Technology Acceptance in Education

Research and Issues

Timothy Teo (Ed.)

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FOREWORD

The potential of information technology (IT) for enhancing education is intuitively compelling. However, opinions about the value of information technology for teaching and learning range from blue-sky optimism to more doubtful views that educational technology may be wasteful or even harmful. Between these extremes, commentators acknowledge that educational technologies can, under proper conditions, deliver superior learning. We often read advice such as "9 key success factors for harnessing technology for learning" or "how to avoid 37 pitfalls of educational technology." We need to move beyond simplistic debates about whether or not IT has anything to offer education, and anecdotal tips, toward establishing a base of scientific knowledge about how to get the best out of educational technology.

Clearly, there are noteworthy examples of both success and failure of educational technologies. The success of educational technology hinges on whether it truly delivers value, is perceived as doing so by human participants, and is adopted and used. Without user acceptance, educational technology cannot hope to deliver whatever value it may be capable of in principle. Such reasoning constitutes the theme of this edited collection: what motivates learners, educators, and other stakeholders to accept or reject new educational technologies? How can these motives be influenced by the design features of the technology? How does acceptance depend on contextual contingencies?

These chapters build upon and contribute to scientific knowledge about what motivates people to accept IT in general, based largely on the technology acceptance model (TAM). TAM was originally created in the 1980's to predict and explain knowledge worker adoption of productivity applications such as word processing, e-mail, and graphics tools. Over the more than two decades since this introduction, the application domains for TAM and its many extensions and refinements have broadened out in several directions to encompass groupware, e-commerce, knowledge management, enterprise resource planning systems, and educational technology. TAM has emerged as a leading scientific paradigm for investigating acceptance of educational technology by students, teachers, and other stakeholders. This collection contains a exemplary sampling of current research in this tradition.

The chapters in this volume span a range of countries and cultures, multiple levels of education from K-12 to higher education to graduate school, a range of technologies including both synchronous and asynchronous, mobile, internet, and virtual reality, and address both teacher and student perspectives. As illustrated by these chapters, discussions of educational technology are moving beyond seemingly paradoxical assertions for and against the universal merit of educational technology toward a more nuanced, principled, evidence-based understanding of the condition for success. The following book makes a substantial contribution toward advancing this endeavor.

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TIMOTHY TEO

1. TECHNOLOGY ACCEPTANCE RESEARCH IN EDUCATION

Technology acceptance can be defined as a user's willingness to employ technology for the tasks it is designed to support. Over the years, acceptance researchers have become more interested in understanding the factors influencing the adoption of technologies in various settings. From the literature, much research has been done to understand technology acceptance in the business contexts. This is understandable, given the close relationship between the appropriate uses of technology and profit margin. In most of the acceptance studies, researchers have sought to identify and understand the forces that shape users' acceptance so as to influence the design and implementation process in ways to avoid or minimize resistance or rejection when users interact with technology. This has given rise to the identification of core technological and psychological variables underlying acceptance. From these, models of acceptance have emerged, some extending the theories from psychology with a focus on the attitude-intention paradigm in explaining technology usage, and allowing researchers to predict user acceptance of potential technology applications.

Traditionally, it has been observed that developers and procurers of technological resources could rely on authority to ensure that technology was used, which is still true in many industrial and organizational contexts. However, with the increasing demands for educational applications of information technology and changing working practices, there is a need to re-examine user acceptance issues as they emerge within and outside of the contexts in which technology was implemented. This is true in the education milieu where teachers exercise the autonomy to decide on what and how technology will be used for teaching and learning purposes. Although they are guided by government policies on how to integrate technology in teaching and learning, teachers spent much of their planning time to consider how technology could be harnessed for effective lesson delivery and assessment to be conducted.

These circumstances have provided the impetus for researchers to examine technology acceptance in educational settings. Although these studies have typically involved students and teachers as participants, their findings have far-reaching implications for school leaders, policy makers, and other stakeholders. In recent years, technology acceptance research has been reported with increasing frequency in education-related journals and this is an indication of its growing importance in the realm of educational research. Against the above backdrop, this book aims to present a focused collection of articles in technology acceptance with special attention on education to inform both educational practitioners and researchers on the practical applications and research issues in technology acceptance.

T. Teo (ed.), Technology Acceptance in Education: Research and Issues, 1–5.

EXAMINING TECHNOLOGY ACCEPTANCE

The first part of the book focuses on the general issues of technology acceptance research. In chapter 2, Smarkola investigated student teachers' and experienced classroom teachers' computer usage beliefs, intentions, and self-reported computer usage in the classroom using a mixed methodology approach (i.e., quantitative and qualitative), and compared the efficacy of the technology acceptance model (TAM) (Davis, 1989) and the decomposed theory of planned behavior (DTPB) (Taylor & Todd, 1995) for predicting computer usage intentions. Using questionnaire surveys and semi-structured interviews, Smarkola found that, although the TAM was a good predictor of intentions, the DTPB emerged as the more important model for predicting teachers' intentions. Similarities as well as significant differences were found between student teachers' and experienced teachers' computer usage.

In chapter 3, Wong and Teo investigated 245 student teachers' self-reported intentions to use (ITU) computers from a Malaysian higher education institution. Data were collected from student teachers and these were tested against the TAM using the structural modelling approach. The authors found that perceived usefulness (PU) of computer technology, perceived ease of use (PEU), and attitude towards computer use (ATCU) to be significant determinants of ITU. Additionally, the results of the study revealed that (1) PEU significantly influenced PU; (2) both PU and PEU significantly influenced ATCU, and (3) both PU and ATCU significantly influenced ITU. The results supported the efficacy of the TAM to predict student teachers' intention to use technology in Malaysia.

Chapter 4 is a qualitative study conducted by Bennett, Maton, & Carrington who investigated the reasons why digital technologies are adopted by university students in their everyday and academic lives. The findings provided insights into how the 'rules of the game' in different contexts influence the ways in which individuals perceived the utility of a technology and how they used it. This research drew on sociological concepts as an orienting theoretical framework to investigate and conceptualise these differences and considered what they meant for the integration of digital technologies in education. In chapter 5, Teo built a model to predict the level of technology acceptance by pre-service teachers. In this study, the relationships among variables associated with factors that influenced technology acceptance were examined and data were collected from 475 participants using a survey questionnaire. Structural equation modelling was employed to test the fit of a hypothesized model and results revealed that perceived usefulness, attitude towards computer use, and computer self-efficacy have direct effect on pre-service teachers' technology acceptance, whereas perceived ease of use, technological complexity, and facilitating conditions affect technology acceptance indirectly. These six variables accounted for approximately 27.1% of the variance of behavioural intention.

Part I of this book ends with a discussion on the equality of students' learning outcomes in technology-mediated learning. In Chapter 6, Hu and Hui used two experimental studies to examine the students' individual differences and focused on the influences of gender and learning style on technology-mediated learning. Specifically, the variables of interest included learning effectiveness, perceived learnability, and learning satisfaction in technology-mediated learning, with classroom-based face-to-face learning as a comparative baseline. Overall, the authors found that students benefit from technology-mediated learning differently, depending on their gender. For example, female students considered technology-mediated learning more effective and satisfactory than male students, but their learning motivation was significantly lower than that of their male counterparts.

ACCEPTANCE OF SPECIFIC TECHNOLOGIES

The chapters in Part II discuss the acceptance of specific technologies in education. In chapter 7, Pynoo and his colleagues examined university students' acceptance of Minerva, a web-based course management system (CMS) at Ghent University (Belgium). Minerva allowed students to download and upload files, discuss course contents with their teachers and fellow-students, and consult the official bulletin board, among other functions. In this study, first-time enrolled students of two faculties (medicine and health sciences, and engineering) were surveyed. Data were collected two months after the start of the academic year via an online questionnaire which contained items on variables from the Technology Acceptance Model (TAM) (Davis, 1989) and the Theory of Planned Behavior (TPB) (Ajzen, 1985). The authors found no significant differences between students of the two faculties although an effect of perceived voluntariness of use was noted: the more students perceive use of Minerva as voluntary, the more positive their attitude and the higher their use, but the lower their intention to use Minerva. Turning to another application, Liaw and Huang examined learners' acceptance of mobile learning (m-learning) in chapter 8. In this study, m-learning was facilitated by the convergence of the Internet, wireless networks, mobile devices and e-learning systems. Guided by the Activity Theory, this study found that learner autonomy of using m-learning, perceived interaction of using m-learning, quality of m-learning functions, and perceived satisfaction of using m-learning were positive predictors on m-learning acceptance.

In chapter 9, Van Schaik explored the application of the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) to web sites usage by students in higher education. Both prescribed web sites and user-selected sites were studied using a non-experimental research design and questionnaire-based measures. The results supported direct and moderated effects of technology-acceptance variables on acceptance outcomes in the research model, supporting UTAUT. As predicted, the research model - based on UTAUT - was more successful in explaining the acceptance of a prescribed library site than that of a prescribed virtual learning environment. The model was also successfully applied to user-selected web sites in that user-selected sites were especially intrinsically motivating. The effect of intrinsic motivation on performance expectancy, mediated by effort expectancy, was also confirmed, demonstrating the broad scope of applicability of UTAUT.

In chapter 10, Cheung and Lee examined the gender differences in the relative impact of both extrinsic and intrinsic motivations, as well as the social influence on student acceptance of an Internet-based Learning Medium (ILM). A total of 504 students participated in this study. The results revealed that attitude had the strongest direct effect on behavioural intention for both male and female students. Perceived usefulness influences attitude and behavioural intention to use an ILM more strongly for male students than it did for female students, whilst subjective norm was a more important factor in determining female students' intention to use an ILM than it was for male students.

Part II concludes with chapter 11 in which Ma and Yuen investigated e-learning systems acceptance using the UTAUT as the framework. An instrument was designed and administered to 128 undergraduate students who were using an e-learning system, named Interactive Learning Network, within one semester of study. Data were collected at the beginning of the semester (Phase A) as well as at the end of the semester (Phase B). The same questionnaire was administered at both Phase A and Phase B amd results showed that in both Phase A and Phase B, Behavioural Intention and Satisfaction were determined by Effort Expectancy and Social Influence ($p<0.001$), with R-sq of 0.519 (Phase A) and 0.615 (Phase B) for Behavioral Intention; and at 0.695 (Phase A) and 0.635 (Phase B) for Satisfaction. Moreover, usage data were extracted from the system, and their correlations with the acceptance factors were examined. In Phase A, a convergent factor effect was found: only usage on "Tasks" was significantly correlated to Social Influence ($p<0.001$). In Phase B, a divergent factor effect was found: usage on "Course Module" was significantly correlated to Performance Expectancy ($p<0.05$), while usage on "Announcement" ($p<0.01$), "My Folder" ($p<0.05$), and "Resources" ($p<0.001$) were significantly correlated with Effort Expectancy.

CONCLUSION

In this book, the acceptance of various technologies by teachers and students were examined using various acceptance models that have been employed and validated in the acceptance literature. In addition, various research methodologies were represented in the chapters. Beside traditional techniques, structural equation modelling was used in many chapters as the main technique for data analysis and this is consistent with an observation by Teo (2009) on the popularity of this technique in educational research and, evidenced by the chapters in this book, acceptance research as well. It is hoped that this book will provide insights on technology acceptance in education and motivate researchers to conduct further studies to gain an enhanced understanding of the factors, influences, and forces that drive users in educational settings to adopt and accept technology in ways they are designed, for the betterment of the teaching and learning process to meet educational outcomes.

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EXAMINING TECHNOLOGY ACCEPTANCE

CLAUDIA SMARKOLA

2. A MIXED-METHODOLOGICAL TECHNOLOGY ADOPTION STUDY

Cognitive Belief-Behavioral Model Assessments in Predicting Computer Usage Factors in the Classroom

ABSTRACT

The purpose of this study was to: a) investigate student teachers' and experienced classroom teachers' computer usage beliefs, intentions, and self-reported computer usage in the classroom using a mixed methodology approach (i.e., quantitative and qualitative), and b) examine the efficacy of the technology acceptance model (TAM) and the decomposed theory of planned behavior (DTPB) for predicting computer usage intentions. This study consisted of a sample of 160 student teachers and 158 experienced teachers from classes within a large urban university. All participants completed a *Computer Usage Intention Survey.* This survey was developed using a theoretical framework of the technology acceptance model (TAM) (Davis, 1989, 1993; Davis, Bagozzi, & Warshaw, 1989). The survey determined participants' beliefs, future intentions usage (for the coming 6 months) and self-reported usage (for the past three months) of integrating computer applications (e.g. Word Processing, Spreadsheets, Database, Multimedia, Internet, Games, Drill and Practice, Simulations, Tutorials, Problem Solving, and educational subject-specific software) into subject-specific lessons. After completion of the *Computer Usage Intentions Survey*, a purposeful sample of the study's participants was selected for semi-structured interviews. This sample consisted of a total of 19 participants, 10 student teachers and 9 experienced classroom teachers. The interview questionnaire was developed using a theoretical framework of the decomposed theory of planned behavior (Taylor & Todd, 1995). Although the TAM was a good predictor of intentions, the DTPB emerged as the most important model for predicting teachers' intentions. Similarities as well as significant differences were found between student teachers' and experienced teachers' computer usage.

INTRODUCTION

With increasing global competition, mastery and application of technologies is vital in nearly every field of human endeavor (U.S. Department of Education Office of Educational Technology, 2004). According to Davis (1989, 1993) an individual's technology acceptance is a crucial factor in determining the success or failure of a

T. Teo (ed.), Technology Acceptance in Education: Research and Issues, 9–41.

computer systems project. Integrating computers into the classroom in a meaningful way is essential when preparing teachers and students for the 21st century (U.S. Congress, 2000; U.S. Congress Office of Technology Assessment, 1995; U.S. Department of Education, 2002). For meaningful computer education integration to occur it is imperative to first understand teachers' beliefs and intentions toward technology adoption.

Student teachers and experienced teachers believe that it is important to learn to use computers as a tool to integrate computer applications into the classroom (Bliss & Bliss, 2003; Discoll, 2001; Doering, Hughes, & Hoffman, 2003; Schnackenberg, Luik, Nisan, & Servant, 2001; Willis & Sujo de Montes, 2002). Despite the advances made in educational technology, concerns regarding sufficient and competent technology adoption still exist (Brzycki & Dudt, 2005). Wedman and Diggs (2001) commented that teacher education programs have relied more on technology utilization courses rather than creating authentic learning environments where technology is pervasive and integral. Benson, Farnsworth, Bahr, Lewis, and Shaha (2004) found that student teachers felt comfortable with the technology they learned, but did not feel comfortable in teaching it to school children. Swanson (2006) noted in the Education Week Technology Counts Edition that only 26 states have policies in place to help ensure teachers are competent in technology. Hall (2006) found that faculty and K-12 teachers successfully modeled technology standards for student teachers, but many activities were focused on lower cognitive skills. Thus, it remains crucial that teacher technology adoption and acceptance issues be researched to better thoroughly understand teachers' behavior for using technology.

Technology Acceptance

Two technology acceptance models were used to measure teachers' computer usage beliefs and intentions: (a) the technology acceptance model (TAM) (Davis, 1989, 1993; Davis, Bagozzi, & Warshaw, 1989), and (b) the decomposed theory of planned behavior model (DTPB) (Taylor & Todd, 1995). Although TAM is a parsimonious model and a good predictor of computer usage, the DTPB is an extended model to better understand determinants of computer usage intentions. Descriptions of each of the models are explained below along with graphic representations depicted in Figures 1 and 2.

Technology Acceptance Model (TAM)

Davis's TAM was adapted from the theory of reasoned action (TRA) proposed by Fishbein and Ajzen (1975). Davis et al. (1989) found TAM to be a better predictor than TRA of intentions in using software. TAM predicts that user acceptance of technology is determined by three factors: (a) perceived usefulness, (b) perceived ease of use, and (c) behavioral intentions. Davis et al. found that both perceived usefulness and perceived ease of use directly mediated behavioral intentions (with perceived ease of use also having a direct effect on perceived usefulness). In turn, behavioral intentions were found to be a strong predictor of actual use (See Figure 1) (Davis et al.; Taylor & Todd, 1995).

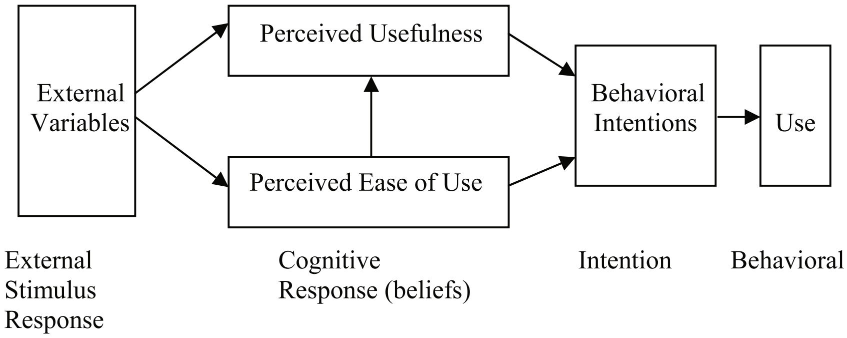

Figure 1. Technology acceptance model (TAM).

Reprinted from A critical assessment of potential measurement biases in the technology acceptance model, International Journal of Man-Machine Studies, 45, D.F. Davis and V. Venkatesh, p. 20, Copyright (1996), with permission from Elsevier.

The TAM instrument has been used extensively by researchers investigating a range of issues in the area of user acceptance, such as the World Wide Web and software utilization (Dishaw & Strong, 1999; Lederer, Maupin, Sena, & Zhuang, 2000; Moon & Kim, 2001). More recently, the TAM has been used in educational settings to investigate various issues including: a) student acceptance of online courses, b) course websites as effective learning tools, c) online student communication for a class project, d) e-learning (e.g., WebCT) in undergraduate courses, e) gender differences in preservice teachers, and f) student teachers' perceptions of computer technology in relationship to their intention to use computers (Drennan, Kennedy, & Pisarski, 2005; Gao, 2005; Kelleher & O'Malley, 2006; Ma, Anderson, & Streith, 2005; Ngai, Poon & Chan, 2007; Ong & Lai, 2006; Pan, Sivo, Gunter & Cornell, 2005; Pituch & Lee, 2006; Selim, 2003; Yuen & Ma, 2002).

Davis (1989,1993) suggested that further studies needed to be performed to extend TAM to determine the types of external variables, such as, computer self-efficacy and training that could influence the motivating belief factors of perceived usefulness and perceived ease of use. The decomposed theory of planned behavior was developed to further expand TAM to incorporate factors that were not addressed by Davis (Taylor & Todd, 1995).

Decomposed Theory of Planned Behavior (DTPB)

The decomposed theory of planned behavior (Taylor & Todd, 1995) was adapted from the theory of planned behavior (TPB) proposed by Ajzen's (1985). The TPB uses direct measures of *attitudes*, *subjective norms* (i.e. others' influence on a person's behavior), and *perceived behavioral control* [i.e. the extent to which users have control over their behavior which is determined by the person's internal (e.g., skills) and external (e.g., resources, opportunities, etc.) constraints] to predict intention and in turn behavior. In addition, the model includes cognitive belief-based determinants to measure attitudes, subjective norm and perceived behavioral control. Taylor and Todd specified relevant beliefs for attitudes, subjective norm and perceived behavioral control regarding technological behavior. They identified *perceived usefulness*, *ease of use*, and *compatibility* beliefs to explain attitudes; *peer influence* and *superior's influence* to explain subjective norm, and; *self-efficacy* and *facilitating conditions* (i.e. resource constraints/support) to explain perceived behavioral control. See Figure 2.

The predictive power for behavior of the DTPB is similar compared to the TPB and TAM. Taylor and Todd (1995) stated that the DTPB is a more complex model than TAM and only slightly increases the predictor power of behavior. They advise colleagues that if the research goal is to predict computer usage then researchers may find TAM the preferred model because of its parsimonious construct. However, Taylor and Todd stated that those researchers who are looking for a more comprehensive perception of intentions should consider the decomposed theory of planned behavior model.

PURPOSE

The present study was conducted to investigate student teachers' and experienced classroom teachers' self-reported computer usage and computer usage intentions in the classroom using a mixed methodological approach. The primary purpose of the study was to investigate student and experienced teachers' a) self-reported computer usage of computer integration activities in a K-12 school environment, and b) future intentions to integrate computer applications within a K-12 school environment. The secondary purpose was to assess the efficacy of the technology acceptance model (TAM) and the decomposed theory of planned behavior (DTPB) for predicting intentions to use computers.

A Computer Usage Intentions Survey and semi-structured interviews were undertaken to address the following research questions:

Self-Reported Usage

1. What factors predict student teachers' and experienced classroom teachers self-reported computer usage?
2. Do student teachers and experienced classroom teachers differ in their self-reported computer usage?

Intentions to Use

3. Does the field practicum experience change student teachers intentions to use computers?
4. Do student teachers and experienced classroom teachers differ in their intentions to use computers?
5. What factors predict student teachers' and experienced teachers' computer usage intentions?

Assessment of Technology Behavioral Models

6. How effective are the technology acceptance model and the decomposed theory of planned behavior in predicting intentions to use computers.

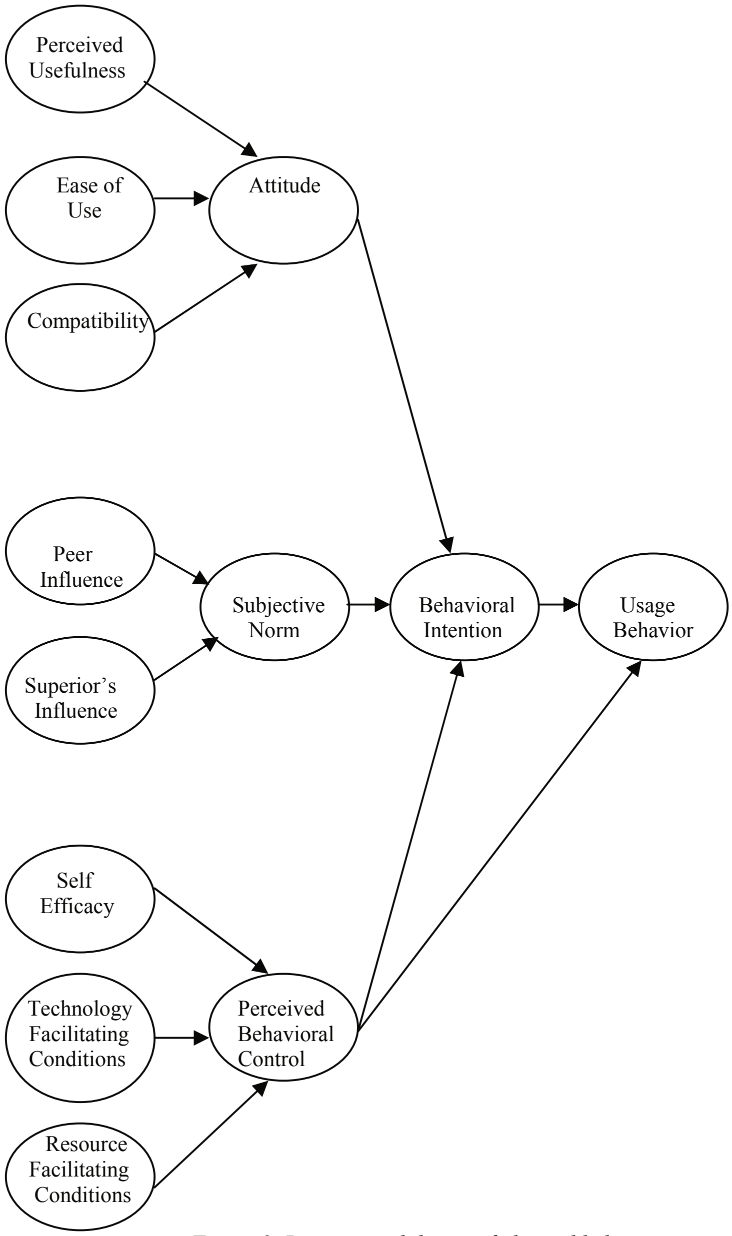

Figure 2. Decomposed theory of planned behaviour.

METHODOLOGY

This study consisted of a dominant quantitative-less dominant qualitative, sequential, mixed-method design to explain factors in computer usage intentions and behavior among educators (Tashakkori & Teddlie, 1998). The quantitative design consisted of a total of 318 teachers who completed a Computer Usage Intentions Survey (Smarkola, 2007) followed by qualitative design with a purposeful sample of 19 teachers who participated in an interview (Smarkola, 2008a). The survey was adapted from the TAM and the interview questions were adapted from the DTPB.

QUANTITATIVE METHODS

Sample and Procedures

The present study employed a convenience sample of 160 student teachers and 158 experienced classroom teachers from classes within a large urban university. Participants completed a Computer Usage Intentions Survey that consisted of four sections: (a) demographic characteristics, (b) self-reported computer integration usage (for the preceding three months), (c) future intentions usage (for the upcoming six months) of integrating computer applications (e.g. Microsoft Office, Multimedia, Internet, etc.) into subject-specific lessons, and (d) perceived ease of use and perceived usefulness of integrating computer applications into subject-specific lessons.

A pre-test and post-test Computer Usage Intentions Survey was distributed to student teachers during one spring semester period. To ensure informed consent, the survey was accompanied by a cover letter mandated by the University IRB office. Students were asked to put the last four digits of their social security number on the survey so that students felt they could remain anonymous and so that pre-post test analysis could be conducted by the researcher. Student participants completed the pre-test within the first two weeks of the semester. They completed the post-test within the last two weeks of the semester. The students were given 10 minutes to complete the survey. Of the 160 student teachers who completed the survey, 110 participated in both the pre- and post-tests. The pre-post test attrition rate was largely due to the fact that graduating seniors did not feel committed to attending their final classes.

The same Computer Usage Intentions Survey was also distributed to K-12 experienced classroom teachers who were students in two College of Education Graduate Programs (i.e., Teacher Apprenticeship Program and Master of Science in Education). There were 158 experienced teachers that participated in a one-time only completion of this survey. Both student and experienced teacher respondents voluntarily provided their contact information on this survey to participate in a 30–45 minute interview.

Instrument

The TAM instrument (Davis, 1989, 1993) uses multiple item scales for its three measures of perceived usefulness, perceived ease of use, and behavioral intentions. The TAM can be readily adapted as an assessment instrument in a variety of technology contexts. An item can be revised by substituting the type of technology in question in the sentence stem, for example, “WordPerfect is often frustrating,” “software maintenance tools are often frustrating,” or “integrating computer application use into subject specific lessons is often frustrating.” The Computer Usage Intentions Survey for the present study focused on the sentence stem of integrating computer application use into subject specific lessons.

The item format is a 7-point (from strongly agree to strongly disagree) Likert type rating. A high degree of convergent and discriminant validity was found for perceived usefulness and perceived ease of use (Davis, 1989). Reliability testing (Davis; Davis & Venkatesh,1996) showed Cronbach alpha coefficients exceeding .90 for perceived usefulness, perceived ease of use and behavioral intentions. The TAM instrument has been widely validated (Davis & Venkatesh; Doll, Hendrickson, & Deng, 1998; Hendrickson & Collins, 1996; Karahanna & Straub, 1999; Szajna, 1996).

For the current study, the instrument consisted of five items for the perceived usefulness scale, four items for perceived ease of use scale, and two items for behavioral intentions scale. The item format was a 7-point Likert scale (i.e., 7 = *strongly agree* to 1 = *strongly disagree*). A principal axis factor analysis with varimax rotation was performed on the combined student and classroom teacher data. The factor analysis yielded the following factors: (a) behavioral intentions, (b) perceived usefulness, and (c) perceived ease of use. Thus, this survey maintained the three main constructs of behavioral intentions, perceived usefulness and perceived ease of use that constitute the technology acceptance model (Davis et al., 1989).

A Cronbach alpha reliability analysis was done to determine the internal consistency for the items within each of the three factors. Reliability scores for intentions, perceived usefulness and perceived ease of use were .92, .93 and .75, respectively.

QUALITATIVE METHODS

Sample

Of the 160 student teachers and 158 experienced teachers who completed the Computer Usage Intentions Survey, 54 student teachers and 64 experienced classroom teachers volunteered to be interviewed. The goal of choosing interviewees was to get participants who best represented each of their teacher groups’ beliefs and intentions. It was important to acquire a homogeneous interview group for the student teachers and for the experienced teachers to make conclusions about *typical* units of analysis regarding each groups’ normative (i.e., most common) computer beliefs and intentions (Tashakkori & Teddlie, 1998). Thus, teachers of their respective groups were purposefully selected at or near the mean of their groups’ beliefs and intentions from the Computer Usage Intentions Survey until saturation of content emerged during the interview process (Merriam, 1998). This resulted in an interview sample of 19 participants, specifically 10 student teachers and 9 experienced teachers. The interviews were held at a time and location most convenient to the participants (i.e., researcher’s office, participants’ K-12 school, or participants’ college course classroom-before or after class). All interview participants agreed to be tape recorded and signed an Audiotape Consent Form.

All interviewees were demographically identified through an 11 digit interviewee identification key code (see Appendix A). Demographic totals for both teacher groups were diverse in nature. The sample of 10 student teachers consisted of 8 females and 2 males; 7 were White, 1 Black, 1 Asian, and 1 other. Five student teachers taught in the city and 5 in the suburbs; there were 5 elementary, 2 middle school, and 3 high school teachers. The sample of 9 classroom teachers consisted of 3 males and 6 females; 8 were white and 1 black. Five classroom teachers taught in the city and 4 in the suburbs; there were 4 elementary, 3 middle school, and 2 high school teachers.

Interview Instrument

The DTPB framework was chosen for the qualitative procedure because it provided for a more in-depth analysis of computer acceptance that was fundamental for acquiring participants' perceptions during the interview process. Interview questions for this study were written to be consistent with the variables associated with the DTPB.

In this study, the semi-structured interview computer usage questionnaire focused on the following four main categories supported in the DTPB: intentions, attitudes, subjective norms (i.e., peer influence and superior's influence), and perceived behavioral control (i.e., self-efficacy, external constraints, support, training). An additional belief, *perceived consequence*, was not proposed in the DTPB but was included in this study's interview computer usage questionnaire. According to Triandis's (1971) behavioral intentions model, perceived consequence is an individual's evaluation of potential rewards gained by performing an act. Thus, perceived consequence is a belief measure for an individual's choice of behavior based upon potential rewards (i.e., teachers' job opportunity, job security, and meaningful work). Additionally, the interview began with a *grand tour* question that asked what the interviewee thought about the role of computers and education.

Qualitative Analysis

A qualitative analysis of participant interviews was made using the Constant Comparative Method (Merriam, 1998). An independent transcriber was hired to transcribe all interviews verbatim. After this transcription process, the transcripts were repeatedly read by the researcher and initial content codes (e.g., high/low computer confidence, more/less computer training, etc.) were created from content found in the transcripts. These initial content codes were documented on the transcripts. The initial content codes were then analyzed to determine how they were related to support or reflect a general theme or topic. Themes were created and placed into a category development table (Constas, 1992).

Qualitative Verification

Peer examination was performed on the typed interviews. An impartial researcher not involved in the study examined the category development of the interview data, looking for disconfirming or negative cases. Method triangulation was also used in the research process to aid in the trustworthiness of the analysis. Participants' responses from the interviews were matched to their responses on the Computer Usage Intentions Survey. Additionally, conversations were audio taped during the interviewing process and verbatim quotes were used as part of this study's results. Furthermore, a code mapping analysis procedure of student teachers' and classroom teachers' interviews was documented. According to Anfara, Brown, and Mangione (2002) code mapping is part of an audit trail that provides readers with disclosure of the interview process and adds to the trustworthiness of the analysis. Additionally, multiple theories, specifically, the technology acceptance model and the decomposed theory of planned behavior were used to help interpret and explain the data (Tashakkori & Teddlie, 1998).

RESULTS

Demographic Statistics

The sample of 160 student teachers consisted of 69.6% (n = 110) females and 30.4% (n = 48) males. Eighty percent (n = 125) were White, 9% (n = 14) African American, 1 % (n = 2) Hispanic, 5 % (n = 8) Asian/Pacific Islander, and 5 % (n = 8) Other. In the sample of 158 experienced classroom teachers, 71.7% (n = 114) were female and 28.3% (n = 45) were male. Eighty-five percent (n = 135) were White, 7.5% (n = 12) African American, 2.5 % (n = 4) Hispanic, 1 % (n = 2) Asian/Pacific Islander, and 4 % (n = 6) Other. (Demographic data do not equate to original samples sizes because some participants did not complete all items.) Experienced teachers varied in number of years in teaching: (a) 57.9% had 1 to 3 years of teaching experience, (b) 17.6% had 4 to 6 years, (c) 6.9% had 7 to 9 years, and (d) 17.6% had over 10 years.

Forty-two percent of student teachers taught in the city, 51% in a suburban area and 7% in a rural district. Thirty-one percent of experienced teachers taught in the city, 66% in a suburban area and 3% in a rural district. Percentages of student teachers teaching in the following grades were: (a) 58% in K-5 grades, (b) 10% in 6–8 grades, and (c) 32% in 9–12 grades. Percentages of experienced classroom teachers teaching in the following grades were: (a) 48% in K-5 grades, (b) 24% in 6–8 grades, and (c) 28% in 9–12 grades.

Approximately 94% of student and classroom teachers had four or more years of computer experience, and 95% had a home computer. About half (46%) of the student teachers were skilled at using both MacIntosh and PC; half (50%) were skilled at using only the PC, and a small percent (3%) were skilled using only the MacIntosh. About half (51%) of classroom teachers were skilled at using both MacIntosh and PC; nearly half (44%) were skilled at using only the PC, and a small percent (5%) were skilled using only the MacIntosh.

Although computer usage experience between student and experienced teachers are similar, a significant difference was found among types of training that student teachers and classroom teachers felt most contributed towards their computer skill development, χ^2 (3, N = 318) = 14.369, p = .002. Approximately 60% of student teachers reported being self-taught, 28.1% took college courses, 8.8% learned on-the-job, and 2.5% received other types of training. Approximately 44% of experienced teachers reported being self-taught, 29.1% took college courses, 20.3% learned on-the-job, and 6.3% received other types of training. About 85% of both student and classroom teachers noted that their school made computer resources readily available to them.

Demographic data of the 160 student teachers and 158 experienced teachers regarding their self-reported computer software usage is given in Tables 1, 2, 3 and 4.

Table 1. Percentage of teachers' requiring student assignments using computer software

	Student teachers	*Experienced teachers*
Word processing	69%	67%
Spreadsheet	08%	06%
Database	03%	04%
Multimedia/Presentation	25%	28%
Internet	68%	75%
Subject Specific	29%	42%

Table 2. Percentage of teachers' using the computer to complete work assignments (e.g., lesson planning, teaching, grading, etc.)

	Student teachers	*Experienced teachers*
Word processing	96%	96%
Spreadsheet	44%	56%
Database	13%	21%
Multimedia/Presentation	35%	33%
Internet	88%	91%
Subject Specific	26%	45%

Table 3. Percentage of teachers facilitating types of instructional software with students

	Student teachers	*Experienced teachers*
Drill and Practice	42%	46%
Tutorial	36%	34%
Problem Solving	25%	34%
Games	44%	51%
Simulations	17%	17%
Research & Searches	42%	50%

Table 4. Teachers' computer usage in the past three months

	Times Used Computer in Past Three Months						
	None	1-6	7-12	13-18	19-24	25-30	> 30
Student Assignments							
Student Teachers	29%	40%	13%	10%	2%	1%	5%
Experienced Teachers	26%	39%	17%	4%	5%	2%	7%
Teach Lessons to Students							
Student Teachers	44%	40%	10%	2%	1%	2%	1%
Experienced Teachers	40%	39%	9%	4%	3%	2%	3%
Administrative Work							
Student Teacher	5%	8%	6%	5%	8%	6%	62%
Experienced Teacher	2%	12%	9%	11%	10%	5%	51%

Results for Self-Reported Usage

Research Question #1 – Factors Predicting Self -Reported Computer Usage

A multiple regression analysis (see Table 5) of student teacher data was performed to investigate student teachers' perceived ease of use, perceived usefulness, and intention factors predicting: (a) student assignments requiring computer usage, (b) student teachers using the computer to teach lessons to students, and (c) student teachers using the computer to complete work assignments (e.g., lesson planning, grading, etc.). Results showed that both perceived ease of use and perceived usefulness predicted student teachers' computer usage in teaching lessons to their students. However, perceived ease of use and perceived usefulness explained only 15% of the variance for this computer usage. No statistical significance was found for factors predicting student assignments requiring computer usage or student teachers using the computer to complete their work assignments.

A regression analysis (see Table 6) of experienced teacher data was performed to investigate teachers' perceived ease of use and perceived usefulness predicting: (a) student assignments requiring computer usage, (b) teachers using the computer to teach lessons to students, and (c) teachers using the computer to complete work assignments (e.g., lesson planning, grading, etc.). Results showed that perceived usefulness predicted teachers' computer usage to teach lessons to their students. Perceived usefulness explained 14% of the variance in computer usage. Teachers' perceived usefulness predicted student assignments requiring computer usage. Perceived usefulness explained 15% of the variance in student computer usage.

Table 5. Regression analysis for student teachers' self-reported usage

Variables	*β*
Computer Usage for Teaching Lessons	
Perceived Ease of Use	.242**
Perceived Usefulness	.250*
Adj. $R^2 = .146$	

*p < .05. **p < .01.

Table 6. Regression analysis for experienced teachers' self-reported usage

Variables	*β*
Assigning Student Computer Lessons	
Perceived Usefulness	.297**
Adj. $R^2 = .138$	
Computer Usage for Teaching Lessons	
Perceived Usefulness	.371**
Adj. $R^2 = .146$	

**p < .01.

Research Question #2 - Differences in Teacher Groups' Self-Reported Computer Usage

An omnibus MANOVA (Wilks' Lambda = 2.597, $p = .053$) showed that there were no significant differences among the usage activities (i.e., student assignments requiring computer usage, teachers using the computer to teach lessons to students, and teachers using the computer to complete work assignments in lesson planning, grading.). Within a three month period, over half of student and experienced teachers used the computer at least 30 times to complete administrative tasks. During the same time period, about 40% of student and experienced teachers used computer software one to six times in their teaching and for student computer-related assignments.

Analysis revealed a statistically significant difference between the types of software used by the teacher groups. Results showed a statistically significant difference between the teacher groups for spreadsheet use, $\chi^2(1, N = 292) = 3.949$, p = .047. About 44% of student teachers and 56% of experienced teachers used spreadsheets in their jobs. There was also a difference between the groups for subject specific software, $\chi^2(1, N = 293) = 10.708$, p = .001. Twenty-six percent of student teachers used subject specific software compared to 45% of experienced teachers who used this type of software. There were no statistically significant differences between the teacher groups' usage of database, multimedia/presentation, Internet and Word processing; however, Internet and Word processing were used much more than the other types of software.

Additional analysis showed a significant difference between the teacher groups in educational software usage with their students, $\chi^2(1, N = 289) = 6.312$, p = .012. Seventy four percent of student teachers used educational software compared to 86% of classroom teachers who did so. There were no significant differences between the teachers groups as to the kinds of educational software used (i.e. drill and practice, tutorials, games, simulations, problem solving, research searches). There was a statistically significant difference between student teachers and classroom teachers in their students' use of subject-specific software, $\chi^2(1, N = 293) = 4.342$, p = .037, (29% and 42%, respectively). There were no significant differences between the teacher groups engaging their students in using general utility programs such as, word processing, spreadsheet, database, multimedia/ presentation software, and the Internet. However, both teacher groups asked their students to use Internet and Word processing more than the other general utility and subject-specific programs.

Results for Intentions

Research Question #3 - Pre-Post Testing on Student Teachers' Computer Usage Intentions during their Student Teaching Experience

A statistically significant difference on computer usage intentions, $t(108) = -2.557$, p < .05 was found between student teachers' in their pre-test ($M = 10.71$, $SD = 2.85$) and post-test responses ($M = 11.49$, $SD = 2.55$). A statistically significant difference was also found between student teacher pre-test data ($M = 17.56$, *SD* = 4.64) and post-test data (*M* = 18.60, *SD* = 3.79) on perceived ease of use $t(107) = -2.849$, $p < .05$. No statistically significant difference was found for perceived usefulness.

Research Question #4 – Teacher Group Differences in Intentions to Use Computers

A MANOVA was performed between teacher groups on: (a) perceived ease of use, (b) perceived usefulness, and (c) intentions. No statistically significant differences were found between student teachers (using the post-test data) and experienced classroom teachers in their perceived ease of use, perceived usefulness, and intentions (Wilks' Lambda = 1.0312, $p = .379$). Mean differences between teacher groups in their perceptions and intentions are shown in Table 7.

Table 7. Mean ratings of student and experienced teachers in computer usage perceptions and intentions

	Student teachers	*Experienced teachers*
Perceived Ease of Use	4.63	4.39
Perceived Usefulness	5.07	5.01
Intentions	5.69	5.38

Note: Mean ratings scaled to item Likert scale 1= Strongly Disagree to 7 = Strongly Agree.

Research Question #5 – Factors Predicting Computer Usage Intentions

Quantitative Results

A multiple regression analysis of student teacher pre-test data showed that perceived ease of use ($\beta = .281$, $p < .001$) and perceived usefulness ($\beta = .576$, $p < .001$) predicted computer usage intentions. Both perceived ease of use and perceived usefulness explained 48% (Adj. $R^2 = .478$) of the variance in computer usage intentions. A regression analysis of student teacher post-test data showed that perceived ease of use ($\beta = .180$, $p < .01$) and perceived usefulness ($\beta = .634$, $p < .001$) predicted computer usage intentions. These variables explained 50% (Adj. $R^2 = .498$) of the variance in computer usage intentions.

A multiple regression analysis for experienced teachers showed that perceived ease of use ($\beta = .201$, $p < .001$) and perceived usefulness ($\beta = .601$, $p < .001$) predicted computer usage intentions. These variables explained 50% (Adj. $R^2 = .500$) of the variance in computer usage intentions.

Qualitative Results

Student Teacher Results

The following four themes emerged from the student teacher interviews: (a) The Value of Computers to Teaching and Learning, (b) Make Way for Learning Through the Internet (c) Wanted – Computer Training in First Year Teaching, and (d) High Personal Computer Confidence. Details of each theme for the student teacher participants are discussed below (Note: Comments are followed by teachers' identification key code, see Appendix A for more details):

The value of computers to teaching and learning. When student teacher participants were asked about the role of computers and education, all 10 participants in some way made a point about the value and/or importance of computers in education. Examples of student teacher comments are documented below.

– I think now today more than ever it's more important than it has been….whether it's in the classroom or outside the classroom….It's kind of a necessity as I said before, you can't get around it. Either use it and keep up or get left behind and that's not really an option in education. (ST-FW-SMI)
– I think they are important. If you don't have a computer you're left behind and none of these students have them. (ST-FB-CHI)
– I feel it plays a very important role in education because technology is involved more in the students' everyday lives. (ST-FA-CEL)
– I think the biggest thing is it's there, so use it like any other resource you have. (ST-MW-CHI)

Student teachers saw the value and usefulness of computer usage within the classroom; this usefulness was driven by internal and external motivations. During the interview, student teachers described their internal motivations for computer usage as: (a) feeling computer usage was compatible with the way they work, (b) recognizing the need for their students to learn computers to facilitate learning within the classroom, and (c) seeing the necessity to enhance students' future prospects outside the classroom (e.g. within society). External motivations for computer usage within the classroom were driven by student teachers' perception of societal and school administration needs. Additionally, all participants thought that having computer experience was valuable because it would make them more marketable and provide them with more job opportunities. Examples are documented below:

– Increase (job opportunity) because if you say no I don't like to do computers – you can't do that, you have to that's what they (administration) look for. (ST-FW-SMI)
– …I think a lot of schools are now trying to integrate technology as much as possible because technology is such a big part of our lives now. (ST-FW-SEL)
– I think it would increase. You see even administrators may not know anything about computers but it is such that technology is a buzzword. You should know it…(ST-MW-CHI)
– Increase (job opportunity)….I think that if I said I hate computers, you will get a red check on your interview sheet. (ST-FW-SEL)

The Value of Computers to Teaching and Learning theme supports findings in the Computer Usage Intentions Survey (quantitative part of the mixed-method research), where perceived usefulness (a factor of TAM) was found to be a statistically significant predictor of student teachers' computer usage intentions to integrate computer applications within their subject-specific lessons.

Make way for learning through the Internet. When asked about the role of the computer in the classroom and the student teachers' intentions on using the computer, it became apparent that all 10 participants were primarily discussing computer integrated lessons using the Internet as opposed to the use of other types of software applications. This theme was reasonably supported by the self-reported usage data from the Computer Usage Intentions Survey that showed 88% of student teachers used the Internet (e.g., planning, teaching, etc.) for their job, and 69% of these teachers asked their students to use the Internet. The survey data showed that student teachers ranked only word processing usage higher than the Internet.

While discovering a pattern of Internet usage during the interviews, the participants were asked *why* they seemed to focus on the Internet.

– I like to look through and find things (on the Internet) like that because software is so expensive to buy especially if you're going for different subject areas and stuff….But I like to find things on the Internet also so that my children can go home and actually use them too. Cause you can't lend out that software. (ST-FW-SEL)
– The Internet is so up-to-date, it's so here. The Internet is so immediate and there are so many activities….A lot of things that software does provide, is becoming available on the Internet, either downloadable from the Internet or on the Internet. And software gets outdated quickly. And the stuff can be really expensive…. I think that could be a great family connection because teachers are always looking for ways for students to transfer - what I have heard in school I can do at home. (ST-FW-SEL)
– Through a lot of my grade programs we've had to search the Internet sources and I've found simulations on the Internet where you don't have to buy them….There is software, but it costs more money. So I think I could have benefited from seeing a dissection and having it on the Internet and that way an animal is not being harmed and students aren't getting yucky and throwing organs around and you could actually see systems. (ST-FW-SMI)
– I couldn't even name any software. I focus on the Internet cause that's all I know about realistically and I'ld be overjoyed with what I can do with all these different things. It's so accessible to people, it's everywhere….I think about communications with people around the world. Even if you could only pull it off once a semester or once a year. Some country where there might be a lot of stereotypes…. Just communicate with this classroom or this group of people. (ST-MW-CHI)

The student teachers' own experiences with the Internet were positive. The participants saw the Internet as a useful, accessible, and an inexpensive source, and thus, related the relevance of the Internet to the students they would be teaching. The student teachers felt comfortable using the Internet and saw how they could transfer these positive experiences to teach their children to use and learn from the Internet.

Wanted – computer training in first year teaching. Although the student teachers found their college educational technology course extremely valuable, this experience alone was not enough for them to feel fully prepared in applying computer-integrated lessons within their classrooms. Even though the Computer Usage Intentions

Survey (quantitative results) reported that student teachers mostly used the Internet and Word to support their field experience, the interviews (qualitative results) indicated that only 5 of the 10 of the student teachers had the opportunity to actually use computers within a classroom during their practicum or student teaching experiences.

As training and support issues were discussed with the participants, a pattern of responses emerged indicating that most of the student teachers wanted more training and support using computers in their classroom during the first year of their teaching. Much of their discussions centered on learning how to use computers within their lessons rather than technical hardware/software support. Below are examples of the types of training student teachers would like to see as a first year teacher.

– Training of different software and the different ways of using the computer integrating it into your curriculum. (ST-FA-CEL)
– Probably another mentor teacher who knows exactly what they're doing by computers or who has example lessons of how to integrate computers and lessons. I would like to see that teacher in action. (ST-MW-SEL)
– But I would ask teachers who have been in this thing for a while what kind of lessons would they choose to do with computers. Cause it is real important what you decide to do and how you decide to do it. (ST-FB-CHI)
– I'm looking for a school that has good professional development and a good curriculum reader that I can go to for curriculum ideas. I would like to see one person in the school who knows a lot about computers to brainstorm with. (ST-FW-SMI)
– I know that you're suppose to have a teacher with you now as kind of a mentor so it would be nice if they were up on technology and how to use it. (ST-FW-CEL)
– I would like to see some kind of presentation made to me as to what the possibilities are available to me….something that would clue in the staff what can be done on the computer. (ST-MW-CHI)

High personal computer confidence. Although the participants felt there was a severe lack of computer resources in the schools, they still felt confident that they would infuse technology into their own classrooms. On a scale on 1–10 (1 = low confidence and 10 = high confidence), the average confidence rating among the student teachers for carrying out computer-integrated lessons in their classrooms was an eight. Although, student teacher participants had high computer confidence, they discussed the use of computers in a limited way, primarily focusing on Internet usage (see theme, Make Way for Learning Through the Internet)

During the interview process, the participants discussed their valuable prior training which contributed in providing a foundation for the student teachers' high confidence and willingness to use computers in their classroom. Examples are documented below:

– Yea, the technology in the classroom (course) was really a valuable one. They gave us .… valuable websites that they knew about and how to demonstrate to children how to use certain programs like PowerPoint and Word. And they also gave us some interesting activities to do with the kids related to computers…. I actually feel more comfortable doing something with a computer… (Rated herself a confidence of 9.) (ST-FW-SEL)

– The 255 class was when I actually had to use the software….I didn't even think of educational software at that time….I wasn't in the educational set yet. But it was great to be able to learn how to do that….There are probably some things I don't know yet, like educational software. I feel like I have to play around with this stuff and then I would be Okay. (Rated herself a confidence of 8.) (ST-FW-CEL)
– But the one that actually taught you how to use it (computer) in the classroom was 255….Yes I did, definitely (find it valuable). Cause there are things you might not have thought about, that class helps you think about. Oh, Wow, I could do that with this…plus it becomes more familiar. There's nothing worse than going on a computer and not knowing how to tell the kids how to use it. (Rated herself a confidence of 8.) (ST-FW-SMI)

Experienced Teacher Results. The following four themes emerged from the classroom teacher interviews: (a) School Support Necessary, (b) Personal Perseverance for the Computing Cause, (c) More Computer Integrated Training Wanted, and (d) High Personal Computer Confidence with Support. Details of each theme for the experienced teacher sample are discussed below (Note: Comments are followed by teachers' identification key code, see Appendix A for more details):

School support necessary. Overall, classroom teachers who received support reported using many different types of software. Computer Usage Intentions Survey data (quantitative results) from this study support this finding. Statistical results from the survey showed that experienced teachers significantly used more spreadsheet and subject-specific software than did student teachers. Experienced teachers also asked their students to use subject-specific software more often than did student teachers. Furthermore, classroom teachers used educational software (e.g. drill and practice, problem solving, games, and research) in their classroom with their students more often than did student teachers.

