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TABLET PERSONAL COMPUTER INTEGRATION IN HIGHER EDUCATION: APPLYING THE UNIFIED THEORY OF ACCEPTANCE AND USE TECHNOLOGY MODEL TO UNDERSTAND SUPPORTING FACTORS

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ABSTRACT

Many educational institutions have implemented ubiquitous or required laptop, notebook, or tablet personal computing programs for their students. Yet, limited evidence exists to validate integration and acceptance of the technology among student populations. This research examines student acceptance of mobile computing devices using a modification of the "Unified Theory of Acceptance and Use of Technology" (UTAUT) recently developed by leading researchers in the technology acceptance field. The objective of the study is to identify the variance of selected acceptance elements that contribute to the overall behavioral intent to use Tablet PCs (TPC). These outcomes are then used as a means to forecast, explain, and improve integration of the technology in the higher education context. The research also contributes to UTAUT's theoretical validity and empirical applicability and to the management of information technology (IT) based initiatives in education.

Technology has a ubiquitous presence in educational institutions across the United States. Higher education has been particularly aggressive in acquiring mobile technology, some institutions even adopting computing initiatives that require every student to own their own computing device. Hundreds of higher education

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and K-12 institutions are involved in various levels of mobile computing implementation (Brown, 2009). These technological implementations have required re-engineering network topologies and overhauling the data communication facilities. Many of these institutions have decided to adopt specialized devices of notebook computers that allow pen-based data entry and screen manipulation.

In an analysis of institutions migrating to the wireless, mobile environment, Penuel (Penuel, 2006) found one or more of four primary motivations driving decisions to integrate mobile computing into the instructional environment:

1. to improve academic success;
2. to increase equity of access of digital resources;
3. to increase a region's economic competitiveness by preparing students to effectively use technology in the workplace; and
4. to effect a transformation in the quality of instruction.

Other research has also suggested the application of computer technology in collegiate classrooms improves teaching when integrated appropriately (Surry & Land, 2000).

Terms have been assigned to technology integration ranging from using technology to make learning more efficient or effective (Newby, Stepich, Lehman, & Russell, 2006; Roblyer & Edwards, 2001) to the use of technology for problem-solving (Ertmer, 2005; Jonassen, Howland, Moore, & Marra, 2003). For the purpose of this study, we will describe technology integration as a sustained and persistent change in a social system instigated by the "acceptance" of the technology (Rogers, 1983). Acceptance and subsequent use of the technology to support student learning is premised by professed beliefs which lead to intentions followed by planned behavior. In using a modification of the "Unified Theory of Acceptance and Use of Technology" (UTAUT) model, the study will analyze acceptance of tablet computers (TPC) in a small upper Midwestern university. The primary constructs of the instrument are performance expectancy, effort expectancy, social influence, and facilitating conditions. Other research variables include self-efficacy, attitude toward using technology, and anxiety. This study specifically examines the adoption of tablet personal computers (TPC), but the majority of the questions asked address the more generic mobile computing with only use questions specifically addressed toward TPCs.

To establish a rationale for the interest in mobile computing among educational institutions, a brief review of the nature and impacts to date of mobile computing is presented, followed by a presentation of the theoretical foundations of technology use prediction by behavior is reviewed. Data is then presented that reveals the level and rate of technological buy-in (integration) at this campus in order to identify the aspects of the environment that most contribute to the adoption process and the support structures (social, environmental, etc.) that facilitate this process. Finally, we consider in a concluding section, future directions for inquiry on one-to-one computing initiatives.

MOBILE COMPUTING

Marc Weiser, a researcher at the Palo Alto Research Center (PARC) near Sanford University, proposed three waves of computing on campus, the first being mainframes, the second being networked personal computers, and a third where digital technology is so integrated into campus activities that it would be invisible (Weiser, 1998). Weiser entitled this third wave as ubiquitous computing. Several terms are applied to the concept of ubiquitous computing: mobile computing, one-to-one computing, wireless computing, and m-learning. These descriptors and others attempt to give identity to the idea that every student has full-time access to a computer, the Internet, and other resources that allow them to work anytime anywhere with the technology. Whatever it's called, it clearly reflects more than having a computer. It reflects a learning environment where all students have access to a variety of digital devices and services. More than the "one-to-one" conception of use, mobile computing reflects the "many to many" idea of technology use. Specifically, learning in a mobile computing environment

> . . . includes the idea of technology being always available, but not itself the focus of learning. Moreover, our definition includes the idea that both teachers and students are active participants in the learning process, who critically analyze information, create new knowledge in a variety of ways (both collaboratively and individually), communicate what they have learned, and choose which tools are appropriate for a particular task. (Research Center for Educational Technology, 2008)

A number of key developments have converged to hasten the movement of computing from fixed to mobile status. Those developments include: advances in micro- and nano-technology; universal Internet access; wireless networking systems on multiple standards; decreasing costs; and educational priorities that recognize technology's importance in helping learners adapt 21st century skills. Not only are universities, colleges, and other institutions of higher education initiating mobile computing initiatives, but states and districts are making even bigger investments to make mobile computing environments out of middle and high schools.

