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Elucidating user behavior of mobile learning

A perspective of the extended technology acceptance model

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Abstract

Purpose – The purpose of this paper is to propose and verify that the technology acceptance model (TAM) can be employed to explain and predict the acceptance of mobile learning (M-learning); an activity in which users access learning material with their mobile devices. The study identifies two factors that account for individual differences, i.e. perceived enjoyment (PE) and perceived mobility value (PMV), to enhance the explanatory power of the model.

Design/methodology/approach – An online survey was conducted to collect data. A total of 313 undergraduate and graduate students in two Taiwan universities answered the questionnaire. Most of the constructs in the model were measured using existing scales, while some measurement items were created specifically for this research. Structural equation modeling was employed to examine the fit of the data with the model by using the LISREL software.

Findings – The results of the data analysis shows that the data fit the extended TAM model well. Consumers hold positive attitudes for M-learning, viewing M-learning as an efficient tool. Specifically, the results show that individual differences have a great impact on user acceptance and that the perceived enjoyment and perceived mobility can predict user intentions of using M-learning.

Originality/value – There is scant research available in the literature on user acceptance of M-learning from a customer's perspective. The present research shows that TAM can predict user acceptance of this new technology. Perceived enjoyment and perceived mobility value are antecedents of user acceptance. The model enhances our understanding of consumer motivation of using M-learning. This understanding can aid our efforts when promoting M-learning.

Keywords Learning, Taiwan, Mobile communication systems

Paper type Research paper

1. Introduction

The third generation (3G) mobile services can be used as an efficient learning tool. Mobile learning (M-learning) is an activity in which people carry out learning activities using a mobile device like a cell phone or a personal digital assistant (PDA). M-learning allows users to access learning material anytime and anywhere (Clyde, 2004; Gay *et al.*, 2001; Hill and Roldan, 2005; Liu *et al.*, 2003). This new M-learning technology encourages users to attend a variety of learning activities, including to search for knowledge, participate in discussion groups and access informational contents online

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(Chang *et al.*, 2003; Roschelle, 2003). M-learning compliments electronic learning (E-learning) by creating an additional access channel for mobile users with mobile devices. Because of the potential widespread use of 3G mobile devices, M-learning is likely going to be the next wave of any learning environment, such as museums (Goh and Kinshuk, 2004; Hsu *et al.*, 2006).

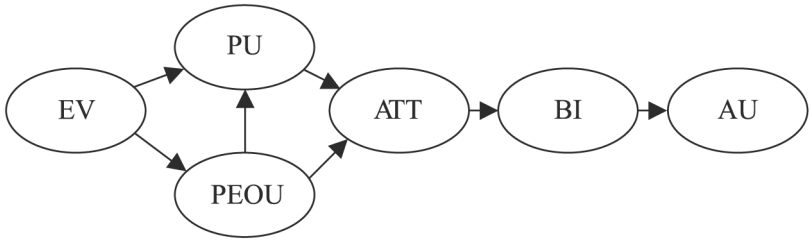
The 3G networks are not yet commonly available, and M-learning is still in its infancy, with many aspects of mobile learning yet to be explored (Taylor, 2003). Previous studies have extensively addressed M-learning from technical perspectives (Chang *et al.*, 2003; Chen *et al.*, 2003; Liu *et al.*, 2003), but few empirical works are available on M-learning from a customer's standpoint. As a result, M-learning suppliers can provide quality M-learning to customers only by studying the customers carefully.

The primary goal of this work was to enhance our understanding of user acceptance of M-learning. This study addresses the ability to predict consumer acceptance of M-learning in terms of individual differences (i.e. perceived usefulness) as stipulated by the technology acceptance model (TAM). TAM is a model for explaining the user acceptance of novel technology, and has been theoretically and empirically justified (Devaraj *et al.*, 2002). Because M-learning technology is still in its development stage, the crucial motivational variables that will affect its adoption by users need to be explored. This study developed two new constructs, namely "perceived mobility value" and "perceived enjoyment". The appropriateness of TAM in explaining consumer acceptance of M-learning is examined using the LISREL software. Because of their familiarity with mobile devices, university students were chosen using an online survey for evaluating user acceptance of M-learning.

2. Theoretical background: Technology Acceptance Model (TAM)

Behavior prediction has been one of the major purposes of psychological theories. Some of the more useful theories include the theory of reasoned action (TRA) (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975), the social cognitive theory (SCT) (Compeau and Higgins, 1995; Hill *et al.*, 1987) and TAM (Davis, 1989, 1993). TAM, originally presented by Davis (1989), is derived from TRA (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975). TAM is a behavioral model that describes the antecedents of the adoption of information technology (IT), and is considered a robust tool for measuring the adoption of new technology by users (Agarwal and Prasad, 1999; Davis, 1989; Doll *et al.*, 1998; Segars and Grover, 1993). Over the years TAM has been validated by various applications and extensions, including web-based information (van der Heijden, 2003; Yi and Hwang, 2003), internet banking (Wang *et al.*, 2003) and electronic commerce (Henderson and Divett, 2003; van Dolen and de Ruyter, 2002). The M-learning technology is novel, and is therefore appropriate to be examined using the TAM model.