Experienced teachers depended on both equipment resources and personal support from school administrators to successfully integrate technology into their classroom. Three of the nine teachers who did not have the appropriate resources and support could not integrate computer applications into their classroom as they would have liked, and expressed aggravation or frustration with the situation. Psychologically, it appeared that the teachers who had more school support appreciated this support and felt good about providing their students opportunities to enhance their learning. Examples of supportive and non-supportive remarks are noted below.

Supportive statements.
– So, um, over the years, we've had trainings as we got new computers in our classroom and in our building….And, of course, the principal likes seeing that cause I'm working on the computer….But obviously the more that we do with computers and technology, the more he likes it. So, I have tried like I said, at least once a day, the children are on the computer or they're using some kind of technology, even those centers. (CT-FW-SEL16)
– I've always had support from my principals….I guess you could say that I've gotten support from the district in some way because they put the computer in

the classroom….and luckily I did get support from the cluster leader. They (the students) using pick one of the software disks that we have out that are available, they've gotten to know the different programs….It's not like one program is stuck in there and that's all they can use. (CT-MW-CEL08)

- Well, a lot of it (computer application usage) was mandated by the district. (Note: She has three computers in her classroom and the school has a mobile laptop lab.) Like CCC and Earobic, these are things that they (students) are required to do. The other programs are just to support my teaching in the curriculum. (CT-FW-SEL05)
- Our school just purchased new textbooks for each grade which comes with two CDroms….Our school also purchased five mobile labs for the students to use so we constantly have them on the mobile labs whether it's just for word processing or research over the Internet. Every room is hooked up to the converter box where you can do PowerPoint presentations over the televisions. A lot of students are involved with that. Prentice Hall came in and trained us on the available CDroms…. The principal does (support us) in certain ways, like he had a guy come in for one of our inservices and teachers had to build their own websites with assignments where the students actually go on and get their assignment online. (CT-FW-SHI03)

Non-supportive statements (expressing frustration).

- When they (computers) are available they are really great…. Now the computer teacher is out sick and when we send work to his printer we don't even get it so it's like a whole thing where when I want the kids to work on the computer, they can't print stuff and it's a problem….I guess the word processing software would be good if I could use it and I would use it for them (students) to do their writing on. (CT-FW-CMI02)
- Well the school I'm at has very limited resources. I have been unable to implement any kind of Webquest and those relevant types of various drills and practice. I would certainly like to learn more about them and incorporate them when I move on to better school districts. (CT-MW-CHI01)
- I think our principal has gone to great lengths to make sure that every classroom has at least one working computer with Internet access….but the problem is there's the assumption that now that you have the computer, use it and people don't necessarily know how to incorporate it. How to generate a lesson that's technology centered, that's assisted. (CT-FB-CMI03)

Personal perseverance for the computing cause. Experienced teachers implied a belief system of perseverance in using computers in the classroom, despite their lack of compatibility with handling the technology within the classroom. These teachers expressed a resilience to use computers when faced with obstacles, seeing that a bigger purpose was at stake, a purpose for children to gain necessary computer skills to prepare them for real world experiences. The teachers' comments showed a belief that society's reliance on computers transcended many of their trepidations to use computers.

- I don't have a computer personality….Yea. I do use computers….If computers were not a part of education then we would be doing children a huge disservice because the job market is leaning more and more towards computers and if you

do not have that experience, it's getting harder and harder to get a job. (CT-FW-SEL05)
– I didn't grow up in a generation of computers in classrooms so it's still kind of foreign learning how to incorporate it as an instructional tool….Being a new teacher you just have to learn….in general the role of the computer is pretty significant. (CT-FB-CMI03)
– I don't know I can say it's compatible with who I am. I think actually I would say contrary to that….But at the same time my focus around using it is because I think there's an understanding it's necessary for them (students) to gain certain skills that are offered in all these programs. (CT-MW-CHI01)
– It's a struggle to learn as much as I can about computers, but it's essential….It is essential for the way society is moving. (CT-MW-CMI02)
– Definitely (feel computers are compatible)….I don't handle situations where the technology goes caput and I can't carry on. I tend to get flustered, however, since I've had alternative assignments ready it hasn't been as much of a problem….I think that they (computers) are extremely important….If you can get them (students) working with technology especially, computers, I think it only enhances learning for them because it's something they enjoy doing. (CT-FW-SHI03)

This theme depicts teachers' perceived usefulness of computers in the classroom and supports findings in the Computer Usage Intentions Survey, where perceived usefulness (a factor of TAM) was found to be a statistically significant predictor of experienced classroom teachers' computer usage intentions to integrate computer applications within their subject-specific lessons.

More computer integrated training wanted. Six of nine teachers stated that a person in their household (i.e., mother, father, niece, husband, girlfriend, and daughter) had influenced them to use computers in some way. All nine teachers felt that their educational technology college course was extremely valuable. Yet, all the teachers wanted additional computer integrated training from their school. Overall, teachers felt they needed more specific computer training that related to their personal classroom experiences.

Seven teachers specifically mentioned or implied onsite training and eight teachers specifically mentioned or implied computer integration training. Examples of teachers needs are documented below:
– I would like some more inservice training where like somebody outside comes in, that would be nice. Give us fresh ideas. Actual samples of lessons. (CT-FW-SEL05)
– I would certainly like to have some onsite training….I never saw any kind of staff development in anything let alone focusing on making sure that lesson plans incorporate areas of technology… (CT-MW-CHI01)
– I think there needs to be more aides involved as far as the computer themselves and what we use them for… (CT-FW-SHI03)
– I guess I would like some more training into exactly what can be done. A lot of it I kind of felt my way through….There's not a lot out there resource wise, training wise, so it would be nice to have more of that. (CT-MW-CEL08)

– The training is what we need….It's not enough to put computers in every classroom, you have to say here are workshops, not every teacher is on the same blanket….Here is the lesson and goals and here is the computer. Infusing the two is where I have difficulty. (CT-FB-CMI03)

High personal computer confidence with support. Although most experienced teachers felt there was a lack of computer resources in the schools, 8 of 9 teachers still felt confident about integrating technology into their classrooms. On a scale on 1–10 (1 = low confidence and 10 = high confidence), the average confidence rating among the experienced teachers for carrying out computer-integrated lesson in their classrooms was approximately an eight. These teachers commented on the contribution their valuable college computer course had on their computer confidence level.

Overall, teachers innocently communicated their inability to segregate confidence and support issues when discussing computer classroom integration. Classroom teachers indicated they felt confident about infusing computers into their classrooms when supported by their school administration and students. It was apparent that having support notably contributed to most teachers' high personal confidence.

– Pretty confident because when there's questions that I can't answer one of the students can do it. I'm constantly asking students. (Rated herself a confidence of 9.) (CT-FW-SHI03)
– Pretty confident. My kids are the same way at school. If I need something done there at school, there are people in there who can do it for me. Go do this and they know how to do it. (Rated herself a confidence of 8.) (CT-FW-CMI02)
– On my level, what I need to do in my classroom, I feel I'm right up there, a 10 (confidence)….We have a fifth grader here who takes over for the support tech when she's not available….We told him that we were going to get him a pager next year so that he can come back and help us. He knows so much. He can teach me a thing or two. (CT-FW-SEL05)
– I would say an 8 (confidence). An especially if we're looking at using it in just my classroom….She (grade teacher partner) is very much into the computer and using it. She just kind of reeled me in and I knew that I could go to her for help or if I had any questions. So knowing that she was there to help was I think something that influenced me to use it (computer) a little bit more. (CT-FW-SEL16)
– I'm not fully confident but I'm not – that doesn't prevent me from doing it. There's some things I know I don't know and we (students and teacher) struggle through it together….It's basically in school like either the tech assistant, other teachers who might know more than I do. Everyone is helpful here. Even the student teacher. (Rated herself a confidence of 7.) (CT-FW-SEL05)

DISCUSSION

Self-Reported Computer Usage

In this study, beliefs did not predict as well for student and experienced teachers' computer usage as it did for their usage intentions. (see computer usage intentions section below). Overall, belief predictor factors explained a low percentage of variance for the teacher groups' self-reported computer usage. Specifically, perceived usefulness and perceived ease of use predicted student teachers' computer usage to teach lessons to their students. Perceived usefulness predicted experienced teachers' computer usage to teach lessons and to assign students' computer related work.

The findings in this study for self-reported usage are not altogether consistent with other studies. Many researchers have found perceived usefulness, perceived ease of use and intentions explain a moderately low to high percentage of variance of computer usage, with only a few studies indicating an accounted variance of less than 20% (Davis, 1993; Dishaw & Strong, 1999; Hendrickson & Collins, 1996; Igbaria, Guimaraes & Davis, 1995; Igbaria, Schiffman, & Wieckowski, 1994). In the present study, predictor factors explained only roughly 15% of the variance for the teachers groups' computer usage. This self-reported usage finding indicates that the TAM instrument does not comprehensively account for teachers' usage. Thus, it appears that the TAM instrument may need to include more items (within a new content domain) to better predict teachers' usage. Due to the qualitative findings in this study, a likely new content domain that may increase the amount of accounted variance accounted for is *planned behavioral control* (PBC). Ajzen's (1985) theory of planned behavior and the decomposed theory of planned behavior (Taylor & Todd, 1995) include PBC as a variable that affects intentions. This added variable addresses users' perceived internal and external constraints that could control for their behavior. Given the findings in this study and in the research by Venkatesh, Morris, Davis, and Davis (2003) the addition of this item construct to the TAM theory and instrument may better predict teachers' use of computers.

Overall there were statistically significant differences among the types of software used but not the usage activities between the two teacher groups. Experienced classroom teachers used spreadsheets, subject-specific and educational software more than did student teachers. Experienced teachers also asked their students to use subject-specific software more often than did student teachers. One possible explanation is that teachers who are more experienced with their subject matter are more adept at using new tools, including computers, to help facilitate teaching and learning. However, both teacher groups in the present study primarily used word processing and the Internet for administrative purposes and for student assignments.

There were no statistically significant differences between student and experienced teachers for usage activities (i.e., student assignments requiring computer usage, teachers using the computer to teach lessons to students, and teachers using the computer to complete work assignments in lesson planning and grading). Findings from this study indicate that both student and experienced teachers use computers for mostly administrative work.

COMPUTER USAGE INTENTIONS

Quantitative

After completing their student teaching experience, student teachers indicated greater intention to integrate computer applications into their subject-specific lessons and perceived this integration as easier to use than they originally thought. These findings substantiate student teaching literature (Brent, Brawner &Van Dyk, 2002; Doering et al., 2003; Willis & Sujo de Montes, 2002) that indicates actual classroom technology experience is a critical contributing component to pre-service teachers' computer usage in the classroom.

There were no statistically significant differences between experienced classroom teachers and student teachers (after practicum completion) in their intentions to integrate computer applications into subject-specific lessons. In this study, both teacher groups indicated positive perceived usefulness, perceived ease of use, and intentions of using computers in their classroom lessons.

Experienced classroom teachers and student teachers, both prior to and after their practicum, indicated that their perceived ease of use and perceived usefulness of integrating computer applications within subject-specific lessons predicted their computer usage intentions. These factors explained about 45–50% of the variance in computer usage intentions. Additionally, both student and experienced teachers indicated that perceived usefulness of computer integration had a stronger effect on their computer usage intentions than did their perceived ease of use with computers.

The findings that perceived usefulness and perceived ease of use predicted intentions are consistent with other studies. Davis et al. (1989) and Taylor and Todd (1995) found that both perceived ease of use and perceived usefulness explained 45–57% of the variance in computer usage intentions. Additionally, Davis et al. found that perceived usefulness had a direct effect on behavioral intentions with perceived ease of use having an indirect effect through perceived usefulness. Although approximately 50% of both student and experienced teachers' intentions are not explained by the instrument in this study, this instrument does provide a reasonable and parsimonious way to measure computer acceptance.

Qualitative

The decomposed theory of planned behavior framework used in this study substantiated and extended TAM findings. DTPB results indicate that there are more similarities than differences in computer usage beliefs between neophyte and experienced teachers. Both student and classroom teachers believed that preparing children to use computers had an important societal purpose; thus, these teachers saw the necessity to acquire appropriate computer classroom integration training. Both student and classroom teachers expressed their confidence to use computers in their classroom. However, student teachers revealed some naïvety in the degree to which they were competent in their computer classroom integration skills (focusing on the Internet). Classroom teachers understood the importance of administrative support, and exhibited resourcefulness when infusing computers into their lessons when supported.

A major theme that supported the TAM is that teachers will use computers if perceived useful. Student and experienced teachers saw the value and usefulness of computer usage within the classroom. This usefulness was driven by the teachers' need to enhance children's learning and prepare them for the real world (internal motivation). In this study, experienced teachers had a philosophy that they would persevere in using computers in the classroom despite their lack of compatibility with handling the technology to give their students the necessary computer skills for future endeavors. Student teachers generally felt comfortable with computers and thought it was imperative that students learn to use computers. This finding is supported by Doering et al. (2003) who found student teachers believed it was imperative to have children use technology for learning. Additionally, student teachers in this study believed that the general population and school administrators (external motivation) regarded computers an important component in educational learning. The student teachers believed that having computer knowledge would increase their job opportunities.

Computer training related to student and experienced teachers' personal classroom lessons emerged to be a critical component for successful computer classroom integration implementation. A major finding of this study indicated that student teachers had a limited understanding of how computers could be used to enhance their teaching. Although student teachers discussed using the Internet in a variety of ways, they scarcely reported teaching strategies using other technological methods. This theme reasonably supports the quantitative finding in this study that student teachers mostly used the Internet and word processing for their job. This finding is comparable to findings from other studies indicating that student teachers have a limited perspective of computer classroom integration techniques (Doering et al., 2003; Gibson & Nocente, 1998; Moursund & Bielefeldt, 1999; Mowrer-Popiel, Pollard, & Pollard, 1994; Willis & Sujo de Montes, 2002). In this study, student teacher discussions centered on learning how to integrate computers in their own classroom lessons, indicating that actual classroom technology experience is a critical component that contributes to student teachers' future computer usage. In this study, only 5 of 10 student teachers interviewed had taught with technology in their classrooms. Yet studies have shown that preservice teachers' placement with a cooperating technology competent teacher was crucial in students' educational technology preparation (Brent et al., 2000; Doering et al.; Willis & Sujo de Montes).

Professional development studies show that classroom teachers believe it is important to acquire training on how to better integrate technology into their pedagogical practices to effectively facilitate teaching and learning (Bliss & Bliss, 2003; Driscoll, 2001; Schnackenberg et al., 2001). This study found that experienced classroom teachers depended on having <u>both</u> equipment resources and personal support from school administrators to successfully integrate technology into their classroom. This finding is consistent with a research outcome from the U. S. Department of Education, Office of Educational Research and Improvement that found teachers are mostly likely to use the Internet for classroom instruction when they had <u>both</u> computer classroom level access and support in the form of training and assistance (Lanahan, 2002). Similarly, Mouza's (2003) study of 15 teachers in a professional development program noted that the major influences in teachers' use of technology included: (a) support received from school administration, (b) availability of school resources, (c) collaboration with other teachers, and (b) student population and needs. Studies have also shown that K-12 school principals do influence the level of technology integration into their school's curriculum (Dawson & Rakes, 2003; Granger, Morbey, Lotherington, Owston, & Wideman, 2002). This study found that teachers who had more available resources from administration were more successful integrating computers into their classroom lessons. This theme may well support the quantitative finding in this study that experienced teachers significantly used more spreadsheet, subject-specific and educational software than did student teachers.

Although both teacher groups explicitly communicated a high degree of competence in using computers for teaching, their conversations revealed limitations. For student teachers, their self-confidence was at odds with their limited knowledge of using computers outside of the Internet. For practicing teachers, their self-confidence was constrained by their felt need for greater administrative support. The discrepancy between confidence and actual ability is of concern. According to Bandura (1986), it is important that an individual's self confidence is reasonably aligned with their actual ability, else one's self-efficacy could be damaged and result in a variety of negative consequences.

ASSESSMENT OF TECHNOLOGY BEHAVIORAL MODELS

The secondary purpose of this study was to investigate the efficacy of using the TAM and the DTPB for predicting intentions to use computers. Comparatively, the DTPB allows researchers to identify a variety of external and internal beliefs that the TAM does not allow for to make predictions regarding the teachers' computer usage (see Figures 1 and 2 for conceptual comparison). The DTPB addresses belief-based measures pertaining to attitudes (e.g., usefulness and compatibility) subjective norms (i.e., peer influence and superior's influence), perceived behavioral control (i.e., self-efficacy, resource constraint/support) and intentions. Compared to the TAM (that focuses on perceived usefulness, perceived ease of use, and intentions), the DTPB has the capability to provide educators and researchers with a more comprehensive view into belief systems that can contribute classroom computer usage issues.

Unlike the TAM, the DTPB includes perceived behavioral control factors (i.e., internal and external issues) that have shown to be important in explaining teachers' computer usage intentions. Previous research has identified the following external constraints for integrating computers into the classroom: (a) time, (b) training, (c) technology-related support, and (d) access to current hardware (Becker, 1994, 1998; Cuban, 2001; Ertmer, Addison, Lane, Ross, & Woods, 1999; Hadley & Sheingold, 1993; Smerdon, et al., 2000; U.S. Congress Office of Technology Assessment, 1995). Results from this study support previous research regarding teachers' beliefs about external limitations regarding their computer usage. Teachers in this study reported training and resource support as external factors that played a role in their behavioral intentions to use computers in the classroom. This study also supports the body of computing literature (Compeau & Higgins, 1995; Davis et al., 1989; Marcinkiewicz, 1994) that suggests teachers' internal beliefs regarding their self-efficacy and perceived usefulness of computer integration can contribute toward their behavioral usage intentions.

Mathieson (1991) stated that although TAM is capable of explaining user behavior across a broad range of end-user computer technologies and user populations, TAM does not explicitly include social behaviors. Social norms and perceived behavioral control variables can tap into important concerns that may be specific to situations, capturing idiosyncratic barriers of use. Educational technology research literature has addressed fundamental external and internal control barriers regarding the teacher population; thus, I recommend that the TAM instrument include an additional content domain that deals with these perceived behavioral control issues.

Since the inception of this study, Venkatesh et al. (2003) have made efforts toward creating a unified view of technology acceptance model; their unified theory of acceptance and use of technology (UTAUT) is a combination of the TAM and DTPB. This model extends the TAM to include social influence and perceived behavioral controls of self efficacy and support resources that explained 70% of the variance in their computer usage intention study. I support the authors' efforts to refine the measurement of core behavioral technology acceptance constructs, as it appears the UTAUT may give researchers a better tool to understand the dynamic influences of technology adoption.

There are many competing models in technology acceptance research that have their own set of determinants for technology adoption. Venkatesh et al. (2003) examined eight prominent behavioral models for technology acceptance, specifically: a) theory of reasoned action, b) technology acceptance model, c) motivational model, d) theory of planned behavior, e) model of PC utilization, f) innovation diffusion theory, g) social cognitive theory, and h) unified theory of acceptance and use of technology (combination of TAM and DTPB). Although one model makes for an efficient research study, I suggest that using multiple models in a study can make for a more thorough understanding of technology adoption and broaden technology acceptance research in our ever-growing technological culture.

LIMITATIONS OF THE STUDY

There were a series of non-random samples taken in the present study that could impair external validity, specifically: (a) the original study consisted of convenience sample of 160 student teachers and 158 classroom teachers, (b) from this original sample, 54 student teachers and 64 experienced classroom teachers volunteered to be interviewed.

IMPLICATIONS FOR PRACTICE AND RESEARCH

Implications for practice and research can be made from the findings in this study. Suggestions for the educational profession are partitioned into three areas: (a) Practical Applications for Teacher Preparation Programs, (b) Practical Applications for School Administrators, and (c) Practical Applications for Educational Technology Researchers.

Practical Applications for Teacher Preparation Programs

This study is consistent with findings from other studies that showed student teachers had greater intentions to integrate computers after their student teaching experience.

However, one type of college experience is not enough to assure that student teachers will be more likely to use computers in their own classroom. Research indicates that the effect on pre-service teachers' use of computers was more pervasive when multiple teacher preparation strategies were used with them (Kay, 2006; Mims, Polly, Shepherd & Inan, 2006). Thus, it is necessary to provide for university field placement initiations to develop new approaches/models to restructure teacher placement experiences to support the integration of technology in the classroom. However, other methods, such as enhancing faculty technology training, and providing pre-service teachers with mentoring/role modeling and online support can also be critical components that contribute to pre-service teachers' computer usage in the classroom.

Additionally, this study showed that student teachers are internally motivated to use technology in the classroom to prepare their students for future endeavors. Thus, it is recommended that college classrooms and training courses validate and reinforce student teachers' desire to have students succeed in a technology-driven world.

A point of significant interest is that experienced classroom teachers used spreadsheet, subject-specific and educational software more than did student teachers. Considering that classroom teachers are more experienced with their subject matter, and may be more adept at finding new tools that complement their teaching, experienced classroom teachers have the opportunity to inform student teachers of the various practical types of software that student teachers would not otherwise be aware of while in their teacher education program. Additionally, unlike the student teachers, experienced teachers' perceived usefulness of computer integration predicted student computer assignment. Moreover, experienced teachers asked their students to use subject-specific software more often than did student teachers. Thus, it appears that experienced teachers have the opportunity to mentor student teachers in integrating computer assignments in a purposeful manner.

Practical Applications for School Administrators

School administrators must provide the necessary resources to support technology-based teaching and learning. A variety of different ways for personally supporting teachers in using technology should be investigated and facilitated before administration can reasonably expect teachers to successfully integrate technology into their classroom.

This research found that it was essential for administrators to make provisions for: a) personalized computer training that is directed toward teachers' specific instructional needs, and b) support resources that include both knowledgeable support personnel as well as up-to-date technologies.

This research showed that teachers were internally motivated to persevere through their own uncomfortable feelings with computers to provide their students with the necessary technology skills to prepare them for real world experiences. It is hoped that administrators can build upon this dedication by working together with teachers to further encourage and inspire classroom teachers to use technology in the classrooms more readily.

Practical Applications for Educational Technology Researchers

Mathieson (1991) noted that the TAM instrument was able to explain user behavior across a broad range of computer usage professions. However, in this study the lengthy DTPB model compared to the more parsimonious TAM was able to provide educators and researchers with a deeper understanding into belief systems. From this research study, it is suggested that at a minimum, a planned behavioral control (PBC) content domain that addresses external and internal computer barrier usage issues specific to the teacher population (e.g., time, training, support, access, etc.) be added to the TAM instrument to provide for a more comprehensive computer usage questionnaire so that better teacher computer acceptance predictions can be made. Venkatesh et al. (2003) made efforts toward creating a unified view of technology acceptance model; their unified theory of acceptance and use of technology (UTAUT) may give researchers the best tool to date to understand the influences of technology adoption.

According to Kay (1993), different professions have a variety of needs, goals and motivations regarding computer usage. Kay further notes that there are several computer instruments that measure various types of attitude/behavior/usage constructs. Venkatesh et al. (2003) examined eight prominent behavioral models for technology acceptance and noted that educational technology researchers have a variety of behavioral models to choose from for their studies. Given the multitude of psychological issues that can affect acceptance of technology, the use and assessment of a variety of models for a particular technology adoption study can give researchers better insights into the most salient points regarding technology intention and behavior.

Not only are multiple behavioral models important to apply within a study but using mixed methods also adds depth to the research. This current research demonstrates the significance of conducting a mixed methodological study. The qualitative findings allowed the researcher to identify weaknesses in the quantitative model and explain the divergence between the survey findings and personal interviews. Mixed method studies can support and verify findings in a unique way; qualitative findings supplement quantitative results that can allow researchers to more readily identify purposeful conclusions.

FUTURE RESEARCH

More technology adoption research that aids local, state, national or international technology standards has potential to promote application and mastery of technology for citizens to compete in the global economy. Technology acceptance research that supports educational technology standards to promote national and international goals for students and teachers can be a complex venue, but can offer great insights into the challenges that face students and teachers so that they may improve themselves as productive citizens (Smarkola, 2008b).

The proliferation of portable electronic devices and wireless networking is creating a change from e-learning to m-learning (Lee & Chan, 2005) and handheld device studies show that m-learning extends the flexibility of anytime, anywhere learning (Motiwalla, 2007). To support m-learning adoption research, *personal innovativeness* (a stable trait) and *anxiety* (a state trait) may better help explain technology acceptance issues. In particular, personal innovativeness (i.e., a form of openness to change) can be used to extend the TAM model to give better insights in adapting new systems and processes in the educational environment (Raaij & Schepers, 2008). Additionally, to further educational technology adoption research, reproduction studies are needed using the unified theory of acceptance and use of technology (UTAUT) to reproduce Venkatesh's et al. (2003) fine work and leadership in technology acceptance research.

It is advised that actual computer usage data (e.g., observations, computer audit trail logs) instead of self-reported computer usage data be used with a technology acceptance instrument for more accurate reporting. Due to the No child Left Behind Act (U.S. Department of Education, 2002) there has been a boom of educational computerized assessment tools, data-analysis tools and built-in monitoring systems to manage student and teacher information in America. According to the Editorial Projects in Education Research Center: a) two-thirds of the states provide educators with access to interactive databases which can analyze school-level information, b) forty-four states provide teachers and administrators with tools that let them download data files from the statewide system, and c) over half the states provide access to students' test performance over time (Edwards, Chronister, & Hendrie, 2006). As a result of the recent national effort to establish computerized educational accounting systems (Trotter, 2006) it may now be easier to acquire actual computer usage data.

CONCLUSION

Findings from this study suggest that educational technology use issues should not merely be perceived as a classroom technology integration process but as a human process regarding beliefs and behaviors in computer usage for teaching and learning. Windschitl and Sahl (2002) suggested that an institutional vision (of a school district, school, etc.) could not be separated from beliefs about effective teaching, signifying the importance of all belief systems being discussed before a commitment is made to introduce teachers to technology. Once computer integration is incorporated into a school, teacher assessments of computer classroom integration are needed. Appropriate methodological approaches and theoretically justified models that support the teacher education culture help valid the assessment process.

Careful evaluation of the numerous behavioral models (Venkatesh et al., 2003) is essential before an educational technology research project begins. Proper use and assessment of these models and their complementary instruments in technology adoption studies are key in our hi-tech psychological field. Culp, Honey and Mandinach (2005) suggested future research in designing more sensitive evaluation instruments, and in defining conditions for effective technology use to increase the understanding of how technology can improve teaching and learning activities. Although there are several instruments to measure general computer beliefs and attitudes, educational technology researchers have found that several particular problem conditions exist for teachers (e.g., time, training, support, access, etc.) to effectively integrate computers into the classroom. Thus, it is recommended that any instrument/tool used to evaluate novice and experienced teachers' technology acceptance include items that measure teachers' perceived internal and external constraints regarding their computer classroom usage. An educational technology instrument needs to be sensitive to teaching and learning issues to provide teachers with the appropriate conditions for effective computer use.

Every profession has distinctive cultural environments with different objectives, ambitions, and drives that influence individuals' computer usage intentions and actual usage. Thus, to properly ascertain computer acceptance within an organization it is important that organizational behavior be thoroughly evaluated so that an appropriate model(s) can be used to best assess employees' computer behavior. Leaders in technology acceptance need to take into consideration that assessment of computer usage within any profession be based upon a behavior model(s) that complements the profession's cultural environment. Making a commitment to create technology acceptance studies that utilize suitable methodological approaches and appropriate cognitive belief-behavioral models establish a crucial foundation to provide for successful assessments and predictions in technology adoption.

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APPENDIX A INTERVIEWEE IDENTIFICATION KEY CODE (7 TO 11 CHARACTER CODE)

1st & 2nd Characters = PARTICIPANTS	ST = Student Teacher CT = Classroom Teacher
3th Character = GENDER	F = Female M = Male
4th Character = ETHNICITY	A = Asian B = Black O = Other H = Hispanic W = White
5th Character = SCHOOL DISTRICT	C = City S = Suburban R = Rural
6th & 7th Characters = SCHOOL LEVEL TEACHER	EL = Elementary (K - 5th grades) MI = Middle (6th - 8th grades) HI = High (9th - 12th grades)
8th & 9th Characters = EXPERIENCE (Classroom Teachers Only)	Ranges from 01 to 16 Years Teaching

(e.g., CT-FW-CEL17 = Classroom Teacher, – Female, White – City Elementary Teacher, 17 Years Teaching Experience)

WONG SU LUAN AND TIMOTHY TEO

3. STUDENT TEACHERS' ACCEPTANCE OF COMPUTER TECHNOLOGY

An Application of the Technology Acceptance Model (TAM)

ABSTRACT

This chapter report an empirical study focussing on the Malaysian student teachers' acceptance of computer technology in a leading research university. The TAM will be used as the basis of the theoretical framework. This study investigated 245 Malaysian student teachers' self-reported intentions to use (ITU) computers. Data collected from these student teachers at Universiti Putra Malaysia were tested against the Technology Acceptance Model (TAM) using the structural modelling approach. The study found perceived usefulness (PU) of computer technology, perceived ease of use (PEU), and attitude towards computer use (ATCU) to be significant determinants of ITU. Additionally, the results of the study revealed that (1) PEU significantly influenced PU; (2) both PU and PEU significantly influenced ATCU, and (3) both PU and ATCU significantly influenced ITU. The results suggest that the TAM is able to predict technology acceptance well among student teachers in Malaysia.

INTRODUCTION

Computer technologies have become one of the most influential pedagogical tools in the classroom (Oblinger & Rush, 1997) and its impact on learning has been profound (Mitra, et al., 2000). In recognition of the potentials of computer technology to reform education, the Malaysian government, in 1996, identified Information Technology and Communication (ICT) as one of the important foundations for its planned transition from a production-based economy to a knowledge-based one by the year 2020 (Multimedia Development Corporation, 2005). Arising from this plan, the Smart School Pilot Project was initiated in 1999 where 87 schools were transformed into smart schools. The Malaysian smart school was defined "as a learning institution that has been systematically reinvented in terms of teaching and learning as well as the improvement of the school management processes in order to help students cope and leverage on the Information Age" (Multimedia Development Corporation, 2005, p. 10). The Smart School Pilot Project emphasised a technology-supported education system and was introduced to help Malaysia fulfil the need for an ICT literate population (Wong, Kamariah & Tang, 2006). The national curriculum will still be used in Smart schools like in any other schools. However, students in

T. Teo (ed.), Technology Acceptance in Education: Research and Issues, 43–61.

smart schools will reap the benefits of self-paced learning and learning away from school with the intervention of the latest ICT tools (Multimedia Development Corporation, 2005).

In 2002, the Malaysian Ministry of Education (MMOE) commissioned a study to assess the impact of the Smart School Pilot Project on teaching and learning. The results were encouraging and it was clear that students and teachers had benefited from the technology-supported project. According to the study, approximately 90% of the students were found to be competent to use the ICT facilities in classrooms and computer laboratories for meaningful learning (Multimedia Development Corporation, 2006). Students were also able to work as a team and engage in peer learning within an ICT-enriched learning environment. The study also reported that teachers were confident enough to integrate ICT into their teaching-learning process with nearly 83% of the teachers possessing a high level of ICT competency (Multimedia Development Corporation, 2006).

Encouraged by the success of the Smart School Pilot Project, the MMOE launched a National Education Blueprint in 2006 to work towards all schools in the nation becoming smart schools by the year 2010 (Ministry of Education, 2006). As a consequence, all teachers in the Malaysian schools must be prepared to teach in the Smart Schools. Progressively, the need to raise the ICT skill level of the teachers and training them to be agents of change in an ICT-mediated learning environment has become more urgent.

Teachers' Use of Computer Technology

Diem (2000) stressed that teacher education plays a vital role in ensuring teachers to use technology in schools. At the same time, large investments are put into training teachers to integrate ICT in the classrooms and upgrading ICT infrastructures in the schools worldwide. In a recent study of English Language teachers in Malaysia, Melor (2007) found that ICT was not widely used for language learning. About 98% of all English language teachers sampled had reported minimal use of ICT to facilitate students for establishing networks with language experts outside of their schools and only a handful of teachers had used the Internet to source for teaching materials. Cuban, Kirkpatrick and Peck (2001) reported that although schoolteachers in two high schools in California, USA were afforded good computer access, most of them do not integrate technology in their teaching-learning process. Computers were instead used mainly to perform administrative tasks such as word processing, keeping grades, and for e-mail (Cuban et al., 2001). A similar situation was noted by Sadiq (2006) who found that Egyptian teachers used computer mostly for word processing and more than 40% of those surveyed did not use the computers unless they were told to use it. In fact, more than two thirds of the teachers in Egypt had attended in-service training courses in computer use but only one third of all teachers had used computers regularly for educational and administrative purposes.

Teachers in many developing countries have the privilege of accessing a diverse range of computer technologies for instructional purposes but evidence from the literature suggests that teachers do not use technology to its fullest potential. Indeed, teachers fail to see technology as an effective instructive tool and in many cases, often use technology for ancillary activities (Bosch, 1993; Becker, 2001; Wozney, Venkatesh & Abrami, 2006).

With the proliferation of technology in the schools, teachers need to ensure that they are adequately equipped to utilise technology tools effectively for instructional purposes. In the case of Malaysian teachers, this need is more acute with a recent initiative by the Malaysian Ministry of Education for all schools to be transformed into Smart Schools. As a teacher's role becomes more complex and diverse, initial teacher training institutions have to keep up with the pace in order to provide adequate training that enable future teachers to match the skills and knowledge required for their employment. In essence, teachers have to acquire new competencies to keep up with constantly changing technologies in education. Not only are teachers expected to possess the right level of knowledge, they are also expected to exhibit a positive attitude toward technology. In the view of Baylor and Ritchie (2002), unless teachers have the necessary skill, knowledge, and attitudes, technology will not be used regardless of how sophisticated it is. For this reason, there is an urgent need to understand Malaysian teachers' technology acceptance. In this paper, technology is used to refer to computers and computer-related objects.

LITERATURE REVIEW

Technology Acceptance Model

The Technology Acceptance Model (TAM) by Davis (1989) is arguably the most widely-used and empirically-supported model for investigating users' technology acceptance (McCoy, Galletta & King, 2007). The TAM is rooted in the Theory of Reasoned Action (TRA) by Ajzen and Fishbein (1980). The TRA, a general model showing how attitude impacts behaviour, posits that the most pertinent determinant of an individual's behaviour is behavioural intention to perform a certain task. It further adds that this intention to perform behaviour is influenced by an attitude toward performing the behaviour and subjective norm. The TRA has been found to be a useful model in various domains, including adoption of Information Technology (Davis, Bagozzi & Warshaw, 1989; Chau, 1996; Gefen & Straub, 1997).

Davis (1989) extended the TRA to examine and predict office users' acceptance of computers by introducing the Technology Acceptance Model (TAM) (Figure 1). In the TAM, technology usage is determined by behavioural intentions to use a system that in turn is jointly determined by the user's attitude towards computer use and perceived usefulness. Attitude towards computer use is also jointly determined by perceived usefulness and perceived ease of use. Lastly, perceived usefulness is influenced by perceived ease of use and external variables such as system features, training, documentation and user support. Therefore, the three variables that are fundamental to the TAM are perceived usefulness, perceived ease of use and attitude towards computer use. From many technology acceptance studies, these variables are hypothesized to be the major determinants of user's intention to use technology.

The TAM has been widely applied in empirical research across a range of technologies. These include the Graphic User Interface (Agarwal & Prasad, 1999),

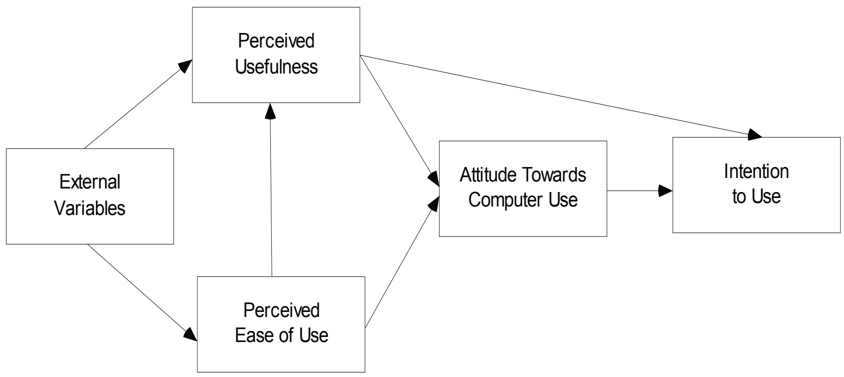

Figure 1. Technology acceptance model (Adapted from Davis, Bagozzi & Warshaw, 1989).

mainframe application (Dishaw & Strong, 1999), accounting applications (Jackson, Chow & Leitch, 1997), World Wide Web (Riemenschneider, Harrison & Mykytyn Jr., 2003), and computer resource centre (Taylor & Todd, 1995). More recently, researchers have expanded the use of the TAM in educational research such as students' satisfaction with online learning (Drennan, Kennedy & Pisarksi, 2005), students' acceptance of online course companion site of a textbook (Gao, 2005), the effect of technical support on students' acceptance towards WebCT (Ngai et al., 2007), and students' perceptions of the effectiveness of a courseware management system (Abdalla, 2007). The TAM has also been used to examine the attitudes of pre-service teachers towards the use of technology (Teo, Lee & Chai, 2008), predict the sources of teachers' instructional technology use (Shiue, 2007), and examine student teachers' technology acceptance (Ma, Andersson & Streith, 2005). However, research on the application of the TAM in education contexts is still considered rather scarce (Teo, 2010; Teo et al., 2008). Teo et al. (2008) suggested that one reason may lie in the difference between the general technology users and teachers. This is mainly because teachers decide for themselves when and how to use technology in their teaching-learning process. Compared to most users in business organizational settings, teachers are not compelled to use technology everyday (Teo et al., 2008).

PURPOSE OF THE STUDY

This study aims to apply the TAM to a sample of Malaysian student teachers. The results of this study may provide insights into the factors that influence the technology acceptance among Malaysian student teachers. A search of databases such as Eric Reproduction Service, Proquest Education Journals, Science Direct, and Ebscohost has revealed that currently no study has employed the TAM as a research framework to examine the technology acceptance of Malaysian student teachers. In addition, the results of this study have the potential to inform the research community on the validity of the TAM in a non-Western context such as Malaysia.

MODEL AND HYPOTHESES DEVELOPMENT

The research model of the present study is shown in Figure 2. Using the TAM (Davies, 1989) as the framework, behavioural intention is used as the dependent variable, with perceived usefulness, perceived ease of use, and attitudes toward use are used as independent variables. For the purposes of structural equation modelling, perceived ease of use is considered as an exogenous variable, while perceived usefulness, attitude towards use, and behavioural intentional to use are endogenous variables.

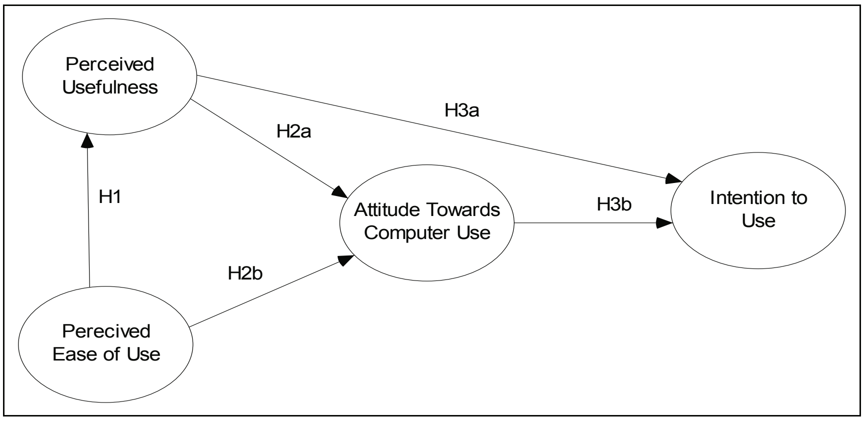

Figure 2. Proposed research model.

Hypothesis for Perceived Usefulness (PU) and Perceived Ease of Use (PEU)

The definitions of perceived usefulness (PU) and perceived ease of use (PEU) are adapted from the original definitions proposed by Davis et al. (1989). In this study, PU is defined as the degree to which a student teacher believes that using computer technology will enhance his or her job performance in school. There is evidence to suggest that teachers tend to use technology when they believe that it can enhance their job performance such as facilitating students to achieve learning goals, conducting administrative duties and managing students (Ma et al., 2005).

PEU refers to the degree to which the student teacher believes that using computer technology will be free from effort. It is possible that while users may believe that technology is useful, they may be, at the same time, perceived the use of technology to be too difficult and that the performance benefits of usage are outweighed by the effort of using the technology (Davis, 1989). This means that, if teachers perceived computer technology as difficult to use, then such technology may not be helpful to enhance their job performance in schools (Ma et al., 2005). Furthermore, the relationship between PU and PEU is that PU mediates the effect of PEU on attitude towards use (Moon & Kim, 2001, Teo, 2008). While PU has a direct impact on attitude towards use, PEU influences attitude towards use indirectly through PU.

H1: Student teachers' perceived usefulness of computer technology will be significantly influenced by their perceived ease of use of computer technology.

Attitudes Towards Computer Use (ATCU)

Studying attitude is important because it predicts an individual's response to an object (Ajzen & Fishbein, 1977; 2005). Attitudes guide behaviour and "favourable attitudes predispose positive responses to the object and unfavourable attitudes predispose negative responses" (Ajzen & Fishbein, 2005, p. 17). From the technology acceptance viewpoint, attitude towards use is a potential user's affective evaluation of the cost and benefits of using the technology (Ndubisi, 2006). Yildrim (2000) stressed that it is unlikely for teachers with negative attitudes toward computer use to be able to transfer their computer skills to students, let alone encourage students to use computers. In the context of this study, it is reasonable to expect that student teachers with positive attitudes toward the computer use are more likely to accept and use computers in the classrooms (Wong et al., 2003). For this reason, the success of computer technology integration in the learning environment depends strongly upon the attitudes of teachers involved (Huang & Liaw, 2005). Askar and Umay (2001) further suggested that if teachers failed to see computers as a tool to fulfil their own or their students' needs, the likelihood of them rejecting technology in their teaching-learning process is high.

H2a: Student teachers' attitude towards computer use will be significantly influenced by their perceived usefulness of computers.
H2b: Student teachers' attitude towards computer use will be significantly influenced by their perceived ease of use of computers.

Intention to Use (ITU)

The dependent variable in this study is an individual's intentions to use (ITU) technology. The TAM implies that PU and PEU are two technology-related antecedents that influence an individual's intention to use technology (McCoy et al., 2007). Based on the TAM, there is a direct influence by PU and ATCU on ITU. Additionally, ITU is indirectly influenced by PEU, which is mediated by PU.

Studies have shown that ITU has a strong link on actual behaviour (Mathieson, 1991; Hu et al., 2003; Gao, 2005). In other words, ITU leads to actual use of a system (Chau, 2001). ITU is used as the dependent variable in this study because it is a practical way to measure technology acceptance. Although student teachers in this study have used technology for personal and academic purposes, most of them possess little or no experience in using technology in the actual school environment. As such it is deemed to be more accurate to measure student teachers' intention to use technology, rather than their actual usage.

H3a: Student teachers' intention to use will be significantly influenced by their perceived usefulness of computers.
H3b: Student teachers' intention to use will be significantly influenced by their computer attitudes.

METHOD

Subjects and Procedures

Participants of this study were student teachers from the Faculty of Educational Studies, Universiti Putra Malaysia (UPM) who had completed their post secondary education. Currently, there are two kinds of entry mode into a teaching programme in Malaysia. Those who have completed the matriculation or pre-university (Form 6) programmes are eligible to apply for such a programme. Student teachers in this study are, therefore, considered representative of Malaysian student teachers, as they possess either one of these post secondary qualifications.

Student teachers were selected in the study for two reasons. Firstly, all student teachers, upon graduating from the teacher training institutions, will be employed by the Malaysian Ministry of Education as permanent teachers in the schools. Secondly, computer technology courses are provided in all teacher-training programmes in Malaysia. Hence, student teachers would be well trained in using technology for instructional purposes by the time they become practicing teachers in the schools. As such, student teachers serve as good proxy whose opinions may mirror those of the future teachers (Teo et al., 2008).

There were 245 participants in this study (183 females and 62 males) and all of them own a computer at home. They had an average of 6.6 years of computer experience (S.D.= 3.8) and reported their average daily computer to be 3.1 hours (S.D. = 2.4). The mean age of the participants was 23.4 years (S.D.= 5.5).

Data were collected via an online survey questionnaire written in PERL (Practical Extraction and Report Language) and PHP (Hypertext Preprocessor). Participants were asked to volunteer and those who agreed to participate were given a URL to access the questionnaire. The online survey was used because of its relative low cost and the speed of data collection (Gaddis, 1998).

Instrumentation

The online survey questionnaire comprised 15 Likert-type items with each item yielding a score of 1 (strongly disagree) to 5 (strongly agree). These items were adapted from various published sources, as indicated in Table 1.

Table 1. List of constructs and corresponding items

Construct	*Item*	
Perceived Usefulness (adapted from Davis, 1989)	PU1	Using computers will improve my work.
	PU2	Using computers will enhance my effectiveness.
	PU3	Using computers will increase my productivity.
	PU4	I find computers a useful tool in my work.

Table 1. (Continued)

Perceived Ease of Use (adapted from Davies, 1989)	PEU1	My interaction with computers is clear and understandable.
	PEU2	I find it easy to get computers to do what I want it to do.
	PEU3	Interacting with computers does not require a lot of mental effort.
	PEU4	I find computers easy to use.
Intention To Use (adapted from Davies, 1989)	ITU1	I will use computers in future.
	ITU2	I plan to use computers often.
Attitude Towards Computer Use (adapted from Thompson et al., 1991; Compeau and Higgins, 1995)	ATCU1	Computers make work more interesting.
	ATCU2	Working with computers is fun.
	ATCU3	I like using computers.
	ATCU4	I look forward to those aspects of my job that require me to use computers.

RESULTS

The statistical analysis comprised two stages. The first stage examined the descriptive statistics of the measurement items and assessed the reliability and construct validity of the measure used in this study. The second stage tested the proposed research model and this involved assessing the contributions and significance of the manifest variables path coefficients.

Descriptive Statistics

The descriptive statistics for each construct items are shown in Table 2. All means were greater than 3.0, ranging from 3.81 to 4.44. This indicates an overall positive response to the constructs that are measured in this study. The standard deviations for all variables were less than one, indicating a narrow dispersion of item scores around the mean scores.

Table 2. Descriptive statistics of the constructs

Construct	*Mean*	*SD*
Perceived Usefulness (PU)	4.29	.61
Perceived Ease of Use (PEU)	3.81	.63
Attitude Towards Computer Use (ATCU)	3.95	.60
Intention To Use (ITU)	4.44	.62

Factor Structure

The items were subjected to Principal Axis Factor (PAF) analysis with oblique rotation. PAF is a form of factor analysis that seeks the least number of factors that account for the common variance (correlation) of a set of variables. PAF is used when the purpose of the research is to identify latent variables that contribute to the common variance of the set of measured variables, excluding variable specific (unique) variance (Kline, 2005). As such, PAF is preferred for purposes of structural equation modelling (SEM) as it accounts for the covariation among variables. For these reasons, PAF was considered suitable for this study.

Table 3. Principal axis factor analysis of all items

	PU	*PEU*	*ATCU*	*ITU*
PU1	**.858**	.505	.674	.555
PU2	**.931**	.443	.573	.524
PU3	**.934**	.399	.593	.534
PU4	**.568**	.335	.479	.508
PEU1	.410	**.788**	.466	.315
PEU2	.458	**.694**	.454	.444
PEU3	.224	**.496**	.319	.180
PEU4	.325	**.808**	.416	.342
ATCU1	.594	.397	**.820**	.471
ATCU2	.542	.505	**.806**	.471
ATCU3	.503	.466	**.819**	.499
ATCU4	.405	.475	**.610**	.411
ITU1	.566	.368	.595	**.615**
ITU2	.561	.420	.569	**.938**
Eigenvalues	6.780	1.491	1.015	0.772
% of Variance Explained	48.43	10.65	7.25	5.51

Note: Rotation Method: Oblique.

