Prediction of User Acceptance and Adoption of Smart Phone for Learning with Technology Acceptance Model

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Abstract
This study examines how the Technology Acceptance Model (TAM) can be used as a practical tool for early user acceptance and adoption of testing mobile communication devices for learning by evaluating the relationships among perceived usefulness, perceived ease of use, attitude towards using, behavioural intentions to use and actual use. In the study, 60 potential users were presented with an introductory demonstration of smart phone for a digital systems course. Following the demonstration, data on user perceptions and attitudes about smart phones were gathered based on this initial exposure. Subjects with prior experience using the smart phones were eliminated from further analysis resulting in a final sample of 40 users. Hierarchical multiple regression was used to assess the overall model and influence of each variable of interest in determining actual use of smart phone. The analysis showed that both the user perceptions and attitudes have significant positive effects on behavioural intention and actual use of smart phone. Implications of these findings for practice and research are examined.

Keywords
Technology acceptance model, perceptions and attitudes, perceived ease of use, perceived usefulness, smart phone

Introduction

With the increased use of more advanced mobile communication devices which tend to merge portability and connectivity features to allow broader applications and opportunities for real life learning, education is now being transformed by the use of wireless mobile technologies for mobile learning (Kassop, 2003). This scenario has made user perception and acceptance an increasingly critical issue, as the end users are crucial for the effective use of the information technologies (Cheney & Dickson, 1982). Although user acceptance has received fairly extensive attention in prior research, the

majority of these studies have validated the user acceptance other than education by using specific information systems in Management Information Science (MIS) field.

Mobile communication devices began as wireless cell phones used by business executive people in the 1970's and 80's, and evolved into a essential daily communication device for every level of end users from children to older people to business people on the go. While many previous studies have extensively addressed mobile learning from technical perspectives (Chang, Sheu, & Chan, 2003; Chen, Kao, & Sheu, 2003; Liu et al., 2003), very limited research literature examines learner intention to use, and acceptance of mobile communication devices as new educational technologies for learning purpose. In addition, the study of human computer interaction for mobile devices is a relatively young research field especially in the challenge to determine suitable mobile devices and design effectiveness and engagement of mobile learning contents.

This research explores how mobile communication device, specifically smart phone can be integrated and utilized in a higher education institution setting, and uses the Technology Acceptance Model (TAM) to examine how user perceptions and attitudes will influence smart phone use as learning tool to improve and enhance the learning process. The purpose of this study is to examine and validate the TAM as a practical tool for early use acceptance testing through the effect of user perceptions and attitudes on the user acceptance and use of smart phone. The findings of this study will assist educators and practitioners in understanding critical factors leading to an effective and efficient adoption of smart phone for mobile learning.

Theoretical background

Several intention-based theories and models have been proposed and empirically tested in the last decade to understand user adoption and usage of IT innovations. For example, the Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1980), the Technology Acceptance Model (TAM) (F.D. Davis, 1986), the Theory of Planned Behaviour (TPB) (Ajzen, 1991), Innovation Diffusion Theory (Rogers, 1995), and The IS Success Model (DeLone & McLean, 1992). Those frameworks have been applied to a variety of information technologies in different contexts and populations. Among them, the TAM (F.D. Davis, 1986) is one of the most influential and frequently tested models, and widely applied to explain general information technology adoption in the MIS literature (Saga & Zmud, 1994).

The TAM is a specific model developed to explain and predict users' computer usage behaviour. Derived from the TRA, it predicts user acceptance based on the influence of two use beliefs: Perceived Usefulness (PU) and Perceived Ease of Use (PEU). Both PU and PEU are posited as having significant impact on a user's attitude (AT) toward using the system. Behavioural Intentions (BI) to use is jointly determined by a person's attitude toward using the system and its perceived usefulness. BI then determines the actual use (AU) of the system. Using different methodologies, numerous studies have found that PU and PEU correlate well with IT acceptance across a wide range of information systems (Gefen, Karahanna, & Straub, 2003; Ong, Lai, & Wang, 2004;

Saade & Bahli, 2005). Likewise, empirical research has also shown that BI is the strongest predictor of actual use (F. D. Davis, 1989).