Figure 1 illustrates TAM, which includes six constructs, namely external variables, perceived usefulness, perceived ease of use, attitude, behavioral intention and actual usage. It shows that user behavior is determined by perceptions of usefulness and the ease of use of the technology (Adams *et al.*, 1992; Davis, 1989; Davis *et al.*, 1989; Mathieson, 1991). The concept of actual usage was eliminated from the revised TAM model, because M-learning technology is still at an early stage of development. This study investigates the future acceptance of the emerging M-learning technology, rather



Key:
EV = external variables, PU = perceived usefulness, PEOU = perceived ease of use, ATT = attitude, BI = behavioral intention, AU = actual usage

Source: Davis *et al.* (1989, p. 985)

Figure 1.
Technology acceptance model

than its current usage. Actual usage is not a cogent measure of the value of M-learning, as indicated in previous studies (Lu *et al.*, 2003; Yang, 2005). The following sections describe the constructs of TAM in detail, and its applicability to the present study.

2.1 Perceived Usefulness (PU) and Perceived Ease of Use (PEOU)

TAM posits that two particular behavioral beliefs, perceived usefulness (PU) and perceived ease of use (PEOU), are two fundamental factors for predicting user acceptance, and that the effect of external variables on intention are mediated by these two key beliefs (Adams *et al.*, 1992; Davis, 1989; Davis *et al.*, 1989; Mathieson, 1991). PU is defined as an individual's perception that using a new technology will enhance or improve her/his performance (Davis, 1989, 1993). Applying this definition to this research context, PU means the users' perception that using M-learning enhances their learning performance. A strengthening of this belief creates a positive attitude toward M-learning, thereby increasing the user's intention to use M-learning.

PEOU is defined as an individual's perception that using a new technology will be free from effort (Davis, 1989, 1993). Applying this definition in this research context, PEOU represents the perception that M-learning is easy to use. PEOU is hypothesized to be a predictor of PU. Moreover, both PU and PEOU are affected by external variables (Hu *et al.*, 1999; Venkatesh *et al.*, 2002; Wang *et al.*, 2003). Furthermore, PU and PEOU have a positive effect on attitude. Unlike in TRA, the subjective norm is not a determinant of behavioral intention in TAM; instead, BI in TAM is affected only by PU and attitude (Davis, 1989).

2.2 External variables

Although TAM is a model applicable to a variety of technologies (Adams *et al.*, 1992; Chin and Todd, 1995; Doll *et al.*, 1998), it has been criticized for not providing adequate information on individuals' opinions of novel systems (Mathieson, 1991; Moon and Kim, 2001; Perea y Monsuwe *et al.*, 2004). Davis (1989, p. 985) observed that external variables enhance the ability of TAM to predict acceptance of future technology. In other words, the constructs of TAM need to be extended by incorporating additional factors. Choosing additional factors depends on the target technology, main users and context (Moon and Kim, 2001). Wang *et al.* (2003) noted that variables relating to individual differences play a vital role in the implementation of technology.

Additionally, empirical research based on TAM has discovered strong relationships between individual differences and IT acceptance (Agarwal and Prasad, 1999; Venkatesh, 2000). To understand user perception of M-learning, this study integrated two individual difference variables, namely "perceived mobility value" and "perceived enjoyment", into the proposed TAM model. These two constructs are described below.

Perceived mobility value (PMV). Perceived mobility value (PMV) denotes user awareness of the mobility value of M-learning. Mobility has three different elements including convenience, expediency and immediacy (Seppälä and Alamäki, 2003). Mobility permits users to gain access to service/information anywhere at anytime via mobile devices. In other words, mobility brings the ability to guide and support users in new learning situations when and where it is necessary. Previous studies found that mobile users valued efficiency and availability as the main advantages of M-learning, and these advantages are a result of the "mobility" of a mobile device (Chen *et al.*, 2003; Hill and Roldan, 2005; Ting, 2005). Therefore, M-learning is valuable because of its mobility. Consequently, the perceived mobility value is a critical factor of individual differences affecting users' behaviors. This study treats perceived mobility value as a new variable in the TAM.

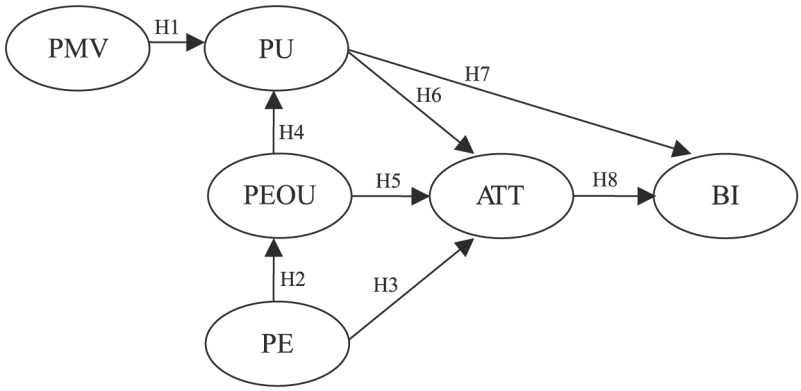
Perceived enjoyment (PE). Individuals engage in activities because these activities lead to enjoyment and pleasure (Teo and Lim, 1997). According to Davis *et al.* (1992), perceived enjoyment is defined as "the extent to which the activity of using the technology is perceived to be enjoyable in its own right, apart from any performance consequences that may be anticipated". In this study, perceived enjoyment denotes the extent to which an individual finds the interaction of M-learning intrinsically enjoyable or interesting. Perceived enjoyment is seen as an example of intrinsic motivation, and it has been found to influence user acceptance significantly. Furthermore, research on the role of enjoyment suggested the importance of enjoyment on users' attitudes and behaviors (Igbaria *et al.*, 1995; Teo and Lim, 1997; Wexler, 2001; Yi and Hwang, 2003). Hence, perceived enjoyment is addressed as a key factor for influencing user acceptance of M-learning.