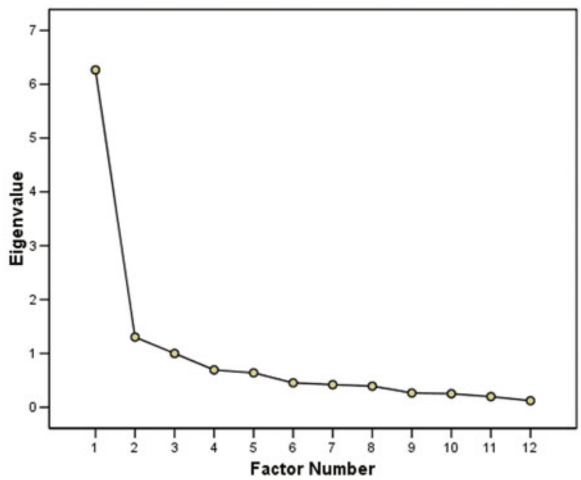

Figure 3. Scree plot of the eigenvalues.

Table 3 shows the PAF analysis of the four constructs. The total variance explained by the four components is 71.84%. All the items have factor loadings over 0.60 except for PU4 and PE3. This research accepted factor loadings of 0.6 and above as practically significant (Hair et al., 2006). For this reason, items PU4 and PE3 were eliminated for further analysis. The total variance explained by the four components after deleting the aforementioned items increased slightly to 77.19%.

The eigenvalues for all components were greater than one except for ITU. A scree test was conducted to examine the plot of the eigenvalues. A closer scrutiny of the graph seems to indicate that the curve begins to straighten at the fifth factor as shown in Figure 3. For that reason, the authors decided to retain four components as a scree test more frequently yields accurate results than the eigenvalue-greater-1 criterion (Green, Salkind & Akey, 2000).

Convergent Validity

In this study, the item reliability of each measure, composite reliability of each construct and the average variance extracted were used as measures to assess convergent validity (Bagozzi & Yi, 1988; Chau, 1997; Fornell & Larcker, 1981).

First, in order to assess the item reliability of an item, its factor loading should be greater than 0.5 (Hair et al., 2006). The factor loadings of all items retained in the measure ranged from 0.610 to 0.938 (Table 3). These values exceeded the threshold set by Hair et al. (2006) and demonstrate adequate convergent validity at the item level.

Secondly, Cronbach's alpha was used to assess the composite reliability of each construct. DeVellis (2003) suggested that an alpha value of .70 is considered acceptable. As shown in Table 4, the reliability scores of all the constructs are between .73 and .88, exceeding the guidelines (>.70) by DeVellis (2003).

The final indicator of convergent validity was determined through the calculation of average variance extracted (AVE) (Fornell & Larcker, 1981). It measures the amount of variance captured by the construct in relation to the amount of variance attributable to measurement error. Convergent validity is judged to be adequate when average variance extracted equals or exceeds 0.50 (i.e. when the variance captured by the construct exceeds the variance due to measurement error). The results

Table 4. Construct reliability and average variance extracted

Construct	*Cronbach's α*	*AVE*
Perceived Usefulness (PU)	.93	.83
Perceived Ease of Use (PEU)	.81	.59
Attitude Towards Computer Use (ATCU)	.84	.59
Intention To Use (ITU)	.75	.63

AVE: Average Variance Extracted. This is computed by squaring the sum of factor loading divided by number of factors of the underlying construct.

in Tables 3 and 4 appear to meet the recommended criteria in the literature, suggesting convergent validity for the proposed constructs and indicators in this study.

Divergent Validity

Two tests were used to demonstrate divergent validity at the construct and item levels. Divergent validity is the extent to which measures of different constructs are distinct (Campbell & Fiske, 1959) and there should be low correlation with measures of different constructs (Aiken, 1994). To establish divergent validity, it should be shown that measures that are not related should not be related (Trochim, 1999).

At the item level, Barclay, Higgins, and Thompson (1995) suggested that divergent validity is present when an item correlates more highly with items in the construct it intends to measure more than items belonging to other constructs. Table 5 shows the correlation matrix for all item scores of each construct. The item scores from the same construct exhibited moderate to high levels of correlation among themselves compared to the item score form other constructs. Based on these values, divergent validity at the item level is considered adequate.

At the construct level, divergent validity is considered adequate when the variance shared between a construct and any other construct in the model is less than the variance that construct shares with its measures (Fornell, Tellis, & Zinkham, 1982). The variance shared by any two constructs is obtained by squaring the correlation between the two constructs. The variance shared between a construct and its measures corresponds to average variance extracted. Divergent validity was assessed by comparing the square root of the average variance extracted for a given construct with the correlations between that construct and all other constructs. Table 6 shows the correlation matrix for the constructs with the diagonal elements have been replaced by the square roots of the average variance extracted. For divergent validity to be judged adequate, these diagonal elements should be greater than the off-diagonal elements in the corresponding rows and columns. Divergent validity appears satisfactory at the construct level in the case of all constructs. This indicates that the each construct shared more variance with its items than it does with other constructs.

*Table 6. Inter-construct correlation matrix**

	PU	*PEU*	*ATCU*	*ITU*
PU	(.91)			
PEU	.49*	(.77)		
ATCU	.63*	.53	(.77)	
ITU	.63*	.46*	.62*	(.79)

Notes: * = $p < .01$; Diagonal in parentheses: square root of average variance extracted from observed variables (items); Off-diagonal: correlations between constructs.

Table 5. Inter-correlations among the items

	PU1	*PU2*	*PU3*	*PEU1*	*PEU2*	*PEU4*	*ITU1*	*ITU2*	*ATCU1*	*ATCU2*	*ATCU3*	*ATCU4*
PU1	1	**.807****	**.799****	.459**	.477**	.358**	.565**	.555**	.599**	.582**	.540**	.420**
PU2		1	**.864****	.391**	.417**	.362**	.508**	.512**	.539**	.478**	.457**	.392**
PU3			1	.372**	.441**	.273**	.506**	.522**	.550**	.504**	.482**	.379**
PU4				.269**	.327**	.268**	.431**	.483**	.401**	.409**	.397**	.345**
PE1				1	**.589****	**.627****	.351**	.318**	.320**	.457**	.416**	.321**
PE2					1	**.544****	.341**	.454**	.362**	.402**	.368**	.403**
PE3						**.424****	.171**	.194**	.265**	.236**	.235**	.333**
PE4						1	.292**	.358**	.290**	.406**	.341**	.373**
ITU1							1	**.598****	.552**	.491**	.468**	.346**
ITU2								1	.459**	.476**	.506**	.412**
ATCU1									1	**.684****	**.626****	**.492****
ATCU2										1	**.676****	**.439****
ATCU3											1	**.571****
ATCU4											.	1

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

MODEL FIT

Test of the Proposed Model

Structural equation modelling (SEM) was performed to test the fit between the research model (Figure 1) and the obtained data. In this study, AMOS 7.0 (Arbuckle, 2006) was used to estimate the model using the maximum likelihood (ML) procedure. Because SEM requires large samples, Hair et al. (2006) indicated that any study with five or fewer constructs, each with more than three items, and high item communality with .60 and higher, could adequately be estimated with a sample size of 150. On this basis, the sample size of this study (N=245) was considered adequate**.** Although ITU comprised only two items, it does not pose an identification problem in the model, given its adequate convergent and divergent validity and relationship with other constructs.

In using SEM, it is a common practice to use a variety of indices to measure model fit (Byrne, 1998; Thompson & Daniel, 1996; Kline, 2005). This is due to the fact that χ^2 is very sensitive to sample size. In this study, the Goodness of Fit (GFI), Normed Fit Index (NFI), Standardised Root Mean Residual (SRMR), and the Comparative Fit Index (CFI) are used. Table 7 shows the level of acceptable fit and the fit indices for the proposed research model in this study (Shumacker & Lomax, 2010). Except for χ^2, all values satisfied the recommended level of acceptable fit. In the case of χ^2, it has been found to be too sensitive to sample size differences, especially for cases in which the sample size exceeds 200. Hair et al. (2006) noted that, as the sample size increases, there is a great tendency for the χ^2 to indicate significant differences. Therefore, this anomaly is assumed to be applicable in the present study with a sample of 245. However, the results of the χ^2 / df value in the present study is well within the recommended χ^2 / df < 5. As can be seen from Table 7, there is a good fit for the proposed research model.

Figure 2 shows the resulting path coefficients of the proposed research model. All hypotheses were supported by the data. The results show that perceived ease of use significantly influenced perceived usefulness ($\beta = 0.526$, $p < 0.05$), supporting hypothesis H1. Attitude towards computer use was influenced by perceived usefulness ($\beta = 0.515$, $p < 0.05$) and ease of use ($\beta = 0.315$, $p < 0.05$), supporting hypotheses H2a and H2b. Intention to use was found to be influenced by perceived usefulness ($\beta = 0.350$, $p < 0.05$) and attitude towards computer use ($\beta = 0.446$, $p < 0.05$), thus supporting hypotheses H3a and H3b.

Table 7. Fit indices of the proposed research model

Fit index	*Recommended level of Fit*	*Proposed research model*
χ^2	n.s at p < .05	93.496, p < .01, significant
χ^2 /df	< 5	2.078
GFI	> 0.90	.941
NFI	> 0.90	.951
SRMR	< 0.05	.04
CFI	> 0.90	.973

Three endogenous variables were tested in the model. PU was found to be significantly determined by PEU, resulting in an R^2 of 0.323. That is, PEU explained 32.3%% of the variance in PU. ATCU was significantly determined by PU and PEU and the percent of variance explained was 55.4% ($R^2 = .554$). The dependent variable, ITU was significantly determined by PU and ATCU resulting in an $R^2 = .685$. That is, the combined effects of PU and ATCU explained 68.5% of the variance of ITU. A summary of the hypotheses testing is shown in Table 8.

Consistent with the findings of major TAM studies, the proposed model of this study demonstrates that intention to use technology is significantly influenced by PU and ATCU, the latter being significantly influenced by PU and PEU (see Figure 4). Finally, PU is significantly influenced by PEU.

Table 8. Hypothesis testing results

Hypotheses	*Causal path*	*Path coefficient*	*Results*
H1	PEU → PU	.526*	Supported
H2a	PU → ATCU	.515*	Supported
H2b	PEU → ATCU	.315*	Supported
H3a	PU → ITU	.350*	Supported
H3b	ATCU → ITU	.446*	Supported

* $p < .01$

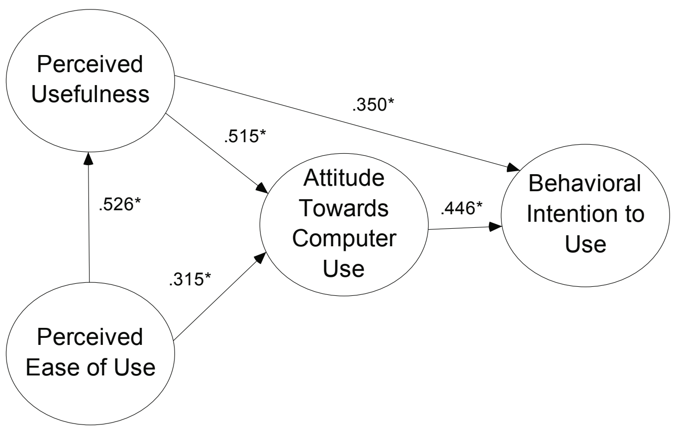

Figure 4. Path coefficients of the research model.

DISCUSSION

This study aims to explore Malaysian student teachers' intention to use technology. The results support all the hypotheses proposed in this study. It was found that perceived usefulness, perceived ease of use, and attitude towards computer use to be significant determinants of the intention to use technology. However, perceived usefulness was found to be a significantly stronger influence than perceived ease of use on attitude towards computer use. Perceived usefulness has a direct impact on intention to use while perceived ease of use influences intention to use indirectly through attitude towards computer use and perceived usefulness. Attitude towards computer use also has a direct effect on intention to use.

The results of this study suggest that perceived ease of use is an important predictor of student teachers' intention to use technology. This finding is compatible with existing studies that applied the TAM in the educational context (Teo et al., 2008; Yuen et al., 2005) as well as those outside education (Malhotra & Galletta, 1999; Legris et al., 2003). Yuen and Ma (2002) explained that teachers would probably use computers once they believe that such machines are free from effort. This means that student teachers that participated in this study would mostly likely use computers either for personal or academic purpose when they perceive that they could use such tools with relatively free of effort. However, Yuen et al. (2005) cautioned that "teachers would not have a higher intention to computer technology use, solely because computer technology was easy to use" (p. 392). Teo et al. (2008) concurred, adding that if computer technology is perceived to be free from effort, the likelihood of teachers believing its usefulness is higher. The findings of this research found a strong link between perceived ease of use and perceived usefulness. In addition, the significant relationship between perceived ease of use and attitude towards computer use in this study supports the notion that positive computer attitudes are associated with perceived ease of use (Teo et al., 2008; Teo, 2008). Student teachers' attitudes towards computer use are influenced by the way they perceived how easily computers could be used to benefit themselves (Sime & Priestly, 2005). Therefore, it is important to ensure that training in the use of technology for student teachers are designed to foster the development of positive perceptions towards the ease of use, with a view to strengthen student teachers' intentions to use technology (Yuen & Ma, 2002).

As shown in this study, perceived usefulness has a greater influence on intention to use. This finding is in congruence with that of Davis and colleagues' (1989). Askar and Umay (2001) suggested that if teachers failed to see computers as useful tools, they will be reluctant to integrate technology into their teaching and learning process. Conversely, when teachers do not have an overview of how computers can be integrated into the teaching and learning process, these tools may not be perceived as useful (Yuen & Ma, 2002). This suggests that when student teachers understand how useful computers are to them, they will most likely use these tools in their formal (academic purpose) or informal settings (leisure and entertainment purposes). It is necessary to ensure that student teachers are exposed to effective use of computers and receive adequate training in both scholastic and non scholastic environments.

This study also found that attitude towards computer use influenced intention to use significantly, indicating that students with positive computer attitudes are more inclined to use computers. This finding clearly supported prior research that found a strong relationship between computer attitude and computer use (Yildrim, 2000; Wong et al., 2003; Huang & Liaw, 2005). Bai and Ertmer (2008) stressed that in order for future teachers to effectively integrate technology into teaching practices, it is important for teacher preparation programs to facilitate positive attitudes toward technology. Supporting this notion, Wong et al. (2006) reported that student teachers who had undergone discrete ICT training exhibited more positive attitudes toward technology and were convinced that such technology was useful to them. Suffice to say, technology training that encourages student teachers to use computer technology can help to enhance positive attitudes and promote their beliefs about the usefulness of such tools.

CONCLUSION

The results of this study are consistent with prior research in TAM applications which suggests that the TAM is a parsimonious model to predict student teachers' technology acceptance. In this study, the TAM is found to be a valid model in predicting student teachers' intentions to use computers. Specifically, perceived usefulness, perceived ease of use and attitude towards computer use were found to be significant determinants of student teachers' intentions to use computers. For this reason, technology-training programmes should focus on developing positive perceptions of computer usefulness and its ease of use as well as to encourage positive attitudes towards computer use among student teachers.

LIMITATIONS

Firstly, student teachers were used as participants. Several researchers have warned that their views might differ from those of practicing teachers (Teo et al., 2008; Yuen et al., 2002) mainly because practicing teachers' technology use is drectly impacted by the school environment (Teo *et al.*, 2008). The student teachers in this study may not have been exposed to the demands and challenges in the real school setting equipped with computer technologies. In addition, teachers' views of technology use have been reported to differ between those who are in the mandatory and voluntary technology use settings (Legris et al., 2003).

Despite careful attention given to the methodology, it is important to note that the data collected was based entirely on participants' honesty and their perceptions toward computer technology. It also must be recognised that the participants involved were undergraduate students who majored in education in one public university and had volunteered to participate in this study. Therefore, caution must be exercised when attempting to generalise any findings for the entire population at the faculty where this study was conducted.

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4. UNDERSTANDING THE COMPLEXITY OF TECHNOLOGY ACCEPTANCE BY HIGHER EDUCATION STUDENTS

ABSTRACT

It is often claimed that all young people are highly adept with the digital technologies that infuse their lives, and that the way they think and behave has created a new gap between them and their teachers. It is suggested that to bridge this gap and ensure that young people are fully engaged, educators must incorporate digital technology more effectively into teaching and learning. This is problematic, however, because technology has had limited impact on education and has failed to be widely adopted as a learning support across many aspects of school and university education. More needs to be known about how technology is seen by young people and their teachers in order to understand the true nature of the problem that has been identified. This chapter will report on recent research investigating the reasons why digital technologies are adopted by university students in their everyday and academic lives. The findings provide insights into how the 'rules of the game' in different contexts influence the ways in which individuals perceive the utility of a technology and the ways in which they use it. This research draws on sociological concepts as an orienting theoretical framework to investigate and conceptualise these differences and consider what they mean for the integration of digital technologies in education.

INTRODUCTION

The idea that all young people can be regarded as 'digital natives' (Prensky, 2001) who are highly adept with digital technologies by virtue of their lifelong exposure to them has captured the academic and popular imagination (eg. Barnes, Marateo, & Pixy Ferris, 2007; Downes, 2005; Toledo, 2007). Though the idea emerged almost a decade ago, only recently has it drawn attention from researchers. This emerging body of work has so far been helpful in dispelling the myth of homogenous generations of 'tech-savvy' young people and in demonstrating the persistence of significant digital divides within populations (eg. Kennedy et al., 2009; Salaway & Caruso, 2008; Jones et al., in press).

This research has, however, contributed little to date to our understanding of how and why individuals choose the technologies they use. This is a significant oversight because a key assumption of the digital native hypothesis is that all young people use all digital technologies in the same ways, for the same purposes and with the

T. Teo (ed.), Technology Acceptance in Education: Research and Issues, 63–77.

same frequency. This gives scant regard to variations in disposition, interest, opportunity and skill. It is a natural result of the simplistic generalisations on which the digital native idea is based, which serve to homogenise all young people into a single type.

Thus important questions remain about the nature and cause of detectable variations in what young people do with digital technologies and what they choose to access. A simple way of thinking about this is that at some level individuals make calculations about the extent to which a technology suits they purposes and needs. These deliberations involve determining a technology's value in terms of what it can achieve for an individual personally, but is also affected by a person's means and capacity to make choices and act upon them.

Bourdieu's concept of 'habitus' provides a useful orienting framework for understanding the diversity of young people's technology use. According to Bourdieu (1990), actors occupy a variety of social fields, each with its own 'rules of the game' or ways of working that structure these different contexts. For Bourdieu practices are shaped by: actors' 'habituses' (or dispositions structured by experiences); their 'capital' (or knowledge and know-how); and the state of play in struggles for status in the 'fields' they occupy (Lingard & Christie, 2003; Maton, 2008). Practice results from relations between a person's disposition (habitus) and his or her position in a field (capital), within the current state of play of that social arena (field). Importantly practices are not simply the result of one's habitus but rather of relations between one's habitus and one's current circumstances.

Drawing from Bourdieu's terms, technology practices need to be understood within their context of use, sensitive to the influence of an individual's habitus. Thus for any individual there is a complex interplay between the nature of the context they are engaged in and what they bring to that context, and this is an active changing process. Thus, investigations of young people's technology practices must ask questions not only about levels of access to technology and the frequency with which various technology-supported activities are undertaken, but must also account for the contexts in which those activities occur, and the value placed on a technology for performing an activity according to the logic of practice within that context. It is possible, and indeed likely, when considered in this way that there will be variations in the ways individuals perceive and use technologies based on what they bring to a context and how they experience that context. With these ideas in mind, this study set out to explore how undergraduate university students used and perceived technologies across everyday and academic contexts.

METHODOLOGY

Semi-structured interviews were conducted with 15 students from a large second year sociology subject in late 2007. The subject was chosen because it not only includes a large cross-section of Arts students, but is a popular elective for students specialising in other disciplines, such as Law and Education. It also had the advantage of not being skewed towards technology-based topics areas such as informatics or engineering, and so was likely to contain young people with varied levels of skills and interest in digital technology.

The interviews were conducted in six focus groups to generate discussion between participants about the questions. All students in the subject were invited to participate in the research and it was made clear that participation was completely voluntary. Students were approached in their tutorial groups with the interviews conducted outside of class time immediately following the tutorial in groups from the same class. Interviews were of around 60 minutes duration.

A semi-structured interview protocols was used to ask participants about the range of information and communication technologies they used the most, using a list of common technologies as a stimulus, and asked to comment on why they used those particular technologies. They were also asked about which technologies they did not use and why, about what activities they undertook with the technologies they did use, about how they thought technologies might be used in the subject they were currently studying, and other ways they thought technologies might be effectively used to support them in their university studies. The purpose of the interviews was to collect data about not only what technologies young people were using, but also in what contexts they were used and how and why they were valued for particular purposes.

In the quotations reported in the following sections participants are identified using their focus group number rather than by a participant number. Due to confidentiality constraints imposed by the human research ethics procedures at the university, students were not individually identified during the interviews, making it difficult to accurately identify individuals from the group interview recordings.

RESULTS

Technologies Used

Students were initially asked to describe their access to key information and communication technologies, and to explain why they used particular technologies. Table 1 summarises the technologies the students in the focus groups had access to.

Table 1. Summary of technologies used (n=15)

Technology	*Number of participants with access*
Desktop computer	6
Portable computer (i.e. laptop or notebook)	9
Electronic Organiser or handheld computer	1
Broadband Internet access (ADSL, cable or wireless)	6
Dialup Internet access	9
Dedicated MP3 player (e.g. iPod)	10
Digital camera (still and/or video)	4
Mobile phone	15

Portable computer One participant who did not currently have a laptop stated buying one was a priority as its portability would mean she could use it for wireless Internet in a range of locations including cafes, the university and libraries, and also to share it with a friend. Laptop users commented on the portability of a laptop and the ability to connect to wireless Internet as a reason for laptop popularity.

Handheld computer Only one of the participants used a handheld computer and was enthusiastic about using it to take notes in lectures to use later for exams and essays, but suggested that it had taken her some time to become used to operating the small keyboard. Another participant had been given a handheld computer but found that it was not useful and did not subsequently use it:

> I was given one and it was kind of too much technology for me. I didn't need all that technology. I didn't need to check my emails on the run. I didn't need to be able to have video calls. I didn't need all the crap and my life isn't so complicated that I need a diary or an organiser to work myself out. So I kind of I just needed the phone to call people and so it was just kind of wasted technology. (Group 4 (G4))

A similar conclusion was expressed by another participant, "You can do it all with your mobile phone now anyway" (G5). In the ensuing discussion about handheld computers, many participants commented on preferring paper diaries rather than electronic organisers, for example "I find a paper diary works much better for me" (G1). Reasons for preferring paper diaries were that the process was quicker and less "fiddly" (G1) because learning how to use a handheld computer or PDA was time consuming. One participant said, "I'm just too lazy to type it all in really" (G5). Another commented:

> And you only write little things [in a diary], like you only write blah blah blah and gym, whereas if you get one of them [PDA], you've got to turn it on, you've got to find the thing, you've got to put it in, then you have got to… it's too complicated (G1).

Another participant commented that a paper diary provides a convenient visual reminder "right in front of you" (G1) which seemed "more organised" than a PDA (G1). In one focus group all the participants used the University's online diary, which was favoured because it was designed specifically to organise the information students needed to remember and as it listed the semester breaks.

Other reasons not to use a handheld computer that participants stated were that it was another item to carry around, for example in addition to a phone and potentially an iPod or MP3 and a digital camera, and subsequently another thing to lose. Financially the loss of a handheld computer was also significantly greater than a paper diary and it was also perceived as easier to lose or get stolen (G3).

Dedicated MP3 player One participant used her brother's iPod as she did not yet have her own. One participant used a phone to play MP3s. Two participants used a computer for playing music instead of an MP3 player: "I don't use an MP3 player because I play all my music through my computer" (G3). In addition, one participant had considered buying an MP3 player but had not yet "forked out" the money (G6).

Digital camera For two participants the use of a digital camera was situational - one was an overseas student from Malaysia and wanted to take photos while in Australia, another purchased a digital camera when they first became available as a cheap commodity, however, was now less likely to use one unless travelling or on holidays. She explained, "I'm going overseas in a couple of months so that will be coming with me, but it's not an everyday occurrence" (G3). One focus group talked at length about using digital cameras, relating that they preferred them in comparison to film photography because they only had to pay to develop the photos that they wanted, and could store them easily to computer. Two respondents had used a digital video camera, though one had only used it at [college] and one used it rarely "for special purposes" (G1).

Mobile phone Mobiles were used for "connecting to people" and staying in touch with friends (G4). Participants stated that the reminder function on a mobile was useful as an organising tool to remember birthdays or to phone someone, and preferable to an electronic organiser as it is also possible to call someone. One participant explained, "Things I am likely to forget I put in my mobile phone because it actually makes a noise to remind me, that something's due" (G1). Another participant commented that her mobile was used as a multi purpose piece of technology:

> On my phone there is a lot of like, camera video recording and stuff, and my phone has an MP3 player on it so you are finding that your phone has everything you want and that the quality is actually getting really good on the phone. (G2)

Technology-Supported Activities

All participants used technology for communicating. Of these most stated that they used mobile phones, two specified emailing on computer, one used MySpace, and two others were not specific about which technologies they used to communicate. Five respondents commented on uploading photos under the category of 'sharing files' and also stated they sent group assignments to each other.

Accessing information was the other main activities and this included using computers, the Internet, library databases, Wikipedia and Answers.com. One participant explained how she used library databases for accessing information for essays, and other means of accessing information for looking up gigs and other "fun stuff" (G4). Wikipedia was used widely amongst participants to gain background information about a topic as participants acknowledged that they could not reference this site for university work. One explained, "There's Wikipedia if I need like a clear definition and then I can go to the library to actually understand what I'm researching" (G3). One participant subscribed to emailing lists and received information on social justice issues. This participant also described surfing the Internet for 'functional' purposes (G6), rather than recreationally.

In addition to these activities which participants identified spontaneously, a number of emerging technology-based activities were probed by the interviewer to determine to what extent these young people were engaged in Web2.0 activities.

This was of particular interest given that, at the time of the study, young people were regarded to be the quintessential Web2.0 users (Lorenzo et al., 2007).

Writing blogs. None of the respondents wrote their own blogs at the time of the interview, though a few had written a blog in the past. One participant wrote a blog whilst in secondary school when she had more time:

> I write some stuff down, but I won't blog it. I used to blog on MSN Faces but that was only random things like oh, I am going to the Green Day concert or like, yeah I am going to the World Cup in soccer. Like things like that (G1).

Overall, most participants seemed uninterested in writing a blog in future except one who had considered writing an anonymous blog about "an issue of concern to me", but had not done so yet (G6).

Reading blogs. Three participants regularly read a blog – one participant read MSN blogs, one participant read band blogs, and one read the Sydney university blog, because her she knew the author. Another read a blog written by a friend to update others about her overseas travels:

> Yes, yes, I have over the last year and a half I've… partly because I have a friend who lives… who's currently in Palestine, in the West Bank… But I'm not assiduously looking at because I'm at university and there's other things to do (G6).

Four participants indicated they read blogs very occasionally. One said, for example, "I see people put up blogs all the time and I don't really bother looking at them" (G2).

There was a common sentiment that most blogs were not very interesting and participants were judgemental about those who wrote them. One said, "Just like a 'vent your spleen' sort of thing, that's what I see it as, like had a bad day and they'll rant about something" (G5). Further two participants thought that blogs were self indulgent commenting:

> P1: It's so self indulgent and people won't reply to your emails now like it's just like 'read my blog'. I'm like 'I don't want to just read about your life' like I find it really… oh yeah.
>
> P2: I just think it's a bit, you know, self-indulgent or something. If you're a great writer and you're telling funny stories but if it's just like, today I went to uni and I was really upset and whatever, who wants to read that. (G4)

Social Networking. Ten respondents used social networking sites (eg. Facebook, MySpace, Bebo) at the time of the study. Typical comments included:

> You feel connected [on MySpace and Facebook] to people in so many ways without having to get on the phone and talk, and it is your daily schedule of what you are doing. (G2)

> Especially for people that who aren't that close to you and you wouldn't usually pick up the phone to talk to, or have a big conversation, but you still wanted to say something little, or, see how they're going. (G1)

Five participants explained that they used social networking for keeping in touch with people they knew already, especially friends that were not geographically close or not in frequent contact:

> I don't really use it to communicate with my friends that I have now that live around me but it's like school mates that I haven't seen for five years. (G3)

Participants explained that Facebook and MySpace were a good to "keep in touch with" friends and family while travelling and share photos at no cost. Equally, social networking sites were considered a good way for friends travelling overseas to stay in contact. There was one exception with one participant preferring to phone overseas instead, in part because she did not have home Internet access but also because:

> I would rather phone people in England… I love talking to them on the phone then we just have a good chat. It forces me to talk the on the phone. (G5)

Only two participants said they used sites like Facebook and MySpace for making new friends.

One participant used Facebook as a means of contact more due to not having a home landline and not wanting to pay for costly mobile calls:

> We tend to either SMS and say 'meet me somewhere for coffee' or arrange it over Facebook and go out. I don't tend to talk on the phone to my friends nearly as much as I tend to meet them now and chat and that's it. I can't afford to talk to them without having a landline. It's too expensive. (G4)

Similarly, another participant explained:

> I'm finding increasingly though my friends and I are using things like Facebook to organise things rather than over going back and forth with ten different SMSs. It just goes on Facebook now, you just assume that everyone kind of checks it every one to two days and that's that. So I've actually used my mobile phone less having joined Facebook. (G4)

Overall, the two main advantages of social networking sites discussed were that the lack of pressure to reply to a message immediately compared with SMS, and that it was free to use.

Several participants explained how they had used Facebook to share information for university:

> When we did our group assignment everyone works and has all this responsibility, it's easier to just communicate online. It was like 'oh we should have it on Facebook. It would be heaps easier'. (G5)

Another agreed, "I've done that like for another subject running this semester. We've just all communicated via Facebook just because it's easier" (G5).

Although use of Facebook was popular, some participants expressed negative sentiments about it. Typical comments included: "You waste time" (G4) and, "I collect friends I never talk to" (G4). Two participants admitted reluctance to sign up to Facebook at first, despite subsequently becoming quite addicted to using it:

> I thought I wasn't going to do it, but I did. I joined up in the mid-semester break. I don't usually use it but like it's fun when you do. It's just a cheaper way to send out an invite to a party. (G3)

Participants also raised the issue of the quality of communication on social networking sites:

> I just feel like Facebook's like meaningless communication. Like you see what your friend from 15 years ago is doing, it's sort of interesting but it doesn't like add to your life in any way. (G5)

Social networking sites were also viewed by several participants as a useful distraction, for example one said it was "good as a little break when studying in the library" (G2).

When comparing MySpace to Facebook, the latter was more popular amongst the participants in this study. One did not like MySpace because of the 'extra' information whereas he felt that Facebook was just social networking making it was easier to "avoid the crap" (G4). Another participant found MySpace overwhelming but thought Facebook looked more interesting (G6). In one group, none of the participants were on MySpace because it was "too complicated" and "takes up too much of my time" (G5).

Podcasting. Listening to podcasts was neither a widespread or frequent activity amongst the participants in this study. Of those that had listened to podcasts or watched vodcasts, five respondents listened to music from radio broadcasts, and one participant watched two episodes of a television program she had missed on YouTube. One participant downloaded podcasts from a regular radio series and sporting events, but admitted he often did not "get around to listening to them" (G5).

There was a general lack of understanding about podcast technology. Some participants did not know how to listen to or indeed understand what a podcast was. One explained:

> It's really funny how, like you take things for granted, or you don't realise something because, I have got iTunes, actually I have had it for a long time… I just sort of go to audio, type in what I want and that's it. Like I have never looked at the other ones. So I suppose I just associated iTunes just with music (G2).

There was a belief expressed by one participant due to the name that this technology was iPod specific and therefore wasn't available to her because she did not own an iPod. Also one participant said she did not realised there were video podcasts which she could watch on a computer or iPod.

Usefulness of Technologies for University Study

In this part of the interviews the participants were asked about how the technologies they were currently using assisted them with their university studies and about how technologies they were not currently using might be useful.

Laptops Respondents discussed other students using laptops in lectures to take notes which enabled easier editing. One participant took notes in lectures, saying "it was heaps better than having to print them out and waste all that paper" (G5). However, having a laptop at university was also a distraction. As one participant put it, "It's like having something there to distract you as well" (G1).

Digital video cameras. A group of Education students taking the subject as an elective discussed how digital video cameras could be useful as a learning tool both for themselves and for students at school:

> The digital video camera is definitely useful in education if you can have permission from the parents to use it. You can take it to class and video-tape us doing lessons, so that we can hone our own teaching skills. Also for kids to video-tape things in their classroom. It's a different way of recording it so they don't have to write, like, a journal entry of how they did an assignment, they can just record it on a video camera. (G1)

Another participant explained that video-taped footage can be beneficial in modelling a behaviour or skill:

> The most useful thing I find is when they are like, telling us in lectures, or teaching us how to teach, I find it really useful when I am watching a video of someone doing it, rather than us being told, this is what you should do. (G1)

Podcast lectures. Participants' reactions to the use of Podcasts at university varied. Some said liked podcasts for lectures because they preferred learning through listening. Others said they found it hard to concentrate on a podcast and needed to see who was speaking in front of them at a lecture or tutorial:

> I have listened to one lecture that I missed once on a podcast and I didn't like it because it's much easier for me to sit in a lecture and watch someone talk rather than [listen to a podcast]. (G1)

Several indicated they would be unlikely to listen to the recording afterwards, because doing so required motivation, for example:

> There is the option [of listening when the lecture is available on a podcast] and I have done a few of them. Like, I had to do one last week that I missed online but it's such a struggle to sit there and get through it, as opposed to just bringing myself here and doing it. (G4)

> Last semester I did a course and they recorded the lectures and I started to skip the lectures but I found it more of a chore listening to the lecture at home. I'd get distracted and wander off, that kind of thing and I guess you've got all the gaps and all of that in it or if she cracks a joke that you don't know or something like that. I mean it's just boring and I was like I'll just do the readings kind of thing, so it actually detracted from going to uni and learning. (G4)

It was agreed by some that podcasts would be good as a supplement to university teaching modes rather than a complete replacement. The perceived benefits of podcasts included being able to: to make up a lecture missed due to illness; listen to a lecture when there was a timetable clash with another class; and pause it to have a break and then go back to it.

Furthermore, if podcasts were only a supplement then interaction with lecturers was not jeopardised:

> [Podcasts] would probably be a bad thing because you can't then go to the lecturer afterwards and ask, you know sometimes they say that sometimes in a lecture has anyone got questions, do you understand, do you follow? If that was the case, with the podcast, you can't do that. You can't ask the question, you can't clarify anything (G2).

Social interaction. This theme was also evident in general discussion amongst participants about the use of technology in education. This following quote expresses this common sentiment:

> I don't think technology… like solely having things online is a good idea because you're not going to get that interaction and the opinions of others that you want to hear (G5).

Importantly, the role of social interaction in a face-to-face learning environment was imperative to many participants. In particular, it was explained that the seminar format maximised social interaction with the lecturer, "Face-to-face contact with the tutor and getting to know them and their viewpoints, their personalities, just makes the experience all the more worthwhile" (G4).

Social interaction was perceived as something that you can only learn in a real classroom with real people, with participants commenting that they felt there was no "intimacy" (G2) in a virtual classroom:

> Yeah I've often thought about how a university of the future would look like but I'm worried about the lack of face-to-face contact because I think that's really still… really, really important. And in while though I have imagined for example a virtual lecture, not having to come to university and watching it on your computer at home. I sort of feel that I would become more socially isolated or it would increase the propensity for social isolation, and I don't think that's such a good thing. I think there might be some areas where that would be useful, particularly people who have a disability, but then again shouldn't universities be inclusive? So I just think that this is sort of technology will be used as part of the way it has been done but in a more interesting way. (G6)

> I think it's a positive thing that you come to uni because there's other things going on. So if you don't even have the incentive to come you're not going to participate in other events or have a sense of a university community. And I've formed relationships with tutors and lecturers and talk to them about what they've done in the past, what their jobs are and I think that's really helped me like establish a sense of where I want to be and where I want to go with what I've learnt. So you wouldn't have that opportunity to form these relationships or with other people. I don't think technology can replace

> actually standing next to someone and talking to them. It depends what you want to get out of it, like I understand maybe for a mature aged student and you have like other responsibilities and university… you're not going there for like any social aspects or any kind of like political or sporting kind of education then you know online might suit you better. (G5)

> Virtual reading or virtual lecturing as a hundred percent of the course, I think that'd be a disaster. Socially a disaster. Sorry, but that's how I feel. I think it's really, really important that students bounce ideas off each other. I think it's really important that they get used to different age groups in different ideas, different experiences, different people look different. (G6)

Communication. One participant had liked a course coordinator who had used WebCT to update deadlines and make announcements, although he emphasised that the effectiveness related to the consistency of the coordinator, indicating that the technology was only "as good as the user" (G3P9). Some lecturers were not perceived as being so efficient at using WebCT or responding to emails. For this reason, this student suggested that getting announcements via SMS would be useful:

> I'd prefer [SMS] to WebCT. I get confused with WebCT because you need consistency. Some lecturers will use it and others won't and that's really annoying, you'd kind of like everyone to use it or no-one to use it. (G3)

Some respondents had a previous tutor who called mobile numbers to update students that had missed a tutorial or to give information (G1). Another had previously been contacted by mobile phone:

> I got called by a lecturer once because we had to submit everything through a plagiarism detector at [another university] and I hadn't done that so she called me on my mobile phone and told me to do it, so it was a surprise. (G4)

The same participant continued to explain that this was an appropriate course of action by her lecturer, however it would only be acceptable in extreme circumstances such as this.

The idea of receiving text messages from tutors and lecturers provoked mixed reactions. It was suggested that text messages could be useful to alert students about the cancellation of a lecture or tutorial at short notice (within 2–3 hours of it commencing) as not everyone would access email in time, "if you've got a reminder [on your mobile] sort of thing would be good 'hey your thing is due in one week'" (G5).

One participant thought texting was too informal, whereas others disliked it for different reasons. One participant said it would be "creepy" to get a text message from a tutor or lecturer (G5). Another explained:

> I know people [whose tutor called them on their mobile phones]. It was really weird, like you don't expect to get a call from your tutor. You would be like, 'what are you doing calling me', 'how do you have my number?' You are used to getting email but getting a text message, it would feel like they are kind of watching you while you were outside uni. (G1)

One participant stated a preference for keeping a personal email that she did not give to lecturers or tutors so that she could keep her personal life and university separate, explaining “uni is more formal” (G2).

Participants also expressed mixed feelings about lecturers using Facebook, one noting possible tensions from the blurring of the formal/informal when used by lecturers. He explained, “It’s all about boundaries isn’t it, like there has to be a certain line and yeah that can obviously become a problem I could imagine” (G5). In general though, there was outright rejection of this possibility, once again, on the grounds of protecting privacy from authority figures who could spoil the enjoyment of the social sites. Typical comments included: “No because I don’t like that they could look at my personal life… and it’s got all my photos of me like partying on the weekend, so no” (G5); and “Facebook is a place for recreation and fun and friends” (G4).

Writing a blog or wiki. As with other technologies proposed for educational purposes, there were mixed views about writing blogs. Four participants stated outright that they would not write a blog, especially if it was to be assessed. Others felt embarrassed about presenting their opinions, for example “I’d feel silly having everyone read my stuff” (G3). Another disliked it because of the fallibility of technology:

> Too much can go wrong. You get online and it doesn’t work and you haven’t got this plug-in or your cookies don’t work or oh it’s just a nightmare! (G4)

One respondent objected because personal communication was better:

> I prefer the personal interaction, I just find computers so impersonal. It gets lost in translation. (G4)

Writing a blog was seen by some participants as a “bit of a hassle” for university, and too private to share publicly, though it may be acceptable for the tutor to read it and comment on appropriateness. Others were happy to write about a subject that they felt passionately about. Some participants felt that online reflections were reasonable to demonstrate understanding of the readings, to find out what others had to say, or to communicate if you preferred not to talk in tutorials. Some participants had already written a blog as part of their studies in law and social work. These courses required weekly reflections for interaction and feedback; however, the participant stated that because everyone left this to the last minute it did not work so no one actually benefited from it (G3).

Only one participant commented directly about writing a wiki entry, saying “I am never really confident enough in myself like in what I know [to write in a Wikipedia site]” (G2).

DISCUSSION

A key finding from the study is that popular technologies tended to be those with what was deemed to be sufficient functionality without being excess to requirements. Even for these young people it was possible for a technology to be regarded as too elaborate or complicated for the purpose, for example using a handheld computer as an electronic diary. Related to this was the general observation by many participants that ease of use and convenience were important – according to participants if the overhead of learning to use or to operate a technology was too high for its perceived usefulness, then the technologies itself would not be deemed useful. Furthermore, some technologies were not used often or were deemed less important because their functions were seen as too specialised and not for 'daily use'. These themes are consistent with concepts from the Technology Acceptance Model literature (eg. Teo, 2009), which highlights the importance of perceived usefulness and ease of use. Cost sensitivity was also a theme, which considering that the participants were all university students is not surprising. It does, however, demonstrate how this factor is important in decision making, for example in the non use of handheld computers which were regarded as too expensive and could easily be lost, the choice not to purchase an iPod if another device would suffice, and the popularity of Facebook as a free service.

The findings also suggest that technology was regarded as valuable for supporting two mains types of activities – accessing information and communicating (with social networking as an important sub-set). There was very limited self publishing or use of other Web2.0 tools (other than social networking) and a number of participants were not aware of what blogs and wikis were. These findings are consistent with similar studies conducted at around the same time (eg. Kennedy et al., 2007). This suggests that 'consumption' rather than 'creation' of information was much more prevalent amongst these participants. This contradicts claims made at the time that amongst younger generations "bypassing traditional authority channels, self-publishing – in print, image, video, or audio – is common" (Lorenzo et al., 2007, p. 2). It is also evident from the interviews that not all participants regarded themselves as technically skilled in relation to digital technologies, commenting on needing help or raising concerns about technology being too complicated to use. This also runs counter to the popular image of the digital native.

It is also evident that the participants made subtle distinctions made about forms of technology used for particular functions. For example, mobile phones and Facebook were both regarded as important tools for maintaining social relationships with family and friends. Phone calls were regarded by some participants as more intimate or immediate and reserved for family and close friends, while Facebook was said to be particularly useful for maintaining more distant relationships (similar to idea of online networks as means of maintaining weak social ties as suggested by Jones, Ferreday & Hodgson, 2008).

Participants also demonstrated a capacity for critiquing both their own and others' technology practices. A number commented on the potential for technology use to distract them from other activities, for example the distraction of Facebook during study time. Others explained the difficulties they experienced trying to motivate themselves to 'catch up on' missed lectures by listening to podcasts. This suggests these students were aware of the need for them to be motivate themselves to be self-regulated learners but did not necessarily see technology as a means to assist them achieve this. Participants also demonstrated varied perspectives on what activities were valuable or 'socially acceptable'. For example, few participants expressed interest or experience in self-publishing activities, some explaining that they did not consider it a good use of their time. A small number, however, were derisive of other people's blogs, indicating they considered the activity to be self-indulgent. These attitudes carried over to discussions about the potential usefulness of blogging as part of university studies, which drew reluctance from some, who assumed this would involve sharing something private, like everyday blogging, rather than an academic form of reflection. This suggests that practices in everyday life are imbued with particular assumptions; in turn suggesting that blogging for academic purposes would require a re-imagining of the familiar form of the activity. This finding has implications for attempts to re-cast everyday technology practices into academic forms and suggests the need for sensitivity to the differences between the 'rules of the game' in these contexts.

This is further highlighted by the preference expressed by some participants for a strong boundary between formal and informal environments, with a number commenting on what might be appropriate for university and what should be reserved for fun and friends. Some students were particularly resistant to the idea of the university intruding on their personal online spaces, some likening it to surveillance. Others were less concerned with potential intrusion and saw value in the possible convenience offered. This further highlights the situated nature of technology use in terms of how it regarded by individuals for a purpose in a particular context, and how that varies between individuals.

A final theme worthy of comment is the strong resistance expressed by most students to the prospect of technology replacing the social interactions they deemed necessary for an effective learning experience. Many expressed concern that their experience of learning at university would be degraded if technology was used as a replacement rather than a supplement to current teaching methods. Most still expressed a desire for teaching staff to not only use technology more effectively but also for more effective teaching in general through smaller class sizes and more interactive methods. This further suggests the need to be sensitive about the nature of the context, in this case the nature of social interaction in a learning context, which may differ from the nature of social interaction in a personal context.

CONCLUSION

The research reported in this chapter aimed to develop a broader understanding of young people's technology practice, moving away from documenting levels of access to technology and the frequency of particular technology-supported activities, to develop a deeper appreciation of how young people come to value and use technologies for particular purposes. While this is a small, exploratory study it does highlight the importance of the ideas an individual develops about a technology (formed through experience as part of an ongoing process), in conjunction with the nature of the context of use. This suggests that not only are variations in technology use between individuals is to be expected, but also that perceptions and uses of technologies in different contexts are likely vary. This has implications for how universities approach the integration of technologies intended to support student learning, particularly when those technologies are associated with particular practices and values in contexts outside formal education.

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TIMOTHY TEO

5. MODELING TECHNOLOGY ACCEPTANCE AMONG PRE-SERVICE TEACHERS

ABSTRACT

The purpose of the study is to build a model that predicts the level of technology acceptance by pre-service teachers at a teacher training institute in Singapore. It examines relationships among variables associated with factors that influence technology acceptance. Data was collected from 475 participants using a survey questionnaire. Employing structural equation modelling, a hypothesized model was tested for model fit in the study. The resulting model is found to have a good fit. Perceived usefulness, attitude towards computer use, and computer self-efficacy have direct effect on pre-service teachers' technology acceptance, whereas perceived ease of use, technological complexity, and facilitating conditions affect technology acceptance indirectly. These six variables account for approximately 27.1% of the variance of behavioural intention. Perceived usefulness appeared to the strongest determinant of behavioural intention.

INTRODUCTION

As businesses become more technology-based with fast-paced internationalization, workers are increasingly faced with the need to use sophisticated tools to fulfil their job requirements. In like manner, the education sector is expanding in terms of its technological needs. For many countries, the integration of technology has been hailed as the essential step toward the improvement of teaching and learning. For this reason, many governments have launched major initiatives and invested heavily to build and maintain ICT infrastructures in the schools (Pelgrum, 2001). Associated with such high-stakes investment, research in user acceptance and adoption of technologies has grown in the last two decades. In particular, researchers were interested in identifying the conditions or factors that facilitated technology integration into businesses (Legris, Ingham, & Collerette, 2003). Over time, models were developed and tested to predict technology acceptance. Among these models, the Technology Acceptance Model (TAM) (Davis, Bagozzi, & Warshaw, 1989) is among the most popular models in technology acceptance studies (McCoy, Galletta & King, 2007). The TAM has received empirical support for being robust and parsimonious in predicting technology acceptance and adoption in various contexts and using a variety of technologies. For example, the TAM was empirically proven successful in predicting about 40% of a system use and found to be a parsimonious representation of how perceptions and attitudes affect technology use (Legris et al., 2003). Figure 1 shows the TAM.

T. Teo (ed.), Technology Acceptance in Education: Research and Issues, 79–99.

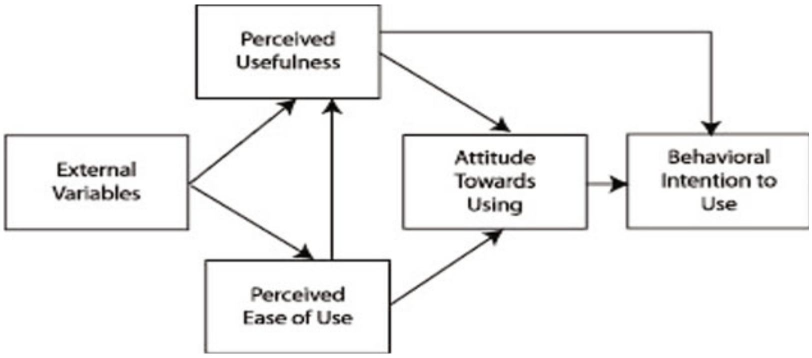

Figure 1. Technology acceptance model (Davis, Bagozzi, & Warshaw, 1989).

Although the TAM has been extensively tested and validated among users in the business world, its application in education is limited. This situation could be due to the differences in the way general users and educational users respond to technology. The latter, especially teachers, tend to possess greater autonomy over their choice of technologies more than general technology users. Hu, Clark, and Ma (2003) suggested that educational institutions have fundamentally different objectives compared to business organisations and as such, teachers experience less peer competition in the use of technological resources. The limited application of the TAM in educational contexts has provided support for its parsimony and predictive powers. Some examples of the uses of the TAM to study issues of educational interest include user acceptance for various technology applications such as the Graphic User Interface (GUI) (Agarwal & Prasad, 1999), mainframe application (Dishaw & Strong, 1999), accounting applications (Jackson, Chow & Leitch, 1997), and the internet (Riemenschneider, Harrison, Mykytyn Jr., 2003). In recent years, the TAM has been used as the framework to examine students' satisfaction with online learning (Drennan, Kennedy & Pisarksi, 2005), students' acceptance of an online course companion site of a textbook (Gao, 2005), the effect of technical support on students' acceptance towards WebCT (Ngai et al., 2007), and the attitudes of pre-service teachers towards the use of technology in education (Teo, Lee and Chai, 2007).