As mobile computing devices have entered schools, understanding their impact on student learning is an evolving work upon which a body of literature is emerging (Penuel, Kim, Michalchik, Lewis, Means, & Murphy, 2001). The availability of Internet resources, and the application of tools such as online simulations, applets, pod casting, wikis, blogs, and other means of gathering and using information are promoted as ways to allow students to construct and manipulate knowledge while encouraging teachers to modify their instructional methods. However, understanding the behaviors of students and teachers that lead to improved interactions with each other and with networked resources can be a complex task to undertake.

From research on mobile computing in both secondary and higher education contexts, benefits supporting the adaption of mobile computing environments include the availability of digital tools such as databases, scientific probes, spreadsheets, and calculators to encourage higher level thinking (van't Hooft & Swan, 2007). Mobile computing environments appear to be more student-centered (Norris & Soloway, 2004; Swan, van't Hooft, Kratcoski, & Unger, 2005). Research shows that constructivist teaching practices are more prevalent (Cambre & Hawkes, 2004; Rockman, 2003; Swan et al, 2006). Attendance rates improve and disciplinary referrals decline (Knezek & Christensen, 2005; Zucker & McGhee, 2005). Student attitudes toward school improve (Lane, 2003; Mouza, 2006). And, the use of project-based and inquiry-based lessons increase with the use of ubiquitous computers (Norris & Soloway, 2004; Swan et al., 2005).

Outcomes of mobile computing suggest direct impacts on student learning. In a university study of tablet computers in the classroom, researchers targeted student assessment outcomes using a pre/post intervention design (Hategekimana, Hawkes, El-Gayar, & Christoph, 2005). The researchers compared classroom assessment scores for students not participating in a Tablet PC environment to the scores of students in the following semester participating in a Tablet PC environment in five general education courses (Algebra, Composition, Information Systems, World Civilization, and U.S. History). Where all instructional components of the course were kept consistent from semester to semester, except the introduction of a student-leased Tablet PC, the math course was the only one of the five courses found to have shown a significant positive difference using a two sample, unpaired *t*-test (analysis of variance was performed in cases where more than two sections of a course were involved).

Another area of the impact of one-to-one computing has been improvements in technology literacy (Lowther, Ross, & Morrison, 2003). In a study of effects of laptop use among high school students in Germany, Schaumburg (2001) found that students had greater knowledge than their non-laptop program counterparts on hardware networks and operating systems, productivity tools, Internet navigation, and computer security. Because of the frequency of use of computers at school and at home in one-to-one programs, positive effects on student writing have been realized (Jaillet, 2004; Light, McDermott, & Honey, 2002; Trimmel & Bachmann, 2004). Study of an experimental middle school laptop program in Maine found a positive effect size on a statewide test for 8th grade students of science in nine demonstration schools versus 214 schools serving as the control group. Another study examining the effects of mobile computing on state achievement test scores in California found results for writing yielded clear, positive effects (Gulek & Demirtas, 2005). The institution upon which this study is based implemented a Wireless Mobile Computing Initiative (WMCI) where all full-time freshmen and sophomores were provided with a tablet/notebook wireless computing device starting in 2004 (Dakota State University (DSU), 2005). Faculty could apply for course redesign grants to modify their courses to take advantage of this new technology. This program placed approximately 500 TPCs into the hands of students with another 300 being added in years 3 and 4. The result is the availability of over 1000 computers to the students who, before the initiative, had access to fewer than 300 desktop computers in teaching laboratories. After the completion and maintenance of the initiative, students continued to have access to about 100 specialized desktop computers in teaching laboratories dedicated to graphics arts, information assurance, and other disciplines. The WMCI provides for integration of tablet technology across the disciplines of business, education, and science. In addition, a campus wide course management system was integrated after the initial stages of the program.

THE ADOPTION OF TECHNOLOGICAL INNOVATIONS

While the previous discussion shows positive effects of mobile computing in pockets of use, results are sporadic and even inconsistent. The lack of quality professional development, school policies that fail to support mobile technology use, instructors' beliefs about the role of technology in the curriculum, and cultures that are just not supportive of mobile computing adoption have made the integration of mobile initiatives problematic in U.S. schools and universities. Many researchers and authors conclude from their experience that technology integration of any kind has been sparsely achieved, if at all (Bauer & Kenton, 2005; Bolick, Berson, Friedman, & Porfeli, 2007; Er & Kay, 2005; Franklin & Molebash, 2007; Hew & Brush, 2007; Lawless & Pellegrino, 2007). Other researchers believe that technology integration has been achieved more in some segments of industry and society than others (Drucker, 2006; Hughes & Ooms, 2004; Judge, Puckett, & Cabuk, 2004; Swain & Pearson, 2003).