3. Research model and hypotheses

As shown in Figure 2, the proposed TAM includes two external variables, namely "perceived mobility value" and "perceived enjoyment". These two constructs may significantly affect existing TAM variables. In addition, other relationships between the constructs proposed by the original TAM are also presented (Davis *et al.*, 1989; Venkatesh and Davis, 2000). The next section describes in detail all hypotheses concerning the relationships among the variables in the model.

3.1 Perceived mobility value

PMV has not been tested previously, but it relates to users' personal awareness of mobility value. Mobility enables users to receive and transmit information anytime and anywhere (Anckar and D'Incau, 2002; Coursaris *et al.*, 2003; Hill and Roldan, 2005; Ting, 2005). The mobility associated with time-related needs will encourage users to adopt mobile technology since enhanced accessibility is expected to affect dynamic interaction and high levels of engagement (Anckar and D'Incau, 2002, p. 48). Hence, users who perceive the value of mobility also understand the uniqueness of M-learning and have a strong perception of its usefulness. In other words, perceived mobility value



Key:
PMV = perceived mobility value, PE = perceived enjoyment, PU = perceived usefulness, PEOU = perceived ease of use, ATT = attitude, BI = behavioral intention

Figure 2.
Proposed extended TAM model

has a positive effect on the perceived usefulness of M-learning. Therefore, this work treats perceived mobility value as a direct antecedence of perceived usefulness (PU).

H1. Perceived mobility value has a positive effect on perceived usefulness.

3.2 Perceived Enjoyment (PE)
The concept of perceived enjoyment (PE) adapted from Davis *et al.* (1992) means that users feel enjoyable from the instrumental value of using M-learning. Prior studies on technology acceptance behavior examined the effects of perceived enjoyment on perceived ease of use (Igbaria *et al.*, 1996; Venkatesh, 2000; Venkatesh *et al.*, 2002; Yi and Hwang, 2003). New technologies that are considered enjoyable are less likely to be difficult to use.

H2. Perceived enjoyment has a positive effect on perceived ease of use.

There is a causal relationship between perceived enjoyment and attitude. When users feel that M-learning is enjoyable, the stimulus of happiness in turn enhances their perception of M-learning. Venkatesh (2000) found that perceived enjoyment indirectly influences users on adoption. Other research showed that attitudinal outcomes, such as happiness, pleasure, and satisfaction, result from the enjoyable experience (Childers *et al.*, 2001; Moon and Kim, 2001; van der Heijden, 2003; Yu *et al.*, 2005). These findings indicate that enjoyment highly correlates with the users' positive attitudes.

H3. Perceived enjoyment has a positive effect on attitude.

3.3 Perceived ease of use, perceived usefulness, attitude, and behavioral intention
TAM delineates the causal relationships between perceived usefulness (PU), perceived ease of use (PEOU), attitude and behavioral intention (BI) to explain users' acceptance of technologies. PEOU is hypothesized to be a predictor of PU. Additionally, attitude is determined by two salient beliefs, namely PU and PEOU (Davis, 1989). Finally, BI is determined by PU and attitude.

The influence of PEOU on PU. TAM posits a strong direct link between PEOU and PU. If all other factors are equal, users are likely to consider a technology to be more useful if they perceive that it is easier to use (Brown and Licker, 2003; Bruner and Kumar, 2005; Hu *et al.*, 1999; Igbaria and Iivari, 1995). Therefore, PEOU is likely to have a direct effect on the PU of the construct.

H4. Perceived ease of use has a positive effect on perceived usefulness.

The influence of PEOU and PU on attitude. The attitude toward using a given technology is the overall evaluation that predicts a user's likelihood of adopting that emerging technology. Past research indicates that attitude is influenced by both PEOU and PU components (Childers *et al.*, 2001; Dabholkar and Bagozzi, 2002; Mathieson, 1991; O'Cass and Fenech, 2003). Thus, that attitude is positively influenced by PU and PEOU is proposed herein.

H5. Perceived ease of use has a positive effect on attitude.

H6. Perceived usefulness has a positive effect on attitude.

The influence of PU and attitude on BI. In TAM, BI is influenced by both PU and Attitude. This relationship has been examined and supported by many prior studies (Adams *et al.*, 1992; Davis *et al.*, 1989; Hu *et al.*, 1999; Venkatesh and Davis, 1996, 2000). Therefore, this study presents the following hypotheses.