LITERATURE REVIEW

Teachers' Acceptance of Technology

Despite research evidence showing the capability of technology to transform teaching and learning (Bereiter & Scardamalia, 2006), the use of computers in the classrooms remains peripheral and minimal (Lim & Khine, 2006) and teachers do not use technology effectively (Zhao & Cziko, 2001). For example, Becker (2001) found that teachers used computer infrequently and often used games and drills in the classroom. In their study, Bayhan, Olgun and Yelland (2002) found that 81.8% of the teachers in their study did not use computers for teaching and learning and this could be due to the lack of confidence and professional development.

The teacher is the key to effective use of technology in the educational system (Zhao, Hueyshan, Tan & Mishra, 2001) and it is important for teachers to understand the precise role of technology in teaching and learning so that they can learn to cope effectively with the pressure created by the continual innovation in educational technology and constant need to prioritize the use of technology. While stakeholders in education expect teachers to engage technology consistent with their beliefs that technology impacts on teaching and learning, it must be borne in mind that teachers are faced with many variables that interact with each other to either facilitate or discourage the acceptance of technology. These variables include personal factors, such as computer self-efficacy (Gong, Xu, & Yu, 2004), technical factors such as technological complexity (Thong, Hong, & Tam, 2002) and environmental factors such as facilitating conditions (Ngai, Poon, & Chan, 2007). Therefore, the need to understand teachers' acceptance of technology calls for an examination into the factors that influence teachers' acceptance of technology. The successful use of technology in teaching and learning depends on the factors that significantly influence teachers' technology acceptance, which provides an insight into issues relating to teachers' adoption and usage of technology.

Technology Acceptance

The theoretical grounding for this research draws from the technology acceptance model (TAM). Being among the first models to include psychological factors affecting technology acceptance, the TAM has been empirically proven capable of explaining user behavior across a broad range of end-user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified. The Technology Acceptance Model (TAM) specifies the causal relationships between perceived usefulness, perceived ease of use, attitude towards computer use, and behavioral intention to use technology. Rooted on the principles adopted from Fishbein and Ajzen's (1975) Theory of Reasoned Action (TRA), Davis (1989) proposed the perceived ease of use and perceived usefulness to be the fundamental determinants, operative in the context of computer user behavior. Perceived usefulness has to do with the degree to which a person believes technology will help him or her to perform a certain task in an efficient and productive manner. In contrast, perceived ease of use refers to the extent to which a person thinks that the use of technology will be relatively free of effort.

Perceived ease of use was hypothesized to have a significant direct effect on perceived usefulness. Perceived usefulness concerned the expected overall impact of technology on job performance (process and outcome), whereas perceived ease of use pertained only to those factors related to the process of using the technology per se (Davis, 1993). In the TAM, usage is determined by behavioral intention. The significant link between Behavioural Intention and actual usage has been established by research. For example, Yi and Hwang (2003) found a direct and significant influence ($\beta = 0.19$; $p < .001$) of behavioural intention on actual usage of the web-based environment in their study. Behavioral intention, in turn, is affected by attitude toward usage, as well as the direct and indirect effects of perceived usefulness and perceived ease of use. Both perceived usefulness and perceived ease of use jointly affect attitude, whilst perceived ease of use has a direct impact on perceived usefulness.

Despite the accolades given to the TAM for its predictive ability of technology acceptance, Dishaw and Strong (1999) pointed out that it is necessary to explore further the nature and specific influences of technological and usage-context factors that may alter the user's acceptance, to increase external validity of the TAM. A critical review of the TAM has revealed a need to include other variables in order to provide a broader view and a better explanation of technology adoption (Legris, Ingham, & Collerette, 2003). One objective of studying external variables is to determine the chain of influence from these variables to the dependent variable specified in the TAM (e.g. Behavioural Intention or System Usage). Some studies have introduced product factors such as technological complexity (Cheung & Huang, 2005), user factors such as computer self-efficacy (Hasan, 2006), and environmental factors such as technical or organizational support (Ngai et al., 2007), to expand the TAM. Others have tested the validity of the TAM model using a variety of technologies, services, and environments. These included personal computers, email systems, the Internet, and online shopping and e-Commerce (e.g. Lederer et al., 2000; Moon and Kim, 2001; Gefen, 2003; Zhang and Prybutok, 2004). Against this background and using the TAM as a framework, this study proposes to

1. evaluate the validity of the TAM for an educational context;
2. assess the extent to which the variables in the TAM predict the technology acceptance among pre-service teachers;
3. appraise the significance of the relationships of the three external variables: technological complexity, computer self-efficacy, facilitating conditions and the variables in the TAM.

RESEARCH MODEL AND HYPOTHESES

TAM Hypotheses

The TAM has received empirical support as a robust and parsimonious model across gender, settings, and times (e.g. Cheung & Huang, 2005 ; Drennan, et al., 2005 ; Groves & Zemel, 2000; Liaw & Huang, 2003; Moon & Kim, 2001; Pan, Sivo, & Brophy, 2003; Thong et al., 2002). Additionally, the TAM is adopted in this study because it possesses predictive validity in studies whose participants were pre-service teachers (e.g. Kiraz & Ozdemir, 2006; Ma, Anderson, & Streith, 2005; Teo, 2009).

Perceived usefulness (PU) is defined as the degree to which a person believes that using a particular technology will enhance his or her job performance (Davis et al., 1989). Together with perceived ease of use (PEU), referring to the degree to which a person believes that using a particular technology will be free of effort (Davis et al., 1989), PU and PEU are two fundamental belief constructs in the TAM that constitute a significant influence on attitude towards computer use, which in turns affects the behavioural intention to use technology (Liaw & Huang, 2003; Cheung & Huang, 2005). In addition, PEU influences PU (Moon & Kim, 2001) and PU has a direct effect on attitude towards computer use (Teo, Lee, & Chai, 2007), and behavioural intention to use technology (Hassan, 2006). From the above TAM research, the following hypotheses were formulated.

H1: Attitudes Towards Computer Use will have a significant influence on Behavioural Intention
H2: Perceived usefulness will have a significant influence on Behavioural Intention
H3: Perceived usefulness will have a significant influence on Attitudes Towards Computer Use
H4: Perceived Ease of Use will have a significant influence on Perceived Usefulness
H5: Perceived Ease of Use will have a significant influence on Attitudes Towards Computer Use

Technological Complexity (TC)

Technological complexity refers to the degree to which technology is perceived as relatively difficult to understand and use (Thompson et al., 1991). Generally, complexity penalizes a users' perceived ease of use of technology. This is largely due to the natural limit on human's information processing capacity. To tackle a higher degree of complexity, more attention is demanded of the user. Subramanian (1994) found insignificant effects of PEU on BI and attributed it to technological complexity. He attributed the insignificant effect of PEU for both the v-mail and customer dial-up systems that was used in the study to the fact that communication technologies were much easier to use than software packages such as Harvard Graphics and spreadsheets. From another perspective, Teo et al. (1999) attributed the lack of significant effects of PEU on BI to the low technological complexity of the tool (Internet) perceived by their participants. The authors argued that, since the internet was relatively easy to use, the learning process, in which PEU was confirmed to have a significant influence on BI, was quickly completed. Given that TC influenced the extent to which a technology is perceived to be difficult to use, it was proposed that TC has a significant influence on PEU (Cheung & Huang, 2005). Additionally, there was evidence of a close relationship between TC and PU as well (Lu, Yu, Liu & Yao, 2003).

H6: Technological complexity will have a significant influence on Perceived Usefulness
H7: Technological complexity will have a significant influence on Perceived Ease of Use

Computer Self-Efficacy (CSE)

Self-efficacy refers to a person's judgment of their capabilities to organize and execute courses of action required to achieve specific goals. It is not concerned with the skills one possesses but with the extent to which one believes what one can do with the current level of skills one possesses (Bandara, 1977). This belief has an influence on one's ability to perform a task, the degree of effort used, and the persistence of that effort. Research on self-efficacy usually focuses on specific domain or context, such as computer self-efficacy. Computer self-efficacy denotes a user's assessment of his or her capability to use a computer and may influence an individual's perception of a technology's ease of use and acceptance decision (Gong, Xu & Yu, 2004). Individuals with a weak sense of computer self-efficacy will be frustrated more easily by obstacles to their performance and will respond by lowering their perceptions of their capability to use technology. Consequently, the individual will feel that he or she may meet a lot of problems in using technology in the future. By contrast, individuals with a strong sense of computer self-efficacy do not become deterred easily by difficult problems, and will persist with their efforts, with the result that they are more likely to overcome whatever obstacle was present (Compeau and Higgins, 1995). Moreover, before an individual has any hands-on experience of the new technology or system, the general perception of computer self-efficacy becomes the anchor of an individual's perception of how a technology is easy to use (Gong, Xu & Yu, 2004). In an education setting, computer self-efficacy affects teachers in various ways. For example, it affects the extent and the way technology is used in the everyday instructional practice and this is important since technology has the potential to transform the roles teacher plays in the classroom, from that of a knowledge transmitter to a facilitator of learning (Bereiter & Scardamalia, 2006).

H8: Computer self-efficacy will have a significant influence on Perceived Usefulness
H9: Computer self-efficacy will have a significant influence on Perceived Ease of Use
H10: Computer self-efficacy will have a significant influence on Behavioural Intention

Facilitating Conditions (FC)

Facilitating conditions are factors in the environment which exert an influence over a person's desire to perform a task. Groves and Zemel (2000) found out that facilitating supports (skills training, information or materials available, and administrative support) were rated as very important factors which influenced the use of instructional technologies in teaching. Recently, Lim and Khine (2006) reveled that teachers in their study had cited poor facilitating conditions (e.g. lack of access to computers, inadequate technical support given teachers) as a barrier to ICT integration in the classroom. Specifically, facilitating conditions were found to have a positive effect on attitude towards computer use (Ngai, Poon, & Chan, 2007). Among the types of support given to teachers, technical support was ranked highly on the list of factors that affect teachers' implementation o technology (Groves & Zemel, 2000). Specifically, technical support includes the provision of helpdesks, hotlines, and online support services. Technical support has been cited as one of the important factors in the acceptance of technology for teaching (Williams, 2002) and in user satisfaction (Mirani & King, 1994) and a high level technical support has been found to be responsible for promoting more positive attitudes towards computer use (Igbaria, 1990).

H11: Facilitating Conditions will have a significant influence on Perceived Usefulness
H12: Facilitating Conditions will have a significant influence on Perceived Ease of Use

H13: Facilitating Conditions will have a significant influence on Attitudes Towards Computer Use

These hypotheses give rise to the structural model represented in Figure 1.

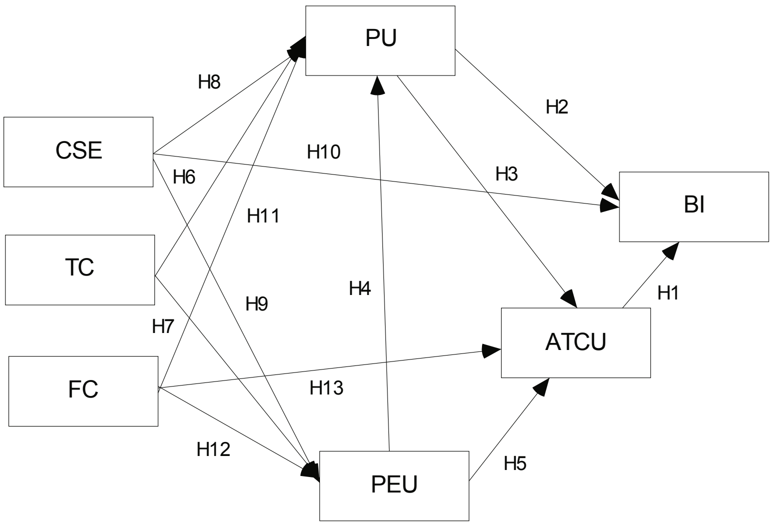

Figure 2. Research model.

METHOD

Research Design

This study employs a structural equation modeling (SEM) approach to develop a model that represents the relationships among the seven variables in this study: behavioural intention, attitudes towards computer use, perceived usefulness, perceived ease of use, computer self-efficacy, technological complexity, and facilitating conditions. Data was collected through using a survey questionnaire comprising questions on demographics and multiple items for each variable in the research model.

In this study, the measurement and path models were analysed. The measurement model is a conventional confirmatory factor model that comprises a set of observed variables which are multiple indicators of the latent variables shown in the research model (fig. 2). The path model is analysed by decomposing the effect of one latent variable on another variable into direct, indirect, and total effects. Direct effect shows the unmediated influence of one variable on another. Indirect effect is the influence of one variable on another that is mediate by at least one other variable. The total effect is the sum of direct and indirect effects (Bollen, 1989).

The usual steps for doing SEM statistical analysis were followed in this study. Data was screened for missing data and outliers. This was followed by establishing the convergent and discriminant validities of the data. In SEM, it is important to ensure multivariate normality in the data and adequate sample size in order to get reliable results. For these purposes, Kline's (2005) recommends that the skew and kurtosis indices should not exceed │3│and │10│ respectively, to ensure normality of the data. On the size of the sample, Hair et al. (2006) recommends that sample size determination should consider the model complexity, estimation technique, number of constructs, number of indicators per constructs, and item communality. The SEM software, AMOS 7.0 provides an estimate of an adequate sample size in the form of Hoelter's (1983) critical N, which is the largest sample size for which one would accept at a .05 level of significance a model with the given chi-square statistic and degrees of freedom. In this study, the Hoelter critical N is 417 at the .05 level of significance. On this account and the above recommendations, the sample size (N=475) in this study is regarded as adequate.

Research Participants and Data Collection

Participants in this study were 475 pre-service teachers at the National Institute of Education (NIE) in Singapore. They were recruited from three different study programmes: a 1-year Post Graduate Diploma in Education (Secondary), a 1-year Post Graduate Diploma in Education (Primary), and a 4-year Bachelor of Arts (with Education). Together, the participants form about 40% of the combined student population of these three programmes. Among the participants, 73.9% were female, and the mean age of all participants was 23.2 years (SD=4.30). The majority of the participants had access to a computer at home (87.6%) and the mean year of computer usage was 7.24 (SD=4.03). The reported mean hours of daily computer usage was 3.22 (SD=2.17). Before the survey questionnaire was administered, participants were briefed on the purpose of this study and told of their rights to withdraw from the study at anytime during or after the study. Overall, each participant took not more than 20 minutes to complete the questionnaire. Table 1 shows the profile of the participants.

Table 1. Demographic information of the participants (N=475)

Variable		*Number*	*%*
Gender			
	Male	124	26.1
	Female	315	73.9
Programme			
	Postgraduate Diploma in Education	246	55.6
	(Secondary)	101	21.3
	Postgraduate Diploma in Education (Primary)	110	23.2
	Bachelor Degree		
Home computer ownership			
	Yes	416	87.6
	No	59	12.4
Age		23.22 (SD = 4.30)	
Mean years of computer usage		7.24 (SD = 4.03)	
Mean hours of daily computer usage		3.22 (SD = 2.17)	

Measures

A survey instrument was designed to measure the seven constructs in the research model. Comprising two sections, the first required participants to provide their demographic information and the second contained 18 statements on the seven constructs in his study. They are: perceived usefulness (PU) (three items), perceived ease of use (PEU) (three items), attitudes towards computer use (ATCU) (three items), technological complexity (TC) (three items), computer self-efficacy (CSE) (two items), facilitating conditions (FC) (two items), and behavioural intention (BI) (two items). Each statement was measured on a five-point Likert scale with 1=strongly disagree to 5=strongly agree. These items were adapted from various sources and these are listed in Appendix 1.

RESULTS

The statistical analyses in this section include examining the descriptive statistics and assessing the reliability and validity of the measurement items used in this study. This is followed by testing of the hypotheses by assessing the model fit through using various fit indices and evaluating the path model.

Descriptive Statistics

The descriptive statistics of the constructs are shown in Table 2. Except for CSE, all means are above the midpoint of 3.00. The standard deviations range from .61 to .93 and this indicates a narrow spread around the mean. The skew index ranges from .01 to -1.54 and kurtosis index ranges from -.74 to 5.34. Using Kline's (2005) recommendations that the skew and kurtosis indices should not │3│and │10│ respectively, the data in this study is regarded as normal for the purposes of structural equation modelling.

Table 2. Descriptive statistics of the study constructs

Construct	*Item*	*Mean*	*Standard deviation*	*Skewness*	*Kurtosis*
PU	3	4.17	.63	-.67	1.78
PEU	3	3.87	.63	-.30	.30
ATCU	3	4.15	.61	-1.18	4.45
TC	3	3.16	.93	.01	-.74
CSE	2	2.29	.82	-.85	1.15
FC	2	3.48	.85	-.48	.11
BI	2	4.45	.61	-1.54	5.34

PU= Perceived Usefulness; PEU= Perceived Ease of Use; ATCU= Attitude Towards Computer Use; TC= Technological Complexity; CSE= Computer Self-Efficacy; FC= Facilitating Conditions; BI=Behavioural Intention

Convergent Validity

To evaluate the adequacy of the measurement model, the indicators of validity and reliability are examined. Fornell and Larcker (1981) proposed three procedures in assessing for convergent validity of the measurement items: (1) item reliability of each measure, (2) composite reliability of each construct, and (3) the average variance extracted.

The item reliability of an item was assessed by its factor loading onto the underlying construct. A factor loading of .70 and above was used to identify if an indicator was related to its construct and indicative of a well-defined structure (Hair et al., 2006). This is consistent with Gefen et al. (2000) who explained that an item loading of .707 accounted for about 50% of the variation in the construct that it purported to measure. In this study, the factor loadings of all the items in the measurement model ranged from 0.740 to 0.921 (Table 3). This exceeds the recommendations by Hair, et al. (2006) and Gefen et al. (2000), thus demonstrating convergent validity at the item level.

Table 3. Results for the measurement model

Latent Variable	*Item*	*Factor loading (> .70)**	*Average variance extracted (> .50)**	*Composite reliability (> .70)**
PU			.69	.96
	PU1	.740		
	PU2	.880		
	PU3	.865		
PEU			.61	.95
	PEU1	.780		
	PEU2	.748		
	PEU3	.805		
ATCU			.60	.93
	ATCU1	.785		
	ATCU2	.787		
	ATCU3	.746		
TC			.76	.89
	TC1	.854		
	TC2	.893		
	TC3	.863		
CSE			.76	.87
	CSE1	.866		
	CSE2	.878		
FC			.82	.91
	FC1	.921		
	FC2	.891		
BI			.71	.94
	BI1	.816		
	BI2	.869		

* Indicates an acceptable level of reliability or validity.

(1) Fit indices: $\chi 2$ = 223.373 (p = 0.001), df = 105, $\chi 2$/df = 2.127, SRMR = 0.043, RMSEA = 0.049, CFI = 0.971, TLI = 0.958.

(2) CR= $(\sum\lambda)2/ (\sum\lambda)2+(\sum\delta)$.

(3) AVE: Average Variance Extracted. This is computed by adding the squared factor loadings divided by number of factors of the underlying construct.

Hair et al. (2006) recommends that the composite reliability should be used in conjunction with SEM due to the tendency of the Cronbach's alpha to understate reliability. This is computed from the squared sum of factor loadings (λ) and the sum of the error variance terms for a construct (δ). For composite reliability to be adequate, a value of .70 and higher was recommended (Nunnally & Bernstein, 1994). As shown in Table 3, the reliabilities of all the constructs ranged from 0.87 to 0.96, well above the recommended level.

The third indicator of convergent validity, average variance extracted, measures the overall amount of variance that is attributed to the construct in relation to the amount of variance attributable to measurement error (Fornell & Larcker, 1981). Convergent validity is judged to be adequate when average variance extracted equals or exceeds 0.50, when the variance captured by the construct exceeds the variance due to measurement error (Segars, 1997). As shown in Table 3, the convergent validity for the proposed constructs of the measurement model is adequate.

Discriminant Validity

Discriminant validity measures the extent to which constructs differ. Fornell et al. (1982) suggests that discriminant validity is present when the variance shared between a construct and any other construct in the model is less than the variance that a construct shares with its indicators. The variance shared by any two constructs is obtained by squaring the correlation between the two constructs. The variance shared between a construct and its indicators corresponds to average variance extracted. Discriminant validity was assessed by comparing the square root of the average variance extracted for a given construct with the correlations between that construct and all other constructs. If the square roots of the AVEs are greater than the off-diagonal elements in the corresponding rows and columns in a correlation matrix, this suggests that a construct is more strongly correlated with its indicators than with the other constructs in the model. In Table 4, the diagonal elements in the correlation matrix have been replaced by the square roots of the average variance extracted. Discriminant validity appears satisfactory for all constructs. This indicates that each construct shared more variance with its indicators than it does with other

Table 4. Discriminant validity for the measurement model

Construct	*PU*	*PEU*	*ATCU*	*TC*	*SE*	*FC*	*BI*
PU	(.83)						
PEU	44**	(.78)					
ATCU	.61**	.49**	(.77)				
TC	.06	.33**	.18**	(.87)			
CSE	-.09*	.03	-.07	.14**	(.87)		
FC	.1**	.25**	.27**	-.07	-.07	(.91)	
BI	.41**	.30**	.40**	.06	-.16**	.05	(.84)

Notes:
(1) * $p< .05$; ** $p< .01$.
(2) Diagonal in parentheses: square root of average variance extracted from observed variables (items); Off-diagonal: correlations between constructs.

constructs. Having achieved discriminant validity at both the item and construct levels, the constructs in the proposed research model are deemed to be adequate for further analyses.

Model Fit

The model fit of the research model in this study was tested using AMOS 7.0 (Arbuckle, 2006). From the literature, it is common practice to use a variety of indices to measure model fit (Kline, 2005). Hair et al. (2006) suggested that model fit indices are classified into three categories. These are the absolute fit indices that measure how well the proposed model reproduces the observed data. In other word, the fit indices evaluate the overall discrepancy between the implied and observed covariance matrices. They include the χ^2 statistic, the goodness-of-fit Index (GFI), the standardized root mean residual (SRMR). The next category of fit indices, parsimonious indices, is similar to the absolute fit indices except that it takes into account the model's complexity. These include the root mean square error of approximation (RMSEA) and the adjusted goodness of fit (AGFI). Finally, the incremental fit indices assess how well a specified model fit relative to an alternative baseline model. In AMOS 7.0, the baseline model is known as the null model, which assumes that all observed variables are uncorrelated. Examples of incremental fit indices are the comparative fit index (CFI) and Tucker-Lewis index (TLI). In this study, all the above-mentioned fit indices will be used except for the GFI and AGFI as these have been found to perform badly under simulation studies (Brown, 2006).

Table 5 shows the recommended level of acceptable fit and the fit indices for the research model in this study. Except for the χ^2, all values satisfied the recommended level of acceptable fit. In the case of the χ^2, it has been found to be too sensitive to large sample sizes and a high number of observed variables (Hair et al., 2006).

Table 5. Fit indices for the research model

Model fit indices	*Values*	*Recommended guidelines*	*References*
χ2	10.787, p < .029	Non-significant	Klem, 2000; Kline, 2005
χ2 /df (deg. of freedom)	2.697	< 3	Kline, 2005
SRMR	.023	< .05	Klem, 2000; McDonald and Ho, 2002
RMSEA	.060 (.017, .104)	< .05 (good fit) <.08 (fair fit)	McDonald and Ho, 2002
CFI	.989	=> .90	Klem, 2000; McDonald and Ho, 2002
TLI	.943	=> .90	Klem, 2000; McDonald and Ho, 2002

It was noted that, as the sample size increases, there is a great tendency for the χ^2 to indicate significant differences. Similarly, as a model becomes more complex (i.e. greater number of observed variables), the value of the χ^2 will go up. For these reasons, it has been suggested that the ratio of χ^2 to its degree of freedom be computed (χ^2 / df), with a value of not more than 3 being indicative of an acceptable fit between the hypothetical model and the sample data (Carmines & McIver, 1981). The result of the model fit as shown by the various fit indices in Table 5 indicates that the research model has a good fit.

Hypothesis Testing

Table 6 shows the results of the hypothesis test and Figure 3 shows the resulting path coefficients of the research model. Overall, ten out of thirteen hypotheses were supported by the data. All the hypotheses relating to the TAM variables were supported. Among the external variables, technological complexity did not significantly influence perceived usefulness but was a significant influence on perceived ease of use (β = 0.233, p < 0.001). Computer self-efficacy was a significant influence on perceived usefulness (β = 0.069, p < 0.05) and behavioural intention (β = 0.096, p < 0.001). Finally, facilitating conditions has a significant influence on perceived ease of use (β = 0.212, p < 0.001) and attitudes toward towards computer use (β = 0.086, p < 0.001).

Four endogenous variables were tested in the model. Behavioural intention was found to be significantly determined by perceived usefulness, attitude towards computer use, and computer self-efficacy, resulting in an R^2 of 0.27. This means that perceived usefulness, attitude towards computer use, and computer self-efficacy explained 31 percent of the variance in behvaioural intention. The other three endogenous variables, attitude towards computer use, perceived usefulness, and perceived ease of use were explained by their determinants in amounts of 45%, 21%, and 18% respectively.

Table 6. Hypothesis testing results

Hypotheses	*Path*	*Path coefficient*	*t- value*	*Results*
H1	ATCU → BI	.195**	3.733	Supported
H2	PU → BI	.220**	4.386	Supported
H3	PU → ATCU	.464**	12.693	Supported
H4	PEU → PU	.450**	9.947	Supported
H5	PEU → ATCU	.244**	6.532	Supported
H6	TC → PU	-.050	-1.655	Not supported
H7	TC → PEU	.233**	8.224	Supported
H8	CSE → PU	.069*	2.167	Supported
H9	CSE → PEU	.001	.030	Not supported
H10	CSE → BI	.096**	3.179	Supported
H11	FC → PU	.049	1.526	Not supported
H12	FC → PEU	.212**	6.942	Supported
H13	FC → ATCU	.086**	3.389	Supported

* p < .05; ** p < .001.

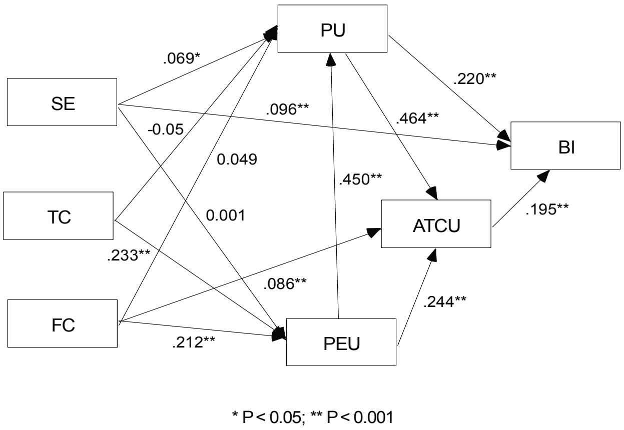

Figure 3. Path coefficients of the research model.

Path Analysis

Table 7 shows the standardised total effects, direct and indirect effects associated with each of the seven variables. A coefficient linking one construct to another in the path model represents the direct effect of a determinant on an endogenous variable. An indirect effect reflects the impact a determinant has on a target variable through one or more other intervening variables in the model. A total effect on a given variable is the sum of the respective direct and indirect effects. Interpretation of the effect sizes was based on the recommendations by Cohen (1988), with values less than 0.1 considered small, those with less than 0.3 are medium, and values with 0.5 or more considered large.

The most dominant determinant of behavioural intention is perceived usefulness, with a total effect of 0.324. This is followed by attitude towards computer use and perceived ease of use with a total effect of 0.196 and 0.195 respectively. Among the three variables external to the TAM, computer self-efficacy has the strongest effect on behavioural intention, with a total effect of 0.159. Technological complexity and facilitating, with their total effects of 0.043 and 0.100, have little effects on behavioural intention. Together, these six determinants accounts of approximately 27% of the variance in behavioural intention to use technology.

For attitude towards computer use, the prominent determinants are perceived usefulness and perceived ease of use, with total effects of 0.482 and 0.468 respectively. The strong relationship between perceived usefulness and perceived ease of use is demonstrated by the latter being the prominent determinant of the former, with a total effect of 0.448. For perceived ease of use, the dominant determinant is technological complexity with a total effect of 0.342, which is entirely a direct effect.

Of the four endogenous variables, attitude towards compute use has the greatest amount for variance account by its determinants, at approximately 45%. This is largely due to the effects contributed by perceived usefulness and perceived ease of use, thus stressing the importance of the relationship among these three variables.

Table 7. Direct, indirect, and total effects of the research model

Outcome	*Determinant*	*Standardised estimates*		
		Direct	*Indirect*	*Total*
Behavioural Intention (R^2 = .271)	PU	.229	.095	.324
	PEU	–	.195	.195
	ATCU	.196	–	.196
	TC	–	.043	.043
	CSE	.130	.029	.159
	FC	–	.100	.100
Attitude Towards Computer Use (R^2 = .454)	PU	.482	–	.482
	PEU	.252	.216	.468
	TC	–	.125	.125
	CSE	–	.044	.044
	FC	.120	.166	.285
Perceived Usefulness (R^2 = .214)	PEU	.448	–	.448
	TC	-.073	.153	.080
	CSE	.089	.001	.090
	FC	.065	.128	.194
Perceived Ease of Use (R^2 = .184)	TC	.342	–	.342
	CSE	.001	–	.001
	FC	.286	–	.286

DISCUSSION

The results of this study showed that perceived usefulness, attitude towards computer use, and computer self-efficacy have direct effect on behavioural intention to use technology, while perceived ease of use, and technological complexity, and facilitating conditions affect behavioural intention use indirectly. Overall, there is evidence to support existing theories and assumptions that the six selected variables affected the technology acceptance among pre-service teachers' in Singapore. Data also indicated that the resulting model is an adequate fit to the observed relationships among the factors that influenced pre-service teachers' technology acceptance.

Given the direct effects on behavioural intention, we infer that when technology is perceived to be useful and using it would improve their performance and make them more efficient, pre-service teachers are more likely to use technology. A positive attitude has a direct influence on behavioural intention. Consistent with current research, when users have positive feelings towards the use of computers, they are likely to continue using technology and use it in a greater way as long as the usage is sustained by the positive attitudes. Behavioural intention is found to be predicted by computer self-efficacy. When users possess a favourable judgment of their ability to use technology, they tend to be inclined to use technology. It is important to note that computer self-efficacy has a direct effect on perceived usefulness and perceived ease of use, although the effect size of the latter is smaller. This is noteworthy in that, of the two beliefs variables which are known to have significant influence on behavioural intention in the TAM, computer self-efficacy has more impact on perceived usefulness (0.90) and less effect on perceived ease of use (0.01), suggesting that it is possible that computer self-efficacy may be conceived as a similar construct as perceived ease of use.

Facilitating conditions have the greatest direct effect on perceived ease of use, followed by attitude towards computer use, and perceived usefulness. In other words, the perception of adequate support (e.g. technical, personnel) to enable users to apply technology has more influence on users perception of the extent to which a task involving technology is free from effort than how much the use of technology enables one to be more productive or efficient. Technological complexity has a positive direct impact on perceived ease of use and a negative effect on perceived usefulness. If a technology is perceived to be difficult to learn and use, it is likely to be perceived to be so tedious and time-consuming that a lot of effort has to be expended in order to benefit from it. On the relationship between technological complexity and perceived usefulness, the negative effect suggests that when users perceive a technology to be complex, they tend to find the technology less useful in that they would be unlikely to be productive and efficient by using it.

It is common for variables to interact with each other to indirectly influence another variable via one or more intervening variables. For example, attitude towards computer use and perceived usefulness mediate the effect of perceived ease of use on behavioural intention. This suggests that perceived ease of use, which has an indirect effect on behavioural intention, also influences perceived usefulness and attitude towards computer use. Users do not use technology simply because they perceive it to be easy. Users have to possess a positive attitude towards computer use and perceived technology to be useful at the same time. Similarly, the effects of both facilitating conditions and perceived ease of use on behavioural intention are mediated by attitudes towards computer use. It may be concluded that even if users perceived technology to be relatively free of effort or have access to well-supported infrastructures to use technology, they do not use it more unless they possess positive attitudes towards computer use.

This study uses SEM for data analysis which is an area of contribution to the technology acceptance literature. Some affordances of SEM include a simultaneous examination of the interaction of variables under study. This is in contrast to multiple regressions which measure only the direct relationships between the independent variable and the dependent variable while controlling for other variables. In other words, only the effects that are not mediated by other intervening variables are attributed to the independent variables. The use of path analysis in this study allows both the direct and indirect effects to be analyzed, hence the possibility of achieving a more accurate model.

This study has several implications for the school administrators and teacher educators. Although, perceived usefulness and perceived ease of use have been found to predict acceptance, they do not remain static. Teachers who perceive computers to be useful and easy to use may soon experience limitations if they do not participate in continuing professional development to keep abreast with more advanced skills and knowledge on the use of computers. The importance of professional development was highlighted by Sugar, Crawley and Fine (2004) who found that when students have experienced the affordances of technology in their learning, they would expect technology integration to continue over and over time, this may cause anxiety and insecurity to teachers. To support teachers in their use of technology, school administrators need to implement strategies that ensure effective successful experiences for teachers in the use of technology for teaching and learning.

For the teacher educators, pre-service teachers should be given access to the different types of technology that they will likely to use in the schools. This is to develop their computer self-efficacy, which is linked both prior experience and attitudes towards technology. Paraskeva, Bouta, and Papagianni (2007) defined prior experience as the amount of time a user spent in using different technologies. This is consistent with previous research by Yuen, Law, & Chan (1999) who recommended that pre-service teachers should, in the course of their training, be provided with the skills and experiences that will be relevant in their future job as a teacher, in order that these pre-service will know how to integrate technology as part of their instructional strategies to optimise students' learning.

Although care has been taken to ensure that the methodology in this study is sound, there are limitations. Firstly, the data collected was through self-reports and this may lead to the common method variance, a situation that may inflate the true associations between variables. Secondly, although pre-service teachers may use technology with the end goal of becoming a teacher in mind, their views and interactions with technology may differ from that of the practicing teachers. It is possible that pre-service teachers engage in more volitional uses of technology than the practicing teachers, and that the former are not exposed to the same demands as practicing teachers do in terms of the use of technology from within and outside their professional environments. In this way, pre-service teachers may not fully appreciate the demands and stresses involved in integrating technology in a real school setting.

Finally, the variance of the dependent variable, behavioural intention was explained by the six variables by a mere 27.1%, leaving 72.9% unexplained. Possible reasons include the exclusion of other variables in the model. Despite being extensively validated, the TAM has to be tested in light of the uses of technology in most environments becoming more complicated over time. This has raised the possibility that other variables not included in the TAM may have the potential to exert influence on users' acceptance of technology in significant ways.

Future research could include a comparative study between practicing and pre-service teachers to establish the extent to which the technology acceptance of pre-service teachers is different from practicing teachers. The results of such study would inform teacher educators to devise strategies to narrow the gap, if any, by providing access to and teaching relevant technologies at the teacher training stage. To address the issue of common method variance arising from a single method of data collection, future research could employ the multi-trait multi-method (MTMM). Finally, a study could be conducted to examine other variables of interest to the education community and how these variables may extend the TAM at various levels of technology acceptance.

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APPENDIX 1 LIST OF CONSTRUCTS AND CORRESPONDING ITEMS

Construct	*Item*	
Perceived Usefulness (adapted from Davies, 1989)	PU1	Using computers will improve my work.
	PU2	Using computers will enhance my effectiveness.
	PU3	Using computers will increase my productivity.
Perceived Ease of Use (adapted from Davies, 1989)	PE1	My interaction with computers is clear and understandable.
	PE2	I find it easy to get computers to do what I want it to do.
	PE3	I find computers easy to use.
Attitudes Toward Computer Use (adapted from Thompson et al., 1991; Compeau and Higgins, 1995)	ATCU1	Computers make work more interesting.
	ATCU2	Working with computers is fun.
	ATCU3	I look forward to those aspects of my job that require me to use computers.
Technological Complexity (adapted from Thompson et al., 1991)	TC1	Learning to use the computer takes up too much of my time. (R)
	TC2	Using the computer involves too much time. (R)
	TC3	It takes too long to learn how to use the computer. (R)
Self-Efficacy (adapted from Compeau and Higgins, 1995)	CSE1	I could complete a job or task using the computer if I could call someone for help if I got stuck. (R)
	CSE2	I could complete a job or task using the computer if someone showed how to do it first. (R)
Facilitating Conditions (adapted from Thompson, et al., 1991)	FC1	When I need help to use the computer, someone is there to help me.
	FC2	When I need help to learn to use the computer, someone is there to teach me.
Behavioural Intention	BI1	I will use computers in future.
	BI2	I plan to use the computer often

(R) This item has been reverse coded.

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6. IS TECHNOLOGY-MEDIATED LEARNING MADE EQUAL FOR ALL? EXAMINING THE INFLUENCES OF GENDER AND LEARNING STYLE

ABSTRACT

The current research investigates the equality of students' learning outcomes in technology-mediated learning. We study important individual differences and focus on the influences of gender and learning style. We perform two experimental studies that employ methodologically rigorous designs, multiple learning outcome measures, and previously validated measurement scales. Specifically, we examine learning effectiveness, perceived learnability, and learning satisfaction in technology-mediated learning, using classroom-based face-to-face learning as a comparative baseline. Our investigations address some limitations commonly found in many prior studies, including instrument reliability and confounding factors. Overall, our findings suggest that students benefit from technology-mediated learning differently, dependent on their gender. For example, female students consider technology-mediated learning more effective and satisfactory than male students, but their learning motivation is significantly lower than that of their male counterparts. Learning style also matters, perhaps to a lesser extent. Students who rely more on concrete experience, as opposed to abstract conceptualization, find the course materials delivered through technology-mediated learning more difficult to learn. Our findings have several implications for research and practice, which are discussed.

INTRODUCTION

The Internet has become a salient, worldwide education platform. According to Global Industry Analysts (2008), the technology-mediated learning market in the U.S. alone amounted to 17.5 billion dollars in 2007 and the global market is expected to exceed 52.6 billion dollars by 2010. Internet-based education provides a greater geographical reach and increased learner control with substantially enhanced cost-effectiveness. Advocates also believe that technology-mediated learning has the potential to tailor to individuals' learning needs through adaptive hypermedia (De Bra, Brusilovsky, & Conejo, 2002), personalization (Carchiolo, Longheu, Malgeri, & Mangioni, 2003), and Web 2.0 technologies (Rosen, 2006). Technology-mediated learning has been shown to facilitate digital inclusion by delivering education to social groups generally considered disadvantaged or underprivileged in a conventional,

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classroom-based learning setting; e.g., people living in areas not adequately supported by the existing educational infrastructure (Li & Qi, 2008).

Many studies have examined the effectiveness of technology-mediated learning, with a common emphasis on comparing technology-mediated learning and classroom-based, face-to-face learning. Inconsistent results are reported. Several meta-analysis studies show technology-mediated learning not significantly different from face-to-face learning in terms of learning effectiveness (Bernard, Abrami, Lou, Borokhovski, Wade, & Wozney 2004) or learning satisfaction (Allen Bourhis, Burrel, & Mabry, 2002). The "no significant difference" phenomenon can be viewed as supporting the use of technology-mediated learning as a viable alternative to face-to-face learning (Ubell, 2000). Collectively, however, these evidences show that students may not learn with equal efficiency in a technology-mediated learning environment. Several researchers have specifically cautioned against the equality implications in technology-mediated learning; e.g., Hills (2003), Hvorecky (2004), Manochehr (2006), Khan (2005).

Hvorecky (2004) argues that technology-mediated learning requires great self-discipline and self-motivation from students; therefore, it may not be equally appropriate for every student. According to Arbaugh (2000), female students tend to participate more in online discussions than male students. Manochehr (2006) reports that learning style may not impact students' learning effectiveness in conventional classroom-based learning, but can have significant influences in technology-mediated learning. The concerns about important equality implications in technology-mediated learning demand proper considerations. The effectiveness of learning is influenced by personal variables; e.g., individual student preferences in the design and evaluation of courses delivered through a technology-enabled platform completely or partially (Hills, 2003; Khan, 2005).

Although technology-mediated learning may help to mitigate social inequality through digital inclusion, the influences of individual differences (e.g., gender, learning style) on students' learning effectiveness or outcome warrant further investigation. This chapter explores the learning equality in technology-mediated education by examining the influences of two of the most studied individual factors in education research – gender and learning style – on students' learning effectiveness, perceived course 'learnability', and learning satisfaction in a technology-mediated learning environment, using face-to-face learning as a comparative baseline. We conducted two empirical studies: one focusing on the gender influences in students' learning of Photoshop and another targeting the impacts of learning style in students' learning of English as a foreign language. Overall, our results show that the benefits of technology-mediated learning seem to vary with gender and learning style. Our findings have important implications for research and practice, and can shed light on the future use of technology-mediated learning to foster desirable equality in education.

The remainder of the chapter is organized as follows. Section 2 reviews prior technology-mediated learning research in general and specifically the effects of gender and learning style. In Section 3, we develop our hypotheses. Section 4 describes our study designs and data collections. In Section 5, we describe our data analyses, highlight important results and discuss their implications. We conclude the chapter in Section 6 with a summary and several future research directions.

LITERATURE REVIEW

In spite of its profound social and political implications, the equality in technology-mediated learning has received little research attention. Digital divide is essential and has been studied from different perspectives, including information technology (e.g., Strover 1999), intention to use a technology (Lam & Lee, 2006; Hsieh, Rai, & Keil, 2008), and general technology skills (Hargittai, 2002). A handful of studies examine the relationship between technology-mediated learning and digital divide. For example, Chen (1986) investigates how digital divide affects the learning effectiveness of different student groups in technology-mediated learning. Chen reports that female students may be disadvantaged in technology-mediated learning because of their relatively lower computer self-efficacy and technology usage. Meyers, Bennett, and Lysaght (2004) investigate adult women in rural areas and their experiences in technology-mediated learning, suggesting several strategies for making technology-mediated learning more equitable. Li and Qi (2008) analyze the use of technology-mediated learning for delivering education to rural areas in mainland China. From a research perspective, the learning equality in technology-mediated learning is important and may be influenced by individual differences or characteristics, which however have not yet received much research attention.

Previous studies examine the impact of several individual differences in technology-mediated learning, without any explicit focus on learning equality; e.g., Arbaugh (2000), Manochehr (2006). The collective findings can be commonly characterized as inconsistent or even contradictory. Consider gender, for example. Keasar, Baruch, and Grobgeld-Dahan (2005) examine technology-mediated learning in science education and report no significant gender effects on students' learning of biology. On the contrary, McSporran and Young (2001) note that technology-mediated learning shifts substantial responsibilities from the instructor to students. They argue that female students tend to be more effective in time management and show empirically that female students learn more effectively in a technology-mediated environment than their male counterparts. Analysis of previous research results seemingly suggests that, in technology-mediated learning, differential learning effectiveness is observed among students with versus without certain characteristics.

To the point, gender is important and has key implications to issues surrounding diversity and equal opportunity. Thus, understanding the gender effect on students' learning is crucial as it allows system developers and instructors to better design technology-mediated learning systems and courses by properly addressing the key barriers commonly experienced by students of the disadvantaged gender. As Crew and Butterfield (2003) note, the use of technology-mediated learning, if adequately designed, may allow female students to learn more effectively in computer programming, a subject area that historically attracted less interest from female students (Bombardieri, 2005).

Learning style is also important, although its significance in technology-mediated learning is not well understood. People have different preferences in how they perceive, acquire or process information, and obtain knowledge (Kolb, Rubin, & Osland, 1990). Conventional classroom-based teaching typically delivers information (knowledge) in a one-to-many fashion, thus making it difficult to accommodate each student's individual needs or preferences. According to Bielawski and Metcalf (2002), technology-mediated learning offers increased flexibility and learner control; therefore, it may be able to better support or facilitate individualized learning, as compared with classroom-based face-to-face learning. Manochehr (2006) shows learning style to have no significant influence on students' learning effectiveness in a conventional instructor-centric learning environment; however, its effects are far more significant in technology-mediated learning. These findings suggest undesirable learning inequality in technology-mediated learning; i.e., not all students learn equally effective in technology-mediated learning. On the contrary, Neuhauser (2002) reports insignificant effects of learning style in technology-mediated learning. It is important to further examine whether students of different genders and/or different learning styles can benefit equally from technology-mediated learning.

Considerable previous research compares students' learning effectiveness in technology-mediated learning and classroom-based, face-to-face learning environments; the findings are mixed at best. For example, Alavi, Wheeler, and Valacich (1995) and Piccoli, Ahmad, and Ives (2001) report no significant differences in students' learning effectiveness in technology-mediated versus face-to-face learning. However, Beerman (1996) shows the use of technology-mediated learning to improve students' learning achievement and learning satisfaction significantly. Analysis of the prior research and inconsistent results points to several plausible explanations. First, many previous studies target various learning outcomes and use different measurements. For example, Alavi (1994) measures learning effectiveness by examining the degree to which a learning process is characterized by three essential learning aspects: active learning and construction of knowledge, co-operation and teamwork in learning, and learning through problem solving. Gardner, Simmons, and Simpson (1992) measure learning effectiveness using students' attitudes toward a course subject. Clements (1991) examines learning effectiveness on the basis of the level of creativity students demonstrate. The use of different measurements makes direct comparisons of the reported results difficult. Second, the instrument used to evaluate a focal learning outcome may have questionable validity or reliability (Phipps & Merisotis, 1999). Third, many studies examining the effects or moderating effects of individual differences on students' learning effectiveness or outcomes adopt a "one-shot design" and do not include an adequate comparative baseline or control group; e.g., face-to-face learning (Phipps & Merisotis, 1999).

This research attempts to reconcile the inconsistent results in the extant literature by addressing several limitations commonly found in prior studies. Specifically, we re-examine the potential inequality in technology-mediated learning by using methodologically rigorous study designs, statistically validated instruments to measure learning effectiveness or outcomes, and including classroom-based, face-to-face learning for control purposes. Academic performance is not the sole purpose of students' learning (Hirschheim, 2005); as a result, we incorporate multiple outcome measures in our studies, including learning effectiveness, perceived learnability, perceived learning community support, learning motivation, and learning satisfaction.

Our foremost goal is to analyze and compare, in technology-mediated learning, the learning effectiveness and outcomes among students who differ in gender or learning style. Our findings shed light on how to better design technology-mediated learning systems and how to better deliver courses using technology-mediated learning so as to foster desirable learning equality among students, despite their differences in gender or learning style.

HYPOTHESES DEVELOPMENT

Technology-Mediated Learning and Gender

Intrinsic gender-based differences have been observed in conventional classroom-based settings. For example, female students tend to perform better than male students in subjects related to language or social science; male students often outperform female students in mathematics and science. Prior research in neurosciences also shows several fundamental yet intriguing differences between genders in sensation and perception development (Sax, 2006). In our case, if the design of a technology-mediated learning system or a course using such systems fails to consider these differences, the disparity between genders is likely to propel and widen. Each gender has advantages and disadvantages in technology-mediated learning. For example, female students are more disciplined and therefore may learn more effectively in technology-mediated learning than male students (McSporran & Young, 2001). Female students, however, tend to exhibit less positive attitudes toward computer technology and thus may prefer less technology in their learning than male students (Katz, 2006). A review of previous research suggests important gender differences in technology-mediated learning; e.g., Arbaugh (2000), Li (2006).

According to cognitive learning theory, learning is an active, constructive and goal-oriented process (Shuell, 1986; Wittrock, 1978, 1986; Alavi, 1994). In this light, learning outcomes and experience are crucial. We focus on several learning outcome measures: perceived learning effectiveness, perceived learnability, learning motivation, and learning satisfaction. Specifically, perceived learning effectiveness refers to the extent to which a student considers his or learning supported by a medium for learning (e.g., technology-mediated or face-to-face) to be effective for acquiring the information (knowledge) delivered through that medium (Hu, Hui, Clark and Tam, 2007). Perceived learnability denotes the extent to which a student considers the presented learning materials learnable (Hu et al., 2007). Learning motivation refers to the degree to which a student is motivated to make extra efforts towards achieving the learning objectives (Ruohotie, 2000). Learning satisfaction manifests as a student's overall positive assessment of his or her learning experience (Keller, 1983). We test the following hypotheses:

H1: There exists a significant between-gender difference in the perceived learning effectiveness among students supported by technology-mediated learning versus by classroom-based, face-to-face learning.

H2: There exists a significant between-gender difference in the perceived learnability among students supported by technology-mediated learning versus by classroom-based, face-to-face learning.
H3: There exists a significant between-gender difference in the learning motivation among students supported by technology-mediated learning versus by classroom-based, face-to-face learning.
H4: There exists a significant between-gender difference in the learning satisfaction among students supported by technology-mediated learning versus by classroom-based, face-to-face learning.