According to Davis (1989), the two perceptions explaining system use are perceived ease of use and perceived usefulness. Perceived ease of use refers to the extent to which an individual perceived that using a system is easy or effortless (F. D. Davis, 1989). Previous studies revealed that if an individual perceives a system to be easy to use, he/she is more likely to perceive the system to be useful also (Morris & Dillion, 1997). In addition, if an individual perceives the system to be easy to use, the individual is more likely to use the system, especially among novice users. Perceived usefulness refers to "the degree to which a person believes that using a particular system would enhance his or her job performance," (F. D. Davis, 1989, p.320). Many previous studies have shown that perceived usefulness was the major determinant of attitude towards system use (Langford & Reeves, 1998; Venkatesh & Davis, 1996). Empirical studies have shown that perceived usefulness has a strongly impact on usage than ease of use. Behavioural intention is "a measure of the strength of one's intention to perform a specified behaviour" (Fishbein & Ajzen, 1975, p.288). It is correlated with the usage (F. D. Davis, Bagozzi, & Warshaw, 1989) and is a predictor for usage (Szajna, 1996). According to TAM and TRA, behavioural intention is the most appropriate predictor of actual use (Ajzen & Fishbein, 1980; F. D. Davis, Bagozzi, & Warshaw, 1989). Taylor and Todd (1995) stress that based on Ajzen and Fishbein's definition of behavioural intention "direct experience will result in a stronger" (p.563), more stable behavioural intention-actual use behaviour relationship.

Davis et al. (1989) indicate that the key purpose of TAM is to provide a basis to trace the impact of external factors on internal beliefs, attitudes, and intentions. Many IT researchers have since used TAM as a basis to explore and identify other determinants and relationships specific to a particular IT usage in different contexts (Venkatesh, Morris, Davis, & Davis, 2003). Hence, since the adoption of smart phone in the online learning environment is very closely tied to computer usage, this theory should be directly applied to the adoption of this innovation.

Research model and hypotheses

In this study, the TAM was used as the baseline model to verify the following hypothesized relationships in the context of smart phone usage among higher educational learners. Figure 1 shows the studied model which posits the perceived usefulness and perceived ease of use have direct effects on attitude toward learning object use and intention to use. Attitude toward learning object use has a direct effect on behavioural intention, which in turn, affects the actual use of learning objects.

- H_1: PEU of smart phone will have a significant positive influence on PU of smart phone.
- H_2: PEU of smart phone will have a significant positive influence on AT toward using smart phone.
- H_3: PU of smart phone will have a significant positive influence on AT toward using smart phone.

H_4: PU of smart phone will have a significant positive influence on BI to use smart phone.

H_5: AT toward using smart phone will have a significant positive influence on BI to use smart phone.

H_6: BI to use smart phone will have a significant positive influence on AU of smart phone.

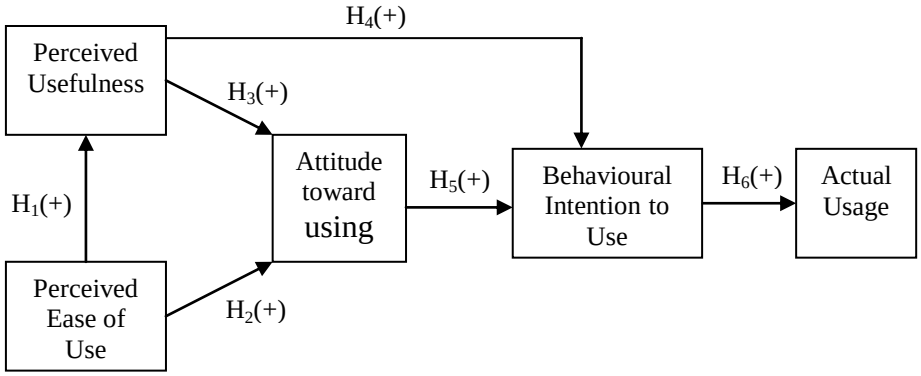

Figure 1: Research model and hypotheses

Methodology

Instruments

Data for this study was collected via a questionnaire by the instructors. A review of the IS literature was used to identify existing measures for constructs, which had been used in previous IS research. The scales for PU, PEU, AT, BI and AU were adapted from literature studies (Adams, Nelson, & Todd, 1992; Chin & Todd, 1995; Corwin, 1998; F. D. Davis, Bagozzi, & Warshaw, 1989; Szajna, 1996; Venkatesh & Davis, 2000; Wallace, 1998). Items were rewritten as necessary to fit the context of this study. A five-point Likert scale from strongly disagree to strongly agree was used to measure the items. The instrument in this study was divided into two sections in the questionnaire. The first section contains items used to measure all the independent variables assumed to affect smart phone acceptance and adoption. Multi-items were used to measure each. The second section contains five questions relating to demographic data about the respondent. The questionnaire is enclosed in the appendix.