H7. Perceived usefulness has a positive effect on behavioral intention.

H8. Attitude has a positive effect on behavioral intention.

4. Methodology

4.1 Study context and sample

Undergraduate and graduate students in two Taiwan universities were asked to evaluate their perception of M-learning by completing an online survey. All respondents were guaranteed confidentiality of their individual response. An embedding program was added to the electronic survey to check for missing responses. As a result, 313 usable questionnaires were obtained, of which 47.3 percent ($N = 148$) were from male respondents, and 52.7 percent ($N = 165$) from female respondents. The majority of the respondents, 85.6 percent ($N = 268$), were between 20 and 24 years of age, and 99 percent ($N = 310$) possessed mobile devices. The experience of using mobile devices ranged from 0 to 15 years, with a mean of 6.61 years.

4.2 Questionnaire design

The items used to construct each variable were mainly adopted from previous studies, as shown in Table I, to assure content validity. Appropriate items were designed to measure two new constructs, namely perceived mobility value and perceived enjoyment. Participants were asked to evaluate statements using a 5-point Likert-type scale ranging from strongly disagree (1) through neutral (3) to strongly agree (5). The questionnaire consisted of 19 items addressing all six constructs.

Table I. Research variables

Variable	Description	Type	Items	Source	Questionnaires
PE	Perceived Enjoyment	Independent	3	Moon and Kim (2001); Yi and Hwang (2003); Yu *et al.* (2005)	(PE1) M-learning would make me feel good (PE2) M-learning would be interesting (PE3) I would have fun using M-learning
PMV	Perceived mobile value	Independent	4	Newly created by this research	(PMV1) I know that mobile devices are the mediums for M-learning (PMV2) It is convenient to access M-learning anywhere at anytime (PMV3) Mobility makes it possible to get the real-time data (PMV4) Mobility is an outstanding advantage of M-learning
PU	Perceived usefulness	Independent/Dependent	Davis (1989	Davis (1989, 1993); Venkatesh and Davis (1996); Yang (2005)	(PU1) Using M-learning would save me much time (PU2) M-learning would enhance my effectiveness in learning (PU3) Overall, M-learning would be useful
PEOU	Perceived ease of use	Independent/Dependent	Davis (1989	Davis (1989, 1993); Venkatesh and Davis (1996); Yang (2005)	(PEOU1) Using M-learning would not require a lot of my mental effort (PEOU2) My interaction with M-learning would be clear and understandable (PEOU3) M-learning would be easy to use
ATT	Attitude	Independent/Dependent	3	Bagozzi *et al.* (1992); Hu *et al.* (1999)	(ATT1) In my opinion it would be very desirable to use M-learning (ATT2) I would like to use M-learning (ATT3) I hold a positive evaluation of M-learning
BI	Behavioral intention	Dependent	3	Bagozzi *et al.* (1992); Hu *et al.* (1999)	(BI1) I intend to use M-learning when it becomes available (BI2) If I were asked to express my opinion of M-learning, I intend to say something favorable (BI3) In the future, I intend to use M-learning routinely

5. Results

A confirmatory factor analysis was conducted using LISREL 8.51 (Jöreskog and Sörbom, 1993) to test the model. The hypothesized relationships among the variables in this model were analyzed, and the parameters were estimated with the maximum likelihood method. Covariances among manifest variables of the technology acceptance model are presented in Table II. The proposed structural equation model was then tested for the fit between data and model. As shown in Table III, the overall goodness of fit of the TAM model was verified with seven fitness measures, namely the comparative fit index (CFI), goodness-of-fit (GFI), adjusted goodness-of-fit (AGFI), normalized fit index (NFI), non-normalized fit index (NNFI), Critical N (CN) and root mean square error of approximation (RMSEA). All the model-fit-indices exceeded the acceptance levels suggested by previous research, and the results indicate that the data fit the TAM model well. Therefore, the TAM model, as expected, clearly explains the user acceptance of M-learning.

All direct paths in TAM were significant, so *H1*, *H2*, *H3*, *H4*, *H5*, *H6*, *H7* and *H8* were all supported. The *t*-value of a parameter indicates the strength of the relationship the parameter represents. The higher the *t*-value is, the stronger the relationship is. Figure 3 indicates that although PU ($t = 6.98$) and PEOU ($t = 2.07$) significantly affect attitude, the effect of PU is stronger than that of PEOU, which is in agreement with previous findings (Gentry and Calantone, 2002; O'Cass and Fenech, 2003; van der Heijden, 2003; Yu *et al.*, 2005). The results indicate that users' perception of usefulness is more important than their perception of ease of use in influencing their attitude of using M-learning. In addition, *H4* was supported, showing that PEOU is likely to have a direct effect on the PU of the construct, which again is consistent with previous research (e.g. Brown and Licker, 2003; Davis *et al.*, 1989; Yu *et al.*, 2005). Therefore, the perceived ease of use of M-learning encourages an individual to regard M-learning as a useful technology. Furthermore, behavioral intention was primarily affected by usefulness ($t = 2.06$) and attitude ($t = 5.56$), which implies that both usefulness and attitude are critical factors. The results indicate that attitude is indeed a mediator between beliefs and user intention (Gentry and Calantone, 2002; van der Heijden, 2003; Yu *et al.*, 2005).