Technology-Mediated Learning and Learning Style

Learning style refers to the important characteristic behaviors of an individual, which can serve as a relatively stable indicator of how he or she perceives, interacts with, and responds to a learning environment (Kolb et al., 1990). Technology-mediated learning has the potential to provide learning tailored to individual students' needs or preferences, through effective use of adaptive multimedia and increased learner control in terms of the pace, time, or location (Bielawski & Metcalf, 2002). Previous research fails to consistently and convincingly prove that students with different learning styles can equally benefit from technology-mediated learning. Our literature review shows many prior studies use instruments with questionable reliability, or do not include face-to-face learning for control purposes, making it difficult to rule out the potential confounding effects of some interacting (conflicting) factors (Phipps & Merisotis, 1999). To address these limitations, we employ validated instruments to measure learning outcomes and include classroom-based, face-to-face learning as a baseline for comparison (control) purposes.

Our dependent variables are objective and perceived learning effectiveness, perceived course learnability, perceived learning community support, and learning satisfaction. In the English learning context, perceived learning effectiveness measures the extent to which a student believes he or she has achieved learning objectives of the course. We use tests designed by experienced English language teachers to objectively measure students learning effectiveness. Learning satisfaction here has the same meaning as in the Photoshop study; it measures a student's overall positive assessment of his or her learning experience (Keller, 1983). Perceived course learnability is similar to perceived learnability in the Photoshop study, except that it is about students' perception of the learnability of materials for the entire course in contrast to just a lab session. We analyze students' perception of the learning community support in technology-mediated or face-to-face learning, which denotes the extent to which a student perceives that the learning environment creates an active, strongly bonded community facilitating and fostering experience exchange and knowledge sharing among peers and their instructors (Hu et al., 2007). We include perceived learning community support in the English study because the study lasted for an entire semester and perceived learning community support has been shown to be an important determinant of learning satisfaction (Wang, 2003).

We use Kolb's Learning Style Model to assess students' learning style and investigate its influences on the learning equality in technology-mediated learning.

Experiential learning represents a core premise of this model, which explores the nature of an individual's learning through experience, reflection, conceptualization, and active experimentation (Kolb et al., 1990). As depicted in Figure 1, a student's learning style can be described on the basis of the relative importance of abstract conceptualization versus concrete experience for perceiving and acquiring information, as well as reflective observation versus active experimentation for processing and assimilating information.

The information perceiving and acquisition by an individual can be experiential (e.g., through senses or feelings) in some "concrete" way (i.e., concrete experience), or through abstract conceptualization (i.e., "meta-level" comprehension) underpinned by formal logic, reasoning, analogy, or metaphor. Concrete experience emphasizes "being involved" and typically deals with immediate human situations in a "live" experiential manner. In contrast, abstract conceptualization focuses on logics, concepts, intuitions, or patterns, placing great value on conceptualization of a higher order, through reflection and internalization. When learning, a student can engage in both concrete experience and abstract conceptualization simultaneously, but may show a noticeable tendency of preferring one over the other. Similarly, students also differ considerably in the way they process information: some prefer active experimentations that focuses on "doing" and others prefer reflective observations that emphasizes "watching." Again, when learning, students often rely on both active experimentation and reflective observation simultaneously; they may, however, exhibit notable preferences for one in a specific learning scenario or task.

Many existing technology-mediated learning systems offer limited support of "live" activities in students' learning (Hamilton & Cherniavsky, 2006). As described, students who primarily learn through concrete experiences tend to value active participations by themselves, peers, and instructors. Such participation-oriented learning demands substantial support of simultaneous interactions and live feedback that are generally better supported by classroom-based, face-to-face learning than by technology-mediated learning. On the other hand, abstract thinkers usually prefer working individually and have a tendency of placing less value on live or group-based participation-oriented learning activities. They might be more tolerant of a learning environment offering limited simultaneous interaction support or live feedback. Therefore, we test the following hypotheses:

H5: In technology-mediated learning, students who are abstract thinkers exhibit higher objective learning effectiveness than do those who are concrete thinkers.

H6: In technology-mediated learning, students who are abstract thinkers perceive greater learning effectiveness than do those who are concrete thinkers.

H7: In technology-mediated learning, students who are abstract thinkers perceive the overall course more learnable than do those who are concrete thinkers.

H8: In technology-mediated learning, students who are abstract thinkers consider the learning community support to be stronger than do those who are concrete thinkers.

H9: In technology-mediated learning, students who are abstract thinkers show higher learning satisfaction than do those who are concrete thinkers.

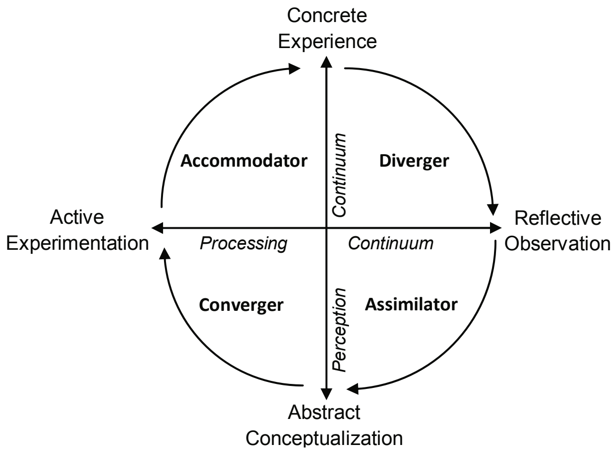

Figure 1. Kolb's learning style model (Kolb et al., 1990).

STUDY DESIGN AND DATA COLLECTION

Study 1: Technology-Mediated Learning and Gender

To examine the influences of gender, we conducted a controlled experiment on students learning Photoshop for Web content publishing. Our experiment consisted of 6 sessions, all conducted in a designated computer laboratory and administered by the same investigator. Half of the sessions used technology-mediated learning and the remaining employed classroom-based, face-to-face learning. Each subject could choose freely which experiment session to join but did not know beforehand whether that session would involve technology-mediated or face-to-face learning. We recruited subjects from undergraduate students taking an introductory Information Systems course in a major English-speaking university in Hong Kong. The Hong Kong government has long recognized the importance of information technology for supporting and fostering learner-centric learning. In the past decade, substantial resources have been allocated to create (upgrade) the IT infrastructure and improve the technical support in various education institutions, leading to evident, significant improvements in computer access and Internet connectivity (Plomp, Anderson, & Law 2009). As a result, our subjects in general are familiar with IT and feel comfortable learning through an electronic medium.

The specific Photoshop topics included in our study were: adding text to images, straightening scanned images, cropping images, correcting exposure, using the Spot Healing Brush, using the Red Eye Removal tool, removing wrinkles, creating a glamour look, and applying liquefied distortion. We designed experimental tasks pertinent to these topics and included some additional, similar tasks to be completed by subjects if they were motivated to do so. We maintained the necessary symmetry across all the sessions; e.g., using the identical learning materials, following the same experiment procedure, utilizing the same warm-up tasks and experimental tasks, and providing all subjects with the same amount of time sufficient for their completing the additional tasks if they chose to do so.

We gathered subjects' demographic information and computer self-efficacy (Compeau & Higgins, 1995) before the experiment. We asked each subject to complete all the experimental tasks and used a post-experiment survey to collect their assessment of perceived learning effectiveness, learnability, learning community support and satisfaction. We also recorded the number of additional tasks a subject completed in the experiment and used it as a proxy for learning motivation. Latent constructs were operationalized using measurement items based on a seven-point Likert scale, with 1 being "strongly disagree" and 7 being "strongly agree." To reduce potential anchoring or floor (ceiling) effects, we randomly sequenced the question items in the questionnaire. The instruments used to measure our latent constructs are presented in the Appendix.

Technology-Mediated Learning and Learning Style

To examine the effects of learning style, we performed a longitudinal field experiment on students' learning English as a foreign language. Our subjects were freshmen who enrolled in a freshman English class offered in multiple sections. Each section used either classroom-based, face-to-face learning solely (i.e., the control group) or a balanced combination of technology-mediated and face-to-face learning (i.e., the treatment group), consistent with the salient blended approach to technology-mediated learning (Masie, 2002). Each subject was randomly assigned to a treatment or control session according to his or her class schedule availability. The use of the designated course Web site was mandatory for subjects in the technology-mediated group. This site contained programmed multimedia course materials, including online instructions, exercises, illustrations, and diagnostic feedback, which target different fundamental aspects of English learning. Our study Web site resembles many existing Web-based learning sites and offers limited support of spontaneous interactions, live feedback, and learning community building. Students in the face-to-face group met in the classroom twice as often as their counterparts supported by technology-mediated learning but had no access to the course Web site.

We collected data at the beginning and the end of a 15-week semester. One week before the study, each subject took an online English test to provide a baseline for our objective learning effectiveness assessments. Subjects took another test, also online, at the end of the study (semester). We used the difference between the two test scores to measure each subject's objective learning effectiveness. We gathered subjects' demographic information and assessed their learning style (i.e., abstract conceptualization versus concrete experience, and reflective observation versus active experimentation) within the first two weeks of our study. At the end of the 15-week study, we collected from each subject his or her assessment of perceived learning effectiveness, perceived course learnability, learning community support, and learning satisfaction. All question items employed a seven-point Likert scale, with 1 being "strongly disagree" and 7 being "strongly agree". We randomly sequenced the items in the questionnaire. These question items are presented in the Appendix.

DATA ANALYSES AND RESULTS

Study 1 – Technology-Mediated Learning and Gender

A total of 326 subjects voluntarily participated in the study, representing approximately half of the targeted student population. We removed responses by 17 subjects who did not complete the questionnaire; as a result, our sample consists of 309 subjects. Students in technology-mediated and face-to-face learning groups were highly comparable in demographics, computer self-efficacy, and average Internet usage, as shown in Table 1.

Table 1. Summary of demographics in photoshop study

	Face-to-face group	*Technology-mediated group*
Gender	Male: 41 (41%) Female: 59 (59%)	Male: 51 (45.5%) Female: 61 (54.5%)
Average computer usage per week	< 5 hours: 13 (13%) 5–10 hours: 26 (26%) 11–15 hours: 17 (17%) 16–20 hours: 15 (15%) > 20 hours: 29 (29%)	< 5 hours: 10 (8.9%) 5–10 hours: 20 (17.9%) 11–15 hours: 18 (16.1%) 16–20 hours: 21 (18.8%) > 20 hours: 43 (38.4%)
Average Internet usage per week	< 5 hours: 1 (1%) 5–10 hours: 13 (13%) 11–15 hours: 26 (26%) 16–20 hours: 18 (18%) > 20 hours: 42 (42%)	< 5 hours: 0 (0%) 5–10 hours: 13 (11.6%) 11–15 hours: 26 (23.2%) 16–20 hours: 20 (17.9%) > 20 hours: 53 (47.3%)
Computer Self - Efficacy	Mean: 5.39 S.D.: 0.83	Mean: 5.42 S.D.: 0.85

All the constructs show a reasonably satisfactory Cronbach's alpha value (Nunnally 1978): 0.62 for perceived learning effectiveness, 0.69 for perceived learnability, and 0.77 for learning satisfaction. We examine our instruments' convergent and divergent validity by performing an exploratory factor analysis. As shown in Table 2, items that measure the same construct exhibit substantially higher loadings than do those measuring other constructs. The eigenvalue of each extracted factor exceeds 1.0, a common threshold used by previous research (Kim & Mueller, 1978). Overall, our instruments exhibit adequate reliability and convergent/discriminant validity.

To test the main effects of technology-mediated learning and its interaction with gender, we performed a two-way analysis of covariance (ANCOVA), using computer self-efficacy as the covariate. Table 3A summarizes our hypothesis testing results. Regarding the main effects of technology-mediated learning, students using face-to-face learning completed more tasks ($p < 0.01$), perceived greater learning effectiveness ($p < 0.01$), and showed higher learning satisfactions ($p < 0.01$) than their counterparts supported by technology-mediated learning. We observe a significant interaction effect of technology-mediated learning and gender on students'

Table 2. Analysis of convergent and discriminant validity for latent constructs in photoshop study

Question Items	*Components extracted*			
	Factor 1	*Factor 2*	*Factor 3*	*Factor 4*
Computer self-efficacy (CSE-1)	**0.80**	0.10	0.09	0.03
Computer self-efficacy (CSE-2)	**0.78**	0.04	-0.03	-0.02
Computer self-efficacy (CSE-3)	**0.80**	0.04	0.02	-0.04
Computer self-efficacy (CSE-4)	**0.68**	0.09	0.05	0.18
Learning satisfaction (LS-1)	0.071	**0.79**	-0.11	0.14
Learning satisfaction (LS-2)	0.17	**0.78**	0.15	-0.01
Learning satisfaction (LS-3)	0.00	**0.66**	0.01	0.32
Perceived learnability (PL-1)	-0.01	-0.04	**0.88**	0.07
Perceived learnability (PL-2)	0.02	-0.12	**0.85**	-0.05
Perceived learnability (PL-3)	0.09	0.19	**0.60**	-0.05
Perceived learning effectiveness (PLE-1)	-0.12	0.10	0.01	**0.81**
Perceived learning effectiveness (PLE-2)	0.16	0.10	-0.05	**0.72**
Perceived learning effectiveness (PLE-3)	0.12	0.49	0.01	**0.63**
Eigenvalue	3.08	2.16	1.8	1.05
Percent variance explained	23.71	16.61	14.01	8.07

learning motivation measured by the number of additional learning tasks completed by a student ($p < 0.01$). We find a similar, significant interaction effect on perceived learning effectiveness ($p < 0.05$) as well as on learning satisfaction ($p < 0.05$), shown in Table 3A. Gender by itself does not seem to affect perceived learning effectiveness, perceived learnability, learning motivation, or learning satisfaction significantly.

In Table 3B, we summarize the mean of each dependent variable observed in the respective groups (i.e., technology-mediated or face-to-face) and gender. As shown,

Table 3A. ANCOVA analysis results for photoshop study

Dependent variables	*Sig.*			
	Computer self- efficacy	*Technology-mediated learning*	*Gender*	*Technology-mediated learning × gender*
Learning Motivation (LM)	0.31	< 0.01**	0.07	< 0.01**
Learning Satisfaction (LS)	< 0.01**	< 0.01**	0.085	0.05*
Perceived Learnability (PL)	0.24	0.56	0.84	0.88
Perceived Learning Effectiveness (PLE)	0.12	< 0.01**	0.37	0.05*

* Significant at 0.05 level. ** Significant at 0.01 level.

Table 3B. A Comparison of descriptive statistics for photoshop study

Variables	*Mean (S.D.)*			
	Face-to-face learning		*Technology-mediated learning*	
	Male	*Female*	*Male*	*Female*
Learning Motivation (LM)	7.71 (1.89)	8.06 (1.67)	5.44 (3.05)	4.07 (2.70)
Learning Satisfaction (LS)	5.50 (0.71)	5.52 (0.79)	4.82 (1.16)	5.21 (0.90)
Perceived Learnability (PL)	4.67 (0.94)	4.62 (0.93)	4.73 (1.08)	4.70 (1.03)
Perceived Learning Effectiveness (PLE)	5.21 (0.82)	5.13 (0.94)	4.46 (1.20)	4.80 (0.95)
Computer Self-Efficacy (CSE)	5.41 (0.87)	5.58 (0.88)	5.55 (0.96)	5.53 (0.86)

male and female students in the face-to-face group have a comparable mean for each dependent variable. In contrast, we note greater differences in mean values between male and female students supported by technology-mediated learning. We cannot attribute these differences to computer self-efficacy, which has been identified as an important factor for explaining the relatively low learning performance by female students in technology-mediated learning (Chen, 1986), because our subjects, both male and female, report comparable computer self-efficacy. Overall, our data support H1, H3, and H4; but not H2.

According to our results, male students seem more motivated in technology-mediated learning than female students. This finding may be explained in part by the general between-gender difference in intrinsic motivation that involves technology. As Li (2006) notes, male students tend to enjoy using computer technology more than their female counterparts; e.g., enjoyment or satisfaction derived from trying out new software or using it for different purposes. Nevertheless, female students in our sample perceive their learning in a technology-mediated setting more effective and satisfactory. These between-genders differences observed in the outcomes of technology-mediated learning are intriguing and deserve further investigation in future research.

Study 2 – Technology-Mediated Learning and Learning Style

Our subjects were freshmen at a major university in Hong Kong who enrolled in the freshman English class mandated by the university. A total of 507 students took part in the study, accounting for 29.4% of the targeted population. Incomplete responses were removed; as a result, our effective sample size is 438. Both technology-mediated and face-to-face groups were highly comparable in age, advanced-level English examination scores, general computer competency, and Internet experiences and usage, as shown in Table 4. Notably, we had a larger proportion of males (69% versus 44%) and abstract thinkers (63% versus 53%) in the technology-mediated group than in the face-to-face group.

Table 4. Summary of demographics in English learning study

	Face-to-face group	*Technology-mediated group*
Age	19.0	19.2
Gender	Male: 107 (44.0%) Female: 136 (56.0%)	Male: 135 (69.2%) Female: 60 (30.8%)
Affiliated School	Business: 121 (49.8%) Engineering: 46 (18.9%) Science: 76 (31.3%)	Business: 45 (23.1%) Engineering: 99 (50.8%) Science: 51 (26.2%)
A-Level English Exam	A = 6; B = 22; C = 54; D = 79; E = 39; F = 4	A = 1; B = 11; C = 28; D = 65; E = 73; F = 0
Learning Style	Abstract conceptualization: 153 (63%) Concrete experience: 90 (37%) Active experimentation: 150 (62%) Reflective observation: 93 (38%)	Abstract conceptualization: 103 (53%) Concrete experience: 92 (47%) Active experimentation: 140 (72%) Reflective observation: 55 (28%)
Computer Skills	4.26 (on a 7-point scale)	4.71 (on a 7-point scale)
Average Internet Usage Per Week	< 5 hours: 39 (16%) 5–10 hours: 59 (24%) 11–15 hours: 59 (24%) 16–20 hours: 33 (14%) > 20 hours: 53 (22%)	< 5 hours: 25 (13%) 5–10 hours: 40 (21%) 11–15 hours: 29 (15%) 16–20 hours: 25 (13%) > 20 hours: 76 (39%)

The Cronbach's alpha values are satisfactory: 0.79 for perceived learning effectiveness, 0.78 for learnability, 0.65 for learning community support, and 0.90 for learning satisfaction; all exceed the common threshold of 0.6 for an exploratory study (Nunnally, 1978). We examined the convergent and discriminant validity by performing an exploratory factor analysis. As shown in Table 5, items measuring the same construct exhibit substantially higher loadings than do those measuring other constructs. The eigenvalue of each extracted factor exceeds 1.0, a common threshold used by previous research (Kim & Mueller, 1978). Overall, our instruments exhibit adequate reliability and convergent/discriminant validity.

We performed a GLM analysis on each dependent variable. As summarized in Table 6A, we observe a significant effect of technology-mediated learning on perceived learning effectiveness and learning community support. We also note that technology-mediated learning has a significant interaction effect with learning style on perceived learnability. Overall, our experimental results suggest the important role of learning style for explaining the outcomes associated with technology-mediated learning.

Further analyses show students' information perceiving and acquisition moderates their learning outcomes in technology-mediated learning. As shown in Table 6B, students' information perceiving/acquisition preferences significantly affect their perception of learnability. Specifically, concrete thinkers seem to find the course more difficult to learn compared with abstract thinkers, in support of our H7. The technology-mediated learning system used in the study resembles most existing systems; as a consequence, concrete thinkers may be put in a relatively disadvantaged position, compared with abstract thinkers. This suggests future technology-mediated learning system designs need to consider offering more concrete experiences to target students; e.g., through effective use of multimedia and interactive contents.

Table 5. Analysis of convergent and discriminant validity for latent constructs in English learning study

Question items	*Components extracted*			
	Factor 1	*Factor 2*	*Factor 3*	*Factor 4*
Learning Satisfaction (LS-1)	**0.72**	0.32	0.15	0.16
Learning Satisfaction (LS-2)	**0.73**	0.31	0.06	0.18
Learning Satisfaction (LS-3)	**0.67**	0.14	0.21	0.13
Learning Satisfaction (LS-4)	**0.68**	0.38	0.20	0.23
Learning Satisfaction (LS-5)	**0.55**	0.46	0.13	0.31
Learning Satisfaction (LS-6)	**0.65**	0.18	0.43	0.23
Learning Satisfaction (LS-7)	**0.68**	0.26	0.28	0.25
Perceived Learning Effectiveness (PLE-1)	0.19	**0.67**	0.15	0.21
Perceived Learning Effectiveness (PLE-2)	0.16	**0.80**	0.06	0.00
Perceived Learning Effectiveness (PLE-3)	0.20	**0.74**	0.17	0.06
Perceived Learning Effectiveness (PLE-4)	0.22	**0.69**	0.07	0.13
Perceived Learning Effectiveness (PLE-5)	0.45	**0.52**	0.11	0.11
Perceived Learning Effectiveness (PLE-6)	0.35	**0.54**	0.17	0.05
Perceived Course Learnability (PCL-1)	0.09	0.10	**0.73**	0.08
Perceived Course Learnability (PCL-2)	0.06	0.08	**0.77**	0.15
Perceived Course Learnability (PCL-3)	0.46	0.16	**0.62**	-0.02
Perceived Course Learnability (PCL-4)	0.37	0.11	**0.70**	0.01
Perceived Course Learnability (PCL-5)	0.22	0.27	**0.50**	0.37
Perceived Learning Community Support (PLCS-1)	0.09	0.20	0.40	**0.60**
Perceived Learning Community Support (PLCS-2)	0.30	0.13	0.00	**0.72**
Perceived Learning Community Support (PLCS-3)	0.20	0.04	0.09	**0.77**
Eigenvalue	8.48	1.82	1.33	1.06
Percentage of variance explained	19.87	16.89	13.80	9.86

Table 6A. GLM analysis results

Dependent variables	*Sig.*		
	Learning style	*Tech-mediated learning*	*Learning Style × Tech-mediated learning*
Objective Learning Effectiveness (OLE)	0.132	0.749	0.897
Perceived Learning Effectiveness (PLE)	0.351	0.015*	0.459
Perceived Course Learnability (PCL)	0.392	0.210	0.044*
Perceived Learning Community Support (PLCS)	0.388	0.012*	0.175
Learning Satisfaction (LS)	0.640	0.727	0.586

* Significant at 0.05 level.

Table 6B. A comparison of descriptive statistics

Dependent variables	*Mean (S.D.)*		*p-value*
	Abstract thinkers	*Concrete thinkers*	
Objective Learning Effectiveness (OLE)	2.80 (7.89)	1.97 (7.26)	0.45
Perceived Learning Effectiveness (PLE)	4.52 (0.86)	4.56 (0.74)	0.69
Perceived Course Learnability (PCL)	4.64 (0.77)	4.39 (0.81)	0.03*
Perceived Learning Community Support (PLCS)	3.90 (0.96)	3.98 (0.87)	0.54
Learning Satisfaction (LS)	4.35 (1.05)	4.22 (0.89)	0.38

* Significant at 0.05 level.

We summarize our hypothesis testing results in Table 7, As shown, our data support H7 but do not support H5, H6, H8, or H9.

Table 7. Summary of hypothesis testing results

Hypotheses	*Results*
H1: There exists a significant between-gender difference in the perceived learning effectiveness among students supported by technology-mediated learning versus by classroom-based face-to-face learning.	Supported
H2: There exists a significant between-gender difference in the perceived learnability among students supported by technology-mediated learning versus by classroom-based face-to-face learning.	Not Supported
H3: There exists a significant between-gender difference in the learning motivation among students supported by technology-mediated learning versus by classroom-based face-to-face learning.	Supported
H4: There exists a significant between-gender difference in the learning satisfaction among students supported by technology-mediated learning versus by classroom-based face-to-face learning.	Supported
H5: In technology-mediated learning, students who are abstract thinkers exhibit higher objective learning effectiveness than do those who are concrete thinkers.	Not Supported
H6: In technology-mediated learning, students who are abstract thinkers perceive greater learning effectiveness than do those who are concrete thinkers.	Not Supported
H7: In technology-mediated learning, students who are abstract thinkers perceive the overall course more learnable than do those who are concrete thinkers.	Supported
H8: In technology-mediated learning, students who are abstract thinkers consider the learning community support to be stronger than do those who are concrete thinkers.	Not Supported
H9: In technology-mediated learning, students who are abstract thinkers show higher learning satisfaction than do those who are concrete thinkers.	Not Supported

DISCUSSION

The main objective of this study is to explore the equality implications of technology-mediated learning, while ruling out potential confounding effects that arise from "one-shot" designs and unreliable measurements. In both the Photoshop and English learning studies, we include multiple learning outcome measures, use statistically validated measurement scales, and include classroom-based, face-to-face learning as a control. Our measurements and study designs allow us to generate empirical results regarding the influences of gender and learning style on students' learning outcomes in technology-mediated learning, critical to digital inclusion and equality in education. Our results show the learning outcomes associated with technology-mediated learning to be affected by individual differences (e.g., gender, learning style). Equipped with this understanding, system developers and educators should be cautious about unexpectedly putting some students in a disadvantaged position when pursuing the benefits of technology-mediated learning, and addressing such undesirable influences appropriately from the perspective of system design, teaching pedagogy, or both.

We made several important observations from our studies. First, concrete thinkers may find the materials delivered through technology-mediated learning more difficult to learn than abstract thinkers. Second, female students may be less motivated in a technology-mediated learning environment than male students. Third, male students may perceive technology-mediated learning less effective and less satisfactory, compared with female students. To foster equally effective learning environments, system developers and educators should examine and reduce partiality in any key aspect of students' learning experiences. For example, to avoid placing concrete thinkers in a disadvantaged position, a technology-mediated learning system should incorporate effective multimedia presentations to create the realism and interactivity simulating "live" learning situations; e.g., network simulation software Packet Tracer by Cisco. Adaptive systems can also be used to accommodate the needs of individual students with different learning styles (Triantafillou, Pomportsis, Demetriadis, & Georgiadou, 2002). To minimize gender inequity, instructors in a technology-mediated learning setting can provide students with sufficient incentives for completing learning exercises, together with effective assessments. Furthermore, we can enhance students' learning outcomes (e.g., effectiveness, satisfaction) in technology-mediated learning by providing increased interactivity, functionality, instruction, and administration (Shen, Hiltz, & Bieber, 2006). Perceived support also provides an important influence on students' learning satisfaction in technology-mediated learning (Wang, 2003). Instructors should take advantage of online chat and discussion forums to foster a supportive learning environment that encourages exchanges and knowledge sharing among students through these channels.

CONCLUSION

We contribute to technology-mediated learning research in several ways. First, we explore the equality of students' learning outcomes in technology-mediated learning and produce empirical evidence suggesting the importance of individual differences in affecting the equality; e.g., gender and learning style. Specifically, we empirically reinforce, with methodological rigor, the theory that technology-mediated learning itself does influence students differently, suggesting potential undesirable inequality of students' learning outcomes in technology-mediated learning settings. Second, we consider the effectiveness of technology-mediated learning as multifaceted and observe that students may benefit from technology-mediated learning in some aspects of learning but be placed in a disadvantaged position in other aspects. Thus, it is important to use multiple measures to examine learning outcomes. By doing so, we can obtain a comprehensive understanding of the learning equality in technology-mediated learning. Third, our results suggest that the subject (topic) of learning may play a role in the equality of technology-mediated learning. When the subject is computer-related, female learners may be less motivated to engage in additional (optional) learning activities; when the learning of a subject requires concrete experimentation, concrete thinkers may find learning more difficult.

Our findings highlight the need to consider individual differences when designing technology-mediated learning systems as well as various courses to be delivered through technology-mediated learning partially or completely. We explore practical implications of our findings and identify several ways by which instructors can avoid introducing unfairness in technology-mediated learning unintentionally. For example, games and simulations of a real-world phenomenon can be used as an effective substitute of concrete experience for concrete thinkers. Proper assessments can be used to motivate students, particularly female students, to participate in online activities in science or technology related subjects. Improved interactivity, functionality, instruction, administration and learning support can help to assure students' perceived learning effectiveness and satisfaction at a desirable level.

Our research has several limitations that should be considered when applying our findings to other technology-mediated learning settings. First, our subjects are undergraduate students in Hong Kong; there might be some cultural differences with respect to the influences of individual differences in technology-mediated learning. Thus, our findings may not be totally applicable to students in a different culture. Second, our results are derived from examinations of two specific subjects; i.e., language and Web content publishing. In our Photoshop experiment, female subjects seem less motivated in technology-mediated learning, as compared with male subjects. This finding is not consistent with the findings of McSporran & Young (2001), who show that female students tend to be more motivated than their male counterparts in a computer-programming course delivered through technology-mediated learning. Therefore, it is important to be mindful about the variables that do not show significant influences on the equality of students' learning outcomes in our studies, but may exhibit important effects in other subjects or student groups.

In turn, these limitations point to several future research directions worthy of our investigative attention. First, we need to examine the relative importance of key individual differences in various cultures. Second, to make the results more generalizable, we need to expand our evaluations by including different student groups and subjects. Third, it is important to develop quantitative measures for assessing the "fit" between technology-mediated learning and a subject or a learning task. This allows us to make informed decisions regarding whether a course or a learning task is likely to be effectively and efficiently delivered through technology-mediated learning. Fourth, we must consider other essential learning outcome measures. Although more comprehensive than many prior studies examining technology-mediated learning, the dependent variables included in our studies can be extrapolated. The use of additional key learning outcome measures enable a fuller depiction of the underlying inequality concerns in technology-mediated learning and encourage the consideration of different and perhaps complementary research methods or designs. Learning is a complex activity; the effectiveness or outcomes of technology-mediated learning may be affected by a host of independent or interrelated factors. Such factors can pertain to the learning system or individual characteristics, which together can create significant interaction effects. Continued efforts are needed to further examine how these factors may affect the equality in students' learning outcomes and experiences in technology-mediated learning. By doing so, we can identify key problems hindering equality and explore how to address them, from a system design or pedagogical perspective, to ensure that students can benefit equally from technology-mediated learning.

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APPENDIX

A. Question Items for Photoshop Study

Learning Satisfaction (LS)
LS-1: I like the idea of learning Photoshop in a lab like this.
LS-2: Learning Photoshop by attending a lab like this is a great idea.
LS-3: My learning experience in this lab is positive.
LS-4: My learning of Photoshop in this lab is pleasant.

Perceived Learning Effectiveness (PLE)
PLE-1: In this lab, I have the opportunities to practice what I learn about Photoshop.
PLE-2: The pace at which the materials are presented in the lab is appropriate for my learning.
PLE-3: Overall, I have good control over the presentation of the materials covered in this lab.

Perceived Learnability (PL)
PL-1: The lab materials are delivered in a way that is easy to for me to comprehend.
PL-2: The lab contents are presented in a way that is clear for me to understand.
PL-3: Learning Photoshop in a lab like this is enjoyable.

Computer Self-Efficacy (CSE)
In general, I can use computer technology to complete a task …
CSE-1: if I have seen someone else using it before trying it myself.
CSE-2: if I can call someone for help if I got stuck.
CSE-3: if someone else can help me getting started.
CSE-4: if someone shows me how to do it first.

B. Question items used in English Learning Study

Learning Satisfaction (LS)
LS-1: I like the idea of learning English in a class like this; i.e., the one I have this semester.
LS-2: Learning by taking a course like this is a good idea.
LS-3: My learning experience in this course is positive.
LS-4: Overall, I am satisfied with the course.
LS-5: In sum, my learning in the course is pleasant.
LS-6: Learning English in a class like this is enjoyable.
LS-7: As a whole, the course is effective for my learning.

Perceived Learning Effectiveness (PLE)
PLE-1: This course supports my learning English by providing many resources and tools.
PLE-2: This course allows me to learn English in many different ways.
PLE-3: The course gives me chances to review what I learn.
PLE-4: This course allows me to improve my understanding of the basic elements of English.
PLE-5: This course allows me to learn to identify the central issues in learning English.
PLE-6: This course allows me to learn factual aspects of using English.

Perceived Course Learnability (PCL)

CL-1: I have no difficulty understanding course materials delivered in class (or via the Web).

CL-2: Overall, I find this course easy to learn.

CL-3: The course is delivered in a way that is easy to learn.

CL-4: The course content is presented in a way that is easy to understand.

CL-5: I find the delivery of the course content clear; i.e., not ambiguous.

Perceived Learning Community Support (PLCS)

PLCS-1: The course makes it easy for me to learn from other students.

PLCS-2: The course facilitates my sharing of what I have learned with other students.

PLCS-3: It is easy for me to discuss with other students concerns related to course contents.

ACCEPTANCE OF SPECIFIC TECHNOLOGIES

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7. UNIVERSITY STUDENTS' ACCEPTANCE OF A WEB-BASED COURSE MANAGEMENT SYSTEM

ABSTRACT

In this study, university students' acceptance of Minerva is assessed. Minerva is the web-based course management system (CMS) of Ghent University. In Minerva students can download and upload files, discuss with their teachers and fellow-students, consult their agenda and the official bulletin board, and much more. Students of two faculties (medicine and health sciences, and engineering) were questioned. Only first grade students who had no prior experience with Minerva – except during the current academic year – were withheld. The questionnaire was taken online, about two months after the start of the academic year. It contained scales of the Technology Acceptance Model (TAM) and the Theory of Planned Behavior (TPB). This way, three models could be tested: TAM, TPB and C-TAM-TPB. 573 usable responses were collected, a net response rate of 40%. The results reveal that there were some interesting differences between students of the two faculties. In TPB and C-TAM-TPB, the main predictor of self-reported frequency of Minerva-use (USE) was attitude (ATT), for both groups. However, ATT was the only predictor of USE for the engineering students, while for the medical students PU (positive influence) and Social Influence (negative influence) also predicted USE. In TAM, the best predictor of ATT was PU for all students, but only for the medical students EOU was also of importance for predicting ATT. C-TAM-TPB gives the best insight into how students accepted Minerva.

INTRODUCTION

When students enroll in university, a new world opens up. A world in which they have to draw on their prior knowledge and skills acquired during secondary education. The amount of background knowledge students can rely on depends on the correspondence between their branch of study during secondary education and the subject at the university. On the other hand, some of the skills students are expected to display, like working with a computer, were not explicitly taught during secondary education. In this case, student's' proficiency depend not only on their prior education, but also on their motivation to use a computer for school tasks and thus they have to acquire these skills on their own. Researchers in the field of technology acceptance try to get a better insight into how a technology is accepted by its users, e.g. student

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teachers intend to use computer technology because it is useful (Ma, Andersson, & Streith, 2005).

In this study, university students' acceptance of a course management system (CMS) is studied. Students of two faculties that are very likely to differ in the level of technology-mindedness are surveyed: students of the faculty of engineering should be more technology prone than students of the faculty of medicine and health sciences.

The aim of this study is threefold. First, we aim to identify the factors that contribute to the acceptance of Minerva, the CMS of Ghent University. As our study involves students of very different faculties, we will also investigate whether there are differences between the students of the two faculties. Acceptance models were originally devised for situations in which (potential) users had the choice to use (or perform a behavior) or not use the technology. However, in many cases users cannot choose to not use a technology, as their job/study requires it (e.g. Duyck, et al., 2008). Moreover, Venkatesh, Morris, Davis, and Davis (2003) found that it does matter whether use of a technology is on a voluntary or mandatory basis. Therefore, we will also assess the effect of perceived voluntariness of use of Minerva on the acceptance of Minerva. To perform our study, we will draw on C-TAM-TPB (Taylor & Todd, 1995a), which is a combination of the Technology Acceptance Model (TAM) (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989) and the Theory of Planned Behavior (TPB) (Ajzen, 1991).

THEORETICAL FRAMEWORK

The field of IS-acceptance is a very mature field of research. With the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975) as a starter and the Technology Acceptance Model as the dominant model, a multitude of models were developed (for an overview see Venkatesh et. al., 2003), followed by even more model refinements, all aiming to achieve a better prediction of the dependent variable: technology acceptance, typically measured as behavioral intention, attitude and/or use. However, independent of the chosen model or measure of acceptance, variance explained fluctuates typically within the range 0.35–0.55 (e.g. Davis, et al., 1989; Dishaw & Strong, 1999; Szajna, 1996; Taylor & Todd, 1995b; Venkatesh, 2000; Venkatesh & Speier, 1999), with exceptions ranging from 0.04 (Adams, Nelson, & Todd, 1992) to 0.70 (Davis, 1989; Han, Mustonen, Seppanen, & Kallio, 2005; Mathieson, 1991). So, there is still room for improvement. The publication of the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, et al., 2003) aimed to halt this sprawl of models. The rationale for UTAUT was gathering the abundant existing knowledge to come up with an overarching theory to better explain technology acceptance.

Technology Acceptance

Acceptance models have been developed from several base theories, but there is one line of models that stands out, those stemming from the Theory of Reasoned Action (Fishbein & Ajzen, 1975). According to this theory, behavioral intention (BI) predicts the performance of behaviors that are under a person's volitional control. Intention is modeled as a function of attitude (ATT) towards behavior: "an individual's positive or negative feelings (evaluative affect) about performing the targeted behavior" (Fishbein & Ajzen, 1975); and subjective norms (SN): "the person's perception that most people who are important to him think he should or should not perform the behavior in question" (Fishbein & Ajzen, 1975). According to the theory of reasoned action, external variables that influence behavior do so only indirectly by influencing attitude, subjective norm, or their relative weights. This theory was extended in two directions, leading to the Technology Acceptance Model (TAM; Davis, 1989) and the Theory of Planned Behavior (TPB; Ajzen, 1991).

The most important limitation of the TRA is its' restriction to predicting behaviors that are under a person's volitional control (Sheppard, Hartwick, & Warshaw, 1988). To overcome this problem, Ajzen (1991) extended TRA with one construct, perceived behavioral control (PBC), to account for conditions where individuals do no not have complete control over their behavior, thus forming the theory of planned behavior. Perceived behavioral control reflects "perceptions of internal and external constraints on behavior" (Venkatesh, et al., 2003), and it can vary across situations and actions. It serves as a predictor of both behavioral intention and the behavior. Davis and colleagues (Davis, 1985, 1989; Davis, et al., 1989) came up with the technology acceptance model, an adaptation of the theory of reasoned action specifically tailored to study the acceptance of information systems.

In TAM, two beliefs are included as antecedents of attitude: perceived usefulness (PU), "the degree to which a person believes that using a particular system would enhance his job performance" (Venkatesh, et al., 2003), and perceived ease of use (EOU), being "the degree to which a person believes that using a particular system would be free of effort" (Venkatesh, et al., 2003). In this first version, subjective norm was omitted, but in later versions of TAM, TAM2 or extended TAM (Venkatesh & Davis, 2000), subjective norm was again added as a predictor of intention for cases where use of the technology was mandatory. Several versions of TAM exist and in some versions, the attitude construct is excluded so that perceived usefulness and perceived ease of use are modeled as direct antecedents of behavioral intention. In TAM3 (Venkatesh & Bala, 2008), the latest version of TAM, practitioners are given a better insight in the actions they can take to influence the two core beliefs of TAM. The abundant previous research on TAM showed that it is a very powerful and parsimonious model to study technology acceptance (Taylor & Todd, 1995b; Venkatesh, et al., 2003). Some researchers even claim that the model is too dominant and has over conquered the field of research (Straub & Burton-Jones, 2007).

As both the technology acceptance model and the theory of planned behavior stem from the theory of reasoned action and extend this theory in a different manner, it makes sense to integrate both models into one, thus forming C-TAM-TPB, which is also referred to as augmented TAM or decomposed TPB (Chau & Hu, 2001, 2002a, 2002b; Taylor & Todd, 1995a). A plus of this model is that it covers more ground than the original models, while it remains easy and fast to administer. Another plus is that there is no need to develop new scales as the scales of TAM and TPB have been administered in hundreds of studies (e.g. the meta-analyses of King & He, 2006; Manning, 2009; Schepers & Wetzels, 2007).

To halt the plethora of model refinements and extensions, Venkatesh et al. (2003) reviewed the existing (technology) acceptance models and they constructed the Unified Theory of Acceptance and Use of Technology. Seven factors that had an influence on technology acceptance were identified; these are displayed in Table 1. Five of the seven are found in different models, while the other two factors, self-efficacy and anxiety appeared only in the Social Cognitive Theory (Bandura, 1986). Only four recurrent factors were incorporated as predictors of behavioral intention and use: performance expectancy (PE), effort expectancy (EE), social influence (SI) and facilitating conditions (FC). The fifth factor, attitude, was removed from the model. UTAUT contains up to four moderating variables: gender, age, experience with the technology, and perceived voluntariness of use. Although UTAUT was set up as a synthesis of the existing models, it can be considered as an extended version of the technology acceptance model, as is shown in Table 1.

Table 1. Overview of the constructs identified by Venkatesh et al. (2003) and the constructs they are related to in previous models

Construct in UTAUT[a]	TRA	TAM	TAM2	TPB	C-TAM-TPB
Performance Expectancy		PU	PU		PU
Effort Expectancy		EOU	EOU		EOU[b]
Social Influence	SN		SN	SN	SN
Facilitating Conditions				PBC	PBC
Attitude	ATT	ATT[c]		ATT	ATT
Self-efficacy					
Anxiety					

Notes: [a] Only the constructs in bold are included in UTAUT; [b] serves as an antecedent of ATT; [c] included as a dependent variable in some conceptualizations of TAM.

An empirical test of UTAUT found that UTAUT explained 70% of the variance in intention, hereby outperforming the models it stems from (Venkatesh, et al., 2003). By reaching this level of variance explained, UTAUT is claimed to be the "ultimate" model to study the acceptance of information systems, gathering the existing knowledge. However, some issues are worth mentioning:

– The 70% level of variance explained was only reached when data were pooled over three moments in time. Variance explained in intention when only one measure was taken into account was in the same range as in the other models.
– Construction of the scales: to develop workable scales, the highest-loading items per UTAUT-factor were chosen to make up a scale (Venkatesh, et al., 2003). This led to scales in which some aspects of constructs were lost, leading to unreliable scales measuring different constructs in some cases (Duyck, et al., 2008; Marchewka, Liu, & Kostiwa, 2007).

– The definition of the dependent variable. Although UTAUT is designed for both mandatory and voluntary settings, it draws on TAM for the dependent variables.

Next to these issues that need to be unraveled, UTAUT has some advantages that make the model very attractive to work with:

– UTAUT is specifically designed for use in both mandatory and voluntary settings.
– With the incorporation of social influence, facilitating conditions and the moderating variables, it covers more ground than the models it originates from, yet it remains a parsimonious model, for some even too parsimonious (Straub & Burton-Jones, 2007).
– UTAUT provides a fast and easy way to get a quite comprehensive view of the users' acceptance of a technology.

In view of the limitations of UTAUT and as we will perform only one measurement, we will use the scales of TAM and TPB to perform our study. This way we will be able to test C-TAM-TPB, a model that contains conceptually the same constructs as UTAUT, as shown in Table 1, but its scales are extensively validated.

A Measure for Acceptance

The models mentioned above are also called intention-based models, as they take intention and/or use as a measure for acceptance. If we keep in mind that these models were originally devised for situations where performance of the behavior was voluntary, intention and use are optimal measures for acceptance. However in situations where use of a technology is mandatory they might be suboptimal: people might use a technology without accepting it, just because they have to. In most organizations, use of a technology is either voluntary or mandatory for all (intended) users. However, for this study, student's' use of Minerva can both be voluntary and mandatory. Lecturers are free to decide to what extent they use Minerva as a tool for their courses. So they can either mandate use of Minerva, or give students the choice. In view of this, we will not limit our study to intention and use. We will use the following measures of acceptance:

– Attitude toward use of the technology (Brown, Massey, Montoya-Weiss, & Burkman, 2002; Davis, 1989; Pynoo, et al., 2007).
– Behavioral intention (Marchewka, et al., 2007; Venkatesh, et al., 2003).
– Behavioral expectation (Davis, 1985; Venkatesh, Brown, Maruping, & Bala, 2008).
– Intensity of use.
– Frequency of use (e.g. Davis, 1985).

Behavioral expectation is closely related to behavioral intention, and has frequently been confounded in the past with intention (Warshaw & Davis, 1985). Unlike intention, expectation takes into account that something might interfere in between the intention to perform a behavior and the performance of the behavior. In theory, behavioral intention and behavioral expectation should together lead to a better prediction of use (Venkatesh, et al., 2008). However, in Dutch there is almost no difference in meaning.

Use or use behavior (Halawi & McCarthy, 2008; Landry, Griffeth, & Hartman, 2006; Venkatesh, et al., 2003) is either observed or self-reported. Here, we propose, next to self-reported frequency of use, self-reported perceived intensity of use as a measure for use and acceptance. For intensity of use, we draw on the observation that in mandatory settings users can only control how much they use the system. Therefore, we assume that people who accept a technology will use that technology as much as possible, while those who don't accept it will use the technology as few as possible.

We will make a distinction between the determinants of each of these five measures for acceptance. This leads to the following research model, as presented in Figure 1.

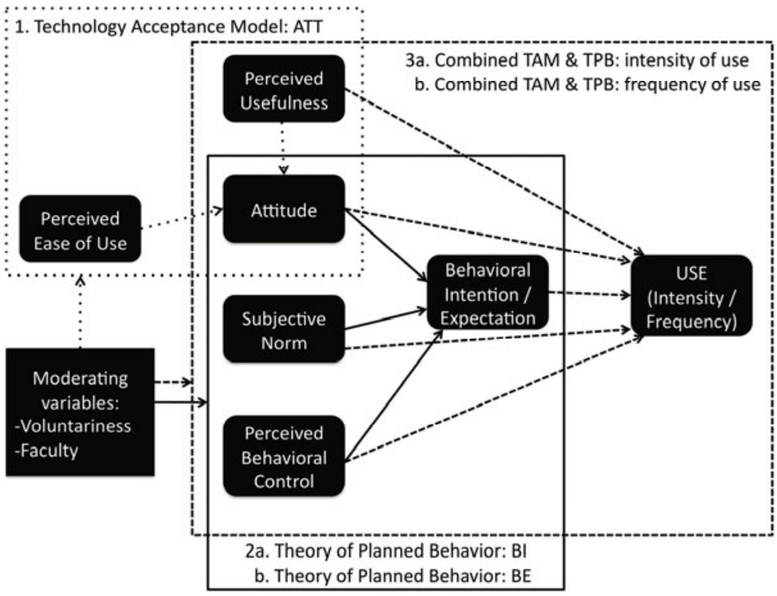

Figure 1. Research model.

As shown in Figure 1, two moderating variables, faculty and voluntariness (perceived voluntariness of use) are included. For our study, we will question students from two faculties: engineering, and medicine and health sciences. As we expect that students from these faculties differ in their level of technology-mindedness and in the number of hours spent working on a computer for study-related tasks, the faculty of the students is added to the research model.

As already stated, we have no objective measure of the extent to which the lecturers mandate use of Minerva. In view of this, and as Venkatesh, et al. (2003) found that there is a difference between users who perceive use of a technology as voluntary and those who perceive its' use as mandatory, we also included perceived voluntariness of Minerva use in our research model.

Student Acceptance of Web-Based Courseware

Several acceptance studies have been reported in the literature in the field of web-based courseware, sometimes with contradictory results. Blackboard is a popular example of web-based courseware studied by several researchers (Halawi & McCarthy, 2008; Landry, et al., 2006; Marchewka, et al., 2007). The studies employing TAM found that the acceptance of Blackboard was primarily influenced by perceived usefulness, but also by perceived ease of use (Halawi & McCarthy, 2008; Landry, et al., 2006). In contradiction with these findings, Marchewka et al. (2007) did not find any correlation between behavioral intention on the one hand and performance expectancy, effort expectancy or facilitating conditions on the other. An explanation for this remarkable finding might lie in the definition of acceptance: behavioral intention (Marchewka, et al., 2007) versus perceived usage (Halawi & McCarthy, 2008; Landry, et al., 2006); or in the way of sampling. Marchewka et al. (2007) took the questionnaire online and the students were free to participate, while the other studies either selected their participants (Halawi & McCarthy, 2008) or depended on the goodwill of the teacher (Landry, et al., 2006).

Ngai, Poon and Chan (2007) investigated the acceptance of WebCT by Hong Kong university students through TAM. The majority of their sample reported to have experience with web-based courseware, therefore it is no surprise that they found behavioral intention to be redundant. The usefulness of WebCT was the main predictor of both attitude and use but ease of use was also important. Interestingly, attitude did not have an influence on the use of WebCT. Stoel and Lee (2003) also investigated students' acceptance of WebCT using TAM. They found that experience with the technology had a positive influence on its perceived ease of use. Attitude toward WebCT was primarily influenced by perceived usefulness, but also by ease of use. Intention to use WebCT was influenced by attitude and usefulness, while intention predicted the frequency of use of WebCT. Shih (2008) studied the adoption intention of web-based courses using a self-developed model with constructs from the theory of planned behavior (perceived behavioral control, attitude) and social cognitive theory (self-efficacy, personal outcome expectations: POE). Self-efficacy was found to have a direct effect on PBC and POE, but not on attitude or intention. Perceived behavioral control was the best predictor of both attitude and intention, while POE, a construct related to perceived usefulness or performance expectancy (Venkatesh, et al., 2003), also predicted intention and attitude. Together with POE and BI, attitude was significant for predicting intention.

