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Students' Acceptance of Tablet PCs and Implications for Educational Institutions

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ABSTRACT

This research develops and empirically tests a factor model for understanding college students' acceptance of Tablet PC (TPC) as a means to forecast, explain, and improve their usage pattern in education. The analysis involved more than 230 students from a regional Midwestern institution. Overall, our model exhibited a good fit with the data and provided satisfactory explanatory power for students' acceptance of TPC in an educational setting. Analysis of the results suggests a number of implications to educational institutions. Most notably are the need for programs aimed at influencing students' attitudes and perceptions towards TPC, creating an environment of a positive image surrounding the use of TPC on campus, and facilitating the use of TPC.

Keywords

Education, Tablet PC, College students, Technology acceptance

Introduction

Tablet PC's extend the mobility provided by laptops by providing the ability to capture handwriting using a magnetic pen. Since the introduction of the first commercial Tablet PC in fall 2002, TPC have been steadily gaining market share with sales expected to reach 14 million by 2009 (Ozok, Benson, Chakraborty, & Norcio, 2008). The portability and ease of note taking made possible by TPC have attracted users from various sectors including healthcare, construction, government, and education.

In education, the application of computer technology in collegiate classroom can improve teaching when used appropriately (Barak, Lipson, & Lerman, 2006). Accordingly, with the proliferation of mobile computing initiatives across campuses, evaluation of such initiatives becomes the logical next step. The evaluation ultimately centers on the students' learning and teaching effectiveness. Yet for such initiatives to improve students' learning and teaching effectiveness, these initiatives must be accepted by students and faculty alike. In that regard, the objective of this research is to understand the factors influencing students' acceptance of TPC as a means to forecast, explain, and improve usage pattern. The research builds on prior technology acceptance research to develop a factor model to assess various factors driving acceptance within the context of students' acceptance of TPC technology. The research contributes to a better understanding of the introduction and management of information technology (IT) based initiatives in education with a particular emphasis on TPC.

The next section provides a brief overview of relevant prior research followed by a detailed depiction of our research model. The research model identifies relevant factors and captures dependency relationships among these factors in the form of a number of hypotheses to be tested in this research. Next, we describe the methodology employed highlighting the study design, data collection, and data analysis. We then summarize the results obtained with respect to measurement validity and model testing results followed by a discussion of implications for educational institutions. We conclude with a summary of research contributions, limitations, and venues for future research.

Related Work

Technology acceptance

The technology acceptance literature documents a rich collection of models and theories that could be used to explain the adoption of information technology innovations (Venkatesh, Davis, & Morris, 2007; Venkatesh, Morris, Davis, & Davis, 2003). With respect to individual (as opposed to organizational) acceptance of technology these models use intention or usage as a dependent variable. Examples of some of the most influential models include the theory of reasoned action (TRA) (Fishbein & Ajzen, 1975); the theory of planned behavior (TPB) (Ajzen, 1991), the technology acceptance model (TAM) (Davis, 1989); along with modifications of these models.

The theory of reasoned action (TRA) (Fishbein & Ajzen, 1975) is anchored in social psychology and particularly in expectancy-value analysis and has been used extensively to study technology acceptance. According to TRA, an individual's acceptance of technology can be explained by his/her intention. This in turn is determined by the individual's positive or negative feelings towards the target behavior (attitude) and the individual's perception that most people who are important to him/her think he/she should exhibit the behavior under consideration (subjective norm). The theory of planned behavior (TPB) (Ajzen, 1991) extends TRA by including perceived behavioral control as an additional determinant of behavioral intention. Perceived behavioral control represents the ease or difficulty of performing the target behavior. Similar to TRA, TPB has been used to predict intention and behavior in a wide variety of setting (Ajzen, 1991).

The technology acceptance model (TAM) is built from TRA and is intended to predict information technology acceptance across diverse technologies, user groups, and organizational contexts. TAM postulates that an individual's acceptance of a technology can be captured by behavioral intention which can be explained by the individual's perception of the usefulness and ease of use of the technology. According to Venkatesh (2008), as of December 2007 there are over 1,700 citations in the Social Science Citation Index and 5,000 citations in Google Scholar to the two journal articles (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989) that introduced TAM. TAM thereby emerged as the most widely employed model for IT adoption and use. Empirical support for TAM has been favorable (Venkatesh, et al., 2007). In a meta-analysis study, King (2006) found that TAM's measures of perceived usefulness, perceived ease of use, and behavioral intent were highly reliable in a variety studies. Both King (2006) and Schepers (2007) agree that perceived usefulness has a higher correlation with acceptance than perceived ease of use.