These and other claims about the acceptance of technologies are usually based on various models explaining the adoption of information technology innovations such as the Apple Classroom of Tomorrow (ACOT) (Apple, 1995) or the Concerns-Based Adoption Model (CBAM; Horsley & Loucks, 1998). A prevailing model is the Technology Acceptance Model (TAM; Davis, Bagozzi, & Warshaw, 1989), based on the theory of reasoned action (TRA; Fishbein & Ajzen, 1975); and the Theory of Planned Behavior (TPB; Ajzen, 1991).

These conceptions of organizational and individual acceptance of technological innovations is based, in part, on Social Cognitive Theory (SCT), the psychometric research area that studies the factors involved in individual decision making. SCT distinguishes itself from traditional social learning theory by incorporating mental processing (cognition) into the interpretation of observational learning. The basis of SCT holds that human behavior is a triadic, dynamic, and reciprocal interaction of three elements: personal characteristics, behavior, and the environment (Bandura, 1977, 1986). While some social scientists propose that behavior is a result of consequences, SCT postulates that goal-directed and self-regulation processes play a large part in how we react to different situations. Furthermore, SCT suggests that there are both direct and indirect effects of reinforcement that learners conscientiously choose. Bandura's research has stimulated researchers to study techniques for promoting organizational change and measuring the success of change.

With this basis for understanding change from the perspective of goal-directed and planned behavior, the Technology Acceptance Model (TAM; Davis et al., 1989), and its derivations, have been a significant tool used to investigate why end users accept information systems innovation. But researchers found the TAM capable of predicting technology adoption success in only up to 40% of the cases (Meister & Compeau, 2002; Venkatesh & Davis, 2000). As a result, researchers have pursued better technology acceptance models capable of delivering higher prediction successes (Legris, Ingham, & Collerette, 2003; Plouffe, Hulland, & Vandenbosch, 2001). Refinements were necessary to overcome barriers that might prevent an individual from adopting a particular information system technology, such as system design characteristics, training, support, and decision-maker characteristics (Taylor & Todd, 1995). Examination of other literature on technology acceptance indicates that social variables such as demographics, managerial knowledge, environmental characteristics, and task-related characteristics would also expand the model's predictive capabilities (Pijpers, 2001). Additional research suggested motivational elements would improve the predictive power of the model even more (Vallerand, 1997).

Research on the TAM led to a modification that incorporates both human and social variables which is now called the "Unified Theory of Acceptance and Use of Technology" (UTAUT) model (Venkatesh, Morris, Davis, & Davis, 2003). The UTAUT model has been demonstrated to be up to 70% accurate at predicting user acceptance of information technology innovations. By generating a significantly higher percentage of technology innovation success the UTUAT is deemed a superior metric than the prior models.

Explaining the adoption of new information technologies has been described as the most mature research area in contemporary information systems research literature (Hu, Chau, Sheng, & Tam, 1999). Research in this area has generated adoption metrics that can be used to determine the probability of successful implementation of information system initiatives. Though the UTAUT model of determining technology acceptance has been used successfully in information systems domains, its application to education has yet to be made.

STUDY CONTEXT

This study was conducted at a small Midwestern university where all students are required to purchase standard issue Tablet computers (TPCs) enabled with all portable computing features of conventional laptops in addition to digital inking capabilities and voice to text translation. While "mobile" could refer to any technology supported by a wireless network, this study assigns Tablet computers exclusively to the term mobile computing. This university has a long tradition of supporting data communication and networking innovations and provides a campus wide wireless network overlay. The study takes place in the second year of a mobile computing initiative so faculty have had no more than 1 year of experience of teaching in the mobile computing environment. Students participating in this study were generally in their first year of using Tablet PCs in the classroom. This study was a onetime snapshot of the adoption environment that is being followed up by a longitudinal study that uses a slightly different research model.

RESEARCH DESIGN

The objective of this study is to measure the acceptance of Tablet PCs by college students using the UTAUT model. Specifically, the research will identify the extent students "accept" the technology, and determine what proportion of that acceptance can be attributed to various characteristics of the model. The expectations are that the study will provide evidence of the integration of the devices by identifying characteristics of acceptance. The components of the model are mapped in Figure 1.

The survey tool used to measure technology acceptance contained 11 items that were negatively worded, with the remaining 42 items being positively worded, pertaining to the constructs used in popular technology acceptance models (see Appendix A). This survey tool was electronically administered to 361 students at the research site. The survey instrument contained questions addressing each of the technology acceptance areas. The nine variables are performance expectancy, effort expectancy, and attitude toward using technology, social influence, facilitating conditions, self-efficacy, anxiety, behavior intention, and use of the system. These variables are defined in Table 1.