METHODOLOGY

Setting

The study is performed in Ghent University. A growth of twenty years made this institution one of the most important institutions for research and education in Belgium. Every year, over 30000 students are enrolled, of which about 2200 foreign students. The university offers study programs in 11 faculties. For the academic year 2008–2009, a record number of 6143 new students were enrolled in the first year.

The study targets the first-year students of the faculty of engineering and the faculty of medicine and health sciences. In the faculty of engineering (ENG), students in the first year can choose between two subject areas: civil engineering or architecture. From the second year on, civil engineers have to choose a specific subject area. The faculty of medicine and health science (MHS) offers a wider variety of choices. Students can choose between medicine, dentistry, physical education and movement sciences, speech therapy and audiological sciences, rehabilitation sciences and physiotherapy, and biomedical sciences. Students who want to enroll for medicine or dentistry have to pass an entrance exam.

In Table 2, the response rate and other characteristics of our study population are displayed. The response rate is almost equal across the faculties, but the distribution of females and males is quasi mirrored. The faculty of engineering is a rather "male" faculty, while the faculty of medicine and health sciences is more a "female" faculty.

Table 2. Response rate and distribution of the sexes. °Newbie students are students that are enrolled in the first year, for the first time

Faculty	*Number of "newbie" students°*	*Number of respondents*	*Response rate*	*Female/male*
MHS	892	308	34.5%	215/93
ENG	539	157	29.1%	50/107
Total	1431	465	32.5%	265/200

Technology: Minerva

The technology under study is Minerva, the open source digital learning environment of Ghent University. Teachers can post their study material on the website and mandate students to hand in tasks through Minerva. The technology is especially suited to communicate with teachers and fellow-students. In most faculties, using

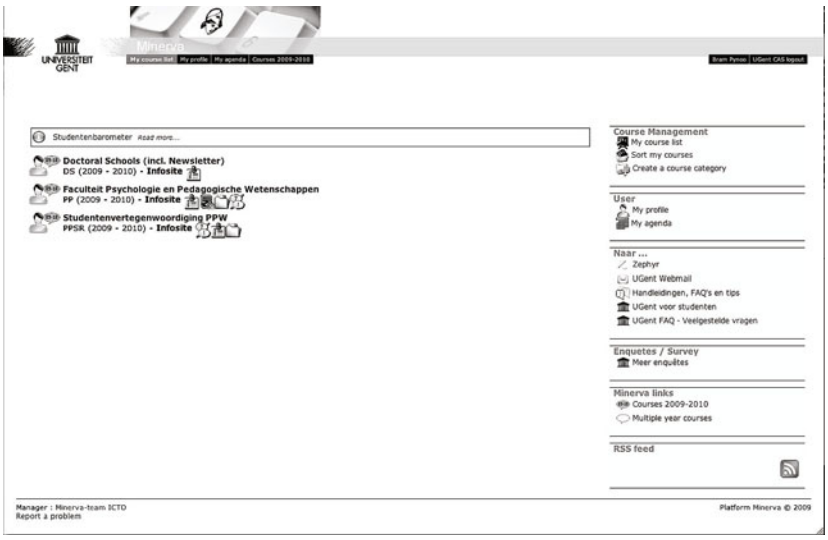

Figure 2. Sample screenshots of Minerva: personal homepage (upper) and course homepage (lower).

Minerva is the best way to stay up-to-date. Minerva is accessible both from within and outside of the university. Figure 2 shows some screenshots of Minerva. The upper panel is an example of a personal home page in Minerva. The list of courses is displayed on the left side of the screen. The icons next to the courses indicate the changes since your last visit. On the right side of the screen, links to more general information are listed. The lower panel shows a typical opening page of a specific course. Categories in grey are not in use for this course.

Questionnaire

The questionnaire was taken online and consisted of 22 items, as displayed in Table 3. Items were taken from validated scales of TAM and TPB. The items had to be scored on a 7-point Likert scale. Five dependent variables were assessed: attitude, behavioral intention, behavioral expectation, intensity of use, and frequency of use. Frequency of use is derived from the work of Davis (1985), while we constructed the intensity of use measure.

Table 3. Questionnaire items

Perceived Usefulness (PU)
Using Minerva for my studies allows me to perform my tasks more quickly
Using Minerva enhances my study results
I find Minerva useful for my studies
Perceived Ease of Use (EOU)
Learning to use Minerva was easy for me
It was easy for me to become skilful in using Minerva
I find Minerva easy to use

Table 3. (Continued)

Subjective norm (SN) My teachers think I should use Minerva I have to use Minerva because my teachers demand it I use Minerva because my fellow students use it My fellow students think that I should use Minerva
Perceived Behavioral Control (PBC) I possess the knowledge and skills to use Minerva I decide how and when I use Minerva I have the necessary material resources to use Minerva
Attitude (ATT) Using Minerva is a bad / good idea Using Minerva is a stupid / wise idea I hate / I love to think of the idea of using Minerva Using Minerva is unpleasant / pleasant
Perceived Voluntariness (VOL) I experience the use of Minerva as mandatory (=1) / voluntary (=7)
Behavioral Intention (BI) (Intention) I intend to use Minerva frequently in the coming weeks of school (Expectation) I expect I will use Minerva frequently in the coming weeks of school
Use Behavior (USE) (Intensity) During a regular week of school, I use Minerva as few as possible (=1) / as much as possible (=7) (Frequency) During a regular week of school, I use Minerva: never (=1) / less than one time / about one time / several times / about one time a day / several times a day (=6)

Hypotheses

The main aim of this study is to investigate the acceptance of Minerva by students of two faculties (Engineering & Medicine and Health Sciences). Acceptance of Minerva is operationalized in five ways: attitude, behavioral intention, behavioral expectation, intensity of use, and frequency of use. To determine which factors influence the acceptance of Minerva, three models are utilized (see Figure 1) to test five hypotheses:

– H1a: ATT will be predicted by PU and EOU
– H1b: BI will be predicted by ATT, SN and PBC
– H1c: BE will be predicted by ATT, SN and PBC
– H1d: Intensity of use will be predicted by PU, ATT, BI, BE, SN and PBC
– H1e: Frequency of use will be predicted by PU, ATT, BI, BE, SN and PBC

In addition to the constructs in these models, we will also assess the impact (both direct and moderating effect) of two moderating variables on the acceptance of Minerva: faculty and perceived voluntariness of use.

For faculty, we hypothesize that

– H2a: Faculty will have a direct influence on the acceptance of Minerva.
– H2b: Faculty will moderate the relationship between the independent and dependent variables.

For perceived voluntariness of use, we hypothesize that:

- H3a: Voluntariness of use will have a direct influence on the acceptance of Minerva.
- H3b: Voluntariness of use will moderate the relationship between the independent and dependent variables.

RESULTS

In view of the conceptual overlap between behavioral intention and behavioral expectation, and the confusion in the past (Warshaw & Davis, 1985), we first inspected the correlation between these items. A Pearson product-moment correlation of $r = .78$ was observed; therefore behavioral intention and behavioral expectation were combined into one behavioral intention scale. So, hypothesis 1c was dropped and BE was deleted from H1d and H1e.

Descriptive Statistics

Table 4 displays the descriptive statistics are displayed. The main observation is that there are almost no differences between the students of the two faculties except in the frequency of computer and Minerva use. As expected, engineering students make more use of a computer for school tasks than medical students ($t(198.288)=6.878$, $p<.001$). This difference cannot be attributed to a different distribution of males and females in the two faculties; $t(301)<1$ for medical students and $t(68.832)=1.597$, $p=.12$ for engineering students. We also compared male and female students, but no differences in mean scores were found on any scale (results not reported here).

Reliability and Validity

To assess the validity and reliability of the scales, confirmatory factor analyses in Amos 6.0 were run. From these CFA's, composite reliabilities (CR) and Average Variance Extracted (AVE) were computed. To meet the requirements for acceptable reliability, CR should exceed .70 (Hair, Anderson, Tatham, & Black, 1998); the criterion for convergent validity is a value of AVE higher than .50 and discriminant validity is established if the square root of AVE exceeds the correlation of the construct with the other constructs. Table 5 presents an overview of these results.

As can be deduced from Table 5, the reliability and convergent validity of three scales (PU, EOU and ATT) was good, just below the threshold for PBC and poor for the SN-scale. For two scales, PU and PBC, there was a problem with discriminant validity, as their correlation with EOU exceeded the square root of AVE. In view of the poor reliability and convergent validity, the SN-scale was excluded from this study, and SN was deleted in hypotheses 1b, d and e.

Table 4. Descriptive statistics. The right column shows the 2-sided significance level of the independent samples t-test comparing the faculties of MHS and ENG

	MHS	*ENG*	*Significance level t-test (2-sided)*
PU	4.92 (1.14)	5.05 (1.27)	.26
EOU	5.90 (1.12)	6.06 (1.22)	.18
SN	4.45 (1.01)	4.56 (1.01)	.26
PBC	6.02 (0.92)	5.95 (1.04)	.46
ATT	5.70 (0.98)	5.67 (0.98)	.79
BI	5.99 (1.06)	6.01 (1.23)	.86
Use intensity	5.32 (1.34)	5.28 (1.29)	.77
Use frequency	4.93 (0.75)	5.33 (0.70)	<.001
Voluntariness	3.47 (1.73)	3.51 (1.65)	.79
Pc-use for school (hours/week)	5.76	10.81	<.001

Table 5. Reliability and validity. The first two columns display the values for composite reliability and Average Variance Extracted. In the following columns, the correlations are given. The values on the diagonal are the square root of AVE

	CR	*AVE*	*PU*	*EOU*	*SN*	*PBC*	*ATT*	*BI*	*Use int*	*Use freq*
PU	.78	.54	.73							
EOU	.90	.76	.74***	.87						
SN	.53	.37	-.04	.10*	.60					
PBC	.65	.40	.43***	.67***	.06	.64				
ATT	.86	.61	.65***	.46***	-.17**	.34***	.78			
BI			.59***	.63***	.21***	.59***	.51***	N/A		
Use int			.36***	.27***	-.15**	.19***	.52***	.34***	N/A	
Use freq			.28***	.22***	-.11*	.09*	.31***	.25***	.52***	N/A

Notes: *p<.05, **p<.01, ***p<.001 (all 2-sided).

Regression Analysis

To identify the factors that contribute to the acceptance of Minerva, and to assess the impact of the moderating variables, four hierarchical linear regressions

(Model 1: direct effects only; Model 2: addition of interactions) were run in SPSS 15.0. An overview of the results is presented in Table 6.

The main purpose of this study was to identify the factors that contribute to the acceptance of Minerva. The results in Table 6 show that perceived usefulness of Minerva was the strongest determinant of attitude, but ease of use and voluntariness of use were also significantly related. The more use of Minerva was perceived as voluntary, the higher the respondents' attitude toward use of Minerva. For intention to use Minerva, perceived behavioral control and attitude toward use of Minerva were the most important determinants, while mandating use of Minerva also had a beneficial influence.

The predictors of intensity and frequency of Minerva use differed slightly. Attitude and intention were significant predictors of both intensity and frequency of use. Frequency of use was also predicted by voluntariness (the more use is perceived as voluntary, the higher the frequency of use), faculty (students from the engineering faculty use Minerva more frequently) and perceived behavioral control. The effect of perceived behavioral control on frequency was negative and thus counterintuitive, indicating that the less control the students experience, the higher the frequency of Minerva use.

Furthermore, it is worth mentioning that the amount of variance explained in the dependent variables was moderate to high. About 50% of the variance in attitude and intention was explained and between 19% and 29% of the variance in use. Adding the moderating variables led to minor, but statistically significant changes in variance explained, except for frequency of use.

The faculty of the student did not play a major role. The most important effect was a main effect of faculty on frequency of use ($ß=.25$, $p<.001$). This effect was due to the higher frequency of Minerva use by engineering students. We also found a small yet significant main effect of faculty on attitude ($ß=-.05$, $p=.02$): medical students have a slightly better attitude toward use of Minerva. The interaction between faculty and ease of use was also significant ($ß=-.07$, $p=.01$): ease of use was more important for medical ($ß=.23$, $p<.001$, not reported here) than for engineering ($ß=.09$, $p=.07$, not reported here) students in forming their attitude. The usefulness of Minerva was more important for predicting engineering student's' intensity of use. However, the regressions per faculty revealed that PU had no effect on intensity of use for both the engineering ($ß=.09$, $p=.23$) and medical ($ß=-.08$, $p=.10$) students. We also found that the 3-way interactions between attitude and both intensity ($ß=.15$, $p=.001$) and frequency ($b=.12$, $p=.01$) of use were significant. To interpret these, separate regressions per faculty were performed (not reported here), showing that the interaction VOL*ATT was more important for predicting use (intensity & frequency) with the medical students.

Perceived voluntariness of use was more important than faculty. The more the respondents experienced that their use of Minerva was voluntary, the higher their attitude toward Minerva and use of Minerva (both intensity and frequency), but the lower their intention to use it. Furthermore, voluntariness moderated the relationships between attitude and PU & EOU, intention and PBC, intensity of use and BI, frequency of use and ATT, and as mentioned above a 3-way interaction between use and ATT.

Table 6. Results of regression analysis. The values reported are standardized regression coefficients

Dependent	*Attitude*	*Behavioral intention*	*Intensity of use*	*Frequency of use*
Adj. R2	.49	.49	.28	.19
Faculty	-.05*	.03	-.01	.25***
VOL	.21***	-.19***	.11*	.14***
PU	.50***		-.02	.05
EOU	.19***			
PBC		.47***	-.05	-.11**
ATT		.43***	.42***	.17***
BI			.16***	.18***
Adj. R2	.52	.50	.29	.20
Faculty	-.05*	.04	-.05	.23***
VOL	.22***	-.21***	.15***	.18***
PU	.49***		-.02	.05
EOU	.17***			
PBC		.45***	-.04	-.09*
ATT		.47***	.38***	.12**
BI			.17***	.20***
Fac*PU	.02		.10*	-.05
Fac*EOU	-.07*			
Fac*PBC		.11***	.00	.02
Fac*ATT		-.02	-.03	.05
Fac*BI			-.03	-.06
Vol*PU	-.09**		.08°	.05
Vol*EOU	-.10***			
Vol*PBC		.07**	-.07°	.00
Vol*ATT		.05°	-.06	-.10*
Vol*BI			-.08*	-.03
Fac*Vol*PU	.00		-.11*	-.10°
Fac*Vol*EOU	-.01			
Fac*Vol*PBC		-.02	.02	-.02
Fac*Vol*ATT		.02	.15**	.12*
Fac*Vol*BI			-.02	.03

Notes: °p<.10, *p<.05, **p<.01; p<.001.

DISCUSSION

Reliability and Validity

The reliability and convergent validity of three scales (PU, EOU and ATT) was acceptable to good, while the convergent validity was low for PBC and SN. The reliability of the PBC-scale was just below the threshold for acceptable reliability, while the SN-scale scored very low on reliability. The low reliability of the PBC-scale is a recurrent problem: other researchers also encountered this problem (Duyck, et al., 2008; Marchewka, et al., 2007), in using UTAUT's FC-scale, which has a very high degree of overlap with the PBC-scale. Apparently, respondents experience the different aspects of PBC or FC as different, while this was obviously not the case in the original studies, e.g. the reliability of FC in Venkatesh et al. (2003) varied between .83 and .88, which is comparable to the findings of Teo, Lee and Chai (2008) and Shih (2008) in their studies involving students. The SN-scale included influences exerted by both peers and superiors. In the case of students using a technology for their studies, it is logical that these influences can be perceived as different, and thus that the reliability of the underlying scale is poor, as was the case here. Therefore, the SN-scale was omitted from the analyses. However, the differential effect of social norms expressed by either peers or superiors is a matter that deserves further inquiry in follow-up research.

The requirements for discriminant validity were met for three scales (EOU, SN and ATT), while the correlation of PU and PBC with EOU exceeded their respective value of square root of AVE.

H1: Factors Affecting Acceptance

The findings of the regression analyses were in line with previous studies of students' acceptance of web-based courses/course management systems. Consistent with (Ngai, et al., 2007; Stoel & Lee, 2003), perceived usefulness was the strongest predictor of attitude toward use of Minerva, but Minerva's ease of use was also important, confirming H1a. Perceived behavioral control was, just as in Shih (2008) the best predictor of intention, but attitude was also important. Thus, H1b was confirmed. The main predictors of use were attitude and intention. Unlike the studies of (Halawi & McCarthy, 2008; Marchewka, et al., 2007), we did not find a direct effect of the perceived usefulness of Minerva on its use, so hypotheses 1d and 1e were only partly confirmed. The regression analysis with frequency of use as dependent variable revealed one unexpected finding: perceived behavioral control had a small negative effect on the frequency of use. Variance explained in the dependent variables was in the range of what is commonly found in other technology acceptance studies (Davis, et al., 1989; Dishaw & Strong, 1999; Szajna, 1996; Taylor & Todd, 1995b; Venkatesh, 2000; Venkatesh & Speier, 1999), and also comparable to the levels found in previous studies of students' technology acceptance (Halawi & McCarthy, 2008; Ngai, et al., 2007; Shih, 2008).

H2 and H3: Influence of the Moderating Variables

The inclusion of moderating variables led to only a slight yet significant improvement of variance explained. Hence, hypotheses 2b and 3b were only partly confirmed. Faculty and/or voluntariness moderated about one third of all possible relationships between independent and dependent variables. The faculty of the students had a strong direct effect on the frequency of use, but this can be attributed to the higher amount of computer use by engineering students, and a minor effect on attitude, so hypothesis 2a can largely be rejected. Voluntariness of use was of higher importance, confirming hypothesis 3a. We did however find conflicting main effects of voluntariness on the dependent variables: the more students experienced use of Minerva as voluntary, the higher their attitude and use, but the lower their intention to use it.

Intensity of Use

In this study, we considered two alternatives for self-reported use: frequency of use and intensity of use. The rationale for intensity is that users can control how much they use a technology, independent of their absolute frequency of use. This was also what we found: students of the two faculties differed in the absolute frequency of Minerva-use, but no difference was found in their intensity of use. Moreover, from the correlations and the regression analysis we can conclude that intention has about the same effect on both conceptualizations of use, but the effect of attitude on intensity of use was a lot higher than on frequency of use. So, it seems that intensity of use is not only a good measure for acceptance, but it might be better than frequency of use.

Limitations

The main limitation of this study pertains to the reliability of the scales we used. Although we used scales that have been used extensively in the past, we had to exclude the SN-scale from the analysis. The effect of social norms should be further investigated, as the additional analyses we performed (not reported here) indicated that norms have a beneficial effect on acceptance.

Lecturers are free to decide to which extent they use Minerva, and we were unable to take their use of Minerva into consideration for this study. So, another limitation of this study is that we cannot take the amount of information that students can find exclusively through Minerva into account.

Implications

The importance of web-based CMS is only likely to heighten in the future. As there is an annual intake of first-year students, who will also need to (learn to) use that CMS (Minerva, or any other web-based CMS), the findings of this study might have implications for those responsible persons in the organization (lecturers or other faculty members, IT-department) that will have to guide these future students. We will highlight some guidelines below.

Should separate strategies per faculty be deployed?
Our study showed that, despite the difference in hours of computer use for school tasks, the faculty of the student had almost no effect. We did find that ease of use was more important for medical students, while usefulness was more important for the engineering students. But, all in all our results indicate that there is no real need to deploy separate strategies per faculty.

Should use of Minerva be mandated?
Voluntariness of use has a differential effect on the dependent variables. The more use is perceived as voluntary, the higher one's attitude toward and use of Minerva. On the other hand, mandating use of Minerva heightens the intention to use Minerva. So, if we suppose that intention precedes use, a strategy might be to mandate use in the beginning (e.g. providing information only through Minerva),

and then give users more opportunity to either use or not use Minerva (e.g. providing parts of the information not only in Minerva, but also on the notice board).

What other actions can be undertaken?
The organization can also take some more actions to promote the use of Minerva. To create optimal conditions, the organization could:

– provide training material: so that students can learn to use Minerva in a fast and easy way. If Minerva is perceived as easy to use, this will have a positive influence on the attitude toward Minerva.
– provide facilities, e.g. computers and Internet: if students have easy access to a computer with Internet, this will have a positive impact on their intention to use Minerva.
– provide information through Minerva: as soon as the users start using the system, they should be provided with information that is somehow or other beneficial for their studies. This way they immediately experience the usefulness of the system, and this has a positive influence on the attitude toward use of Minerva.

CONCLUSION

In this study, the acceptance of Minerva by newbie-students of the faculties of Engineering, and Medicine and Health Sciences was studied. The models we used for this study were TAM, TPB and C-TAM-TPB. A distinction was made between different conceptualizations of acceptance: attitude, behavioral intention, intensity of use, and frequency of use. The main predictor of use was attitude, followed by intention. Intention to use Minerva was best predicted by perceived behavioral control, but attitude was also very important, while the strongest predictor of attitude was usefulness followed by ease of use. Furthermore, we also investigated two moderating variables: faculty and perceived voluntariness of use. Voluntariness proved to be more important than faculty. The more use of Minerva was perceived to be voluntary, the higher the attitude toward and use of Minerva. However, mandating students to start using the system might also be beneficial. Intensity of use proved to be a good measure for acceptance.

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8. EXPLORING LEARNERS' ACCEPTANCE TOWARD MOBILE LEARNING

ABSTRACT

Even though m-learning provides useful overviews of different applications in education, there is an emerging need for a more applicable framework to provide teachers, educational policy-makers and researchers with a better representation of educational affordances of m-learning. Regarding to wide application of mobile learning, investigating learners' acceptance toward it is an essential issue. This research will investigate learners' acceptance toward m-learning based on educational theories, such as constructivism and activity theory. At first, we will present an m-learning framework. After that, the relationship between m-learning and educational theories will be introduced. Furthermore, m-learning questionnaire survey that based on 170 university students will be investigated. In this research, the users' acceptance is based on factors such as m-learning interaction, m-learning system's functions, learners' autonomy, perceived satisfaction, and perceived usefulness. The last section is discussion and conclusion. We will propose a conceptual acceptance model based on the research findings.

INTRODUCTION

A wireless device, such as a personal digital assistant (PDA), has the potential to give instant gratification to students by allowing them to interact with the Internet access course contents, and retrieve information from anywhere at anytime. Thus, there has been a tremendous change in education recently, especially in higher education. Despite the tremendous growth and potential of the wireless devices and networks, mobile e-learning or mobile learning (m-learning) is still in its infancy and in an embryonic stage (Motiwalla, 2007). Indeed, m-learning is a relatively new tool in the pedagogical arsenal to support students and teachers as they navigate the options available in the expanding world of distance learning. M-learning is the learning accomplished with the use of small, portable computing devices. These computing devices may include smart phones, PDAs and similar handheld devices (McConatha & Praul, 2008).

With a mobile or handheld device, the relationship between the device and its owner becomes one-to-one interaction. Mobile devices have the potential to change the way students behave, the way students interact with each other and their attitude towards learning (Homan & Wood, 2003). The key features of using mobile devices for m-learning are one-to-one interaction place and time independence, capability of

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personalization, and extended reach. These features have a potential to attract more and more learners, especially adult learners (Motiwalla, 2007). Indeed, the place and time independence of m-learning allows students and instructors to utilize their spare time more flexibly. Thus, BenMoussa (2003) identifies several benefits of mobile devices for connectivity. (a), mobile devices offer personalized or individualized connectivity. (b), mobile connectivity improves collaboration via real-time or instant interactivity that may lead to better decision making. And (c), mobile connectivity enhances users' orientation or direction. These benefits can prove equally useful for improving the learning environment.

On the other hand, personal attitudes are a major factor to affect individual usage of information technology. In other words, understanding users' attitudes toward m-learning facilitates the creation of appropriate m-learning environments for teaching and learning. Essentially, methods of assessing m-learning cannot be evaluated using a single linear methodology. It means that is a need to build a multidisciplinary approach to survey learners' attitudes toward m-learning (Liaw, 2002; Liaw, 2007; Wang, 2003). The measurement of m-learning must incorporate different aspects of user perceptions to form a useful diagnostic instrument.

Based on learners' attitudes to accept mobile devices as a powerful learning tool, this research is to build a conceptual model to investigate learners' acceptance toward m-learning. At first, the study will introduce advantages of m-learning and theories of mobile learning. After that, the system implementation will be explained and research methodology will also be described. The final part is discussion and conclusion that is based on the statistical results.

ADVANTAGES OF MOBILE LEARNING

With the trend of the educational media becoming more portable and individualized, the form of learning is being changed dramatically. This work aims to synthesize the cognition and technology domains to establish a new learning model. Therefore, the mobile learning environment posses many unique characteristics, they are (Chen, Kao & Sheu, 2003): (a), Urgency of learning need, (b), Initiative of knowledge acquisition, (c), Mobility of learning setting, (d), Interactivity of the learning process, (e), Situating of instructional activity, (f), Integration of instructional content.

From the viewpoint of Chen, et al. (2003); indeed, the m-learning environment provides a flexible and powerful learning opportunity. Additionally, Liu, et al. (2003) point out that ubiquitous computing that integrates mobile devices, wireless communication, and network technology to construct a mobile learning environment has the following features: (a), reducing the time for tedious activities, (b), engaging students in learning activities, (c), empowering the teacher to monitor students' learning statues, (d), facilitating group collaborative learning, (e), implementing technology-supported activities smoothly.

THEORIES OF MOBILE LEARNING

From Sharples, Taylor, and Vavoula (2005) stated that a first step in postulating a theory of mobile learning is to distinguish what is special about mobile learning compared to other types of learning activity. A theory of mobile learning must therefore embrace the considerable learning that occurs outside classrooms and lecture halls as people initiate and structure their activities to enable educational processes and outcomes. Furthermore, a theory of mobile learning must be based on contemporary accounts of practices that enable successful learning. The popular learning theories for m-learning include constructivism and activity theory.

From educational theories, the constructivist paradigm has dominated educational research many decades. Based on a constructivist perspective, the purpose of education is to cultivate independent and self-directed learners. Handhelds support constructivist educational activities through collaborative groups (Sprague & Dede, 1999), increasing motivation, promoting interactive learning, developing cognitive skills (ordering, evaluating, synthesizing), and facilitating the control of the learning process and its relationship with the real world. Social constructivism establishes a series of principles to be accomplished during the development of an educational activity. Constructive learning, an active and significant learning, means that the students have to modify their current knowledge schemes to integrate new information and acquire new knowledge. Active learning indicates that a student's total participation is expected. Significant learning refers that learning has to be with a meaning and built from the conceptual structure the student already has. Based on the consultation with Zurita and Nussbaum, they point out that the child has to formulate his/her own questions, from multiple interpretations and learning expressions. Reflexive shows that the student has to mirror his/her own experience on other students, making them experts in their own learning (Zurita & Nussbaum, 2004).

On the other hand, a mobile learning theory should embrace the considerable part of learning that occurs outside classrooms and lecture halls as people keep doing their learning activities. In activity theory, the activity of mobile learning can be separated into two perspectives of tool-mediated activity: 1) semiotic layer and 2) technological layer (Sharples, et al., 2005). The semiotic layer describes learning as a semiotic system in which the learner's object-oriented actions are mediated by cultural tools and signs. The learner internalizes public language that was instantiated in writing and conversation, as private thought which then provides the resource for control and development of activity. The technological layer represents learning as an engagement with technology in which tools such as computers and mobile devices serve as interactive agents in the process of coming to know, creating a human-technology system to communicate, mediating agreements between learners and aiding recall and reflection (Sharples, et al., 2005).

A mobile learning theory must take into account the ubiquitous use of personal and knowledge sharing technology. The activity theory is a cultural-historical activity system and is mediated by tools that both constrain and support learners in their goals of transforming their knowledge and skills. From the concept of the activity theory, Engeström (1999) analyses the collective activity through an expanded framework that shows the interactions between tool-mediated activity and the cultural rules, community and division of labor. Rules operating in any context or community refer to the explicit regulations, policies, and conventions that constrain activity as well as the implicit social norms, standards, and relationships among members of the community (Jonassen, 2002). The community consists of the individuals and subgroups that focus at least some of their effort on the object. Division of labor refers to both the horizontal division of tasks between cooperating members of the community and the vertical division of power and status (Engestrom, 1999). Sharples, et al. (2005) adapted Engeström's framework to show the dialectical relationship between technology and semiotics. They renamed the terms – control, context and communication – that could be adopted either by learning theorists or by technology designers. (Liaw, Hatala, & Huang, 2010). Figure 1 presents a framework of activity theory for analyzing mobile learning. Based on the technological approach of the activity theory (such as mobile devices for learning), learning is mediated by knowledge and technology that act as instruments for productive enquiry, in a mutually supportive and dynamically changing relationship. The mediation can be analyzed from a technological perspective of human-computer interaction, physical context and communication activities (Liaw, et al., 2010).

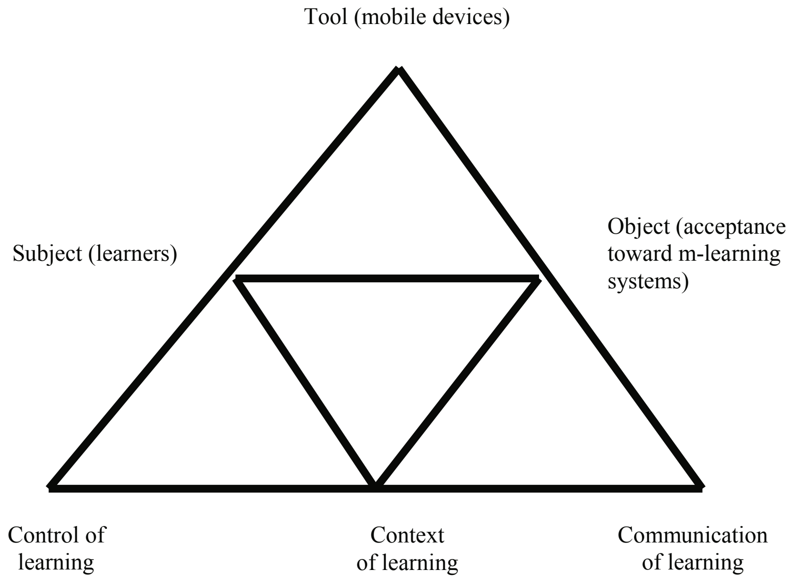

Figure 1. A Framework for analysing mobile learning based on activity theory.

Arievitch (2007) believes that the major educational principles originating from activity theory can be outlined as follow: First, students are active learners, not passive recipients of information. Second, students acquire new knowledge within meaningful learning activities. And third, teachers have to provide adequate learning technology or tools for students' learning activities and to frame the mastery of a new activity in a series of interrelated stages leading students to master new knowledge. Based on the technology approach of the activity theory (Sharples, et al., 2005) which includes the elements of control, context and communication, as well as from Arievitch's (2007) perspective of educational technology on activity theory, in our m-learning research, the control of learning can be viewed as learners' autonomy toward m-learning. The context of learning can be referred as m-learning system functions and satisfaction toward system functions, and the communication of learning can be pointed as interactive and communicative activities of m-learning. The Table 1 presents the three components based on activity theory and m-learning (Liaw, et al., 2010).

Table 1. The components based on activity theory and m-learning perspectives (from Liaw, et al., 2010)

Component	*Activity theory perspective*	*M-learning perspective*
The control of learning	* Learners directly access learning materials conveniently. * Learners control the learning pace and style. * Learners are independent and competent.	* Systems provide self-regularity or autonomous learning functions. * Learners use systems personally and independently.
The context of learning	* Context is an integral property of interaction. * Context embraces the multiple communities of actors who interact around a shared objective.	* Systems offer functions for learning activities, such as retrieval content or information, sharing knowledge. * Systems provide high quality functions to encourage and enhance learners' usage.
The communication of learning	* Learners adapt their communication and learning activities. * Learners invent new ways of interacting that create new rules and exclusive communities.	* Systems supply various interaction and communication to support diversely learning activities. * Systems provide meaningful communication. * Learners use systems individually or collaboratively.

In this research, we will apply activity theory to investigate learners' attitudes toward the acceptance of m-learning.

SYSTEM IMPLEMENTATION

MVBS-ATS, Mobile-based Virtual Body Structures Auxiliary Teaching System, is a Web-based 3D VR interactive learning system that is designed for undergraduate medical students to obtain knowledge about the structure of human body. The mobile VR learning system is designed in four parts: PDA as an m-learning tool, Web pages, Web server and Database. The developer used PHP, Java Script to design the web page and utilized Autodesk 3dsMax and VR4MAX to build the 3D body organ modules. 3dsMax is a commercial software package used to create 3D models. With 3dsMax, users can quickly and easily visualize the 3D objects without knowing any special computer language or having to export application-specific files. VR4MAX provides high performance real-time interactive virtual reality environment. For the Web server part, the website developer used Apache and PHP to establish a web server and the MySQL database to access text data. In addition, we built an FTP Server to store the 3D module files. Figure 2 presents the technology components of the MVBS-ATS.

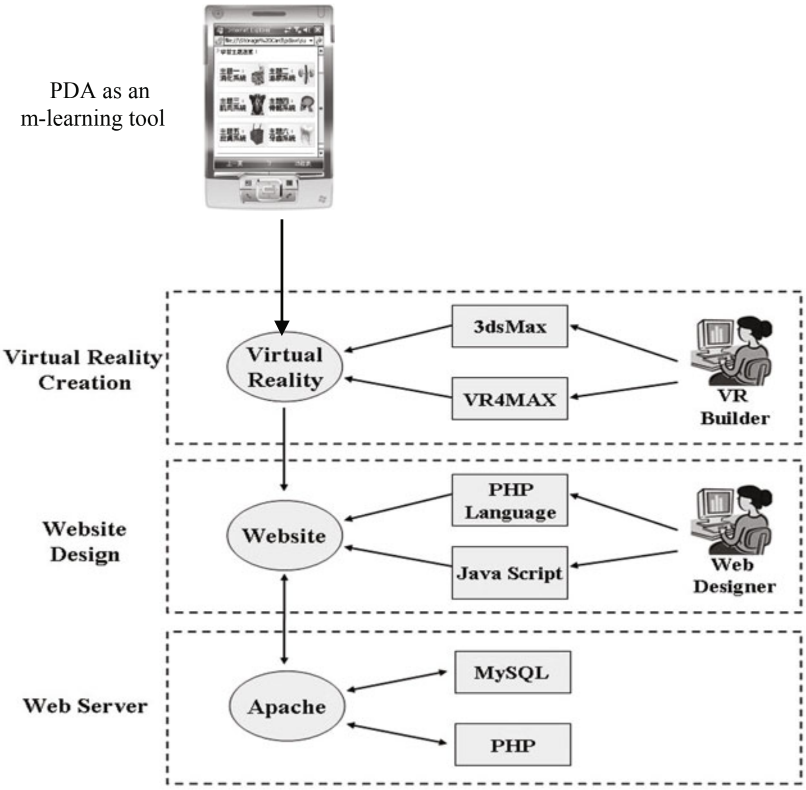

Figure 2. Structure of MVBS-ATS.

RESEARCH METHODOLOGY

Research Hypotheses

This study explores users' attitudes towards m-learning environment. Essentially, activity theory provides an alternative lens for analyzing learning processes and outcomes that capture more of the complexity and integration with the context and community that surround and supports it (Liaw, Chen & Huang, 2008). From the viewpoint of activity theory, individuals actively construct their knowledge within social realms; therefore, powerful learning tool, and social interaction are all critical for enhancing learning outcome. In this study, based on approach of activity theory, the four factors, including m-learning interaction, m-learning system functions, learners' satisfaction toward m-learning, and learners' autonomy toward m-learning, are evaluated to investigate learners' acceptance toward m-learning.

As Liaw, et al., (2009) stated, based on the activity theory approach, system satisfaction, system activities, learners' autonomy, and system functions have positive influence on system acceptance toward m-learning. Based on their researching findings, they have proposed a theoretical conceptual model when applying m-learning. Four affordances will improve the acceptance of m-learning systems: enhance learners' satisfaction, encourage learners' autonomy, empower system functions, and enrich interaction and communication activities. Figure 3 presents learners' acceptance toward m-learning systems that is based on the perspective of activity theory.

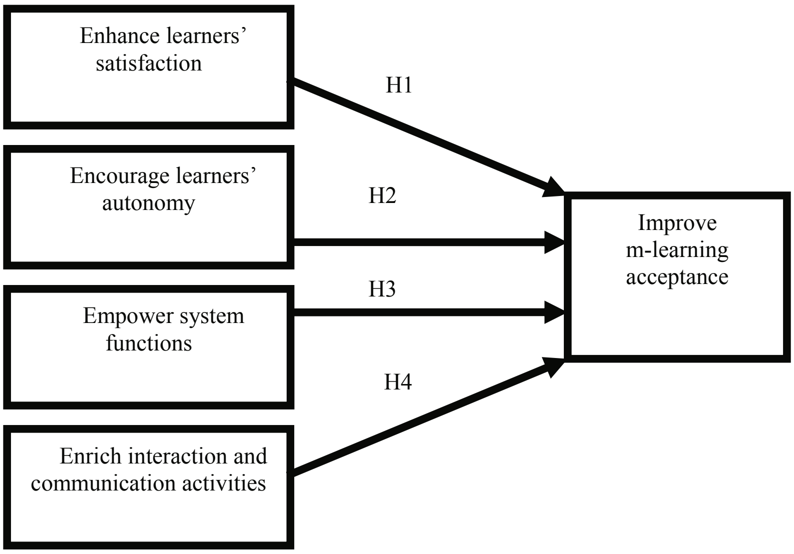

Figure 3. The acceptance conceptual model of m-learning.

Therefore, based on m-learning interaction, m-learning system functions, learners' autonomy, we propose the following hypotheses:

H1: With the increase perceived satisfaction of using m-learning provides, the acceptance of the m-learning system increases.
H2: With the increase learners' autonomy of using m-learning provides, the acceptance of the m-learning system increases.
H3: With the increase quality of m-learning functions provides, the acceptance of the m-learning system increases.
H4: With the increase perceived interaction by using m-learning provides, the acceptance of the m-learning system increases.

Participants

This study conducts a survey for understanding learner attitudes toward the m-leaning environment. A total of 190 university students were taught on how to use the system. Students were allowed to use the system anytime for a period of one month. After that, a questionnaire survey for m-learning was distributed to participants during class. Participants were invited to complete the questionnaire. All subjects were asked to respond to the questionnaire and their responses were guaranteed to be confidential. All 190 students have completed the questionnaire survey. However, 22 missing responses for m-learning questionnaire were eliminated. The study group comprised of 168 students which includes 71 male students and 97 female students.

Measurement

The questionnaire is revised from the previous research of Liaw, et al. (2010) and the Cronbach's α of that research was 0.96. Based on the Cronbach's α, the reliability was acceptable. Because this research is based on the theoretical approach; thus, the content validity of questionnaire should be conducted for understanding learners' attitudes toward m-learning and also for fitting activity theory. To enhance content validity, this research conducts a content validity study involves four steps, which include: determining who will review the questionnaire, preparing the reviewers for the content validity study, setting up the content validity survey, and analyzing whether the survey is valid or not (Rubio, Berg-Weger, Tebb, Lee, & Rauch, 2003).

When determining who will review the questionnaire, we invite three experts as participants. The second step is to prepare the content validity study. This step includes providing an explanation of the final questionnaire to be used, including the purpose of the questionnaire and definitions of factors related to the study. The third step in the content validation process is to prepare the content validity survey. The response form contains three columns (Rubio et. al., 2003) including representativeness, clarity, and comprehensiveness for measuring each item. Representativeness permits the participant to express whether or not they believe the question is accurately representing the content domain of the theoretical definition. Clarity will help reviewers to determine how clearly the question is to the participant. Comprehensiveness will permit participants to decide if they desire to delete or keep the individual question. The final step in conducting a content validity study is to analyze the measure to determine if the survey is valid. This step consists of Content Validity Index (CVI), to determine if the instrument as a whole is valid. The CVI is conducted by counting the number of participants who rate the question as a crucial item or not. When two or three participants rate a question is crucial, then we keep the question. The final questionnaire includes 19 questions to investigate learners' attitudes toward m-learning.

The whole questionnaire included three major components: (a) demographic information, (b) computer experience, and (c) attitudes towards m-learning. The following shows the content of the questionnaire.

- Demographic information: The demographic component covered gender and the field of study.
- Computer experience: In this component, participants were asked to indicate their experience with computers, the Internet, PDA, and m-learning.
- Attitudes toward m-learning: Participants were asked to indicate their attitudes towards m-learning.

These 19 questions of attitudes toward m-learning were adopting a 7-point Likert scale (ranging from 1 which means "strongly disagree" to 7 which means "strongly agree"). The attitudes toward m-learning includes five factors, quality of m-learning functions, perceived interaction of using m-learning, perceived satisfaction of using m-learning, learners' autonomy of using m-learning, and perceived acceptance toward using m-learning.

RESULTS

The internal consistency reliability was assessed by computing Cronbach's αs. The alpha reliability was highly accepted (α=0.94) and items' coefficients are presented in Table 2. The values ranged from 0.40 to 0.77. Given the exploratory nature of the study, reliability of the scales was deemed adequate.

Table 2. The mean, standard deviation, item-total correlations of m-learning from 1 which means "strongly disagree" to 7 which means "strongly agree")

Items	*M*	*S.D.*	*r**
Quality of m-learning functions:			
I know how to operate PDA for m-learning.	2.94	1.57	0.39
I know how to navigate web pages with PDA	3.15	1.72	0.44
It is convenient to use m-learning to read course materials.	5.45	1.28	0.73
It is convenient to use PDA for m-learning.	4.70	1.49	0.72
Perceived interaction of using m-learning:			
The m-learning provides interactive opportunities.	5.67	1.38	0.56
The m-learning provides opportunities for communication among learners.	5.61	1.39	0.59
The m-learning provides opportunities for navigating and downloading instruction.	5.04	1.35	0.70
Learners' autonomy of using m-learning:			
I am active in finding Internet resources.	5.65	1.61	0.58
I am active in finding m-learning resources.	3.71	1.68	0.72
I am active in learning m-learning instruction.	3.71	1.67	0.68
Perceived acceptance toward using m-learning:			
The system is useful to find Internet resources.	5.84	1.19	0.59
The system is useful to retrieve online learning instructions.	5.61	1.28	0.68
PDA is a useful tool for m-learning.	4.94	1.38	0.75
The system is acceptable to improve my learning capacity.	4.13	1.68	0.76
The system is acceptable to improve my problem-solving capacity.	4.12	1.65	0.74
Perceived satisfaction of using m-learning:			
I am satisfied with using a PDA to find Internet resources.	5.73	1.46	0.57
I am satisfied with using the m-learning to interact with others.	5.46	1.46	0.55
I am satisfied with m-learning to learn web-based instruction.	4.01	1.58	0.71
I am satisfied with m-learning to retrieve online learning resources.	4.00	1.61	0.66

r*: Corrected Item-total correlation.

Table 3. Correlations among factors

Factor	*1*	*2*	*3*	*4*	*5*
1. perceived acceptance		0.64**	0.77**	0.82**	0.71**
2. perceived interaction			0.68**	0.53**	0.43**
3. perceived satisfaction				0.74**	0.59**
4. learners' autonomy					0.70**
5. quality of functions					

**: P<0.001

Table 4. Regression results of m-learning

Dependent variable	*Independent variables*	*β*	*R2*	*P*
Perceived acceptance	Learners' autonomy	0.42	0.67	<0.001
	Perceived interaction	0.19	0.06	<0.001
	Quality of functions	0.21	0.02	<0.001
	Perceived satisfaction	0.20	0.02	0.002

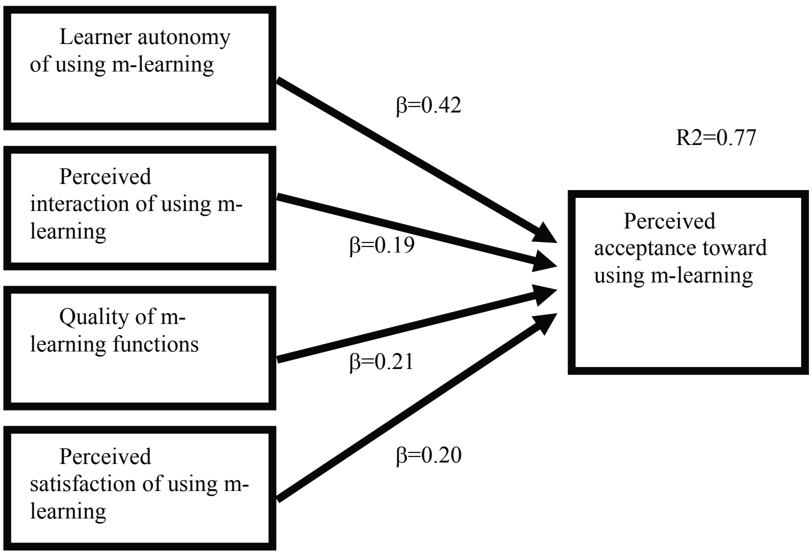

Figure 4. Results of H1 to H4.

Pearson correlation was conducted to understand the degree of correlations among five different factors. The statistical result showed there were high correlations among these five factors, Table 3 presented the result. Essentially, multicollinearity can be controlled by two ways: (1) correlation between independent variables should all around or less than 0.8 (Emory & Cooper, 1991); (2) variance inflation factors (VIF) should less than 10 (Neter & Kutner, 1990). In this study, multicollinearity was ruled out because the correlation between independent variables, as Table 3 shown, are all around or less than 0.8, and the VIFs were all less than 10.

For verifying hypotheses H1 to H4, the result of stepwise multiple regression for the path associated with the variables are presented in Table 4. To investigate H2 to H5, a regression analysis was performed to check the effects of quality of m-learning functions, perceived interaction of using m-learning, perceived satisfaction of using m-learning, and learners' autonomy of using m-learning on perceived acceptance toward using m-learning. The result showed that all four factors were predictors and learners' aotonomy of using m-learning had more contributions than other three other factors ($F(4, 163)=42.19$, $p<0.001$, $R2=0.77$).

The regression results of H1 to H4 are presented at Figure 4.

DISCUSSION AND CONCLUSION

From the statistical results, this research shows that five factors have significant correlations among them. Furthermore, this research also provides that four factors (learner autonomy of using m-learning, perceived interaction of using m-learning, quality of m-learning functions, and perceived satisfaction of using m-learning) are all predictors on m-learning acceptance. In other words, this research supports the conceptual model proposed in the research that is conducted by Liaw, et al. (2009). This research also proves that encouraging learners' autonomy, enriching interaction activities, empowering system's functions, and enhancing learners' satisfaction will directly influence learners' acceptance toward m-learning.

In this research, learners' autonomy is the biggest contributor for m-learning application and usage. From the educational theories, such as constructivism and activity theory, self-paced learners have more capability to control their learning time and procedures by themselves. Indeed, m-learning provides users more opportunities to be active and self-regulatory learners (Liaw, Huang & Chen, 2007).

Furthermore, from the results of the research, enriching interaction activities, empowering system's functions, and enhancing learners' satisfaction are all significant factors to improve users' acceptance toward m-learning. The results provide a critical concept that how to design powerful functions to support learners' interaction and application with mobile devices for learning purpose is a crucial issue. Besides, motivating learners' satisfaction of using mobile devices for learning is also a crucial issue.

This research is based on the approach of activity theory, from the results of this study, it is acceptable that the acceptance of m-learning conceptual model can investigate learners' acceptance toward m-learning. From previous studies to investigate learners' attitudes toward m-learning, not many studies are based on educational theories. Therefore, the research provides evidence that educational theory is an available approach to understand learners' acceptance and attitudes toward m-learning.

Indeed, from the results of this research, we propose the following affordances:

1. Support individual learning application: The m-learning provides learner-cantered learning activities that students can ubiquitously learn at anytime and anyplace. Moreover, the m-learning also can enhance learners' autonomy.

2. Support collaborative learning application: This learning makes use of the available communication and interaction features of mobile devices to encourage learners communicate with others to construct new knowledge.
3. Support adaptive learning application: This application refers to the designed learning environments in which content development tools are built to deliver learning content adaptively to mobile devices. For example, like our system, a combined adaptive learning system for use on both desktop computers and mobile devices at university level.
4. Support educational content delivery application: This application tends to create m-learning platforms on handheld devices to provide various educational services for both learners and teachers. For example, this research uses handheld devices to retrieve resources to assist learners to construct knowledge. Within this application, handheld devices are used as a means for sending and receiving educational information and resources for ubiquitous access.

In summary, although the mobile devices have a limitation in screen size, this study confirms that mobile devices are valuable tools for mobile learning. As mobile learning systems have become more individualized, learner-centered, situated, and ubiquitous, understanding learners acceptance toward those mobile systems are more crucial to enhance learning performance.

ACKNOWLEDGEMENT

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9. UNIFIED THEORY OF ACCEPTANCE AND USE FOR WEB SITES USED BY STUDENTS IN HIGHER EDUCATION

ABSTRACT

A unified framework for researching technology acceptance, the Unified Theory of Acceptance and Use of Technology (UTAUT), was previously proposed and validated. The aim of this paper is to explore the application UTAUT to web sites used by students in higher education. Both prescribed web sites and user-selected sites were studied using a non-experimental research design and questionnaire-based measures. The results support direct and moderated effects of technology-acceptance variables on acceptance outcomes in the research model, supporting UTAUT. As predicted, the research model - based on UTAUT - was more successful in explaining the acceptance of a prescribed library site than that of a prescribed virtual learning environment. The model was also successfully applied to user-selected web sites. User-selected sites were especially intrinsically motivating. The effect of intrinsic motivation on performance expectancy, mediated by effort expectancy, was confirmed. The results demonstrate the broad scope of applicability of UTAUT and motivate its recommended wider use.