The proposed framework includes the hypothesis that perceived mobility value and perceived enjoyment are predictors of using M-learning. As expected, the significant positive relationships among the constructs confirm these hypotheses. The perceived mobility value significantly increases an individual's awareness of usefulness ($t = 6.94$). The more a user appreciates the value of mobility, the more the user will perceive that M-learning is useful. Hence, this study supports the contention that PMV plays an important role in user perceptions of M-learning, which is consistent with other works (Chen *et al.*, 2003; Coursaris *et al.*, 2003; Ting, 2005). The significant link between perceived enjoyment and perceived ease of use ($t = 3.92$) implies that a user who enjoys using M-learning will find it to be easy to use. This result supports *H2*, and is consistent with those of previous studies. Moreover, perceived enjoyment has a direct effect on attitude ($t = 4.80$), which supports H3. Enjoyable experiences do result in positive attitudes. This result underlies the importance of perceived enjoyment in influencing user acceptance of a new technology (Davis *et al.*, 1992; Teo and Lim, 1997; Wexler, 2001; Yu *et al.*, 2005).

	PE1	PE2	PE3	PMV1	PMV2	PMV3	PMV4	PEOU1	PEOU2	PEOU3	PU1	PU2	PU3	ATT1	ATT2	ATT3	BI1	BI2	BI3
PE1	0.33																		
PE2	0.19	0.29																	
PE3	0.14	0.15	0.26																
PMV1	0.06	0.06	0.06	0.30															
PMV2	0.07	0.06	0.06	0.15	0.38														
PMV3	0.05	0.06	0.06	0.16	0.15	0.30													
PMV4	0.06	0.05	0.06	0.14	0.15	0.17	0.28												
PEOU1	0.06	0.06	0.05	0.06	0.05	0.05	0.06	0.40											
PEOU2	0.05	0.04	0.04	0.04	0.04	0.05	0.05	0.17	0.30										
PEOU3	0.04	0.04	0.03	0.07	0.05	0.05	0.05	0.18	0.14	0.29									
PU1	0.06	0.06	0.06	0.09	0.08	0.09	0.08	0.06	0.07	0.07	0.24								
PU2	0.04	0.04	0.03	0.05	0.07	0.08	0.08	0.04	0.03	0.03	0.11	0.33							
PU3	0.02	0.03	0.02	0.08	0.07	0.07	0.08	0.05	0.04	0.05	0.12	0.14	0.21						
ATT1	0.09	0.09	0.07	0.06	0.07	0.07	0.07	0.09	0.08	0.07	0.08	0.12	0.09	0.30					
ATT2	0.10	0.08	0.07	0.07	0.08	0.07	0.06	0.07	0.06	0.06	0.08	0.10	0.07	0.17	0.27				
ATT3	0.05	0.04	0.04	0.07	0.08	0.07	0.06	0.04	0.04	0.03	0.08	0.12	0.09	0.12	0.12	0.25			
BI1	0.06	0.06	0.04	0.08	0.08	0.08	0.09	0.06	0.04	0.06	0.08	0.09	0.07	0.10	0.09	0.10	0.26		
BI2	0.05	0.06	0.03	0.07	0.08	0.08	0.08	0.05	0.05	0.04	0.07	0.09	0.08	0.12	0.12	0.10	0.12	0.24	
BI3	0.06	0.07	0.06	0.07	0.07	0.07	0.07	0.06	0.04	0.06	0.05	0.07	0.06	0.09	0.08	0.06	0.11	0.12	0.25

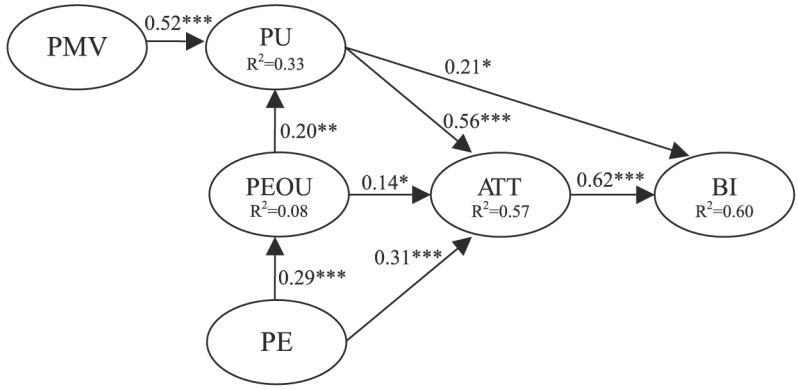
Table II.
Covariance among the research variables for the TAM

6. Conclusions

This work proposes and verifies that TAM can be employed to explain and predict the acceptance of M-learning. The findings of this study have several implications for M-learning providers and researchers interested in M-learning. First, this study found that perceived usefulness (PU) and perceived ease of use (PEOU) are key determinants of user perception of M-learning. However, PU affects individual's attitudes more than PEOU does. Although customers need a simple way to use M-learning, perceived usefulness is critical. In addition to designing a straightforward way to utilize the M-learning technology, providers should also endeavor to maximize the usefulness of