However, TAM has be criticized for parsimony that hampers its use for guiding systems design and technology management practices that are aimed at enhancing users' acceptance of technology (Hu, 2005). Similar concerns are echoed by Mathieson (1991) and Venkatesh and Davis (1996) indicating that there is a need for a better understanding of key acceptance determinants that allow organizations to devise intervention strategies to improve acceptance of new technology. In that regard, efforts to address the parsimoniousness of TAM included adding key antecedents of perceived usefulness (Venkatesh, 2000), key antecedents of perceived ease of use (Venkatesh, 2000), and integrating key concepts from TPB, TRA, and other relevant theories (Chau & Hu, 2002).

Nevertheless, a review of the literature indicates that TAM has been used as a theoretical underpinning for developing generalized models as well as models targeting specific user acceptance contexts. For example, in an attempt to evaluate and integrate concepts from various models, Venkatesh et al. (2003) conducted a comparison of eight models and their extensions to propose a unified theory of acceptance and use of technology (UTAUT). In this model, performance expectancy (perceived usefulness), effort expectancy (perceived ease of use), social influence, and facilitating conditions are key determinants of user intention and usage behavior. Overall, the results indicate that TAM and its extensions compared favorably to other models with three constructs of TAM (and its extensions) being part of the proposed UTAUT model.

Technology acceptance in education

In education, the use of technology acceptance prediction models to study technology acceptance situations would be a useful tool for understanding and managing technology initiatives. Examples of such studies include Gao (2005) who states that "technology acceptance models can serve the purpose of evaluating competing products such as text books and technology systems" and provide a valuable tool to educators. TAM has also been used to examine students' perception of usage, usefulness, and ease of use of web-enhanced instruction (WEI) using Blackboard (Landry, Griffeth, & Hartman, 2006). Moreover, Davis and Wong (2007) use TAM and the flow model to develop an integrated perspective to analyze students' participation and engagement with an eLearning system. Also in the context of eLearning, Saadé (2007) proposes and demonstrates the utility of an expanded TAM to distinguish between the influences of the three proposed dimensions of perceived usefulness, namely, performance-related outcome expectations, personal-related outcome expectations while Kiraz and Ozdemir (2006) incorporates TAM constructs with six different educational ideologies and conclude that different educational ideologies may have different effects on teachers' technology acceptance. Gong et al. (2004) recognize the increasingly important role of information technology in modern education and proposes a framework comprised of a combination of TAM and social cognitive theory (SCT) to evaluate IT acceptance by teachers. Meso and Liegle (2005) uses TAM to assess the suitability and fit of .NET, as a pedagogical tool for teaching a technical information system (IS) course. The study suggests the effectiveness of the technology acceptance theory as an approach for assessing the pedagogical fit and suitability of specific IT for teaching specific IS courses.

With respect to the TPC, Anderson et al. (2006) evaluate faculty acceptance of TPC using the Unified Theory of Acceptance and Use of Technology (UTAUT). Their findings suggest that performance expectancy and voluntariness are the most salient drivers of acceptance for business faculty. Others have underscored the potential for TPC to allow faculty to focus more on the students (Lindsey, 2003). In another study, Anderson (2007) proposes a distributed system that leverages TPC in the classroom to facilitate sharing of digital ink on electronic slides. The purpose is to enhance students' engagement in class. Moreover, Weitz et al. (2006) evaluates the usefulness of TPC for faculty in the context of a pilot study. The results indicate that while participating faculty were convinced of the potential of TPC to meaningfully impact learning, overall, only a fraction were motivated to use the TPC and only one third opted for replacing their notebook with a TPC. In a corporate setting, Garfield (2005) reports on acceptance of the Tablet PC. The study identifies a number advantages and disadvantages related to the use of TPC. Most notable advantages were the ability to multi-task, increased information accessibility, and improved image (as a tech-savvy organization). Disadvantages includes challenges with data input (difficulty with using the stylus), and potential for intimidation (possibly due to fear of being recorded) (Garfield, 2005).

Despite the proliferation of TPC in education and the richness of the technology acceptance literature, the literature is limited when it comes to understanding general students' acceptance of Tablet PC in an education context. It is the objective of this study to examine the factors influencing students' acceptance with an emphasis on the implications for educational institutions.

The Research Model and Hypotheses

Figure 1 depicts the research model. The model leverages TAM, TRA, TPB, and UTAUT as a theoretical foundation and incorporates important factors pertaining to the target technology, user group, and organizational context. Following Chau and Hu (2002), our research model hypothesizes that students' acceptance of TPC can be explained by a number of factors which can be organized into technological, individual, and organizational factors.