INTRODUCTION

The delivery of higher education and other types of education increasingly relies on web-based systems for information and communication (Ngai, Poon & Chan, 2007). These systems include Virtual Learning Environments (VLEs), such as Blackboard™ and WebCT™, and library information systems - especially academic-library web sites. Because intranet and externally accessible web sites increasingly become the interface to information for learning materials and communication, usability [1] becomes of paramount importance for progression and retention of students (van Schaik & Ling, 2005). However, usability is not sufficient and large potential gains in effectiveness and performance will not be realized if users are not willing to *use* information systems in general (Davis, 1993) and educational web sites in particular; therefore, acceptance [2] is crucial.

1.1. Theory of Acceptance

Since the late 1980s various models of technology acceptance have been developed and tested. In 2003, Venkatesh, Morris, Davis and Davis published a landmark

T. Teo (ed.), Technology Acceptance in Education: Research and Issues, 159–181.

paper, the scientific significance of which cannot be overestimated and arguably the most important paper since Davis's Technology Acceptance Model was first published (Davis, Bagozzi & Warshaw, 1989). The authors reviewed and identified eight main competing theoretical models. They integrated these models in a unified model called the Unified Theory of Acceptance and Use of Technology (UTAUT) and then validated the new model. According to this model, *performance expectancy*[3], *effort expectancy* and *social influence* have a positive effect on *behavioral intention*. The effect of the predictors on *behavioral intention* is subject to moderator effects from gender, age, experience and voluntariness of use. *Behavioral intention* and *facilitating conditions* have a positive effect on *user behavior*. The research model adopted in the current study incorporates the relationships between technology-acceptance variables described above and is depicted in Figure 1.

Table 1. Main components of the unified theory of acceptance and use of technology

Performance expectancy	Extent to which a user believes a system use will help achieving gains in task performance
Effort expectancy	Extent to which the user believes that the system will be easy to use
Social influence	Extent to which the user believes that important others believe he or she should use the system
Behavioral intention	User's intention to use the system
Facilitating conditions	Extent to which the user believes that an organizational and technical infrastructure exists to support system use
User behavior	User's rate of system use

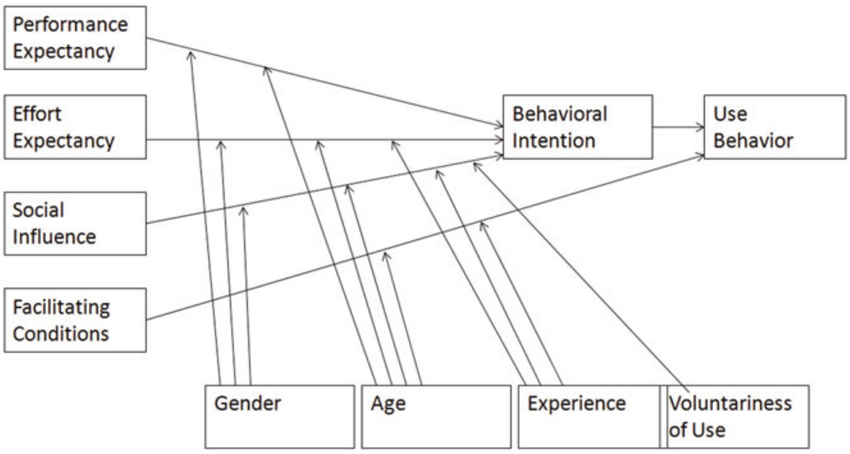


Figure 1. Research model.

The role of mode of use and motivation will now be discussed in relation to technology acceptance. Mode of use is the mental state of a user in relation to a product or system (Hassenzahl, 2003; Hassenzahl & Ullrich, 2007). According to Hassenzahl (2003, pp. 39–40),

> "Usage always consists of behavioral goals and actions to fulfill these goals. In goal mode goal fulfillment is in the fore. The current goal has a certain importance and determines all actions. The product is therefore just 'a means to an end'. ... In action mode the action is in the fore. The current action determines goals 'on the fly'; the goals are 'volatile'. Using the product can be an 'end in itself'. Effectiveness and efficiency do not play an important role. Individuals describe themselves as 'playful' and 'spontaneous'."

The concept of mode of use is related to motivation. Two types of motivation (intrinsic and extrinsic) are distinguished. *Intrinsic motivation* can defined as performing an activity for inherent satisfaction rather than for an instrumental consequence, but *extrinsic motivation* can be defined as performing an activity in order to achieve some instrumental outcome (Sun & Zhang, 2008). In the context of technology acceptance, *perceived enjoyment* is considered as *intrinsic motivation* (Davis, Bagozzi & Warshaw, 1992). Because of its focus on actions rather than goals and sing the product as an end in itself, *perceived enjoyment* will dominate during system use in action mode.

Although Davis et al. (1992), among others, identified the importance of *intrinsic motivation* (the inherent satisfaction derived from system use) as having a strong influence on *behavioral intention*, Venkatesh et al. (2003) dismiss the inclusion of *intrinsic motivation* in UTAUT because its effects on acceptance outcomes are mediated by UTAUT variables. However, as Sun and Zhang (2008) argue conceptually and demonstrate empirically for search engines, *intrinsic motivation* defined as perceived enjoyment is an antecedent of *performance expectancy*, mediated by *effort expectancy*, and thereby ultimately indirectly influences acceptance outcomes. A reason for including perceived enjoyment in Study 2 of the research presented in this paper is to confirm the role of *intrinsic motivation* across different Web sites.

1.2. Acceptance Modeling in Education

Theories of technology acceptance have been applied to the World Wide Web in general (e.g., Sánchez-Franco, 2006; Page-Thomas, 2006) and to various types of web-based information system, including students' use of educational systems (Carswell & Venkatesh, 2002; Lee, Cheung & Chen, 2005; Ngai et al., 2007; Pituch & Lee, 2006; Roca, Chiu & Martínez, 2006; Saadé & Bahli, 2005; Saadé & Kira, 2007; Selim, 2003; Thong, Hong & Tam, 2002). Although there is limited research applying UTAUT to study the acceptance of web-based systems in higher education (but see van Raaij & Schepers, 2008), based on UTAUT as well as the theory of technology acceptance more generally and the nature of web-based systems, some predictions can be made. First, increasingly VLEs are a dominant feature of study programs because almost all information and communication for individual modules is delivered through a VLE on a daily basis. The functionality of a VLE is relatively straightforward to understand, that is - although its use requires basic computer skills - it does not require specific academic skills. On the other hand, the use of library sites is not necessary in every aspect of study programs, even though they are important for academic study work. Furthermore, effective use of the functionality of these sites requires some specific library knowledge over and above basic computer skills. Therefore, the use of a VLE will be perceived as an absolute necessity (mandatory use) and consequently it is predicted that the level of acceptance outcomes (*behavioral intention* and *user behavior*) of a VLE will be higher - with (almost) universal use among its users - than that of a library site. The latter will meet with a lower level of acceptance and more variability, which allows for more influence of acceptance predictors, such as *performance expectancy*, *effort expectancy* and *social influence* on acceptance outcomes.

Second, ceteris paribus, it is more likely that computer users would find a web site chosen more pleasant to use than another site whose use is prescribed; that is, user-selected web sites are more likely to be intrinsically motivating. This is even more likely if a site is used in action mode, where use of the site is an end in itself rather than a means towards an end (as in goal mode).

1.3. Current Studies

The aim of the current paper is to use the Unified Theory of Acceptance and Use of Technology (UTAUT) for the first time to explore the acceptance of web sites used by students in higher education and to investigate the role of *intrinsic motivation*. Specifically, the research set out to test (a) the relations among technology-acceptance variables predicted by the UTAUT model (Venkatesh et al., 2003) and Davis et al. (1992) and (b) the following hypotheses based on the specific predictions made above.

Hypothesis 1: the level of acceptance of a virtual learning environment is higher and its variability of acceptance are less than those of a library site; because acceptance outcomes of a VLE have less variability, acceptance predictors explain less variability in acceptance outcomes for a VLE than for a library site.

Hypothesis 2: *intrinsic motivation* is higher for a user-selected site than for a prescribed web site.

Hypothesis 3: *intrinsic motivation* is higher for a site used in action mode than for a site used in goal mode.

Hypothesis 4: the effect of *intrinsic motivation* on *performance expectancy* is mediated by *effort expectancy*.

Two studies were conducted using a VLE, a library site and other, user-selected, web sites, both testing the research model. Study 1 addressed Hypothesis 1, and Study 2 addresses Hypotheses 2, 3, and 4.

2. STUDY 1

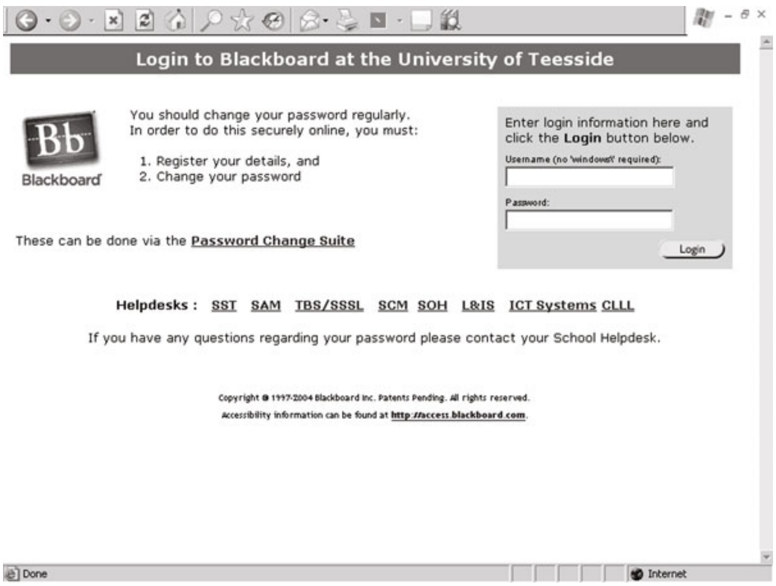
2.1. Method

2.1.1. Design. A non-experimental design was used, based on the research model (see Figure 1). Dependent variables (acceptance outcomes) were behavioral intention and user behavior (measured as self-reported time - in hours - per week spent using a web site - outside the experiment). Independent variables (technology-acceptance variables) included performance expectancy, effort expectancy, social influence (for the first dependent variable), facilitating conditions and behavioral intention (for the second dependent variable). Moderator variables were experience and voluntariness of use (Venkatesh et al., 2003)[4].

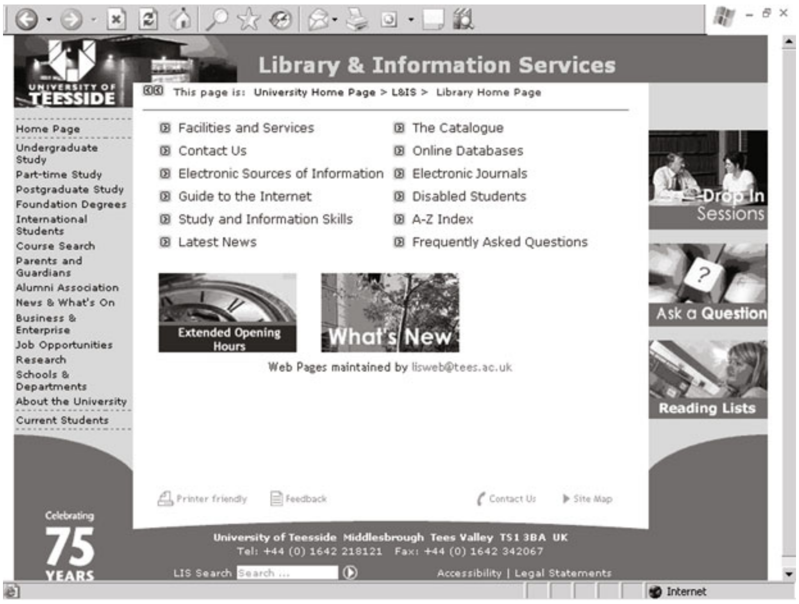
2.1.2. Participants. There were 118 undergraduate psychology students (92 female and 26 male) from Teesside University. They took part as a course requirement. Mean age was 22.61 (SD = 5.24). All had used the World Wide Web and mean experience of using the Web was 7.18 years (SD = 2.84).

2.1.3. Materials and Procedure. A bespoke experimental program written in Visual Basic 6.0 was used to present the home page of two sites (see Figure 2) and questionnaire items for participants to rate both sites in terms of their acceptance. One site was the university's VLE (Blackboard, http://www.blackboard.com/) and the other was the university's library web site, both in the academic year 2005–2006[5]. Students had used both sites as part of their academic studies.

All items were from adopted from Venkatesh et al. (2003) and used 7-point Likert scales with endpoints 'Strongly disagree' and 'Strongly agree' and adapted for the purpose of the current research where necessary. The item set included four items for *performance expectancy*, three for *effort expectancy*, two for *social influence*, two for *facilitating conditions* and three for *behavioral intention* (see Appendix). Participants took part in groups of 15 to 20 in a computer lab. Instructions explained



a.



b.

Figure 2. Home pages used in study 1.

a. Home page of VLE
b. Home page of library site

to participants that they would be asked about their experience of using two existing web sites run by the university. They were then individually shown the home page of a web site (VLE or library site) and subsequently completed the questionnaire items using the experimental program; the procedure was repeated for the second web site. The order of sites was counterbalanced.

2.2. Results

In order to establish psychometric properties of the set of items, factor analysis and reliability analysis were conducted. t tests were used to test Hypothesis 1 and multiple regression analysis to test the research model. Cohen's (1988) conventions for effect sizes were used.

2.2.1. Psychometrics. For both web sites, principal component analysis with direct oblimin rotation produced a five-factor solution. For the VLE 82% of variance was extracted and 85% for the library site. The factors were performance expectancy (absolute size of loadings of factor-specific items ranging from .74 to .92), behavioral intention (factor-specific loadings: .81 to .94), social influence (factor-specific loadings: .86 to .94), effort expectancy (factor-specific loadings: .77 to .96), and facilitating conditions (factor-specific loadings: .78 to .93).

All scales were reliable for both sites, with Cronbach's coefficient alpha > .70 (see Table 2). In order to reduce skew and kurtosis, *user behavior* was logarithmically transformed and the transformed variable was used in all analyses. Correlations among *performance expectancy* and *effort expectancy*, and between antecedents of acceptance (*performance expectancy social influence*, *effort expectancy*, and *facilitating conditions*) and acceptance outcomes (*behavioral intention* and *user behavior*) provide evidence for validity. From the pattern of correlations the association between the dependent variables and the independent variables appeared to be stronger for the library site than for the VLE.

2.2.2. Differences in acceptance outcomes between sites. Related to Hypothesis 1, mean acceptance outcomes were significantly higher for the VLE than for the library site: for behavioral intention, $t(117) = 5.89$, $p < .001$, $r = .48$ (large effect size), and user behavior, $t(117) = 2.37$, $p < .05$, $r = .21$ (small to medium effect size) (see also Table 2). The variance for the library site was significantly greater than that for the VLE: for behavioral intention, $F(117, 117) = 3.37$, $p < .001$, and for (logarithmically transformed) user behavior, $F(117, 117) = 1.75$, $p < .01$.

Table 2. Reliability, descriptives and correlations (Study 1)

A. Virtual Learning Environment (VLE)

s	PE	EE	SI	FC	BI	lnUse[a]	rlUse[b]	Use
EE	***.49							
SI	***.35	*.19						
FC	**.24	***.39	***.41					
BI	.09	*.22	.06	**.25				
lnUse	.05	.04	.10	.10	-.04			
Mean	6.10	6.27	4.69	5.69	6.66	1.46	5.29	4.54
SD	1.01	0.82	1.51	1.20	0.75	0.63	2.88	5.72
ICR	0.90	0.88	0.83	0.74	0.82	NA	NA	NA

B. Library web site

	PE	EE	SI	FC	BI	lnUse[a]	rlUse[b]	Use
EE	***.49							
SI	***.44	**.24						
FC	***.52	***.38	***.60					
BI	***.61	***.57	***.35	***.44				
lnUse	***.30	*.21	***.33	***.32	***.37			
Mean	5.34	5.31	4.18	4.75	5.94	1.30	4.67	4.48
SD	1.17	1.22	1.58	1.33	1.38	0.83	3.30	6.54
ICR	0.91	0.92	0.91	0.71	0.95	NA	NA	NA

Note: ICR: internal consistency reliability (Cronbach's alpha). Remaining figures are means, standard deviations and correlations between constructs. PE: *performance expectancy*; EE: *effort expectancy*; SI: *social influence*; FC: *facilitating conditions*; BI: *behavioral intention*.
[a]logarithmically transformed *user behavior* to reduce skew and kurtosis.
[b]logarithmically transformed *user behavior* retransformed to original scale.
* $p < .05$; ** $p < .01$; *** $p < .001$.

2.2.3. Testing the research model. The research model (see Figure 1) with the effects of the focal variables performance expectancy, effort expectancy, social influence, and facilitating conditions as well as moderation by experience and voluntariness was tested (see Table 3). Excluded were the moderators age, because of a restricted demographic range, and gender, because of an unequal split.

Table 3. Hierarchical multiple regression analysis (Study 1)

A. Virtual Learning Environment (VLE)

Criterion	*Predictors*	β	R^2
Behavioral intention			*.14
	Experience	-.05	
	Voluntariness	.08	
	Performance expectancy	-.06	
	Effort expectancy	.19	
	Social influence	*.20	
	SI×EXP	-.21	
	SI×VOL	-.10	
	EE×EXP	.20	
User behavior[a]			.02
	Behavioral intention	-0.04	
	Experience	0.13	
	Facilitating conditions	0.00	
	FC×EXP	0.05	

B. Library web site

Criterion	*Predictors*	β	R^2
Behavioral intention			***.51
	Experience	.01	
	Voluntariness	.09	
	Performance expectancy	***.32	
	Effort expectancy	***.33	
	Social influence	.16	
	SI×EXP	-.10	
	SI×VOL	-.07	
	EE×EXP	-.03	
User behavior[a]			***.18
	Behavioral intention	**0.32	
	Experience	0.10	
	Facilitating conditions	0.07	
	FC×EXP	-0.14	

[a]logarithmically transformed.
* $p < .05$; ** $p < .01$; *** $p < .001$.

2.2.4. VLE. With a medium effect size, the model for *behavioral intention* was significant with *social influence* as a significant predictor. There were no significant predictors of *user behavior*. The finding that model for *user behavior* was not significant is consistent with the conjecture that the necessity of using a VLE for study in higher education is the overriding factor for its acceptance.

2.2.5. Library site. With a very large effect size, the model was significant for *behavioral intention*. Significant predictors were *performance expectancy* and *effort expectancy*. Both *performance expectancy* and *effort expectancy* have been well-established predictors of *behavioral intention* since the inception of the Technology Acceptance Model (Davis et al., 1989). The effects of *performance expectancy* and *effort expectancy* indicate that those who find the system more useful and easier to use - in this case for academic study - have a stronger intention to use it. With a medium effect size, the model was significant for *user behavior* and *behavioral intention* was a significant predictor, as predicted by UTAUT.

2.2.6. Comparison of sites. In a subsequent single multiple regression analysis, the influence of the predictors on *behavioral intention* across site type (VLE versus library) was directly compared, while controlling for the effect of participant (using criterion scaling - Pedhazur, 1997). Interaction terms between Web-site type and each of the predictors (e.g., site type×*effort expectancy*, site type×*performance expectancy*, etc.) were included. The combined interaction effects were significant, showing that the effect of the predictor set differed between site types, $R^2 = .04$, $p < .05$, with more variance explained for the library site. The same analysis was conducted with *user behavior* as dependent variable. The combined interaction effects were significant, showing that the predictors' effects differed between site types, $R^2 = .07$, $p < .001$, with more variance explained for the library site. The interaction effect of *behavioral intention* with site type was significant, $sr^2 = .07$, $p < .001$, showing that this predictor was more influential for the library site.

2.2.7. Summary of results. Test results provided evidence for Hypothesis 1, with higher levels of acceptance and less variability for a VLE than for a library site. Furthermore, the predictors explained more variability in acceptance outcomes for the library site; in particular, and behavioral intention was stronger as a predictor of user behavior for the library site.

3. STUDY 2

3.1. Method

3.1.1. Design. The same type of design and the same variables were used as in Study 1, with intrinsic motivation as an additional variable.

3.1.2. Participants. There were 121 undergraduate psychology students (96 female and 25 male) from Teesside University, who had not taken part in Study 1. They took part as a course requirement. Mean age was 23.52 (SD = 7.09). All had used the World Wide Web and mean experience of using the Web was 8.36 years (SD = 2.54).

3.1.3. Materials. A bespoke experimental program written in Visual Basic 6.0 was used to present the home page of the library site and that of two other sites as well as questionnaire items for participants to rate each of the sites in terms of their acceptance. One site was the university's library web site in the academic year 2006–2007 (see Figure 3), which students had used as part of their academic studies. The other sites (used in goal mode or used in action mode) were provided by the participants; these were sites that they had used before, with each participant selecting his or her own sites. These sites were not selected in advance of the experiment for each participant, but - after a participant had selected a site - the homepage was displayed in the experiment through the built-in web browser. The program controlled the process of selecting a site and an external search engine was integrated in the program to achieve this.

In addition to the items used in Study 1, three additional items for *intrinsic motivation* (see Appendix) from Venkatesh and Speier (2000) were employed. Venkatesh et al.'s (2003) items for measuring *facilitating conditions* were too specific so that they would not necessarily apply to the other sites that participants selected themselves (see Appendix). Therefore, the items for *facilitating conditions* were only used for the library site.

Figure 3. Home page (library site) used in study 2.

3.1.4. Procedure. Participants took part in groups of 15 to 20 in a computer lab and instructions stated that they would be asked about their experience of using some particular Web sites. They were individually shown the home page of the library web site and then completed the questionnaire items using the experimental program. Participants were then asked to select one site that they had used with an emphasis on achieving goals ("The next part of the experiment will ask you about a Web site that you use outside your university studies with an emphasis on achieving goals - where the site is just a means towards an end."). Individual participants decided themselves which sites to designate as the ones they had used in goal mode outside the experiment. This arrangement was appropriate because users could have used products (web sites) differently, depending on the situation of use (Hassenzahl, 2003). After the home page of the first site appeared on screen participants completed the questionnaire items for the site. This procedure was repeated for another site that they used with an emphasis on actions ("The next part of the experiment will ask you about ANOTHER Web site that you use outside your university studies with an emphasis on actions (rather than achieving goals) - where [using] the site is just an end in itself"). The experiment did not allow participants to select the same site twice[6].

3.2. Results

In order to psychometrically evaluate the set of items, factor analysis and reliability analysis were conducted. Analysis of variance (ANOVA) and analysis of covariance (ANCOVA) were used to test Hypotheses 2 and 3, and multiple regression analysis to test the research model and Hypothesis 4.

3.2.1. Psychometrics. For the library web site, principal component analysis produced a six-factor solution with 85% of variance extracted. The factors were performance expectancy (absolute size of loadings of factor-specific items ranging from .73 to .85), social influence (factor-specific loadings: .91 to .93), intrinsic motivation (factor-specific loadings: .64 to .94), behavioral intention (factor-specific loadings: .86 to .93), facilitating conditions (factor-specific loadings: .89 to .90), and effort expectancy (factor-specific loadings: .84 to .95). For the two other types of site there was a five-factor solution, with 86% of variance extracted for Site 2 and 85% for Site 3. The same factors (except facilitating conditions) were found: performance expectancy (factor-specific loadings: .75 to .93), social influence (factor-specific loadings: .95 to .99), intrinsic motivation (factor-specific loadings: .58 to .98), behavioral intention (factor-specific loadings: .83 to .96), and effort expectancy (factor-specific loadings: .66 to .90).

All scales were reliable for all types of site, with alpha > .70 (see Table 4). Correlations among *intrinsic motivation*, *performance expectancy*, and *effort expectancy*, and between antecedents of acceptance and acceptance outcomes provide evidence for validity. From the pattern of correlations a sizable association between the dependent variables and the independent variables was apparent for all types of site.

3.2.2. Differences in motivation between sites. Voluntariness of use was highest for the sites used in action mode (mean = 6.50, SD = 0.90), followed by that of the sites used in goal mode (mean = 6.16, SD = 1.12) and the library site (mean = 5.65,

Table 4. Reliability, descriptives and correlations (study 2)

A. Library web site

	PE	*EE*	*IM*	*SI*	*FC*	*BI*	*lnUse*[a]	*rlUse*[b]	*Use*
PE									
EE	***.46								
IM	***.50	***.58							
SI	**.23	.03	*.20						
FC	***.43	***.34	***.49	***.32					
BI	***.55	***.42	***.40	**.24	***.44				
lnUse	**.26	**.26	**.29	.07	***.43	*.22			
Mean	5.06	5.2	4.05	3.72	4.69	5.65	1.22	4.37	4.08
SD	1.07	1.14	1.03	1.34	1.29	1.42	0.77	3.16	8.21
ICR	0.89	0.92	0.86	0.88	0.84	0.93	NA	NA	NA

B. Site 2, goal mode

	PE	*EE*	*IM*	*SI*	*BI*	*lnUse*[a]	*rlUse*[b]	*Use*
PE								
EE	***.59							
IM	***.44	***.72						
SI	***.33	***.35	***.41					
BI	**.29	***.42	***.48	**.24				
lnUse	***.38	***.36	***.44	**.24	***.31			
Mean	5.33	5.67	5.29	4.44	5.52	1.14	4.13	4.07
SD	1.09	1.08	1.18	1.47	1.53	0.78	3.18	11.75
ICR	0.89	0.92	0.89	0.93	0.96	NA	NA	NA

C. Site 3, action mode

	PE	*EE*	*IM*	*SI*	*BI*	*lnUse*[a]	*rlUse*[b]	*Use*
PE								
EE	***.46							
IM	***.33	***.71						
SI	***.36	.15	.17					
BI	***.48	***.50	***.44	*.21				
lnUse	***.30	***.30	**.26	.10	***.38			
Mean	5.67	5.97	5.81	4.74	5.83	1.20	4.33	3.56
SD	1.11	1.00	1.10	1.57	1.32	0.76	3.13	4.44
ICR	0.90	0.93	0.90	0.93	0.90	NA	NA	NA

Note: ICR: internal consistency reliability (Cronbach's alpha). Remaining figures are means, standard deviations and correlations between constructs. PE: *performance expectancy*; EE: *effort expectancy*; SI: *social influence*; FC: *facilitating conditions*; BI: *behavioral intention*.

[a]logarithmically transformed *user behavior* to reduce skew and kurtosis.

[b]logarithmically transformed *user behavior* retransformed to original scale.

* $p < .05$; ** $p < .01$; *** $p < .001$.

SD = 1.33), indicating higher voluntariness for user-selected sites. As a manipulation check, ANOVA showed a significant effect of web site on voluntariness of site use, F (2, 240) = 19.49, $p < .001$, $\varepsilon^2 = .09$ (medium to large effect size). All the differences were significant: Site 1 (library site) - Site 2 (goal mode), $p < .01$, r = .28 (medium effect size), Site 1 - Site 3 (action mode), $p < .001$, r = .50 (large effect size), and Site 2 - Site 3, $p < .01$, r = .27 (medium effect size).

Related to Hypotheses 2 and 3, further ANOVA demonstrated a significant effect of web site on *intrinsic motivation*, *F* (2, 240) = 108.87, $p < .001$, $\varepsilon^2 = .31$ (very large effect size). All the differences were significant: Site 1 (library site) - Site 2 (goal mode), $p < .001$, $r = .67$ (very large effect size), Site 1 - Site 3 (action mode), $p < .001$, $r = .81$ (very large effect size), and Site 2 - Site 3, $p < .001$, $r = .35$ (medium effect size). ANCOVA, using other technology-acceptance variables (*effort expectancy*, *performance expectancy* and *social influence*) as covariates, produced the same pattern of results.

To test the specificity of the effect of web site, ANOVA was also conducted on *behavioral intention* and *user behavior*. There was no significant effect of web site on *behavioral intention*, *F* (2, 240) = 1.54, $p > .05$, and *user behavior*, $F < 1$.

3.2.3. Testing the research model. The same strategy was used as in Study 1 to test the research model. Test results are presented in Table 5.

Library site. With a very large effect size, the model was significant for *behavioral intention*. Significant predictors were *voluntariness*, *performance expectancy* and *effort expectancy*. Therefore, as in Study 1, both *performance expectancy* and *effort expectancy* were predictors of *behavioral intention*, confirming previous research (e.g., Venkatesh et al., 2003). With a medium effect size, the model was significant for *user behavior* and *facilitating conditions* was a significant predictor, as predicted by UTAUT[7].

Site 2 - goal mode. With a very large effect size, the model was significant for *behavioral intention*. Significant model predictors of *behavioral intention* were voluntariness, *social influence* and the interaction of *social influence* with experience. Simple effect analysis showed that, for experience at or below the median value, the model was significant with a very large effect size, $R^2 = .47$, $p < .001$. Significant predictors were voluntariness, *effort expectancy* and *social influence*, all $p < .01$. For experience above the median value, the model was significant with a medium effect size, $R^2 = .20$, $p < .05$, with voluntariness as a significant predictor, $p < .05$. These results confirm Venkatesh et al.'s (2003) finding that the effect of *social influence* is stronger with limited experience. With a medium effect size, the model was significant for *user behavior*, with *behavioral intention* as a predictor, confirming UTAUT's prediction.

Site 3 - action mode. With a very large effect size, the model was significant for *behavioral intention*. Significant model predictors of *behavioral intention* were voluntariness, *performance expectancy* and *effort expectancy*, confirming the role

Table 5. Hierarchical multiple regression (Study 2)

A. Site 1, library web site

Criterion	*Predictors*	β	R^2
Performance expectancy			***.32
	Perceived enjoyment	**.31	
	Effort expectancy	**.31	
Behavioral intention			***.46
	Experience	.01	
	Voluntariness	***.36	
	Performance expectancy	***.30	
	Effort expectancy	*.18	
	Social influence	.10	
	SI×EXP	.03	
	SI×VOL	.09	
	EE×EXP	.01	
User behavior[a]			***.19
	Behavioral intention	.02	
	Experience	.07	
	Facilitating conditions	***.42	
	FC×EXP	-.01	

B. Site 2, goal mode

Criterion	*Predictors*	β	R^2
Performance expectancy			***.37
	Perceived enjoyment	.02	
	Effort expectancy	***.63	
Behavioral intention			***.35
	Experience	.12	
	Voluntariness	***.41	
	Performance expectancy	-.03	
	Effort expectancy	.20	
	Social influence	*.19	
	SI×EXP	*-.21	
	SI×VOL	-.14	
	EE×EXP	-.05	
User behavior[a]			*.11
	Behavioral intention	*.33	

C. Site 3, action mode

Criterion	*Predictors*	β	R^2
Performance expectancy			***.22
	Perceived enjoyment	$-.01<\beta<.00$	
	Effort expectancy	***.47	
Behavioral intention			***.42
	Experience	.15	
	Voluntariness	*.23	
		*.24	
	Performance expectancy		
	Effort expectancy	*.20	
	Social influence	.46	
	SI×EXP	-.06	
	SI×VOL	-.41	
	EE×EXP	-.07	
User behavior[a]			***.14
	Behavioral intention	***.38	

[a]logarithmically transformed.
* $p < .05$; ** $p < .01$; *** $p < .001$.

of the latter two in shaping acceptance outcomes according to UTAUT. With a medium effect size, the model was significant for *user behavior*, with *behavioral intention* as a predictor, confirming UTAUT's prediction.

Analysis of *intrinsic motivation*. In relation to Hypothesis 4, as shown in Table 4, *intrinsic motivation* was a significant predictor of both *performance expectancy* and *effort expectancy* and also of *behavioral intention* and *user behavior*. As shown in Table 5, the effect of *intrinsic motivation* on *performance expectancy* was fully mediated by *effort expectancy* for Sites 2 and 3, but *effort expectancy* was a partial mediator for Site 1 (the library site). Furthermore, analysis for Site 1 demonstrated that the effect of *intrinsic motivation* on *behavioral intention* was mediated by *performance expectancy*.

3.2.4. Summary of results. Test results provided evidence for Hypothesis 2 and 3 with highest intrinsic motivation for sites voluntarily used in action mode, second-highest for sites voluntarily used in goal mode and lowest for the prescribed site. Furthermore, significant predictors of behavioral intention included performance expectancy, effort expectancy, and (moderated by experience) social influence. Tests of Hypothesis 4 showed that the effect of intrinsic motivation on performance expectancy was fully mediated by effort expectancy for self-selected sites, but partially mediated for the library site.

4. DISCUSSION

4.1. Support for Research Model

Support for UTAUT was found in that, first, the technology acceptance variables *effort expectancy, performance expectancy* and *social influence* were antecedents of *behavioral intention*, and, second, *behavioral intention* and *facilitating conditions* were antecedents of *user behavior*. In Study 2, the effect of *social influence* was moderated by experience for sites used in goal mode, indicating a stronger effect of *social influence* for those with less experience; experience was not a moderator for the VLE in Study 1, presumably because of the smaller range of experience than for Site 2 in Study 2. Voluntariness was not found to be moderator, possibly due to restricted range. In general, it appears that for Web sites used by students in higher education, the main predictors of behavioral intention (on the one hand *effort expectancy* and *performance expectancy*, and on the other hand *social influence*) are mutually exclusive across different sites. The effect of social influence might be related to (small) groups of students using the same site for coursework in the case of a VLE. The effects of *effort expectancy* and *performance expectancy* may be stronger for sites without reference to a group of peers or other significant others. Obviously, as discussed in Section 4.4, there may be other factors not captured by UTAUT that could influence acceptance of sites by students in higher education.

In support of Hypothesis 1, the VLE received higher levels of acceptance and displayed less variability in acceptance outcomes explained by predictors than the library site. As web-based systems increasingly become part of students' daily activities and with the increasing integration of VLEs with other (e.g., library) systems, it is likely that the level of acceptance of all these systems will increase further, while the variability in acceptance will decrease and the influence of technology-acceptance variables on acceptance outcomes will decrease. This phenomenon can be described as *acceptance by default*. Although increased acceptance would seem desirable, increased level of use does not necessarily mean that systems are used effectively, that is making a contribution to meeting learning outcomes by students. For example, although the use of a word processor by computer users is almost universal nowadays, because of the productivity paradox (Carroll & Rosson, 1987), many users will only use a fraction of the available functionality and not use other (more powerful) functionality that could make their use more effective. The reason for this paradox is that users are not willing to invest the time (cost) required to learn additional functions that would boost these users' effectiveness (benefit). This paradox applies in principle to the use of all types of interactive computer system, including web-based systems in higher education. Indeed, users' ability to use a library site effectively for a range of typical tasks is limited (unpublished data - van Schaik, Price, Porritt & Tilley, 2003) and this is true more generally for users' capability of using library facilities (Hull, 2000). This is also true for the use of Web sites in general by Web users outside the higher-education sector (Nielsen, 2008). As another consequence of increased level of acceptance - but not necessarily matched by increased effectiveness of use - and decreased variability of acceptance, the possibility of influencing acceptance will reduce and sustained system use may become routinized and automatic rather than deliberate (Venkatesh et al., 2000).

Hypotheses 2 and 3 were also supported, that is *intrinsic motivation* was higher for user-selected sites than for a prescribed site, *intrinsic motivation* was higher with use in action mode than in goal mode and *intrinsic motivation* was a significant predictor of *behavioral intention* and *user behavior* for user-selected sites. In support of Hypothesis 4 and consistent with Sun and Zhang (2008), *intrinsic motivation* was an antecedent of *performance expectancy* with *effort expectancy* as a mediator, and was an antecedent of acceptance outcomes for three types of Web site. Although the effect of *intrinsic motivation* is mediated, the results demonstrate its indirect effect on acceptance. The impact is important because it suggests that intrinsically motivating features of artifacts, such as web sites, can indirectly – through *intrinsic motivation*, *effort expectancy* and *performance expectancy* – influence acceptance outcomes, although a test of this conjecture is beyond the scope of the current paper. Although *intrinsic motivation* can be a powerful factor influencing system acceptance (e.g., Davis et al., 1992), this will depend on the quality of interaction offered by the system. System features that enhance *intrinsic motivation* include challenge, curiosity, control and fantasy (Malone & Lepper, 1987). It is likely, that the user-selected sites, both those used in goal mode and - even - more those used in action mode, offered more of these features than the prescribed library site. Although no data were collected to verify this, it is plausible that a reason for the significant influence of *intrinsic motivation* of voluntarily used sites in the current study was that users experienced these sites as hedonic rather than utilitarian. This conjecture is consistent with van der Heijden's (2004) theoretical position regarding the power of *intrinsic motivation* in the acceptance of hedonic products. The results from this paper and the theoretically justified role of *intrinsic motivation* in the acceptance of hedonic systems lead to a recommendation to reconsider *intrinsic motivation* as a factor in UTAUT at least for hedonic products.

The research model was tested for two types of web-based system to support learning in higher education as well as user-selected sites (in goal mode and action mode). The model varied in its predictive power of acceptance outcomes and the predictors of these outcomes, with a lower predictive power for the VLE in Study 1, as is consistent with Hypothesis 1. Overall, the results support the direct and moderated effects of technology-acceptance variables on acceptance outcomes in the research model, in support of UTAUT (Venkatesh et al., 2003) and the role of *intrinsic motivation* (Davis et al., 1992).

Previous research focusing on student-users' acceptance of educational systems found evidence for the influence of *performance expectancy* and *effort expectancy* on *behavioral intention* (Saadé & Bahli, 2005; Thong et al., 2002; Lau & Woods, 2009) and *user behavior* (Ngai et al., 2007; Pituch & Lee, 2006), end-user computing satisfaction as a mediator of the effect of *performance expectancy* and *effort expectancy* on *user behavior* (Roca et al., 2006), *performance expectancy* as a mediator of the effect of *effort expectancy* on *user behavior* (Selim, 2003; van Raaij & Schepers, 2008) and the influence of *intrinsic motivation* and *performance expectancy* on *behavioral intention* (Lee et al., 2005). In contrast to the current study, none of these studies used both *behavioral intention* and *user behavior* as an outcome measure, many did not include a VLE and none included a library site[8]. The results from research that studied the acceptance of a VLE complement those of the current study in finding evidence for two predictors of *behavioral intention* (*performance expectancy* and *intrinsic motivation* in Lee et al., 2005 - but *social influence* and *user behavior* were not included in the model) and four predictors of *user behavior* (behavioral intention, performance expectancy, effort expectancy and attitude towards use, Ngai et al., 2007 - but *intrinsic motivation* and *social influence* were not included in the model).

4.2. Acceptance and System Integration

Although the current study investigated the acceptance of different web-based educational systems (VLE and library system) separately, in reality students need to use these systems together for their academic work. Consequently, the acceptance of a single system is not sufficient for academic success. However, an integrated system can provide a mechanism for a higher level of acceptance and use for the combined available resources. A high level of acceptance of a VLE can be a good starting point for promoting the acceptance of integrated systems (e.g., VLE, library systems and e-mail). In addition to the advantage of potential high acceptance, another advantage of an integrated system could be that the constituent subsystems will be used more because they are all accessed through the same user interface. However, a potential disadvantage of an integrated system, if not designed carefully, is that users may find different (sub)systems difficult to locate and these may therefore be underused. Furthermore, if different systems with conflicting user interfaces are integrated in the same overall system, users may suffer from usability problems caused by the assimilation paradox (Carroll & Rosson, 1987). This involves users inappropriately employing knowledge of the user interface of one (sub)system to that of another. In addition, because of the productivity paradox, effective use of web-based systems - in particular library systems - is not guaranteed. Library systems require not only procedural knowledge in the use of system functionality, but - more fundamentally - also conceptual library knowledge. Users who lack this knowledge will not be able to effectively use academic library systems and may resort to World Wide Web-searches (Jones, 2002) - perhaps even exclusively using this type of search, and this will result in a poor quality of academic work. The effective use of library systems may be promoted by electronic performance support systems that assist with both procedural aspects of system use (e.g., van Schaik, Barker & Famakinwa, 2006) and conceptual aspects (e.g., van Schaik, Barker & Famakinwa, 2007; Barker, van Schaik & Famakinwa, 2007). In summary, integrated, carefully designed and supported systems may result in high acceptance combined with high effectiveness. These considerations regarding integration and the use of electronic performance support apply more broadly to computer-based systems used together in a particular context, beyond students' use of computers in higher education.

4.3. Limitations

Limitations of the studies include the use of a non-experimental design and completion of a survey as part of course requirements. Experimentally designed Web sites (VLE and library site) with the same style of user interface, but different functionality, and completely voluntary participation by a wider range of students would increase internal and external validity. Although the finding that the model for *user behavior* was not significant is consistent with the conjecture that the necessity of using a VLE for study in higher education is the overriding factor for its acceptance, contributing factors to the lack of significance may be (a) the use of a self-report measure for *user behavior* and (b) individual-difference variables (e.g., the Need for Cognition - Cacioppo & Petty, 1982) and situational variables (e.g., ease of access to a computer) that were not measured.

4.4. Future Directions

Future research should explore the general applicability of UTAUT, including the role of *intrinsic motivation* and other constructs of motivation (e.g., self-efficacy and task value) – because they have a distinct impact on behavior (see, e.g., Malka & Covington, 2005), by applying this model to a wider range of systems (e.g., handheld devices - Cyr, Head & Ivanov, 2006; e-commerce - van der Heijden, 2003; Cyr, Hassanein, Head & Alex Ivanov, 2007), user populations (e.g., varying in capabilities, experience and perceptions of computers - Shneiderman, 2000), organizations (e.g., commercial and public sector - Nielsen, 2004) and culture (Fusilier, Durlabhji, & Cucchi, 2008). The relation between effectiveness of use and acceptance should also be investigated. Based on the discussion of the results in Section 4.1, research – in the framework of UTAUT into students' use of some sites in the context of their peer 'network' (e.g. social-networking sites) versus their use of other sites that do not have this context offers the prospect of a further advance in technology acceptance modeling. As a moderator, this social context of use could influence the relative strength of the established predictors (performance expectancy, effort expectancy, and social influence) on acceptance outcomes. Another potentially important moderating influence on acceptance outcomes is national culture (see, e.g., Srite & Karahanna, 2006), in particular in higher education with students from a variety of cultural backgrounds. Furthermore, a burgeoning focus of HCI research is users' aesthetic experience and, more generally, user experience (e.g., Hassenzahl & Tractinsky, 2006); however, the role of aesthetics and user experience in technology acceptance remains underresearched (but see Cyr et al., 2006 and van der Heijden, 2003). The general question for this research is to what extent user experience can enhance system acceptance and, more specifically, how aesthetics variables and other artifact features interact with established technology-acceptance variables in their effect on acceptance outcomes.

5. CONCLUSION

UTAUT is a significant synthesis of extant technology acceptance models. The current study used UTAUT to explore technology acceptance to a range of web sites used in higher education. As predicted, the research model - based on UTAUT - was more successful in explaining the acceptance of a prescribed library site than that of a prescribed VLE. The model was also successfully applied to user-selected web sites, and the impact of *intrinsic motivation* on *performance expectancy* was mediated by *effort expectancy*. The results demonstrate the broad scope of applicability of UTAUT and motivate its recommended wider use.

NOTES

1 "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction" (McNamara & Kirakowski, 2006, p. 28).

2 Technology acceptance can be defined as the demonstrated behavior or willingness by a user to employ information technology for the tasks it is designed to support.

3 The main model components are presented in Table 1.

4 Excluded moderators were gender, because an unequal split in the data, and age, because of a restricted demographic range in the data.

5 Mean experience was 1.72 years (SD = 0.92) for the VLE and 1.70 years (SD = 0.76) for the library site.

6 Mean experience was 1.64 years (SD = 1.10) for the library site, 2.78 years (SD = 2.69) for Site 2, and 3.21 years (SD = 2.94) for Site 3.

7 The correlation of *behavioral intention* with *user behavior* was significant, but *behavioral intention* did not explain statistically significant unique variability in *user behavior* after controlling for *facilitating conditions*.

8 Although Thong et al. (2002) included a digital library, the library site in the current study supported access to both offline and online library materials, whereas a digital library only offers online materials.

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APPENDIX - QUESTIONNAIRE ITEMS

Study 1

Performance expectancy
I find X[a] useful in my studies.
Using X enables me to accomplish tasks more quickly.
Using X increases my productivity.
If I use X I will increase my chances of progressing in my studies.
Effort expectancy
It is easy for me to become skilful at using X.
I find X easy to use.
Learning to operate X is easy for me.
Social influence
People who influence my behavior think that I should use X.
People who are important to me think that I should use X.
Facilitating conditions
University staff has been helpful in the use of X.
In general, the university has supported the use of X.
Behavioral intention
I intend to use X in the next month.
I predict I would use X in the next month.
I plan to use X in the next month.
Voluntariness
My use of X is[b]

Note: The items all used 7-point scales. The endpoints were Strongly disagree (presented left) and Strongly agree (presented right), except for Voluntariness.
[a]X: Blackboard (VLE) or the library web site.
[b]Endpoints: Nonvoluntary (presented left) and Completely voluntary (presented right).

Study 2 (library web site)

Performance expectancy: as in Study 1
Effort expectancy: as in Study 1
Social influence: as in Study 1
Facilitating conditions: as in Study 1
Behavioral intention: as in Study 1
Voluntariness: as in Study 1
Intrinsic motivation
I find using the library web site to be enjoyable.
The actual process of using the library web site is pleasant.
I have fun using the library web site.

Note: The items all used 7-point scales. The endpoints were Strongly disagree (presented left) and Strongly agree (presented right), except for voluntariness with endpoints Nonvoluntary (presented left) and Completely voluntary (presented right).

Study 2 (self-selected sites)

Performance expectancy

I find X[a] useful in particular activities outside my studies.

Using X for particular activities outside my studies enables me to accomplish tasks more quickly.

Using X enhances my effectiveness in particular activities outside my studies.

Using X makes it easier to do particular activities outside my studies.

Effort expectancy

It is easy for me to become skilful at using X.

I find X easy to use.

Learning to operate X is easy for me.

Social influence

People who influence my behavior think that I should use X.

People who are important to me think that I should use X.

Behavioral intention

I intend to use X in the next month.

I predict I would use X in the next month.

I plan to use X in the next month.

Voluntariness

My use of X is[b]

Intrinsic motivation

I find using X to be enjoyable.

The actual process of using X is pleasant.

I have fun using X.

Note: The items all used 7-point scales. The endpoints were Strongly disagree (presented left) and Strongly agree (presented right), except for Voluntariness.

[a]X: a Web site used outside university studies.

[b]Endpoints: Nonvoluntary (presented left) and Completely voluntary (presented right).

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10. EXPLORING THE GENDER DIFFERENCES IN STUDENT ACCEPTENCE OF AN INTERNET-BASED LEARNING MEDIUM

ABSTRACT

The specific features of the Internet have created an ideal place for teaching and learning. There has been a lot of attention on how and why students adopt and use an Internet-based learning medium. In recent years, we witnessed a significant amount of studies on the impact of contextual factors (such as gender difference) on technology usage. These studies have shown that male and female users seem to use technology in a very different way. In view of this, we attempt to explore the gender differences in student acceptance of an Internet-based learning medium (ILM). Specifically, we examine the gender differences in the relative impact of both extrinsic and intrinsic motivations, as well as the social influence on student acceptance of an ILM. A total of 504 students participated in this study. Attitude has the strongest direct effect on behavioral intention for both male and female students. Perceived usefulness influences attitude and behavioral intention to use an ILM more strongly for male students than it influences female students, whilst subjective norm is a more important factor determining female students' intention to use an ILM than it is for male students. We conclude the paper by discussing its theoretical and practical implications.

INTRODUCTION

> *"College students are heavy users of the Internet compared to the general population. Use of the Internet is a part of college students' daily routine, in part because they have grown up with computers. It is integrated into their daily communication habits and has become a technology as ordinary as the telephone or television. (p. 2)" (Jones, 2002)*

New generation has grown up with computers, and the use of the Internet has become a part of their daily routine. According to the Harris Interactive Survey (2009[1], students are now spending twice as much time on their computers as compared to television. The Pew Internet and American Life Project (2009)[2] also found that young people are highly active Internet users. 93% of young people use the Internet. 68% go online for instant messaging, 54% read blogs and 14% regularly post blogs. 55% use Wikipedia and 73% use social network sites. Over 25% have downloaded podcasts, and over 75% view videos on video-sharing sites.

T. Teo (eds.), Technology Acceptance in Education: Research and Issues, 183–199.

Men have long been the dominants of the Internet population. Recent studies[3] however revealed that the Internet gender gap has been bridged. In the US, there are even more women getting online than men. Indeed, most studies have pointed out that the percentages of male and female Internet users are closest among the young people. However, a lot of these studies[4] have indicated that teen's online activities are gender-specific. Doing homework and sending e-greetings are the top two online activities for girls, whilst downloading music and playing online games are the most frequently reported activities among teen boys. These variations yield some interesting gender-specific results that need further exploration.