Study Device

Although many different smart phone platforms are introduced and available in the market and every operating system has its own method and style to present the information on screen, it does not seem to affect the students' perceptions and beliefs and usability of the device. Previous studies reveal that learning is more effective if the device has the basic features of a full QWERTY keyboard and larger LCD touch screen so that accessing and reading texts are relatively easier and navigation of the course content which require the manipulation of graphics are also efficient (Huang, 2009). Thus, in this study, one commercially available smart phone, HTC Touch Pro 2 was selected. It uses a 528 MHz Qualcomm CPU with 288 MBs of RAM and 512 MBs of

Flash. It comes with 5-row full QWERTY keyboard and a large 3.6″ touch screen display.

Participants

The sample was conveniently selected of those who enrolled in Digital Systems course resulting in a sample of 60 potential users of smart phones. Subjects with prior experience using the smart phones were eliminated from further analysis resulting in a final sample of 40 users. Among them, there were 23 males and 17 females. Participants were familiar with the Internet, computers, and keyboarding skills, but without previous mobile learning experience.

Procedure

At the beginning of the trimester, subjects were told the purpose of the study and the instructors provided a brief in-class introduction on the capabilities of smart phones in general for learning. Immediately after the introduction session, each subject had a chance to familiarize himself/herself with the tested devices and the test software. At the end of the session, all subjects received and completed the questionnaire designed to capture the smart phone's perceived usefulness, perceived ease of use, students' attitude toward using smart phone, and their intentions to use smart phone over the remainder semester. At the end of the week period, one of the researchers returned to the class and had subjects estimated the actual use of smart phone in terms of frequency and number of learning objects referred to over the two months interval since initial exposure.

Analysis Methods

In order to assess the stability and consistency of the scales and construct validity for the variables used in this study, a combination of reliability analysis and exploratory factor analysis were used. The respondents' scores for each construct were obtained by summing across all the item scores of the individual variables. The hypothesized relationships among the study variables depicted in the model were tested using multiple regressions and path analyses.

Data Analysis and Results

Instrument Validation

Prior to being used for final data collection, all the measures were analyzed to determine the reliability and discriminant validity of the measurement scales. The reliability analysis of the measurement constructs were determined by measuring the internal consistency of the instrument using the procedure developed by Cronbach (1951). As shown in Table 1, Alpha coefficients for the constructs ranging from .911 to .976 were all well above the .70 standard of reliability as suggested by Nunnally and Bernstein (1994). Therefore the internal consistency of the survey instrument was acceptable and reliable.

Table 1 Descriptive Statistics and Reliability Analysis

Construct	Mean	S.D.	Cronbach's α
Perceived Ease of Use (PEU)	5.23	.860	.927
Perceived Usefulness (PU)	4.88	1.066	.968
Attitude (AT)	5.21	1.039	.976

Behavioral Intention (BI)	4.96	1.030	.911
Actual Use (AU)	5.00	.679	.945

An exploratory factor analysis was conducted to validate the measurement scales for discriminate validity. A total of 22 question items were analyzed at the item level (6 question items for perceived usefulness, 6 question items for perceived ease of use, 4 question items for attitude toward using, 3 question items for behavioural intention and 3 question items for actual use) using factor analysis in SPSS 11.0 for validation. Table 2 shows the results of an exploratory factor analysis using Principal Component Analysis as the extraction method and Varimax as the rotation method. Five factors were generated: perceived ease of use, perceived usefulness, attitude toward using, behavioural intention and actual use. This result revealed that the test was an established instrument with high reliability and validity scores.

Table 2 Exploratory Factor Analysis

	Component				
	1	2	3	4	5
PEU1	**.829**	.158	.008	-.033	.006
PEU2	**.755**	.308	.378	-.030	-.047
PEU3	**.825**	.251	.117	.047	-.003
PEU4	**.881**	.212	.146	.044	-.062
PEU5	**.758**	.114	.285	.206	-.139
PEU6	**.779**	.179	.335	.150	.079
PU1	.170	**.835**	.208	.261	.101
PU2	.262	**.859**	.199	.126	.109
PU3	.258	**.822**	.260	.252	.130
PU4	.210	**.911**	.184	.082	.112
PU5	.251	**.780**	.332	.250	.120
PU6	.203	**.878**	.242	.001	.071
AT1	.336	.411	**.777**	.244	.047
AT2	.353	.366	**.794**	.262	.045
AT3	.368	.419	**.774**	.156	.059
AT4	.252	.491	**.714**	.214	.177
BI1	.086	.245	.241	**.834**	.249
BI2	.057	.351	.036	**.804**	.280
BI3	.076	.057	.233	**.899**	.111
AU1	-.055	.106	.052	.112	**.930**
AU2	-.114	.120	.037	.208	**.930**
AU3	.038	.140	.069	.179	**.909**