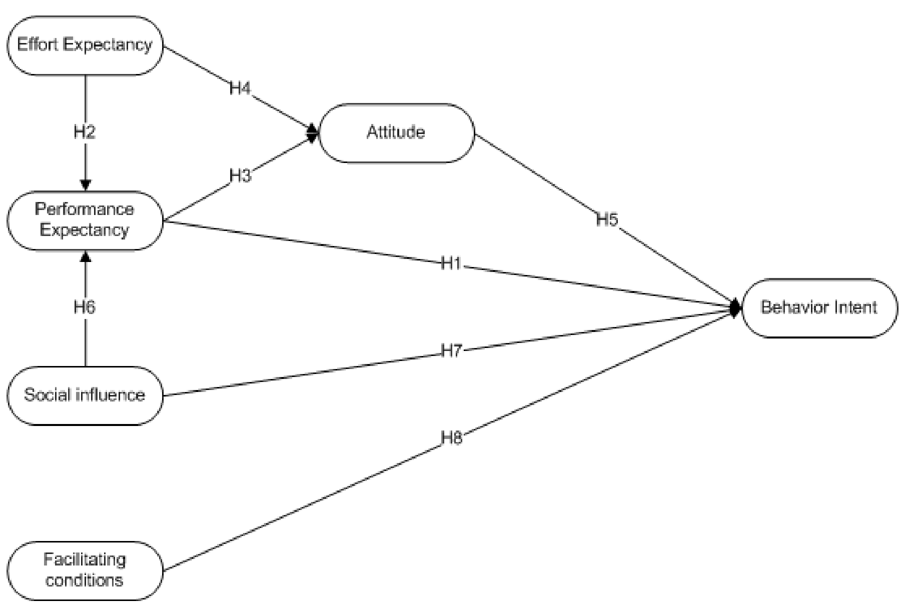

Figure 1: The research model

With respect to technological factors, the research model identifies performance expectancy (PE), and effort expectancy (EE) as key factors. In this study, performance expectancy refers to the degree to which a student believes that using the TPC will help her improve her performance in school, i.e., consider the TPC to be useful. On the other hand, effort expectancy refers to the degree of ease associated with the use of TPC, i.e., the degree to which a student considers the use of TPC to be free of effort. Consistent with TAM and UTAUT, the model suggests that performance expectancy is a key determinant affecting students' acceptance of TPC. Consistent with TAM, performance expectancy and effort expectancy are intrinsically related. Specifically, a student's perception of performance expectancy is positively influenced by his or her perceptions of effort expectancy. Therefore, we tested the following hypothesis:

> H1: The degree to which a student believes that TPC will help him or her to attain gains in school performance (Performance expectancy) has a positive effect on his/her intention to use TPC.
>
> H2: The degree of ease of use (Effort expectancy) associated with the use of TPC as perceived by a student has a positive effect on the degree to which a student believes that TPC will help him or her to attain gains in school performance.

The model identifies students' attitude towards TPC as a critical determinant of their acceptance of the technology. In this study, attitude reflects a student's feelings of favorableness or unfavorableness towards using TPC. In effect, according to TAM, TRA, and TPB, individuals with a positive attitude towards a technology are more likely to accept a technology than those not showing such an attitude. However, Venkatesh et al. (2003) indicate that attitude represents an interesting case where it has shown to be a significant determinant of acceptance in some studies while not being significant in other studies. The study further attributes the results to a possible relationship between attitude on one side and performance expectancy and effort expectancy on the other. The explanation is based on the observation that attitude seems to be significant only when specific cognitions such as performance and effort expectancies are not included in the model. Nevertheless, in a recent quantitative meta-analysis of previous research on TAM, Schepers and Wetzels (2007) confirm the TAM relationships (including the mediating role of attitude as a determinant of behavioral intention. Accordingly, and given the considerable autonomy of students, our model retains attitude together with performance and effort expectancy resulting in the following hypothesis:

> H3: The degree to which a student believes that TPC will help him or her to attain gains in school performance has a positive effect on his/her attitude towards TPC.
>
> H4: The degree of ease of use (Effort expectancy) associated with the use of TPC as perceived by a student has a positive effect on his/her attitude towards TPC.
>
> H5: The attitude of a student towards TPC has a positive effect on his/her intention to accept TPC.

Organizational factors captured in the model include social influence and facilitating conditions. In this model social influence refers to the degree to which a student perceives that important others such as faculty, advisors, and peers believe he or she should use TPC. In this model, we hypothesize that social influence will have a positive and significant effect on both performance expectancy and intention to accept the technology resulting in the following hypothesis:

> H6: A student's perception of the usefulness of TPC (performance expectancy) will be positively influenced by his or her perception on how important others perceive them having used the technology (social influence).
>
> H7: A student's acceptance of TPC will be positively influenced by his or her perception on how important others perceive them having used the technology (social influence).