The research model used for this study is similar to that used in the Venkatesh, Morris, Davis, and Davis (2003) publication in that it contains questions pertaining to the constructs of the UTAUT. Questions were included measuring various demographic characteristics. Survey participants were asked to indicate their response to each statement using a 7-point Likert scale with 1 representing a strong disagreement and 7 being a strong agreement with the statement. The wording has been modified to specifically address the Tablet PC device. Data were collected from students taking a general education course including information system, computer science, education, and arts and science majors at the university. From the participant pool of 361 individual students, the database recorded responses from 268 participants resulting in a response rate of 74%. Five survey submissions were removed due to incomplete submissions with less than 75% of the survey completed. A total of 263 responses were included in data analysis and model construction.

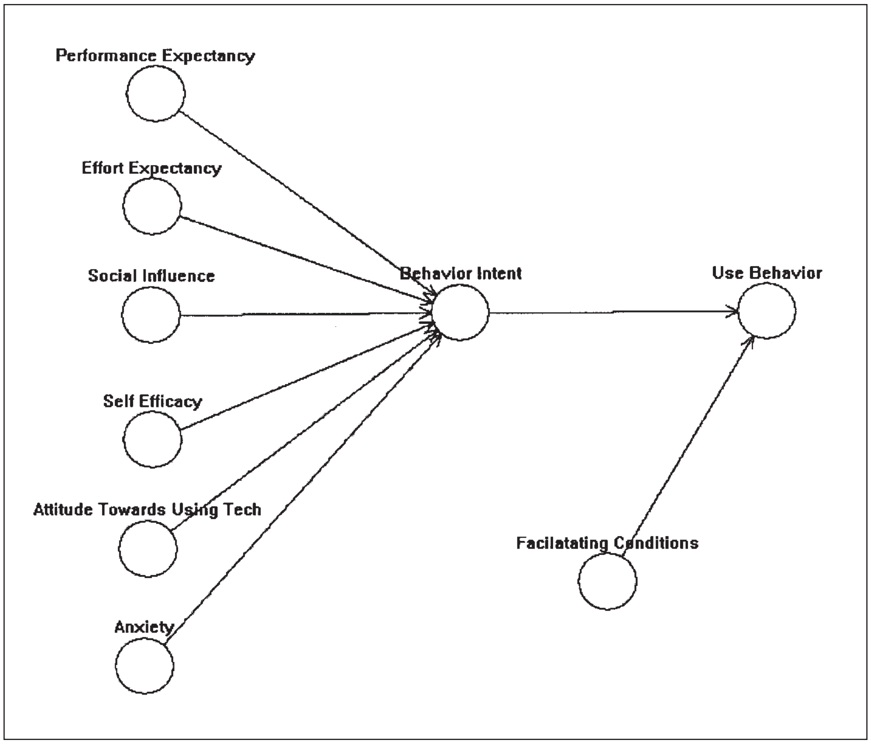

Figure 1. Proposed research model.

DATA ANALYSIS METHODOLOGY

The most common method used for identifying interactions between technology acceptance constructs is regression analysis. The statistical analysis method used for this research was partial least squares (PLS), a powerful second generation statistical technique of covariance based structural equation modeling. PLS has been used by many researchers in the technology acceptance field (Compeau & Higgins, 1995; Venkatesh et al., 2003). The tool used for the analysis was PLS Graph (PLS Graph, Version 2.91.03.04). The software was used to determine the validity of the various measurements or questions. The questions contained in the survey instrument were evaluated for variance (R^2) and retained if the variable had a variance greater than 0.7. PLS was used to study the assessment of latent variables and can also weigh the relationship between the questions used to determine unobservable model constructs.

The research model was evaluated to measure the inclusion of the various statement response variables used to contribute to the model constructs. PLS is

Table 1. Acceptance Model Variables and Definitions

Variable	Definition
Performance Expectancy (PE)	Degree to which an individual believes that using the system will help attain gains in job performance.
Effort Expectancy (EE)	The degree of ease associated with the use of the system.
Attitude Toward Using Technology (ATUT)	Attitude toward using technology is defined as an individual's overall affective reaction to using a system.
Social Influence (SI)	The degree to which an individual perceives that important others believe he or she should use the new system.
Facilitating Conditions (FC)	The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system.
Self-Efficacy (SE)	Self-efficacy is defined as people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives.
Anxiety (ANX)	Computer anxiety as a state of mind of being fearful or apprehensive when using or considering the use of a computer.
Behavior Intention (BI)	Intent to behave (such as intent to adopt a technology for this purpose).
Use of the System (USE)	Use is the intention to use a particular technology and is determined by the various technology acceptance models.

preferred in applications where the constructs are measured primarily by formative indicators such as those used in this study (Chin, Marcolin, & Newsted, 2003; Jarvis, MacKenzie, & Podsakoff, 2003).