Component 1: PU – Perceived Usefulness
Component 2: PEU – Perceived ease of use
Component 3: AT - Attitude
Component 4: BI – Behavioral Intention
Component 5: AU – Actual Use

Sample Demographics

The goal of the study was to apply and evaluate the TAM in smart phone for learning purpose. The population of interest was learners enrolled in Digital Systems course. In the study, 60 potential users were presented with an introductory demonstration of smart phone for learning digital systems. Subjects with prior experience using the smart phones were eliminated from further analysis resulting in a final sample of 40 users. There were 22 male and 18 female students. The majority of the subjects have 2 to 4

years of computer experiences and spent about 2 to 4 hours everyday on the Internet. Overall, the sample group could be considered potential users to use smart phone for mobile learning, and thus met the necessary conditions for taking this survey.

Hypothesis Testing

Hypothesis testing is based on regression analysis using SPSS. H_1 - H_6 test the causal relationships demonstrated in TAM.

Hypothesis 1 (H_1) stated that perceived ease of use of smart phone would have significant positive influence on perceived usefulness of smart phone. It was tested by regressing perceived ease of use on perceived usefulness. As indicated in Table 3, the results of the regression indicated the predictor explained 26.4% of the variance (R^2 = .264, F(1,39) = 13.62, p<.05). It was found that perceived ease of use significantly predicted perceived usefulness (β = .51, p<.05). Thus, hypothesis 1 receives strong support.

Table 3 Regression Test for Hypothesis 1

	Unstandardized Coefficients		Standardized					
	β	Std. Error	Coefficients	t	Sig.	F	Sig.	R^2
PEU	.637	.173	.514	3.691	.001	13.62	.001	.264

Hypotheses 2 and 3 stated that perceived usefulness and ease of use would have significant positive influences on attitude toward using, respectively. These hypotheses were tested by regressing both perceived usefulness (H_3) and perceived ease of use (H_2) on attitude toward using. Table 4 provides results from the regression analysis for both Hypotheses 2 and 3. The results of the regression indicated the two predictors explained 61.6% of the variance (R^2 = .616, F(2,37) = 29.71, p<.001). It was found that perceived ease of use (β = .34, p<.05) and perceived usefulness (β = .55, p<.001) significantly predicted attitude toward using. Thus hypotheses 2 and 3 are supported.

Table 4 Regression Test for Hypothesis 2 and 3

	Unstandardized Coefficients		Standardized					
	β	Std. Error	Coefficients	t	Sig.	F	Sig.	R^2
PEU	.412	.143	.341	2.871	.007	29.71	.000	.616
PU	.540	.116	.554	4.663	.000			

Hypotheses 4 and 5 stated that perceived usefulness and attitude toward using would each have a significant positive influence on behavioral intentions to use. Results for Hypotheses 4 and 5 are presented in Table 5. The results of the regression indicated the two predictors explained 54.0% of the variance (R^2 = .540, F(2,37) = 21.74, p<.001). It was found that perceived usefulness (β = .35, p<.05) and attitude toward using (β = .541 p<.05) significantly predicted behavioral intention to use. Thus hypotheses 4 and 5 are supported.

Table 5 Regression Test for Hypothesis 4 and 5

	Unstandardized Coefficients		Standardized					
	β	Std. Error	Coefficients	t	Sig.	F	Sig.	R^2

PU	.359	.157	.372	2.283	.028	21.74	.000	
A	.415	.161	.419	2.575	.014			
								.540

Lastly, hypothesis 6 stated that behavioral intentions to use would have a significant positive influence on actual use of the system. To evaluate this hypothesis behavioral intention to use was regressed on the actual usage figures reported by subjects two months after the initial demonstration of smart phone. The regression results are presented in Table 6. The results of the regression indicated the predictor explained 16.2% of the variance (R^2 = .162, F(1,39) = 7.37, p<.05). It was found that behavioral intention to use significantly predicted actual use (β = .26, p<.05). Consistent with the previous results, behavioural intentions to use appears to have a strong, positive influence on actual usage behaviour; thus, hypothesis 6 is also strongly supported.