Facilitating conditions are the degree to which a student believes that an organizational and technical infrastructure exists to support his or her use of TPC. According to Ajzen (1991), perceived behavioral control involves internal factors such as self-efficacy, as well as external conditions such as facilitating conditions. Taylor and Todd (1995) further demonstrate the role of external aspects of perceived behavioral control while Venkatesh (2000) highlight the importance of resource availability in user acceptance. In the context of this study, we hypothesize that facilitating conditions such as the TPC help desk, computing services TPC support center, and user training would play a positive role in students' acceptance of TPC. In effect, we tested the following hypothesis:

> H8: A student's acceptance of TPC will be positively influenced the availability and access to support mechanisms (facilitating conditions).

Methodology

Participants

The study is conducted at a Midwest public university which has implemented a Tablet PC computing initiative. By the spring of 2006 all students at this university had their own TPC. As a relatively early adopter of the TPC technology and with the pervasiveness of TPC on the campus, the institution provides an environment for studying students' adoption of TPC. The participant pool consists of 360 students enrolled in courses in a college of business and information systems. All participants have a TPC and used the device in classroom environments. The length of use varied among participants.

Instrument

The survey instrument is based on technology acceptance constructs validated in prior research (Davis, Bagozzi, & Warshaw, 1992; Venkatesh, et al., 2003) and adapted to the context of this study. The variables measured include; performance expectancy, effort expectancy, social influence, facilitating conditions, behavioral intent, and usage. The survey instrument collected additional information such as gender, age, and major. All questionnaire items were measured using a 7-point Likert scale ranging from "strongly agree" to "strongly disagree".

Data collection

The survey instrument was delivered using the Web to ease participation and data acquisition. All participants were enrolled in courses on-campus and used the Tablet devices to take the survey. The survey was conducted during normal class sessions during the last ten minutes of class.

Data analysis

The statistical analysis method used for this study was partial least squares (PLS), a second generation statistical technique for conducting structural equation modeling (SEM) based analysis. The utility of PLS is detailed elsewhere (Falk & Miller, 1992). With respect to technology acceptance, a number of recent studies utilized PLS including (but not limited to) (Al-Gahtani, 2001; Hu, 2005; Venkatesh, et al., 2003).

PLS allows for evaluating the psychometric properties of the scales (indicators) used to measure a variable (construct) (the measurement model), and the estimation of the direction and strength of the relationships among the model variables (the structural model). In effect, PLS includes two sets of equations: the measurement model (outer model) comprised of equations representing the relationships between indicators and the variable they measure, and the structural model (inner model) comprised of equations representing the paths among variable (constructs). PLS calculates weights and loading factors for each item in relation to the construct it was intended to measure. The weights calculated by PLS are used to calculate latent variable scores for the constructs, which reflect the contribution of each variable to its construct.

Evaluating the measurement model includes estimating the internal consistency for each block of indicators and evaluating construct validity. Internal consistency is evaluated using composite reliability (CR) and the average variance extracted (AVE). Both CR and AVE are calculated using the loading factors for each item in relation to the construct it was intended to measure (Chin, 1998). Compared to Cronbach's alpha, CR does not assume that all indicators are equally weighted thereby providing a closer approximation when the parameters are accurate. Cronbach's alpha tends to be a lower bound estimate of reliability (Chin, 1998). Nunnally's (1978) guidelines were used to evaluate the composite reliability obtained for each variable. According to Fornell (1981) AVE should be greater than 0.5 indicating that 50% of the amount of variance in an item that its corresponding variable explains relative to the amount due to measurement error (Chin, 1998).

Construct validity refers to the degree which a variable measures what it was intended to measure (Cronbach, 1951). Construct validity is comprised of convergent and discriminate validity. Convergent validity is degree which similar constructs are related; while discriminate validity is the degree that different constructs are different from each other. Following Gefen and Straub (2005) convergent validity of the variables is evaluated by examining the t-values of the outer model loadings. A t-value greater than 1.96 indicates that the particular indicator is explained by the linear regression of its variable and its measurement error (Gefen & Straub, 2005). Discriminate validity is the degree to which any single construct is different from the other constructs in the model. Discriminate validity is evaluated by examining item loadings to variable correlations and by examining the ratio of the square root of the AVE of each variable to the correlations of this construct to all other variables (Chin, 1998; Gefen & Straub, 2005).