A complete analysis of the model required an examination of both the goodness of fit criteria and the factor loading indicators. The goodness of fit indices measured how well the variable parameter estimates were able to reproduce the sample covariance matrix. The technique did this by taking the presented model as true and modifies the parameter estimates until the covariance difference between the parameter estimates and the sample is minimized.

Data Analysis

The general demographics of the survey participants for gender showed that 119 survey participants were female (45%) and 142 identified themselves as male (54%), 3 participants did not indicate a gender. The mean age of the participants was 22 with 94% being younger than 24. One hundred twenty-seven (48%) survey participants reported themselves as freshman students, 66 (25%) reported themselves as sophomore students, 49 (18%) reported themselves as junior students, 16 (6%) reported themselves as senior students, and 5 did not indicate any student classification.

Construct Validity

The research model used for this research measures the interaction effects between separate variables or constructs of the model via regression analysis. Though they cannot be directly measured, these latent variables (performance expectancy, effect expectancy, social influence, attitude toward using technology, self-efficacy, anxiety, self-efficacy, and attitude toward using technology) interact to identify two direct determinants of usage behavior (behavioral intent and facilitating conditions). Four moderating factors include (gender, age, experience, and voluntariness) each having varying influence on the primary constructs.

To prove construct validity, both convergent and discriminate evidences are measured. The survey instrument was evaluated by performing principal component factor analysis as described by Straub (Straub, 1989; Straub, Boudreau, & Gefen, 2004). The statements included in the instrument were based on statements contained in seminal works of technology acceptance (Compeau & Higgins, 1995; Venkatesh et al., 2003). The statements contained in the survey instrument were evaluated for internal consistency (IC) and retained if the question had an IC greater than 0.7. This is consistent with current articles outlining technology adoption research. PLS-Graph v. 3.0 (Chin, 1996), weighed the relationship between the questions used to determine unobservable model constructs. PLS does this by examining the loading factors and the standard error estimate (Segars, 1997). Statements with IC scores less than 0.7 were removed from the model. Table 2 indicates the variables retained for each of the constructs with their internal consistencies and loading factors.

Discriminate validity is the degree to which any single construct is different from the other constructs in the model. The criteria for measuring discriminate validity is to measure the average variance extracted (AVE), which indicates the average variance shared by a construct and its indicators (Fornell & Larcker, 1981). Discriminate validity is adequate when constructs have an AVE loading greater than 0.5, meaning that at least 50% of measurement variance was captured by the construct (Chin, 1996). In addition, discriminate validity is confirmed if the diagonal elements are significantly higher than the off-diagonal values in the corresponding rows and columns. The diagonal elements are the square root of the

Table 2. Individual Loadings, Weights, and Internal Consistencies (IC)

Construct	Number of questions	Construct IC factor
Performance Expectancy	4	0.86
Effort Expectancy	5	0.96
Attitude Toward Using Technology	4	0.89
Social Influence	4	0.88
Facilitating Conditions	4	0.86
Behavioral Intention	4	0.91
Self-Efficacy	4	0.89
Anxiety	3	0.91
Usage	3	0.86

AVE score for each construct. Table 3 contains the AVE scores and a correlation matrix for the constructs. All constructs have AVE scores greater than 0.5, indicating successful validation. The instrument has achieved acceptable levels of validity. The instrument demonstrates adequate discriminate validity because the diagonal, in **bold**, values are greater than the corresponding correlation values in the adjoining columns and rows (Chin, 1996).

Reliability

Reliability in technology acceptance models refers to the degree which the variables, or indicators, are stable and consistent with what they are suppose to be measuring (Singleton & Straits, 2004). Cronbach's alpha is commonly used by researchers in this area and is recommended by Straub (Straub, 1989) and many others, including Venkatesh and Davis who originated the UTAUT model. Table 4 contains the measures of scale reliabilities for the various construct variable groups. Generally, reliability numbers greater than 0.7 are considered acceptable in technology acceptance literature (Nunnally & Bernstein, 1994; Zhang, Li, & Sun, 2006).

All the variables used to determine the various constructs, except facilitating conditions, met this level of reliability. The items used to measure facilitating conditions were left in the model with alpha values (raw and standard) of 0.64 and 0.70 because of the importance of facilitating conditions to the model.