Table 6 Regression Test for Hypothesis 6

	Unstandardized Coefficients		Standardized					
	β	Std. Error	Coefficients	t	Sig.	F	Sig.	R^2
BI	.266	.098	.403	2.715	.010	7.372	.010	
								.162

Discussions

In summary, the results from this study indicate that actual use of smart phones for learning is significantly influenced by students' intention to use. The results also show that behavioural intention to use smart phones for learning is largely influenced by users' perceived usefulness and attitude towards the smart phone. Students attitude towards the use of the smart phones are influence by the perceived usefulness and perceived ease of use of the smart phones with perceived usefulness having a greater impact than perceived ease of use.

The study proves that the technology acceptance model provides researchers and practitioners a theoretically sound and parsimonious model suitable to predict users' intention to use its relation to the subsequent actual use of learning objects. As perceived usefulness is found to have a direct impact on attitude and behavioural intention to use, it is deemed to the most significant factor affecting user's acceptance of smart phones in learning environment. The significance of perceived usefulness suggests that initial exposure i.e. the introduction and demonstration of the smart phone would be an important factor to allow students to form initial beliefs.

In addition, this study also found that behavioural intention is a good predictor of the actual use of the smart phone by users. In line with other studies (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989; Mathieson, 1991; Taylor & Todd, 1995; Venkatesh & Davis, 2000), this research has validated that user adoption and usage of smart phone is determined by user's beliefs and attitudes.

There are generally two implications from this study. First, the proposed model can be used as a predictive tool for researchers, instructional designers, and proponents of mobile learning. The results of this study can be used during the conceptual design of

learning objects. The proposed model is also useful as a practical tool to test user acceptance, which would provide early clues to risks of user rejection of the mobile learning system. The knowledge of risks at this stage would enable designers to take preventive measures to ensure user acceptance of the mobile learning system.

Secondly, the results of this study shows that smart phones should be perceived as easy to use and useful for learning process to occur. Hence, introductions to the benefits of using smart phones and demonstration of its relevance to mobile learning should be made to ease the students into accepting the mobile learning system. A training session could also be conducted to allow students to be competent in the use of the smart phone prior to the exposure to the mobile learning system.

Conclusion

This study has validated that TAM can be employed to explain and predict the acceptance of smart phone. In predicting smart phones acceptability among higher education learners, it suggests that early user perceptions and attitudes have a very powerful influence on whether users will actually use learning objects in the future. Perceived ease of use and perceived usefulness were shown to be important to users' perceptions of the smart phones. Therefore, educators and practitioners must consider not only the ease of use of learning objects, but also theirs usefulness in order to promote and encourage end user acceptance of smart phones. In future work, a longitudinal study to investigate the extended TAM in smart phone context to gain more insight about how learners' beliefs and attitudes toward smart phones usage change over time as they experience smart phones usage first-hand.

Appendix:

Questionnaire

Perceived Ease of Use (PEU):

PEU1 Learning to use smart phone would be easy for me.

PEU2 I would find it easy to get a smart phone to do what I want it to do.

PEU3 My interaction with a smart phone would be clear and understandable.

PEU4 I would find smart phone to be flexible to interact with.

PEU5 It would be easy for me to become skilful at using smart phone.

PEU6 I would find smart phone easy to use.

Perceived Usefulness (PU):

PU1 Using smart phone would make me easier to learn.

PU2 Using smart phone would improve my learning performance.

PU3 Using smart phone would enhance my effectiveness of learning.

PU4 Using smart phone would improve my efficiency of learning.

PU5 Using smart phone would give me greater control in learning process.

PU6 I would find smart phone useful for online learning.

Attitude toward use (AT):

AT1 Using the smart phone for learning would be a very good/very bad idea.

AT2 In my opinion it would be very desirable/very undesirable for me to use smart phone.

AT3 It would be much better/much worse for me to use smart phone.

AT4 I like/dislike the idea of using smart phone for learning.

Behavioural Intention to use (BI):

BI1 I intend to use the smart phone whenever possible.

BI2 I intend to increase my use of the smart phone in the future for learning.

BI3 I would adopt the smart phone in the future.

Actual use (AU):

AU1 How frequently do you use smart phone?

AU2 How many times do you use smart phone during a week?

AU3 How many learning objects do you access through smart phone every week?

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