Table III.
Fit indices for the extended TAM model

Fit indices	Suggested value	Source	TAM model
Comparative fit index (CFI)	CFI $>$ 0.95	Bentler, 1995	0.99
Goodness-of-fit (GFI)	GFI $>$ 0.9	Hu and Bentler, 1999	0.95
Adjusted goodness-of-fit (AGFI)	AGFI $>$ 0.9	Hu and Bentler, 1999	0.93
Normalized fit index (NFI)	NFI $>$ 0.9	Bentler and Bonnet, 1980	0.92
Non-normalized fit index (NNFI)	NNFI $>$ 0.9	Bentler and Bonnet, 1980	0.99
Critical N (CN)	CN $>$ 200	Hu and Bentler, 1999	351.81
Root mean square error of approximation (RMSEA)	RMSEA $<$ 0.05	Hu and Bentler, 1999; McDonald and Ho, 2002	0.019



Key:
PMV = perceived mobility value, PE = perceived enjoyment, PU = perceived usefulness, PEOU = perceived ease of use, ATT = attitude, BI = behavioral intention

Note:
The figure shown in the edge connecting any two nodes represents the number of unit increase in the dependent variable if the causing variable increases by one unit.
R^2 represents the proportion of the variance of the variable that could be explained by its causing variables

* significant at a 0.05 level
** significant at a 0.01 level
*** significant at a 0.001 level

Figure 3.
Path coefficients of TAM Model

M-learning. Second, this study has shown the importance of perceived mobility value (PMV) to an individual's acceptance of M-learning. The most significant feature of mobile technology is mobility, which enables customers to access learning information at anytime and anywhere. Mobility allows M-learning to become an important channel for obtaining learning material. Therefore, advantages of mobility are crucial to users. Third, individuals who perceive the M-learning technology as being pleasant will also find that using M-learning is simple to use, and they also have a positive attitude toward M-learning. The fact that it is enjoyable is significant to attract users. Fourth, in order to predict user acceptance of M-learning, this study adds two external constructs, perceived enjoyment and perceived mobility value. The predictive power of these two added constructs shows that the new variables are imperative.

As other new technologies become available for digital libraries and museums, TAM can be employed to predict and to explain the acceptance of the new technologies. When applying TAM in another context, the external variables for that context have to be found and examined carefully to ensure that TAM is a viable model for that context. Furthermore, the subjects of this study are students, who are relatively homogeneous as compared with the general population. Population in general may vary substantially in terms of their acceptance of a new technology. For example, adolescents' perception, interest and attitude toward M-learning would be different from those of the elderly. TAM can be employed to compare the differences as well as the similarities of accepting a technology among various groups of populations.

References

Adams, D.A., Nelson, R.R. and Todd, P.A. (1992), "Perceived usefulness, ease of use, and usage of information technology: a replication", *MIS Quarterly*, Vol. 16 No. 2, pp. 227-47.

Agarwal, R. and Prasad, J. (1999), "Are individual differences germane to the acceptance of new information technologies?", *Decision Sciences*, Vol. 30 No. 2, pp. 361-91.

Ajzen, I. and Fishbein, M. (1980), *Understanding Attitudes and Predicting Social Behavior*, Prentice-Hall, Englewood Cliffs, NJ.

Anckar, B. and D'Incau, D. (2002), "Value creation in mobile commerce: findings from a consumer survey", *JITTA: Journal of Information Technology Theory and Application*, Vol. 4 No. 1, pp. 43-64.

Bagozzi, R.P., Baumgartner, H. and Yi, Y. (1992), "State versus action orientation and the theory of reasoned action: an application to coupon usage", *Journal of Consumer Research*, Vol. 18 No. 4, pp. 505-18.

Bentler, P.M. (1995), *EQS Structural Equations Program Manual*, Multivariate Software, Encino, CA.

Bentler, P.M. and Bonnet, D.G. (1980), "Significance tests and goodness of fit in the analysis of covariance structures", *Psychological Bulletin*, Vol. 88 No. 3, pp. 588-606.

Brown, I. and Licker, P. (2003), "Exploring differences in internet adoption and usage between historically advantaged and disadvantaged groups in South Africa", *Journal of Global Information Technology Management*, Vol. 6 No. 4, pp. 6-26.

Bruner, G.C. II and Kumar, A. (2005), "Explaining consumer acceptance of handheld internet devices", *Journal of Business Research*, Vol. 58 No. 5, pp. 553-8.

Chang, C.Y., Sheu, J.P. and Chan, T.W. (2003), "Concept and design of *ad hoc* and mobile classrooms", *Journal of Computer Assisted Learning*, Vol. 19 No. 3, pp. 336-46.

Chen, Y.S., Kao, T.C. and Sheu, J.P. (2003), "A mobile learning system for scaffolding bird watching learning", *Journal of Computer Assisted Learning*, Vol. 19 No. 3, pp. 347-59.