Table 3. AVE Scores and Correlation of Latent Variables

	PE	EE	SI	FC	SE	ANX	BI	USE	ATUT
PE	**0.78**								
EE	0.30	**0.89**							
SI	0.31	0.22	**0.81**						
BI	0.51	0.43	0.45	**0.84**					
USE	0.27	0.27	0.24	0.30	**0.82**				
FC	0.43	0.49	0.43	0.60	0.30	**0.82**			
SE	0.09	0.25	0.14	0.27	0.09	0.16	**0.81**		
ANX	(0.06)	(0.30)	(0.11)	(0.20)	(0.02)	(0.25)	(0.01)	**0.87**	
ATUT	0.57	0.42	0.59	0.69	0.27	0.56	0.18	(0.14)	**0.82**

Table 4. Scale Reliabilities

Construct	Number of questions	Reliability of group
Performance Expectancy	10	0.84
Effort Expectancy	8	0.89
Attitude Toward Using Technology	6	0.89
Social Influence	6	0.76
Facilitating Conditions	5	0.70
Behavioral Intention	5	0.80
Self-Efficacy	5	0.84
Anxiety	4	0.84
Usage	4	0.67

Structural Model Analysis

The research model was evaluated with PLS-Graph to determine the correctness of the model. Because PLS does not require a normally distributed data it is evaluated with *R*-squared calculation for dependent latent variables (Cohen, 1988) and the average variance extracted (Fornell & Larcker, 1981). The PLS-Graph provides an indication of how well the model fits the hypothesized relationship by means of the squared multiple correlations (R^2) for each dependent construct in the model. The R^2 measures a construct's percent variation that is explained by the model (Wixom & Watson, 2001). The R^2 values for each dependent variable are Behavioral Intent (0.55) and Use Behavior (0.11). The interpretation of these factors indicates that the model explains 55% of the variance of the dependent variable BI toward adoption of the Tablet PC and that the dependent variable Use Behavior explains 11% of the variance of the device usage.

Bootstrap method was used in PLS-Graph to determine the strength of the relationships between two dependent constructs in the model. The dependent constructs in the model are behavioral intent and use behavior. The structural path diagram shown in Figure 2 provides evidence that shows the extent to which each variable contributes to behavioral intent.

The positive coefficient values for all constructs, except anxiety, indicate that the participants in this particular study had a positive inclination toward Tablet PC use. Computer self-efficacy does have an impact on students acceptance of the Tablet PC and it is supported by the positive path coefficient of 0.124 of the self-efficacy construct. The anxiety constructs negative coefficient of (–0.073). The low R^2 of 0.11 and the path coefficient of 0.10 suggest that students' use of the Tablet PC does impact their acceptance of the device.

RESULTS AND DISCUSSION

This study attempts to understand the integration of technology into educational institutions using the unified theory of acceptance and use of technology

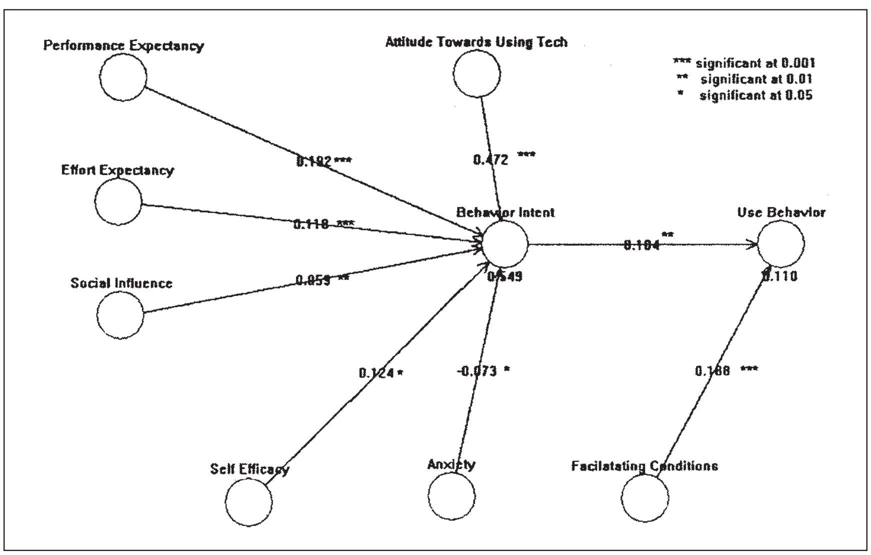

Figure 2. Tablet PC structural model.

(UTAUT) model to determine user's acceptance of Tablet PCs. The UTAUT model was modified in this study by including the constructs of attitude toward using technology, self-efficacy, and anxiety because of their significance in other technology acceptance models.

The study suggests that 55% of the variance in the model is explained by behavioral intent to use the TPC and a low predictive value for use behavior at 11%. The low value for use behavior can be attributed to the questions asked on the survey. An examination of the questions asked about TPC use show that three of the four questions asked pertained to specific Tablet PC use of the devices. Subsequent surveys will correct this error by using more general notebook computer use questions. It is the conclusion of researchers that academic organizations adopting Tablet PC will have a much higher probability of success if they provide, and require, specific training for the proper use of the device. Utilizing the stylist as a pointing device and tablet specific applications. This training should be mandatory and focus on the advantages of pen-based computing.