For the structural model, path coefficients are interpreted as regression coefficients with the t-statistic calculated using bootstrapping (200 samples), a nonparametric technique for estimating the precision of the PLS estimates (Chin, 1998). To determine how well the model fits the hypothesized relationship PLS calculates an R^2 for each dependent construct in the model. R^2 represents the proportion of variance in the endogenous constructs which can be explained by the antecedents (Chin, 1998). The tool used for the analysis was PLS Graph.

Results

Sample size and characteristics

According to Cohen (1988) a sample of at least 175 participants would be needed to achieve 95% confidence. One of the benefits of using PLS-Graph is that it can resample the initial data set, effectively enlarging it and thus reducing overall sample requirements. Guidelines provided with PLS-Graph recommend a sample size equal to the larger of two possibilities: (1) ten times the number of indicators on the most formative construct, in this study ten times the ten indicators of performance expectancy or one hundred participants, or (2) ten times the largest number of antecedent constructs used to determine a dependent variable, in this study ten times six, the number of constructs used to determine behavior intent.

Data was collected from students in all the sections of courses thought to be most likely enrolled in by students in their first year of TPC use. The available participant pool was about 360 individuals enrolled in the selected courses. Several survey submissions were disqualified due to incomplete submissions. Overall, a total of 232 (n=232) usable responses were included in data analysis representing 64% of the participant pool and exceeding the required sample size.. The general demographics of the survey participants are illustrated in Table 1.

Table 1: Survey Sample Characteristics

Participant's demographics	Number	Percent
Number of participants	232	
Average age	22	
Gender		
Male	129	56
Female	98	42
NA	5	2
Class placement		
Freshman	112	48
Sophomore	59	25
Junior	45	20
Senior	16	7
College major		
Arts & Sciences	56	24
Business& Info Sys	103	44
Education.	56	24
Other	17	8
First use of computers		
Elementary	87	38
Middle	78	33

High	35	15
College	32	14
Tablet PC period of use		
Up to 3 Months	36	16
3 to 6 Months	84	36
6 to 9 Months	40	17
12 Months	8	3
>12 Months	64	28

Based on tests of univariate normality (Anderson-Darling test) none of the variables in this study were normally distributed. This phenomenon is similar to other studies of technology acceptance (van der Heijden, 2004). Nevertheless, the use of partial least squares (PLS) for data analysis is appropriate for this study because of its ability to model latent constructs under non-normal conditions (Cohen, 1988). Table 2 summarizes survey responses for each construct item. The calculated values are from PLS Graph (Chin, 1999).

Table 2: Construct item values and standard deviation

Construct Item Calculated Construct	Measured Value	Calculated Value	Standard Deviation
PE1	5.85		1.07
PE3	5.46		1.17
PE5	5.91		1.07
PE10	5.83		1.03
Performance Expectancy		5.75	0.89
EE1	5.98		1.06
EE2	5.78		1.06
EE3	5.85		0.99
EE4	5.77		1.03
EE5	5.94		0.97
EE6	6.03		0.95
Effort Expectancy		5.88	0.87
SI1	4.78		1.20
SI2	4.76		1.23
SI3	5.62		1.01
SI4	5.19		1.21
Social Influence		5.12	0.90
FC1	5.99		0.94
FC2	6.08		0.76
FC5	5.74		1.20
Facilitating Conditions		5.90	0.83
BI1	5.69		1.16
BI3	6.09		1.07
BI4	5.97		1.06
BI5	5.90		1.11
Behavioral Intent		5.89	0.83
ATUT1	5.80		1.05
ATUT 3	5.69		0.94
ATUT4	5.39		1.24
ATUT5	5.78		1.14
Attitude		5.67	1.13

Analysis of measurement validity

While most questions items have been validated elsewhere in the literature (Venkatesh, et al., 2003), we follow the recommendation of Straub (1989) and re-examine the survey instrument in terms of reliability and construct validity. The original thirty four variables initially included in the survey instrument were analyzed in PLS-Graph, resulting in ten items with loading less than .70, a threshold level considered generally acceptable (Fornell & Larcker, 1981). Following the recommendations by (Hair, Tatham, Anderson, & Black, 1998), items with low loading are deleted. The process is continued until no item loading is less than 0.7. Examination of the remaining items revealed that they adequately represent the underlying construct attesting to the content validity of the instrument. Table 3 summarizes the results for the items comprising the model.

