnc@vnu.edu.vn; ORCID: <https://orcid.org/0000-0001-8533-2925>

Trung Tran is Professor of Mathematics Education, Director of the Vietnam Academy for Ethnic Minorities, Hanoi, Vietnam, a lecturer at the University of

Education, Hanoi National University. Professor Tran Trung has published many articles in prestigious international journals in ISI, Scopus, and monograph editors of international publishers (SpringerNature, Taylor & Francis, DeGruyter). At the same time, Professor Tran Trung is also a Guest Editor for some special subjects of the Sustainability Magazine (SSCI, IF2018 = 2,592). The main research areas of Professor Tran Trung are ethnic education, educational management, public policy, and teaching methods. Besides, Professor Tran Trung also participates in interdisciplinary research between education and mathematics, computer science, economics and technology, and the development of scientific research skills. email: trungt1978@gmail.com; ORCID: <https://orcid.org/0000-0002-0459-7284>

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