Positive correlations between most of the model constructs toward behavioral intent and use behavior validate the predictive power of the usage model. Anxiety does show as a negative factor in this analysis (–7%), which would indicate a negative correlation with TPC integration, but anxiety was not a component of the original Venkatesh UTAUT model. The model, as it is constructed in this study, supports 55% of the intention to use the tablet PC and 11% of the use of the Tablet PC.

As a construct, self-efficacy makes a 12% contribution to behavioral intention indicating an impact of computer self-efficacy toward use. This self-efficacy value is as influential on the model as the original model construct of effort expectancy (12%), and is significantly larger than the social influence value (6%) in this study. The influence of self-efficacy on behavioral intention suggests a reconsideration of the decision to remove this construct from the unified model (Venkatesh et al., 2003).

The contribution of the anxiety construct (–7%) to behavioral intent in this study indicates that anxiety has a negative effect on the behavior intent to use the Tablet PC in this environment. This finding is slightly in disagreement with the Venkatesh model's contention that anxiety is a non-factor such technological contexts (Venkatesh et al. 2003, p. 461).

The primary motivation instigating this study was to learn more about the subtleties of mobile computing integration in the higher education domain. This study proposes that the integration of mobile technologies is predicated on acceptance of the technology. The two dependent constructs comprising acceptance used in this model are behavioral intent and use behavior. In the environment of this study, the variables of performance expectancy, effort expectancy, attitude toward using technology, and self-efficacy are key components of behavioral intent. Social influence and anxiety do not appear to have much contribution to behavioral intent. However, these factors are shown to have a different impact on different social groups and therefore be included in this acceptance study.

Social influence (SI), sometimes referred to as social norms, was only significant to the upper classmen in this study but it was fairly significant for that group with a 32% explanation of the variance of behavioral intent. SI measures how the use of technology is influenced by our beliefs of how others will view us. Do our peers and superiors affect our perceptions of technical innovations? These are questions that need time to formulate a plan of study.

To apply the results of the study to the technology implementation process, the success of any technical innovation appears to hinge on quality planning. Adequate planning should include three components that will improve the success of the initiative. First there should be an opportunity for all key stakeholders to meet and discuss the initiative. Second is adequate provision of educational opportunities to provide the skills necessary to correctly use the device. And third, adequate support of the device includes a help desk and repair center. This three-pronged plan encompasses the constructs contained in the model. The meetings and training will benefit the constructs of effort and performance expectancy, and the participants' attitude toward using technology—all which are contributors to behavioral intent. The availability of support and training will increase the use behavior and increase the benefit of using the technology. The end result is significantly higher probability of success which is the desired end result of any project implementation.

A second outcome of this research reveals differences in technology acceptance between students who are mandated to use the devices and those who use them at their own discretion. The university environment used in this study is a mandatory use environment. But since only first and second year students were required to lease or otherwise acquire Tablet PCs, the upper class students who participated in this study used the device at their own discretion. Many upper classmen did voluntarily acquire the initiative devices, and that group appears to have a positive disposition toward Tablet PC use as indicated by their positive response level to attitude toward technology and moderate response toward the influence of performance expectancy and facilitating conditions. The very high score for the upper classmen for social influence indicates that they based their decision to obtain a Tablet PC on the influence or their perceptions of the influence of key stakeholders of the initiative.

Moderating Conditions

This model includes moderating variables that impact the independent variables that, in turn, influence the dependent variables of behavioral intention and use behavior. Those are gender, age, experience, and voluntary use. In the context of this study the examination of a gender bias for the effort expectancy variables did not find a significant difference between males and females. The range of ages for traditional college students did not provide enough population segments to study differences caused by the age of the participants. Experience with computers was shown to have a significant impact on the acceptance of technology indicated by the significance found between freshman and upper classmen in the study. In fact, interpretation of the model with the data extracted for the freshman students has a much higher determination of acceptance than the population as a whole. This is due to good planning and support of this population segment.

One significant moderating variable was found to be computer experience, particularly if the computer use began in elementary and middle school for the participants. This moderating factor should be further evaluated to determine if it is a factor in other populations.

Study Limitations

The instrument records self-reported results. To get an accurate picture of participants' ideas of TPC use, several questions addressed each construct of interest. Yet, no matter how much vigor the investigators applied to the instrument design and analysis, the final result is only a proxy measure of participants self-perceptions, and a threat to the internal validity of the study exists (Campbell, 1969; Campbell & Stanley, 1963). Self-reported use is a relative indicator of usage intention. Precise determination would have required data mining of computer use logs which brings up the issue of privacy and ethics.