Table 3: Individual Loadings, Weights, composite reliabilities (CR) and AVE

Construct	Items	Item Loading	Construct CR	Construct AVE
Performance Expectancy	PE1	0.7818	0.882	0.652
	PE3	0.8039		
	PE5	0.7758		
	PE10	0.8436		
Effort Expectancy	EE1	0.8259	0.946	0.744
	EE2	0.9037		
	EE3	0.9077		
	EE4	0.8672		
	EE5	0.8362		
	EE6	0.8388		
Social Influence	SI1	0.7632	0.857	0.6
	SI2	0.8103		
	SI3	0.7984		
	SI4	0.7075		
Facilitating Conditions	FC1	0.8376	0.85	0.654
	FC2	0.7634		
	FC5	0.8114		
Behavioral Intention	BI1	0.8479	0.922	0.749
	BI3	0.7858		
	BI4	0.8983		
	BI5	0.9133		
Attitude	ATUT1	0.8223	0.887	0.614
	ATUT 3	0.8401		
	ATUT4	0.7575		
	ATUT5	0.8431		

The results show composite reliability (CR) exceeding 0.8 as recommended by Nunnally (1978). AVE which can also be considered as a measure of reliability exceeds 0.5 as recommended by (Fornell & Larcker, 1981). Together CR and AVE attest to the reliability of the survey instrument. The t-values of the outer model loadings exceed 1.96 verifying the convergent validity of the instrument (Gefen & Straub, 2005). Calculating the correlation between variables' component scores and individual items confirmed that intra-variable (construct) item correlations are very high compared to inter-variable (construct) item correlations attesting to the discriminate validity of the instrument. In addition, discriminate validity is confirmed if the diagonal elements (representing the square root of AVE) are significantly higher than the off-diagonal values (representing correlations between constructs) in the corresponding rows and columns (Chin, 1998). As shown in Table 4 the instrument demonstrates adequate discriminate validity as the diagonal values are greater than the corresponding correlation values in the adjoining columns and rows. Overall, the instrument has achieved an acceptable level of reliability and construct validity.

Table 4: AVE Scores and Correlation of Latent Variables

	PE	EE	SI	BI	FC	ATUT
PE	**0.807**					
EE	0.343	**0.863**				
SI	0.343	0.338	**0.775**			
BI	0.521	0.464	0.513	**0.865**		
FC	0.476	0.669	0.565	0.661	**0.809**	
ATUT	0.536	0.501	0.524	0.724	0.624	**0.784**

Model testing results

Figure 2 depicts the structural model showing path coefficients and R^2 for dependent variables.