Childers, T.L., Carr, C.L., Peck, J. and Carson, S. (2001), "Hedonic and utilitarian motivations for online retail shopping behavior", *Journal of Retailing*, Vol. 77 No. 4, pp. 511-35.

Chin, W.W. and Todd, P.A. (1995), "On the use, usefulness and ease of use of structural equation modeling in MIS research: a note of caution", *MIS Quarterly*, Vol. 19 No. 2, pp. 237-46.

Clyde, L.A. (2004), "m-learning", *Teacher Librarian*, Vol. 32 No. 1, pp. 45-6.

Compeau, D.R. and Higgins, C.A. (1995), "Computer self-efficacy: development of a measure and initial test", *MIS Quarterly*, Vol. 19 No. 2, pp. 189-211.

Coursaris, C., Hassanein, K. and Head, M. (2003), "M-commerce in Canada: an interaction framework for wireless privacy", *Canadian Journal of Administrative Sciences*, Vol. 20 No. 1, pp. 54-73.

Dabholkar, P.A. and Bagozzi, R.P. (2002), "An attitudinal model of technology-based self-service: moderating effects of consumer traits and situational factors", *Journal of the Academy of Marketing Science*, Vol. 30 No. 3, pp. 184-201.

Davis, F.D. (1989), "Perceived usefulness, perceived ease of use, and user acceptance of information technology", *MIS Quarterly*, Vol. 13 No. 3, pp. 319-40.

Davis, F.D. (1993), "User acceptance of information technology: system characteristics, user perceptions and behavioral impacts", *International Journal of Man-Machine Studies*, Vol. 38 No. 3, pp. 475-87.

Davis, F.D., Bagozzi, R.P. and Warshaw, P.R. (1989), "User acceptance of computer technology: a comparison of two theoretical models", *Management Science*, Vol. 35 No. 8, pp. 982-1003.

Davis, F.D., Bagozzi, R.P. and Warshaw, P.R. (1992), "Extrinsic and intrinsic motivation to use computers in the workplace", *Journal of Applied Social Psychology*, Vol. 22 No. 14, pp. 1111-32.

Devaraj, S., Fan, M. and Kohli, R. (2002), "Antecedents of b2C channel satisfaction and preference: validating e-commerce metrics", *Information Systems Research*, Vol. 13 No. 3, pp. 316-33.

Doll, W.J., Hendrickson, A. and Deng, X. (1998), "Using Davis's perceived usefulness and ease-of-use instruments for decision making: a confirmatory and multi-group invariance analysis", *Decision Sciences*, Vol. 29 No. 4, pp. 839-69.

Fishbein, M. and Ajzen, I. (1975), *Beliefs, Attitudes, Intention, and Behavior: An Introduction of Theory and Research*, Addison Wesley Publishing, Reading, MA.

Gay, G., Stefanone, M., Grace-Martin, M. and Hembrooke, H. (2001), "The effects of wireless computing in collaborative learning", *International Journal of Human-Computer Interaction*, Vol. 13 No. 2, pp. 257-76.

Gentry, L. and Calantone, R. (2002), "A comparison of three models to explain shop-bot use on the web", *Psychology & Marketing*, Vol. 19 No. 11, pp. 945-56.

Goh, T. and Kinshuk, D. (2004), "Getting ready for mobile learning", *Proceedings of ED-MEDIA 2004 – World Conference on Educational Multimedia, Hypermedia & Telecommunications, Lugano, Switzerland, June 21-26*, pp. 56-63.

Henderson, R. and Divett, M.J. (2003), "Perceived usefulness, ease of use and electronic supermarket use", *International Journal of Human-Computer Studies.*, Vol. 59, pp. 383-95.

Hill, T., Smith, N.D. and Mann, M.F. (1987), "Role of efficacy expectations in predicting the decision to use advanced technologies: the case of computers", *Journal of Applied Psychology*, Vol. 72 No. 2, pp. 307-13.

Hill, T.R. and Roldan, M. (2005), "Toward third generation threaded discussions for mobile learning: opportunities and challenges for ubiquitous collaborative environments", *Information Systems Frontiers*, Vol. 7 No. 1, pp. 55-70.

Hsu, T.Y., Ke, H.R. and Yang, W.P. (2006), "Knowledge-based mobile learning framework for museums", *The Electronic Library*, Vol. 24 No. 5, pp. 635-48.

Hu, L. and Bentler, P.M. (1999), "Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives", *Structural Equation Modeling*, Vol. 6 No. 1, pp. 1-55.

Hu, J., Chau, Y.K., Sheng, R.L. and Tam, K.Y. (1999), "Examining technology acceptance model using physician acceptance of telemedicine technology", *Journal of Management Information Systems*, Vol. 16 No. 2, pp. 91-112.

Igbaria, M. and Iivari, J. (1995), "The effects of self-efficacy on computer usage", *Omega, International Journal of Management Science*, Vol. 23 No. 6, pp. 587-605.

Igbaria, M., Iivari, J. and Maragahh, H. (1995), "Why do individuals use computer technology?", *A Finnish case study, Information & Management*, Vol. 29 No. 5, pp. 227-38.