The findings of this study should only be applied to this unique environment. The conclusions must be carefully evaluated before any attempt is made to project these findings on another university setting. Student populations in other university environments may very well have very different model analysis and distributions than this study's participant pool. In the Venkatesh article, the predictive efficiency of the model was proclaimed to explain as much as 70% of the variance in intention, but this is still a subjective measure of intent to use a technology that can only be used as an indicator of personal choice. To study TPCs more thoroughly, the faculty have contacted other TPC universities to attempt to obtain a wider population of subjects. In addition, longitudinal studies tracking students through their academic progression is planned.

In mandatory use situations, a more direct determination of use may be informative. The same institution, in which this study was conducted, maintains a detailed log of everything the particular TPC user is doing with the device. The researchers have considered the implications of examining this log to determine computer use on this campus.

APPENDIX A: Survey Questions

These are the statements included in the survey instrument. The survey participants' responses were expressed using a 7-point Likert scale where one represented strong disagreement and seven corresponded to strong agreement to the statement.

Performance Expectancy (PE) Questions.
Using the Tablet PC in my classes would:

1. enable me to accomplish tasks more quickly.
2. hamper my performance.
3. would increase my productivity.
4. hamper my effectiveness in class.
5. make it easier to do my homework.
6. hamper the quality of the work I do.
7. because my classmates perceive me as competent.
8. increase the instructors respect for me.
9. decrease my chances of getting a good grade.
10. be useful in my classes.

Effort Expectancy (EE) Questions.

1. Learning to operate the Tablet PC is easy for me.
2. I find it easy to get the Tablet PC to do what I want it to do.
3. My interaction with the Tablet PC is clear and understandable.
4. I find the Tablet PC to be flexible to interact with.
5. It is easy for me to become skillful at using the Tablet PC.
6. I find the Tablet PC easy to use.
7. Using the Tablet PC takes too much time from my normal duties.
8. Working with the Tablet PC is so complicated and difficult to understand.

Attitude Toward using Technology (ATUT) Questions.

1. Using the Tablet PC is a good idea.
2. I dislike the idea of using the Tablet PC.
3. Using the Tablet PC is pleasant.
4. The Tablet PC makes schoolwork more interesting.
5. Using the Tablet PC is fun.
6. I like working with the Tablet PC.

Social Influence (SI) Questions

1. People who influence my behavior think that I should use the Tablet PC.
2. People who are important to me think that I should use the Tablet PC.
3. Professors at this university have been helpful in the use of the Table PCs.
4. My advisor is very supportive of the use of the Tablet PC for my class.

5. In general, the university has supported the use of the Tablet PC.
6. Having the Tablet PC is a status symbol in my university.

Facilitating Conditions (FC) Questions

1. I have the resources necessary to use the Tablet PC.
2. I have the knowledge necessary to use the Tablet PC.
3. The Tablet PC is not compatible with other computer systems I use.
4. The help desk is available for help with the Tablet PC difficulties.
5. Using the Tablet PC fits into my work style.

Self-Efficacy (SE) Questions
I could complete a task using the Tablet PC . . .
1. If there was no one around to tell me what to do as I go.
2. If I had seen someone else demonstrate how it could be used.
3. If I could call someone to help if I got stuck
4. If I had a lot of time to complete the job.
5. If I had just the built in help facility for assistance

Anxiety (ANX) Questions

1. I feel apprehensive about using the Tablet PC.
2. It scares me to think that I could lose a lot of information by using the Tablet PC and hitting the wrong key.
3. I hesitate using the Tablet PC for fear of making mistakes cannot correct.
4. The Tablet PC is somewhat intimidating to me.

Behavioral Intention (BI) Questions

1. Whenever possible, I intend to use the Tablet PC in my studies.
2. I perceive using the Tablet PC as involuntary.
3. I plan to use the Tablet PC in the next three months.
4. To the extent possible, I would use Tablet PC to do different things (school or not school) related.
5. To the extent possible, I would use Tablet PC in my studies frequently.

Usage Questions

1. I use my Tablet PC in slate mode.
2. I use my Tablet PC stylus for navigation.
3. I use my Tablet PC primarily as a notebook computer.
4. I use Windows Journal with my Tablet PC.

Other Information Questions

1. I am a male female
2. I am currently a ___________ at DSU.
   A. Freshman B. Sophomore C. Junior D. Senior E. Grad Student

3. My major is represented by the college at Dakota State University.
   A. Arts & Sciences B. Business & Info Sys C. Education
   D. Graduate E. Other
4. I began using computers regularly in school.
   A. Elementary B. Middle C. High D. College E. Do not use
5. Approximately how many months have you been using the Tablet PC?
   One Two Three Six Nine Twelve More than twelve months

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