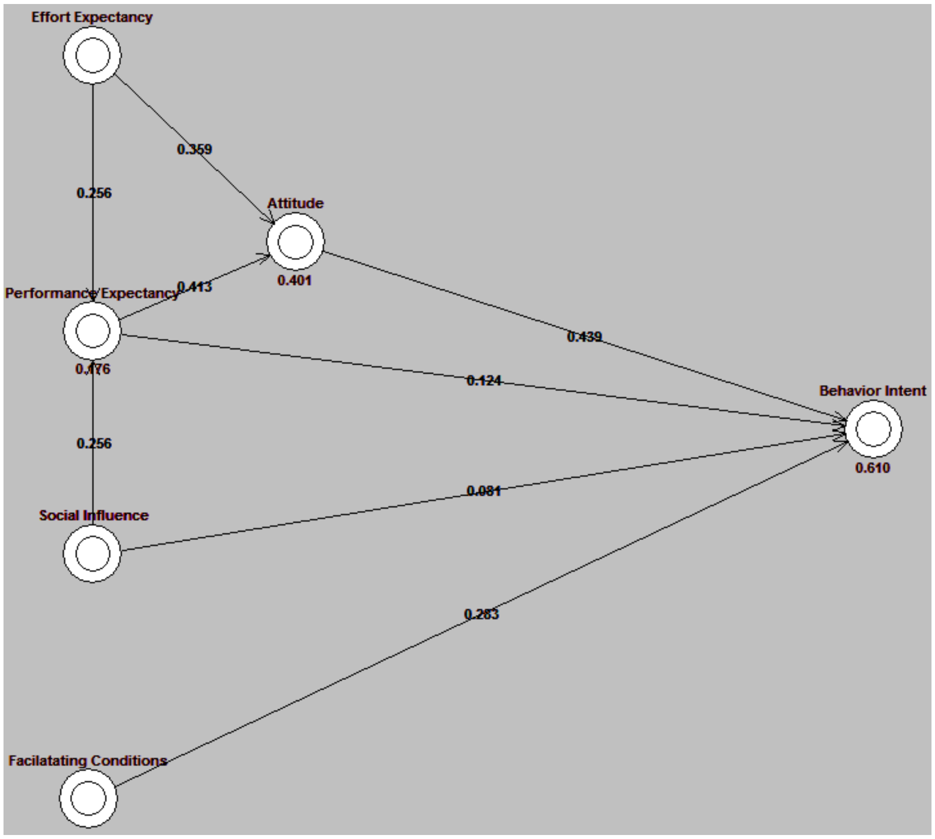

Figure 2. Tablet PC structural model testing results

The R^2 values for each dependent variable indicate that the model was able to account for 17.6% of the variance in performance expectancy, 40.1% of the variance in attitude, and 60% of the variance in behavioral intention. Bootstrap method was used in PLS-Graph to assess the statistical significance of the path coefficients (which have similar interpretation to standardized Beta values in regression analysis). Consistent with hypothesis 1 (H1), the degree to which a student believes that TPC will help him or her to attain gains in school performance (performance expectancy) has a positive effect on his or her intention to use intention to use TPC (β=0.124, p<0.001). Similarly, the degree of ease associated with the use of TPC as perceived by a student has a positive effect on his or her perceived usefulness of TPC consistent with hypothesis 2 (H2) with (β=0.256, p<0.001). Hypothesis 3 (H3) is also confirmed with the degree to which a student believes that TPC will help him or her to attain gains in school performance has a positive effect on his/her attitude towards TPC with (β=0.413, p<0.001). Consistent with hypothesis 4 (H4), the degree of ease of use (Effort expectancy) associated with the use of TPC as perceived by a student has a positive effect on his/her attitude towards TPC with (β=0.359, p<0.001). Similar to H1 and consistent with hypothesis 5 (H5), attitude of a student towards TPC has a positive effect on his/her intention to accept TPC with (β=0.439, p<0.001). Social influence has also proven to be a significant determinant. Consistent with hypothesis 6 (H6) and hypothesis 7 (H7), the degree by which a student perceive the importance of how significant others (such as peers and faculty) perceive him or her using the technology positively influence his or her perception of the usefulness of TPC (performance expectancy) with (β=0.256, p<0.01) and his or her acceptance of TPC with (β=0.081, p<0.05). Consistent with hypothesis 8 (H8), the availability and access to support mechanisms (facilitating conditions) positively influence students' acceptance of TPC with (β=0.281, p<0.01). Overall, all structural relationships depicted in the research model are significant.

Discussion

With the proliferation of various forms of technology across educational institutions, our analysis suggests a number of findings that is of particular relevance to research and technology management in educational settings. With respect to key determinants of TPC acceptance, students' attitude has the most direct influence followed by facilitating conditions, performance expectancy, and social influence. When considering direct and indirect influence, students' attitude still exhibits the most influence on TPC acceptance followed by performance expectancy, facilitating conditions, effort expectancy, and social influence (Table 5).

Table 5: Direct and indirect effect of factors predicting performance expectancy, attitude, and behavior intention

	Performance expectancy (PE)			Attitude (ATUT)			TPC acceptance		
	D	I	T	D	I	T	D	I	T
EE	0.256		0.256	0.359	0.106	0.465		0.236	0.236
PE				0.413		0.413	0.124	0.181	0.305
SI	0.256		0.256				0.081	0.078	0.159
ATUT							0.439		0.439
FC							0.283		0.283

*: 'D' denoted direct effect, 'I' denotes indirect effect, and 'T' denotes total effect

While the results are not consistent with other technology acceptance findings in which performance expectancy seems to have the most influence driving technology acceptance (Schepers & Wetzels, 2007), the results emphasize the importance of managing students' attitude towards the technology.

Accordingly, it is paramount for administrators, technology officers, and project champion to have a better understanding of factors affecting attitude and develop programs for positively influencing students' attitude towards TPC. In this vein, our results suggest a prominent influence of performance expectancy and effort expectancy on students' attitude towards TPC. In effect, students' perception on the extent TPC will improve their productivity and on the degree by which TPC is easy to use (user-friendly) will positively affect their attitude towards TPC. Programs aiming at positively influencing students' attitude (and thus acceptance) should target performance and effort expectancy.

Insofar, it is evident that while performance expectancy is not the most prominent direct driver for acceptance, it continues to play an important role directly and indirectly (through attitude) affecting students acceptance of TPC. In effect, performance expectancy does not play a prominent role as in other studies with other user groups such as law enforcement officers where efficiency gains and perceived usefulness are the single most important acceptance drivers (Hu, 2005). Further analyzing the factors affecting performance expectancy, our model and associated results suggest effort expectancy and social influence as significant determinants of performance expectancy. In effect, students' perception of the degree of ease associated with using TPC has a positive influence on their perception of TPC usefulness. This relation further underscores the importance of developing programs for managing students' effort expectancy as highlighted earlier. Moreover, students' perception on how others believe they should use TPC has a similar positive effect on their perception of TPC usefulness. The latter result emphasizes the importance of cultivating a positive environment surrounding the use of TPC.