Igbaria, M., Parasuraman, S. and Baroudi, J.J. (1996), "A motivational model of microcomputer usage", *Journal of Management Information Systems*, Vol. 13 No. 1, pp. 127-43.

Jöreskog, K.G. and Sörbom, D. (1993), *LISREL 8: Structural Equation Modeling with the SIMPLIS Command Language*, Scientific Software International Inc., Lincolnwood, IL.

Liu, T.C., Wang, H.Y., Liang, J.K., Chan, T.W., Ko, H.W. and Yang, J.C. (2003), "Wireless and mobile technologies to enhance teaching and learning", *Journal of Computer Assisted Learning*, Vol. 19 No. 3, pp. 371-82.

Lu, J., Yu, C.S., Liu, C. and Yao, J.E. (2003), "Technology acceptance model for wireless Internet", *Internet Research*, Vol. 13 No. 3, pp. 206-22.

McDonald, R.P. and Ho, M.R. (2002), "Principles and practice in reporting structural equation analysis", *Psychological Method*, Vol. 7, pp. 64-82.

Mathieson, K. (1991), "Predicting user intentions: comparing the technology acceptance model with the theory of planned behavior", *Information Systems Research*, Vol. 2 No. 3, pp. 173-91.

Moon, J.W. and Kim, Y.G. (2001), "Extending the TAM for a world wide web context", *Information & Management*, Vol. 38 No. 4, pp. 217-30.

O'Cass, A. and Fenech, T. (2003), "Web retailing adoption: exploring the nature of internet users web retailing behaviour", *Journal of Retailing and Consumer Services*, Vol. 10, pp. 81-94.

Perea y Monsuwe, T., Dellaert, B.G.C. and de Ruyter, K. (2004), "What drives consumers to shop online? A literature review", *International Journal of Service Industry Management*, Vol. 15 No. 1, pp. 102-21.

Roschelle, J. (2003), "Keynote paper: unlocking the learning value of wireless mobile devices", *Journal of Computer Assisted Learning*, Vol. 19 No. 3, pp. 260-72.

Segars, A.H. and Grover, V. (1993), "Re-examining perceived ease of use and usefulness: a confirmatory factor analysis", *MIS Quarterly*, Vol. 17 No. 4, pp. 517-25.

Seppälä, P. and Alamäki, H. (2003), "Mobile learning in teacher training", *Journal of Computer Assisted Learning*, Vol. 19 No. 3, pp. 330-5.

Taylor, J. (2003), "A task-centered approach to evaluating a mobile learning environment for pedagogical soundness", paper presented at MLearn 2003, Birmingham.

Teo, T.S.H. and Lim, V.K.G. (1997), "Usage patterns and perceptions of the internet: the gender gap", *Equal Opportunities International*, Vol. 16 Nos 6/7, pp. 1-8.

Ting, R.Y.L. (2005), "Mobile learning: current trend and future challenges", *Proceedings of the Fifth IEEE International Conference on Advanced Learning Technologies (ICALT 2005)*.

van der Heijden, H. (2003), "Factors influencing the usage of websites: the case of a generic portal in The Netherlands", *Information & Management*, Vol. 40, pp. 541-9.

van Dolen, W.M. and de Ruyter, K. (2002), "Moderated group chat: an empirical assessment of a new e-service encounter", *International Journal of Service Industry Management*, Vol. 13 No. 5, pp. 496-511.

Venkatesh, V. (2000), "Determinants of perceived ease of use: integrating control, intrinsic motivation, and emotion into the technology acceptance model", *Information Systems Research*, Vol. 11 No. 4, pp. 342-65.

Venkatesh, V. and Davis, F.D. (1996), "A model of the antecedents of perceived ease of use: development and test", *Decision Sciences*, Vol. 27 No. 3, pp. 451-81.

Venkatesh, V. and Davis, F.D. (2000), "A theoretical extension of the technology acceptance model: four longitudinal field studies", *Management Science*, Vol. 46 No. 2, pp. 186-204.

Venkatesh, V., Speier, C. and Morris, M.G. (2002), "User acceptance enablers in individual decision making about technology: toward an integrated model", *Decision Sciences*, Vol. 33 No. 2, pp. 297-316.

Wang, Y.S., Wang, Y.M., Lin, H.H. and Tang, T.I. (2003), "Determinants of user acceptance of Internet banking: an empirical study", *International Journal of Service Industry Management*, Vol. 14 No. 5, pp. 501-19.

Wexler, J. (2001), "Why computer users accept new systems", *MIT Sloan Management Review*, Vol. 42 No. 3, p. 17.

Yang, K.C.C. (2005), "Exploring factors affecting the adoption of mobile commerce in Singapore", *Telematics and Informatics*, Vol. 22 No. 3, pp. 257-77.

Yi, M.Y. and Hwang, Y. (2003), "Predicting the use of web-based information systems: self-efficacy, enjoyment, learning goal orientation, and the technology acceptance model", *International Journal of Human-Computer Studies*, Vol. 59, pp. 431-49.

Yu, J., Ha, I., Choi, M. and Rho, J. (2005), "Extending the TAM for a t-commerce", *Information & Management*, Vol. 42 No. 7, pp. 965-76.

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