It is interesting to note that despite social influence being a determinant of performance expectancy, it has the least significant direct effect on TPC acceptance. This suggests that social influence's significant and positive effect on TPC acceptance is mediated by other factors such as performance expectancy. In effect, students' assessment of the usefulness of TPC will likely take into account the perception of 'significant' others. However, such perception may have a less direct influence on their acceptance of the technology. This is consistent with other research findings (Venkatesh, 2000; Venkatesh, et al., 2003) for mandatory adoption as well as the findings reported in the meta-literature analysis (Schepers & Wetzels, 2007). It is important to consider that even when the users perceive the system as organizationally mandated, intention to use the system may vary as some users may be unwilling to comply with the mandate (Hartwick & Barki, 1994; Venkatesh & Davis, 2000). Accordingly, the results indicate that "internalization effect" – representing the human's tendency to interpret information from significant others as evidence about reality – is stronger than the "compliance effect" – representing the willingness of people to choose to perform an action when an important referral indicate they should. While, the significance of the "compliance effect" is expected in the mandatory setting of this study, the prominence of the "internalization effect" further highlights the importance of programs shaping the social context of TPC roll out as noted earlier. However, our results differ when time is taken into consideration. While earlier results support declining effort of social influence with experience, the results of this study indicate that even with experienced users (more than 80% of respondents have been using TPC for more than 6 months), social influence continues to influence behavior. The results suggest that students as a user group are more susceptible to social influence over time.

Consistent with prior research (Agarwal & Prasad, 1997; Davis, 1989; Venkatesh, et al., 2003) effort expectancy is also a significant determinant of students' acceptance of TPC (though through indirect effect through attitude and performance expectancy). However, the results suggest that the degree of ease associated with using TPC as perceived by students continues to play a major role in influencing student intention to continue to use the technology even after 80% have been using TPC for more than 6 months. The primary implication of this result is the need to continue to ensure that students continue to perceive TPC as easy to use. One approach, is for the continuous support/training beyond the initial adoption period (which is normally up to 6 months).

It is worth noting the significant and positive effect of facilitating conditions on students' acceptance of TPC acceptance. Initiatives such as help desks and dedicated technology support services are certainly recommended as means for facilitating the use and thus students' acceptance of TPC.

Conclusion

In this study, we employ a variation of the technology acceptance model to assess the influence of various factors driving the acceptance of TPC by college students. Overall, our model exhibited a good fit with the data and provided a satisfactory explanatory power for students' acceptance of TPC in an educational setting. Analysis of the results suggests a number of implications to educational institutions. In effect, institutions wishing to engage in TPC initiatives need to:

- Engage in programs aimed at influencing students' attitudes and perceptions towards TPC. Such programs should emphasize the utility of TPC to students (for school and personal use) as well as the user-friendliness of TPC.
- Create and sustain an environment of a positive image surrounding the use of TPC on campus as the results suggest that students' as a user group are more susceptible to social influence over time.
- Institute support mechanisms such as help desks, user groups, and online support sites to facilitate the use of TPC and respond to students' questions and concerns regarding the effective use of the technology.

We believe this study has both theoretical and practical contributions. With the proliferation of technology-based initiatives in education, studies analyzing the adoption of such initiatives complement existing attempts to evaluate students' learning and teaching effectiveness. Specifically, evaluating the adoption of such IT-based initiatives in education provide insight regarding the factors behind the success or failure (measured in students' learning and teaching effectiveness) of such initiatives. Based on the findings of this study, we can identify factors that induce students to adopt (buy-into) such initiative. Such insight can be used for diagnostic purposes and for the planning and management for technology-based initiatives in education. From a theoretical perspective, the research will add to the literature dealing with mandatory adoption of technical innovations. The research also contributes to the general adoption literature by studying the theoretical validity and empirical applicability of the TAM model.

Future research will need to address the limitations of this study. First, effort expectancy and social influence seem to exhibit influence that extends in time (more than 80% of the respondents have been using the TPC for more than 6 months). Further research is needed to assess the influence of these determinants over time and the causes for such extended influence over TPC acceptance compared to other determinants. As emphasized by Karahanna et al. (1999), an individual's beliefs and attitudes towards technology or cognitive assessment is likely to evolve dynamically over time. Second, with the prominence of students' attitude as a determinant of students' acceptance of TPC, we suggest further research into the role of different types of attitude. As Yang and Yoo (2004) advocates, "attitude deserves more attention in IS research for its considerable influence on individual and organizational usage of IS". Third, in this study, we employed a quantitative model to assess the influence of various factors on TPC acceptance. A case study approach would complement the analysis presented in this research and provide useful and insightful information to TPC implementation initiative.

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