The potential of the Internet as a learning medium has been widely appreciated, and the range of research related to learning and teaching using the Internet is unexpectedly broad (Wolfe, 2001). In the last decade, a lot of attention has been paid on student adoption and acceptance of the Internet as a learning medium (e.g., Lee, 2006; Lee et al., 2005; Ngai et al., 2007; Selim, 2007) and the Technology Acceptance Model (TAM) is the most widely used research framework to explain IT adoption and usage.

Basically, TAM scrutinizes technology acceptance from an extrinsic perspective. As addressed by Davis et al. (1992), perceived usefulness (PU) is an example of extrinsic motivation. In the context of using the Internet as a learning medium for the youth, however, we believe the impact of their emotional feeling, such as happiness and unhappiness, joy and frustration, pity and anger and the like, also play a crucial role in explaining IT acceptance. Often, no matter the behavior is extrinsically or intrinsically motivated, the behavior itself looks precisely the same. Extrinsic and intrinsic motivations, however, are two different drivers evoke behavior. Understanding students' underlying motivators for the acceptance of an Internet-based learning medium (ILM) can help course designers and academic institutions develop a better strategy for the system design and implementation. Moreover, TAM is a simple and precise model for understanding IT usage. The model does not account for social and personal control factors in the prediction of IT adoption. There is a need to extend the original TAM and examine the impact of subjective norm on student adoption of an ILM.

Gender is another research issue in this study. A growing number of studies investigating gender differences have demonstrated the importance of understanding the role of gender with respect to IT in a variety of contexts, including e-mail (Gefen and Straub, 1997), instant messaging (Debrand and Johnson, 2008), blogging (Zhang et al., 2009), Internet use (Teo, 2001), and social network sites (Shi et al., 2010). Interesting results have been found from these studies. For example, men are more likely to use Internet for entertainment and leisure, such as play online games, listening to music (Odell and Schumacher, 2000; Weiser, 2000). Women are more enthusiastic about using email and other computer technologies to keep in touch with others (Debrand and Johnson, 2008). Accordingly, it is likely that there exist gender differences in the student adoption of an Internet-based learning medium. In this study, we specifically explore the gender differences in the relative impact of both extrinsic and intrinsic motivations, as well as subjective norm on student acceptance of an ILM.

In the next section, we address the theoretical background and research hypotheses. We then describe our survey study to empirically test our research model. Next, we discuss the findings of our empirical study. Finally, we conclude the study by discussing the implications for both research and practice.

THEORETICAL BACKGROUND

In this study of student adoption of Internet-based learning medium, the research model is built on theoretical frameworks used or suggested in prior studies.

Technology Acceptance Model

Technology Acceptance Model (TAM) is the most well-known and robust model among a variety of behavioral models in explaining IT adoption and usage. Critical assessments of TAM and comparisons with other intention-based models, such as Theory of Reasoned Action (TRA) and Theory of Planned Behavior (TPB), demonstrated that TAM is a theoretical construct customized for the study of computer-technology acceptance with higher research significance in the IS discipline (Davis, Bagozzi, & Warshaw, 1989; Taylor and Todd, 1995).

> *"The goal of TAM is to provide an explanation of the determinants of computer acceptance that is general, capable of explaining user behavior across a broad range of end-user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified. (p. 985)" (Davis, Bagozzi, & Warshaw, 1989)*

In short, TAM is a simple and precise model for understanding IT usage with few but salient constructs. TAM proposed that the acceptance of a technological innovation is driven by one's attitude toward the use of the innovation which, in turn, is determined by two beliefs, namely, perceived usefulness and perceived ease of use. Because of its strong predictive power in explaining IT adoption, TAM has been widely used in IS research (e.g., Chau, 1996; Straub, Keil, & Brenner, 1997; Venkatesh & Davis, 2000; Venkatesh & Morris, 2000).

Human Motivation Theory

Human motivation theory is widely adopted in behavioral studies. Prior studies have shown that motivation is responsible for why behavior is initiated, persists, and stops, as well as what choices are made. A number of theoretical perspectives (e.g., Atkinson's theory of achievement motivation, Rotter's social learning theory, student motivation theory) have been proposed to examine the motivations of students. One useful perspective posits that behavior can be extrinsically and intrinsically motivated, this theoretical approach appears rather pertinent for the study of motivation of students. (Deci & Rayan, 1985; Deci & Rayan, 1991)

Extrinsic motivation pertains to a wide variety of behaviors which are engaged in response to something apart from its own sake, such as reward or recognition or the dictates of other people. Contrary to extrinsic motivation, intrinsic motivation refers to the fact of doing an activity for its own sake, and the activity itself is interesting, engaging, or in some way satisfying. Consistent with other research on motivation, Davis et al. (1992) found both extrinsic and intrinsic factors are significantly affecting people's behavioral intention to use a new innovation. Their study shows that if an individual finds its advantages to use a particular technology and the technology facilitates the individual's productivity, the individual perceives this technology as useful and he/she is likely to have an extrinsic motivation to use it. On the other hand, if an individual finds fun and enjoyment in using a particular technology, the individual tends to have an intrinsic motivation to use it. Igbaria et al. (1994) and Venkatesh (1999) also obtained similar findings, where both perceived usefulness and perceived enjoyment are significant determinants of technology acceptance.

Social Influence

Social influence has been widely used to explain group and collective behavior (Bagozzi and Lee, 2002). The social influence underlying subjective norm reflects the influence of expectations from significant others and represents what Kelman (1958) terms "Compliance". In IS adoption research, the compliance process appeared to be paramount. Before users have any actual usage experience with a new system, second-hand information, particularly from the primary reference groups (family or friends), are important for their usage decisions (Cheung and Lee, 2010).

Gender Differences in IT Adoption

The questions of gender differences have been a consuming interest in psychology or social psychology for many years. For example, we witness gender difference studies in emotional study (Balswick, 1988), aggressive behavior (Lightdale & Prentice, 1994), criminal justice (Chong, 1998), voting (Studlar, McAllister, & Hayes, 1998), child psychology (Hussong, Curran, & Chassin, 1998), and self-esteem (Quatman & Watson, 2001). Research on gender differences with respect to information technology has attracted attention in recent years (Gefen and Straub, 1997; Wilson, 2004). Studies in IS research have also identified gender as an important moderating variable (Venkatesh et al., 2003; Ahuja and Thatcher, 2005; Shen et al., 2010).

In terms of technology acceptance studies, Venkatesh and Morris (2000) highlighted the gender differences in evaluating new technologies. For instance, technology usage decisions are more strongly influenced by perceptions of usefulness for men, while women are more strongly influenced by perceptions of ease of use and subjective norm. Some researchers explained the gender differences in terms of the way they communicate and interact (Debrand and Johnson, 2008; Teo, 2001).

RESEARCH MODEL AND HYPOTHESES

Figure 1 depicts the research model of student adoption of an Internet-based learning medium (ILM). This research model expands the Technology Acceptance

Model (TAM) by integrating human motivation theory, through the inclusion of the intrinsic motivator perceived enjoyment as a salient determinant of attitude toward the use of an ILM. In addition, the original TAM does not account for social factors in the prediction of IT adoption and usage. We extend the model by adding subjective norm as the determinant of behavioral intention. Since the focus of this study is to explore the gender differences in the adoption of an ILM, we will primarily examine how gender affects the effects of perceived usefulness, perceived ease of use, and perceived enjoyment on attitude toward the use of an ILM, as well as the effects of perceived usefulness, perceived enjoyment, and subjective norm on behavioral intention.

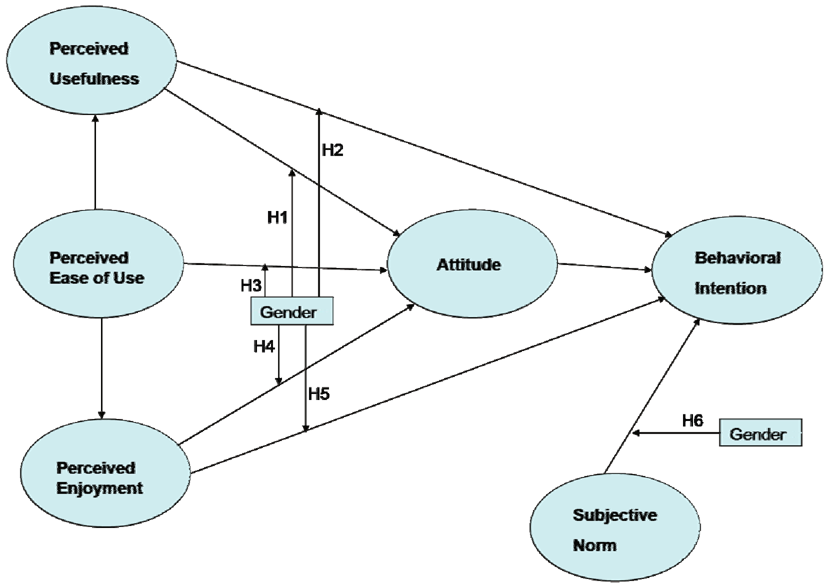

Figure 1. Research model.

Extrinsic Motivation

"*Extrinsic motivation refers to the performance of an activity because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as improved job performance, pay, or promotions. (p. 1112)*" (Davis et al., 1992) According to Davis et al. (1992), perceived usefulness in the technology acceptance model (TAM) is an example of extrinsic motivation.

In the current study of the student acceptance of an ILM, we expect that perceived usefulness will be a critical determinant of attitude as well as intention to use the learning innovative. Students can use an ILM to access and download teaching materials anytime and anywhere. They can also use online chat rooms or discussion boards to communicate and discusses with their instructors and fellow classmates. Moreover, male are stereotyped as "assertive" and "logical" (Venkatesh and Morris, 2000). They tend to be more task oriented than female, as a result, we expect that perceived usefulness influences both attitude and behavioral intention more strongly for male than for female.

H1: Perceived usefulness will influence attitude toward the use of an ILM more strongly for male students than it will influence female students.

H2: Perceived usefulness will influence behavioral intention to use an ILM more strongly for male students than it will influence female students.

Consistent with prior studies using TAM, we believe the relationships among other constructs remain significant. For instance, we expect that the easier the student perceives the use of an ILM to be, the more useful it is perceived to be, and the better the feeling toward using it. We also expect that the better the student feels about the use of an ILM, the higher their intention of using it. Frankel (1990) found that female had a higher level of computer anxiety compared to male. As suggested by Venkatesh and Davis (2000), the inverse relationship between computer anxiety and computer self-efficacy is an important factor of perceived ease of use. Venkatesh and Morris (2000) further suggested that high computer anxiety lowered self-efficacy, and resulted in lower ease of use perception and their favorable feeling of using.

H3: Perceived ease of use will influence attitude toward the use of an ILM more strongly for female students than it will influence male students.

Intrinsic Motivation

"*Intrinsic motivation refers to the performance of an activity for no apparent reinforcement other than the process of performing the activity per se. (p. 1112)*" (Davis et al., 1992) Much of the prior IT adoption and usage studies focused primarily on the impact of extrinsic motivator (i.e. perceived usefulness). Some IS researchers (i.e. Davis et al., 1992; Igbaria et al., 1994; Venkatesh et al., 1999), on the other hand, urged that intrinsic motivation also plays a significant role in stimulating the IT adoption and usage. In the current study, perceived enjoyment is postulated as an intrinsic motivator.

Similar to the utilitarian value, we expect that perceived enjoyment will have a significant impact on both attitude toward the use of an ILM, and intention to use an ILM. Since the Internet-based learning innovative provides students with a self-paced and interactive learning experience, students may feel more playful and challenging to use an ILM. In addition, they may feel more enjoyable through connecting with other classmates in this virtual learning environment. Meanwhile, prior studies have shown that men spend on time using the Internet for entertainment and leisure than women (Odell and Schumacher, 2000; Weiser, 2000). It is very likely that perceived enjoyment plays a more significant role for male than female to determine whether they want to adopt a particular technology.

H4: Perceived enjoyment will influence attitude toward the use of an ILM more strongly for male students than it will influence female students.

H5: Perceived enjoyment will influence behavioral intention to use an ILM more strongly for male students than it will influence female students.

Social Influence

In the current study, we believe that subjective norm which reflects social pressure from significant others to perform a behavior, will remain important in determining student intention to use an ILM. Prior studies suggested that female are stereotyped as "interdependent" and "nurturing". They tend to have a greater concern on others' feelings than male. As suggested by Venkatesh and Morris (2000), female tended to consider the opinions of the others more for the use of new technology than male. We expect that subjective norm will have a higher impact on female students' decision to adopt the use of ILM.

H6: Subjective norm will influence behavioral intention to use an ILM more strongly for female students than it will influence male students.

METHOD

Setting and Procedures

This study aims at investigating student adoption of an Internet-based learning medium, in particular, gender differences in the IT adoption. The learning innovation in question was known as "FaBWeb", which was created as an Internet learning portal containing lecture and tutorial notes, chat-room facilities, and streaming videos of lectures to provide out-of-classroom support to the regular campus-based students at a university in Hong Kong. The Internet-based learning medium was introduced to the first-year undergraduate students at the beginning of the semester. These students were requested to complete questionnaire that covered all the constructs in our research model. Of the 504 usable questionnaires collected, 325 respondents were female and 179 were male.

Measures

The measures of the TAM are well-researched and validated. Measures for perceived usefulness (PU), perceived ease of use (PEOU), perceived enjoyment, attitude (A), and behavioral intention (BI), were borrowed from Davis' prior studies (Davis 1993; Davis et al., 1989). Measures of subjective norm were borrowed from Taylor and Todd (1995). Except the measures of attitude, the sample items of other constructs were modified to fit the specific context of Internet-based learning and the measures were phrased on a seven-point Likert scale, from 1=strongly disagree to 7=strongly agree. A series of statements for attitude toward an Internet-based learning medium were asked, from very bad to very good, very foolish to very wise, very unpleasant to very pleasant, and dislike very much to like very much. Table 1 summarizes the sample items of this study.

RESULTS

Partial Least Squares (PLS) was used to analyze the research model. PLS has been widely used in IS research since it enables the researchers to analyze both the measurement model and the structural model simultaneously. In addition, there is no normal distribution requirement for data when using PLS and it applies to small sample cases (Chin, 1998). Hence, we chose PLS to perform data analysis in this study. In this section, we first examined the measurement model and then the structural model.

Measurement Model

Convergent validity indicates the extent to which the items of a scale that are theoretically related should correlate highly. A composite reliability of 0.70 or above and an average variance extracted of more than 0.50 are deemed acceptable (Hair et al., 2006). Table 1 summarizes the item loading, composite reliability, and average variance extracted of the measures of the constructs of our research model. All measures fulfil the recommended levels, with the composite reliability ranging from 0.703 to 0.949 and the average variance extracted ranging from 0.531 to 0.870.

Table 1. Summary of the psychometric properties of the measures

Measurement instrument	*All*			*Male*			*Female*		
	IL	*CR*	*AVE*	*IL*	*CR*	*AVE*	*IL*	*CR*	*AVE*
Perceived Usefulness (PU)		0.723	0.568		0.864	0.761		0.658	0.534
Using ILM will improve my course grades	0.823			0.859			0.577		
The advantages of ILM will outweigh the disadvantages	0.677			0.885			0.963		
Ease of Use (PEOU)		0.703	0.543		0.884	0.792		0.683	0.519
Instructions for using ILM will be hard to follow.	0.680			0.873			0.705		
It will be difficult to learn how to use ILM.	0.790			0.906			0.735		
Perceived Enjoyment (PENJ)		0.769	0.531		0.787	0.558		0.733	0.487
I would find using ILM to be enjoyable	0.588			0.607			0.511		
The actual process of using ILM would be pleasant	0.846			0.887			0.822		
I would have fun using ILM	0.730			0.721			0.724		

Table 1. (Continued)

Attitude (ATT)		0.906	0.707		0.870	0.656		0.942	0.803
The idea of using ILM is: (Very Bad – Very Good)	0.903			0.915			0.900		
The idea of using ILM is: (Very Foolish – Very Wise)	0.804			0.941			0.862		
Using ILM would be: (Very Unpleasant – Very Pleasant)	0.908			0.913			0.919		
Using ILM is an idea: (Dislike Very Much – Like Very Much)	0.737			0.262			0.907		
Subjective Norm (SN)		0.925	0.870		0.935	0.878		0.928	0.865
People who influence my behavior would think that I should use ILM.	0.925			0.918			0.927		
People who are important to me would think that I should use ILM.	0.940			0.956			0.933		
Behavioral Intention (BI)		0.949	0.861		0.949	0.861		0.949	0.860
I intend to use ILM regularly next semester	0.922			0.912			0.929		
I intend to use ILM next semester to assist me to prepare projects, papers, and assignments	0.930			0.942			0.920		
I intend to use ILM frequently next semester	0.931			0.929			0.934		

Note: IL- Item Loading, CR – Composite Reliability, AVE – Average Variance Extracted.

Discriminant validity is the extent to which the measure is not a reflection of some other variable. It is indicated by low correlations between the measure of interest and the measures of other constructs. Discriminant validity of the measures is demonstrated when the squared root of the average variance extracted for each construct is higher than its correlations with all other constructs (Fornell and Larcker, 1981). Table 2 shows that the square root of average variance extracted for each construct is greater than the correlations between the constructs and all other constructs. The results suggested an adequate discriminant validity of the measures used in the current study.

Table 2. Correlation matrix of the constructs

Construct (Overall)	*ATT*	*BI*	*PENJ*	*PEOU*	*PU*	*SN*
Attitude (ATT)	0.841					
Behavioral Intention (BI)	0.529	0.928				
Perceived Enjoyment (PENJ)	0.402	0.258	0.729			
Perceived Ease of Use (PEOU)	0.175	0.141	0.093	0.737		
Perceived Usefulness (PU)	0.162	0.155	0.122	0.019	0.754	
Subjective Norm (SN)	0.361	0.372	0.228	0.029	0.113	0.933
Construct (Male)	ATT	BI	PENJ	PEOU	PU	SN
Attitude (ATT)	0.810					
Behavioral Intention (BI)	0.536	0.928				
Perceived Enjoyment (PENJ)	0.472	0.161	0.747			
Perceived Ease of Use (PEOU)	0.375	0.166	0.242	0.890		
Perceived Usefulness (PU)	0.642	0.451	0.320	0.320	0.872	
Subjective Norm (SN)	0.368	0.303	0.253	0.130	0.237	0.937
Construct (Female)	ATT	BI	PENJ	PEOU	PU	SN
Attitude (ATT)	0.896					
Behavioral Intention (BI)	0.543	0.928				
Perceived Enjoyment (PENJ)	0.374	0.320	0.698			
Perceived Ease of Use (PEOU)	0.182	0.155	0.077	0.720		
Perceived Usefulness (PU)	0.415	0.349	0.241	0.056	0.444	
Subjective Norm (SN)	0.349	0.412	0.220	0.018	0.197	0.930

(*Note*: Diagonal Elements are square roots of Average Variance Extracted).

Structural Model – Overall Variance Explained

Test of the significance of all paths was performed using the bootstrap resampling procedure. Figure 2 depicts path coefficients and the overall explanatory power of the two research models (male student vs. female student) in this study.

The model for male student accounts for 51% of the variance in attitude and 33.4% of the variance in behavioral intention. All significant paths are indicated with an asterisk and all path coefficients are found statistically significant. Similarly, the model for female student accounts for 27.2% of the variance in attitude and 37.5% of the variance in behavioral intention. Except the paths between perceived ease of use and perceived usefulness, perceived ease of use and perceived enjoyment, as well as perceived enjoyment to behavioral intention, all other path coefficients are found statistically significant.

For male students, attitude exhibits the strongest direct effect on behavioral intention to use an ILM (β=0.431), followed by perceived usefulness (β=0.186), perceived enjoyment (β=0.138), and subjective norm (β=0.135). Perceived usefulness (β=0.508), perceived enjoyment (β=0.247), and perceived ease of use (β=0.147) all demonstrate a significant impact on attitude. Perceived ease of use also has a significant impact on perceived usefulness (β=0.320) and perceived enjoyment (β=0.242).

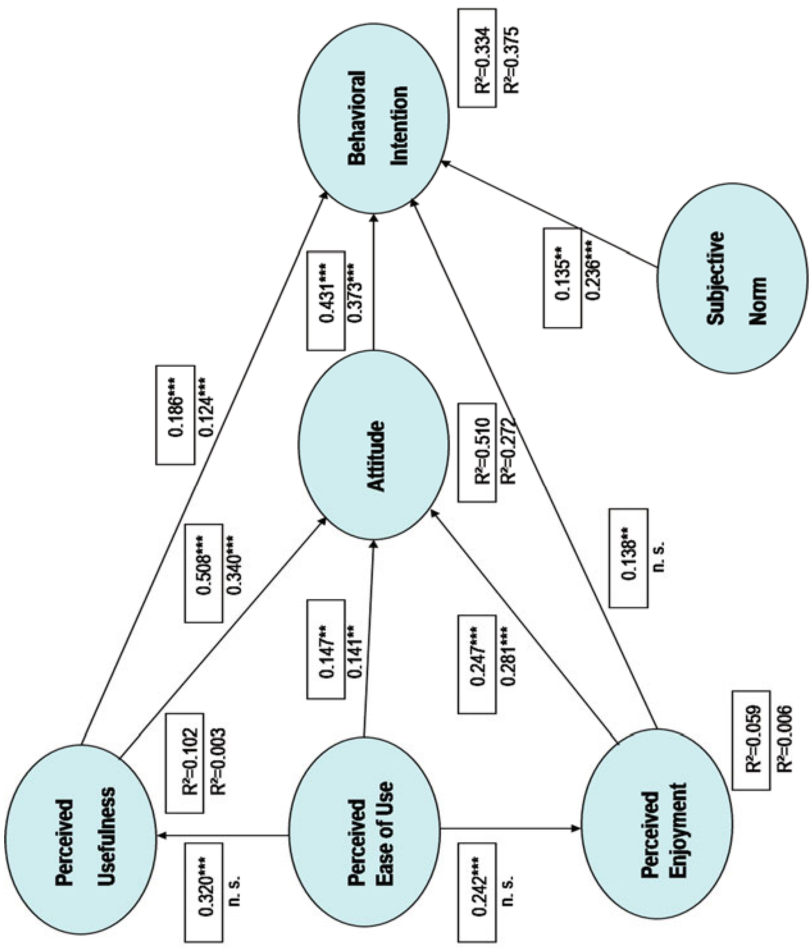

Figure 2. Results.

(*Notes*: The statistics for male students are in the boxes. **p<0.05 ***p<0.01).

For female students, attitude also has the strongest direct effect on behavioral intention to use an ILM (β=0.373), followed by subjective norm (β=0.236) and perceived usefulness (β=0.124). Perceived enjoyment does not have any significant effect on their intention to use an ILM. Perceived usefulness (β=0.340), perceived enjoyment (β=0.281), and perceived ease of use (β=0.141) all demonstrate a significant impact on attitude. Perceived ease of use however does not have any impact on perceived usefulness and perceived enjoyment.

Structural Model – Hypotheses Testing

Hypotheses on the impact of gender can be tested by statistically comparing corresponding path coefficients between the two structural models (Male student vs. Female student). The statistical comparison was carried out using the procedure as stated in Appendix A. Table 3 summarizes the comparisons.

Table 4. Path comparisons between male students and female students

Hypothesis	*Male Students*	*Female Students*	*t-statistics*	*Conclusion*
H1: PU->ATT	0.508	0.340	43.364	H1 is supported
H2: PU->BI	0.186	0.124	15.811	H2 is supported
H3: PEOU->ATT	0.147	0.141	1.198	H3 is not supported
H4: PENJ-> ATT	0.247	0.281	-8.488	H4 is not supported
H5: PENJ-> BI	0.138	n.s.	N.A.	H5 is supported
H6: SN-> BI	0.135	0.236	-24.842	H6 is supported

To examine the moderating effect of gender, we performed analysis in male student group and female student group separately. As show in Table 4, perceived usefulness influences attitude and behavioral intention to use an ILM more strongly for male students than it influences female students. Hypotheses 1 and 2 are statistically supported. The impact of perceived ease of use on attitude has the same effect on both male and female students. Hypothesis 3 is not supported. It is interesting to find that the impact of perceived enjoyment influences attitude more strongly for female students than it influences male students, whilst the impact of perceived enjoyment influences attitude more strongly for male students than it influences female students. Hypothesis 4 is not supported, but Hypothesis 5 is supported. Finally, as hypothesized, the effect of subjective norm on behavioral intention to use an ILM is more important for female students than for male students.

DISCUSSION AND CONCLUSION

Our research incorporated both the motivational perspective and social influence perspective into TAM, and postulated perceived usefulness, perceived enjoyment, and subjective norm as the key factors affecting student acceptance of an ILM. Since the intent of this study is to explore and investigate the gender differences in student acceptance of an Internet-based learning medium, this study empirically demonstrated how gender affects the effects of perceived usefulness, perceived ease of use, perceived enjoyment, and subjective norm on student acceptance of an ILM. The measurement models were confirmed with adequate convergent and discriminant validity with respect to the measurement of all the constructs in the research model. The overall variance explained in the structural model was relatively high for both male and female groups. The results of this study reconfirm the general applicability of the TAM and the existence of a gender impact on the model. The implications for this study are noteworthy for both researchers and practitioners.

Theoretical Implications

The results of the current study indicate that TAM is indeed suitable for investigating IT adoption among student population, and the specific findings of applying the motivational perspective and social influence perspective to the research problem at hand provide us useful insights to the problem.

The results of this study are mostly consistent prior studies on gender differences in technology adoption. For instance, perceived usefulness and perceived enjoyment influence strongly to male students than female students in their intention to use an ILM, whereas, subjective norm exhibits a greater impact on female students in their intention to use an ILM than male students. Studies in sociology have demonstrated that women value connection and cooperation more than men (Meyers et al., 1997) and have more extensive social networks than men (Wellman, 1992; Walker, 1994). In addition, prior research has found that men spend more time on the Internet for entertainment and leisure than women (Weiser, 2000), where as women prefer using computer technologies to expand their social networks and keep in touch with others (Debrand and Johnson, 2008).

It is also interesting to find that the impact of perceived ease of use on their decision to use an ILM is indifferent between male and female students. One possible explanation is that the gender gap of using IT is closing. Both male and female students are growth up with the use of IT. Using the Internet-based learning medium is not particularly difficult for them, and thus the impact of ease of use on their attitude toward the use of an ILM is similar for both male and female students.

Practical Implications

The findings of the current study provide the practitioners (instructors or academic institutions) a salient guideline on the design and implementation of an Internet-based learning medium. Since there is a significant difference in student decision to use an ILM between both male and female students, the practitioners should pay attention to the hygienic factors for the two gender groups during the design process.

Female students adopt and use the ILM because of their significant referents, such as instructors, friends or classmates, instructors may encourage more online interaction. For instance, instructors may make use of online chat rooms and online discussion forums of the ILM to foster student collaboration and create a sense of community. Students, especially female students may be inherently motivated to feel connected to others within a virtual environment. Creating a virtual community of students is therefore likely to improve their intention to use the online learning technology.

For male students, the functionality of an ILM, as well as the enjoyable feeling of using an ILM are important factors determining their decision to use an ILM. To encourage the adoption and use of an ILM, institutions or instructors should emphasize the unique features of a particular learning medium in facilitating the learning process. For instances, they can promote the ideas that an ILM facilitates them in accessing information anywhere, anytime, in or out of the classroom, learning in a self-paced and interactive way, having more instruction time with fewer resources, and assessing the most updated information on their topics. In addition, instructors should make good use of games, quizzes, and other creative approaches to instil more fun and interest in the learning process through the use of an ILM.

Limitations and Future Research

This study is subject to some potential limitations. First, to keep the model parsimonious, the proposed research model focuses on the original TAM and only adds perceived enjoyment and subjective norm in the current investigation. Though the model variance explained is relatively high (above 30% of the variance), future studies should continue to enrich the existing model by adding social technological factors, such as social presence, media richness, and the like.

Another limitation is that the data was collected in Hong Kong. Since gender effect is usually related with culture, our results bear validity only to the context in which this study was conducted. To gain a broader understanding of student acceptance behavior, additional research should be replicated in other countries with different cultures. The measure of gender as a dichotomous variable in this study is consistent with biological sex. However, prior studies have suggested that gender may also be considered as a psychological construct since men and women are not at bipolar extremes on the underlying dimensions captured by gender (Bem, 1981). Future studies could investigate gender differences in IT adoption based on femininity and masculinity to further understand how students make decision to use an ILM.

Because of the cross-sectional nature of the study, spurious cause-effect inferences may be presented. A longitudinal design is needed in the future for valid cause-effect influences. In addition, initial acceptance is only the first step toward the overall success of an IS implementation. It would also be interesting to examine the student continuance behavior.

NOTES

1 Harris Interactive (2009) http://www.harrisinteractive.com/NEWS/newsletters/clientnews/ Alloy_Media_Marketing_WiredCampus_Nov12_2009.pdf

2 Pew Internet and American Life Project (2009) http://www.pewinternet.org/Presentations/2009/52-Networked-Learners.aspx

[3] http://techcrunchies.com/males-vs-females-internet-users-in-usa/

[4] http://www.emarketer.com/analysis/edemographics/20010409_edemo.html

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APPENDIX A

Statistics developed by Wynne Chin to Compare Corresponding Paths

$S_{pooled} = \sqrt{\{[N_1 - 1) / (N_1 + N_2 - 2)] \times SE_1^2 + [(N_2 - 1) / (N_1 + N_2 - 2)] \times SE_2^2\}}$

$t_{spooled} = (PC_1 - PC_2) / [S_{pooled} \times \sqrt{(1/N_1 + 1/N_2)}]$

where S_{pooled} is the pooled estimator for the variance

$t_{spooled}$ refers to the t-statistic with (N1 + N2 – 2) degrees of freedom

Ni is the sample size of dataset for culture i

SEi is the standard error of path in structural model of culture i

PCi is the path coefficient in structural model of culture i

WILL MA AND ALLAN YUEN

11. E-LEARNING SYSTEM ACCEPTANCE AND USAGE PATTERN

ABSTRACT

In the form of e-learning systems, information and communication technology improves both access to and effectiveness of learning. However, recent studies have found that instructors and students are not always fully engaged in online activities. Other studies have found inconsistent results, with learner participation varying significantly across contexts. This study adopts the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) to investigate e-learning systems acceptance. An instrument was designed and administered to 128 undergraduate students who were using an e-learning system, named Interactive Learning Network, within a semester of study to examine the acceptance factors. Data were collected at the beginning of the semester (Phase A) as well as at the end of the semester (Phase B). Survey questionnaires were the same at both Phase A and Phase B, containing instruments of UTAUT, behavioural intention and satisfaction. The results showed that in both Phase A and Phase B, *Behavioral Intention* and *Satisfaction* were determined by *Effort Expectancy* and *Social Influence* ($p<0.001$), with R-sq at 0.519 (Phase A) and 0.615 (Phase B) for *Behavioral Intention*; and at 0.695 (Phase A) and 0.635 (Phase B) for *Satisfaction*.* Moreover, usage data were extracted from the system, and their correlations with the acceptance factors were examined. Interestingly, in Phase A, a convergent factor effect was found: only usage on "*Tasks*" was significantly correlated to *Social Influence* ($p<0.001$). In Phase B, a divergent factor effect was found: usage on "*Course Module*" was significantly correlated to *Performance Expectancy* ($p<0.05$), while usage on "*Announcement*" ($p<0.01$), "*My Folder*" ($p<0.05$), and "*Resources*" ($p<0.001$) were significantly correlated with *Effort Expectancy*. Implications for e-learning systems implementation and for individual learning strategies are discussed in light of the findings.

INTRODUCTION

In contemporary society, the learning process is becoming a vital factor in business and socioeconomic growth. Information and communication technology (ICT) is having a growing and an innovative impact on learning processes (Kamel 2002). In the form of e-learning systems, ICT improves both access to and effectiveness of learning. E-learning plays a key role in the marketplace of organizational learning. However, the availability of ICT alone does not guarantee a high motivation to use it. There is always a need to understand better when an individual user will use ICT.

T. Teo (ed.), Technology Acceptance in Education: Research and Issues, 201–216.

On the other hand, the current literature suggests that knowledge sharing is one of the key steps in knowledge management methodologies (Liebowitz, 2000). Studies have found that informal sharing among employees particularly improves business knowledge (e.g. Armstrong & Sambamurthy, 1999). The acceptance of e-learning systems could be viewed in various aspects. E-learning systems improve learning effectiveness especially through the facilitation of collaborative or group learning in a peer-support and exchange environment. Learners may “work together” asynchronously; they can do joint projects or collaborate in other ways even though their schedules make it difficult to work at the same time. Therefore, e-learning systems maybe well accepted in one aspect but maybe far from acceptance in another. For example, many studies have found that asynchronous communication tools are rarely used (Peter, Lang & Lie, 2003; Schubert, Leimstoll & Wackernagel, 2003; Serrano, Resende, Reis & Mendes, 2003).

Therefore, the objectives of this study are: (1) To identify and empirically test major determinants of intention to use an e-learning system; and (2) To explore if major determinants of intention can predict system users’ knowledge sharing behavior.

LITERATURE REVIEW

E-Learning Systems

E-learning is defined as a teaching and learning environment located within a computer-mediated communication system. It consists of a set of group communication and work “spaces” and facilities, which are constructed in software (Hiltz, 1994, p. 3). The formal goals of e-learning systems are to improve both access to and effectiveness of learning (Hiltz, 1994, p. 9). E-learning can improve access in a number of ways.

Time and Place Utility - Learners can access the system at any time and at any place as long as there is an Internet connection. There are no additional requirements regarding hardware peripherals or software applications.

Shared Work Space - The information and communication technology of the system makes it easy to exchange information that is difficult to share in a traditional classroom. For example, both draft and completed project tasks can be passed back and forth among peers and instructors for discussion of problems in order to comment, compare, or offer constructive criticism.

Participation Opportunity - On the other hand, by making use of both synchronous and asynchronous communication means of e-learning systems, all learners are able to have an equal opportunity to ask questions and make comments. That is the basis for knowledge sharing to take place.

This would not be possible in traditional classrooms due to the fixed time schedule and ritualized routines. Effectiveness of a course is defined in terms of the extent to which a course achieves a set of learning goals for the learner (Hiltz, 1994, p. 12). E-learning systems can improve effectiveness in a variety of ways by facilitating the learning process.

Facilitation of collaborative or group learning in a peer-support and exchange environment - Learners can work together and learn from each other through the synchronous and asynchronous communication tools and the common work space in the learning platform. That is also how knowledge sharing processes take place in e-learning systems.

Facilitation of self-pacing - Learning can take place at a rate adjusted by the learner instead of the instructor. Learners can review the learning material at their own pace. Learners can read discussions as many times as they wish, without the tight time constraints of the traditional classroom.

Use of other computer resources - Learners can access embedded application software in the system - Learners can also access other useful links to the web.

Provision of complete archive of reference material - Learners are able to access to all the learning material, which is stored in the system, at any time they wish.

Therefore, the acceptance of e-learning systems would be more meaningful if it refers to the acceptance of all these above mentioned tools to achieve effective learning goals.

Unified Theory of Acceptance and Use of Technology

User technology acceptance has been examined extensively in prior information system research. Most previous studies have been anchored in the analysis of behavioral intention, the rationale being that an individual is conscious of his or her decision to accept a particular technology.

Several intention-based theories have been developed to explain the phenomenon from different perspectives, including diffusion of innovations (e.g., Rogers 1995; Moore & Benbasat 1991); theory of planned behavior (e.g., Mathieson 1991; Taylor & Todd 1995); the technology acceptance model (e.g., Davis, Bagozzi & Warshaw 1989); and social cognitive theory (e.g., Compeau & Higgins 1995; Hill, Smith & Mann, 1987).

Recently, a unified model, called the Unified Theory of Acceptance and Use of Technology (UTAUT), has specifically been designed to consolidate all these previous different frameworks in order to explain individual technology acceptance decisions across a wide range of information technologies and user populations (Venkatesh, Morris, Davis & Davis 2003).

UTAUT was formulated with four core determinants of intention and usage: performance expectations, effort expectations, social influences, and facilitating conditions; and up to four moderators of key relationships: age, gender, computer experience and voluntariness. The model, with its high explained variance, is strong in predicting intention and use behavior. It is also rich in providing relevant factors to explain intention and use behavior.

Motivation and Research Questions

A review of the literature found that learning is becoming a critical factor in business and socioeconomic growth. With the emergent information and communication technologies, e-learning systems improve both access to and effectiveness of learning. However, simply the availability of e-learning systems alone would not motivate employees to use them.

Therefore, the research aims of this study are: (1) To identify and examine empirically the major determinants of intention to use e-learning systems; (2) To determine if major determinants of intention can predict system usage, particularly different levels of knowledge-sharing activities.

MODEL AND HYPOTHESES DEVELOPMENT

Our modified model based on UTAUT (Venkatesh et al., 2003) for its theoretical basis is shown below (see Figure 1).

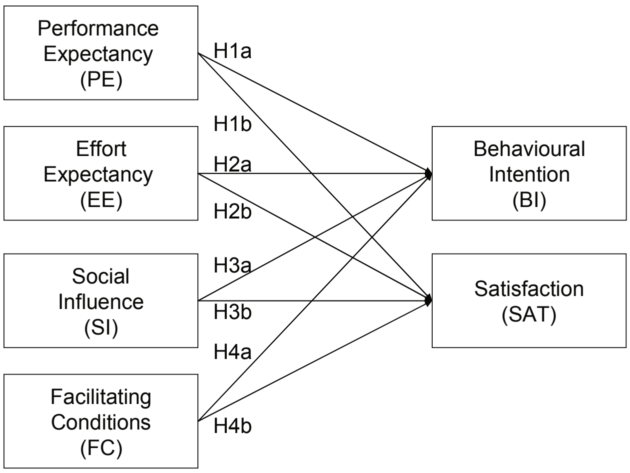

Figure 1. Model framework.

Specifically, performance expectancy was defined as the degree to which an individual learner believed that using the e-learning system would help him or her to attain gains in achieving learning goals. Therefore, we hypothesized that:

> H1a*: Performance expectancy would influence behavioral intention to use the e-learning system. That is, the higher the level of performance expectancy of an individual user toward an e-learning system, the more likely the individual intended to use the system.*

Similarly, it was logical to expect that the higher the degree an individual learner believed that the e-learning system was helpful to his/her performance; the individual learner would be more satisfied with the e-learning system. Therefore, we hypothesized that:

> H1b: *Performance expectancy would influence how an individual learner evaluates the e-learning system. That is, the higher the level of performance expectancy of an individual user toward an e-learning system, the more likely the individual felt satisfied with the use of the e-learning system.*

Effort expectancy was defined as the degree of ease associated with the use of the system. It was expected that ease of use of an e-learning system would influence users in their deciding whether or not to use the system. We posited that e-learning system acceptance was directly affected by effort expectancy. Therefore, we hypothesized that:

H2a: *Effort expectancy would influence behavioral intention to use the e-learning system. That is, the lower the level of effort expectancy of an individual user toward an e-learning system, the more likely the individual intended to use the system*.

Similarly, it was logical to expect that the higher the degree of ease an individual learner believed that the e-learning system was, the individual learner would be more satisfied with the e-learning system. Therefore, we hypothesized that:

H2b: *Effort expectancy would influence how an individual learner evaluated the use of the e-learning system. That is, the lower the level of effort expectancy of an individual user toward an e-learning system, the more likely the individual felt satisfied with the use of the e-learning system*.

Social influence was defined as the degree to which an individual perceived that important others believed he or she should use the new system. Within a social system, an individual's technology acceptance decision might be influenced by such opinions/suggestions to varying degrees.

By and large, learners appeared to have strong psychological attachments to the learning community and exhibited relatively close bonds with peer learners. Several factors might contribute to the described intimate attachments or bonds. For example, an individual learner would like to be a part of the learning community in order not to be isolated. He or she at least needed to use the same communication means to receive and disseminate information among the community.

Individual learners also recognized the fact that there might be a lot of problems in the learning process. It was important to develop a closed-loop community to share resources and to gain support from each other. Hence, it was hypothesized that:

H3a: *Social influence would be a direct determinant of behavioral intention to use an e-learning system. That is, if an individual perceived that someone important to him or her thought he should use the system, he or she would be more likely to use the system*.

Similarly, it was hypothesized that:

H3b: *Social influence would be a direct determinant of satisfaction to use of an e-learning system. That is, if an individual perceived that someone important to him or her thought he should use the e-learning system, he or she would be more likely to satisfy with the use of the e-learning system*.

Facilitating conditions were defined as the degree to which an individual believed that an organizational and technical infrastructure existed to support use of the system. There were all sorts of problems (both technical and psychological) involved in using an e-learning system because of hardware, software and support. Sometimes, it was not the actual functionality of a software application that caused the problem, but the individual user's perception of where his or her stands were. Therefore, facilitating conditions were to measure the perception of an individual user's readiness toward the use of the system. According to UTAUT, although these facilitating conditions might have an effect on the technology acceptance decision-making process, they were not direct determinants of intention and use. Therefore, we hypothesized that:

> H4a: *Facilitating conditions would not influence the intention to use an e-learning system. That is, whether an individual perceived that an e-learning system provided all the necessary infrastructure and support for their use of the system would have no direct relationship with his or her intention to use the system*.

Similarly, it was not because of how an individual learner perceived facilitating conditions ready for his or her use of the e-learning system, he or she would evaluate the use of the e-learning system more positively. Therefore,

> H4b: *Facilitating conditions would not influence satisfaction to use of an e-learning system. That is, whether an individual perceived that an e-learning system provided all the necessary infrastructure and support for their use of the system would have no direct relationship with his or her satisfaction to the use of the e-learning system.*

Age, gender, experience and voluntariness were suggested as part of UTAUT (Venkatesh et al., 2003) and were included in the analysis. They were analyzed to find out how they influenced the acceptance factors, including performance expectancy, effort expectancy, social influence and facilitating conditions, towards intention, satisfaction and use.

METHOD

Background

An e-learning system, named Interactive Learning Network, was launched in a university in Hong Kong last year. The e-learning system provided a number of functionalities that facilitated access to resources and communication between instructors and among individual users to improve teaching and learning over the Internet. This e-learning system allowed for the creation of modules, personal profiles, and storage folder settings; possessed calendar and announcement capabilities; provided a synchronous communication tool (online chat room) and an asynchronous communication tool (discussion forum), learning material dissemination tools such as a resources folder, and assessment tools such as an assignment folder and online quiz. There were also other tools such as an online survey. This was the second year that the e-learning system was being used in the university.

Subjects

A total of 128 respondents completed the surveys in both Phase A and Phase B. The data from those respondents who only completed the survey in either Phase A or Phase B were discarded. There were 40 male and 88 female respondents. 22 of the respondents (17.2%) ranged from 19 to 20 years of age; 87 (68%) ranged from

21 to 22 years of age; and 19 (14.8%) ranged 23 to 24 years of age. They came from the three faculties at the university, including 11 from the Arts faculty; 51 from Commerce; and 66 from Social Science.

Measures

There were four constructs in the UTAUT model: performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC). Each of the constructs had 4-items. Altogether, there were 16-items. The dependent variables included behavioral intention (BI) and satisfaction (SAT), with 3-items for behavioral intention and 2-items for satisfaction. The survey included demographic items and the instrument for the UTAUT items, which are listed in the Appendix. Each statement was given a seven point Likert scale ranging from strongly disagree (1) to strongly agree (7).

In addition to the survey instrument, this study also collected system log data from the e-learning system. These system log data mainly included the usage record of the respondents. The personal system log of each respondent who completed the surveys could be extracted for analysis. However, to protect the privacy of the respondents, the student ID or login ID was discarded before analysis. The usage log included eight different applications, which are listed in the table below (see Table 1.)

Table 1. Online activities usage and e-learning system applications

Usage	*E-learning applications*
USG1	View Community Announcement
USG2	Enter Course Module
USG3	Enter/Upload Assignment
USG4	Modify My Profile/Enter My Folder
USG5	Enter Course Resources
USG6	Enter Discussion Forum
USG7	Scheduler/Calendar
USG	Total Login

Data Collection

At the beginning of the second semester (Phase A), a survey was put online, and the students were asked to participate in the study through the e-learning system. The usage log of every participant was captured for that month. At the end of the semester (Phase B), the same survey was introduced, but the items were rearranged randomly.

RESULTS

Summary of Variables

A summary of the descriptive statistics of the constructs of UTAUT, including performance expectancy (PE1-4); effort expectancy (EE1-4); social influence (SI1-4), facilitating conditions (FC1-4), and the two dependent variables, behavioral intention (BI1-3) and satisfaction (SAT1-2) was shown in Table 2 below. The internal consistency was measured by reliability Cronbach's alpha coefficient for each of the constructs. All of them were over 0.7, except FC which was close to 0.7, attained the threshold value suggested by prior studies (Nunnally & Bernstein, 1974). The items for each of the construct were then added together to form a composite scale to the corresponding construct for further regression analysis.

Table 2. Descriptive statistics of instrument items

	Phase A			*Phase B*		
	Mean	*Std. Dev*	*Alpha*	*Mean*	*Std. Dev*	*Alpha*
PE1	5.11	1.138	0.7953	5.51	1.071	0.8597
PE2	5.15	1.130		5.36	1.084	
PE3	4.90	1.189		5.12	1.168	
PE4	4.00	1.386		4.33	1.289	
EE1	5.22	1.101	0.8589	5.54	.926	0.8499
EE2	4.98	1.133		5.48	1.018	
EE3	5.38	1.094		5.83	.705	
EE4	5.41	1.187		5.72	.891	
SI1	5.65	1.054	0.7325	5.81	.999	0.8121
SI2	5.02	1.298		5.12	1.161	
SI3	4.93	1.138		5.35	1.045	
SI4	5.46	1.216		5.62	.954	
FC1	5.45	1.254	0.6866	5.84	.991	0.6137
FC2	5.25	.939		5.63	.929	
FC3	4.87	1.089		5.21	1.127	
FC4	4.30	1.251		4.44	1.110	
BI1	5.74	.966	0.8963	5.80	.988	0.8878
BI2	5.91	.964		5.89	.914	
BI3	5.55	1.121		5.68	1.021	
SAT1	5.19	1.148	0.8304	5.71	.818	0.7593
SAT2	5.06	1.176		5.47	1.129	

The descriptive statistics for the usage log of each of the applications in the e-learning system were listed in Table 3 below. The means referred to the total number of logins per respondent.

Table 3. Descriptive statistics of online activities usage (N=128)

	Phase A				*Phase B*			
	Min	*Max*	*Mean*	*Std. Dev.*	*Min*	*Max*	*Mean*	*Std. Dev.*
USG1	27	420	98.51	64.93	39.00	634.00	148.68	93.81
USG2	67	705	275.13	140.85	68.00	1008.00	385.27	181.30
USG3	1	218	66.18	61.18	.00	319.00	91.88	84.19
USG4	30	694	133.33	103.68	43.00	1059.00	200.98	148.53
USG5	1	2948	312.86	428.81	12.00	4016.00	489.77	592.94
USG6	1	791	89.24	123.83	.00	3167.00	144.93	313.25
USG7	1	133	17.33	23.76	.00	134.00	19.44	26.03
USG	196	5082	994.30	728.90	322.00	7127.00	1499.96	1095.76

Regression analysis results for e-learning system acceptance

The data collected was analyzed using a two-step linear regression procedure with "enter" method. Firstly, BI and SAT were treated as dependent variables and were predicted by all the independent variables, AGE, GENDER, EXP, VOL, PE, EE, SI, FC. Secondly, USG1-7 and USG were treated as dependent variables and were predicted by all the independent variables including AGE, GENDER, EXP, VOL, PE, EE, SI, FC, BI, SAT (see Table 5a and Table 5b)

Analysis of UTAUT data collected in Phase A

Regression model testing found that performance expectancy, effort expectancy, and social influence were all directly and significantly related to intention to use the e-learning system in Phase A (see Table 4 below). The beta coefficients for the constructs were 0.298 ($p<0.001$); 0.331 ($p<0.001$); and 0.215 ($p<0.01$), respectively, supporting hypotheses H1, H2 and H3. Facilitating conditions were found not to be significantly related to intention to use the e-learning system, supporting hypothesis H4. On the other hand, all the four moderators: age; gender; computer experience; and voluntariness, were found not to be significantly related to intention to use the e-learning system. The variance explained by the model is comparable to most previous studies on information technology acceptance ($R^2 = 0.519$, $p<0.001$).

Satisfaction was found to be determined by age (ß = 0.139, $p<0.05$); effort expectancy (ß = 0.352, $p<0.001$); social influence (ß = 0.412, $p<0.001$); and behavioral intention (ß = 0.201, $p<0.01$). Satisfaction was found not to be significant in any of the usage patterns of the e-learning system. The variance explained by the model is comparably high ($R^2 = 0.695$, $p<0.001$).

Analysis of UTAUT data collected at Phase B

Regression model testing found that performance expectancy, effort expectancy, and social influence were all directly and significantly related to intention to use the e-learning system in Phase B (see Table 4 below). The beta coefficients for the

Table 4. Regression analysis on behavioral intention (BI) and satisfaction (SAT)

	Phase A		*Phase B*	
Variables	*BI*	*SAT*	*BI*	*SAT*
AGE	n-s	0.139*	n-s	n-s
GENDER	n-s	n-s	n-s	n-s
EXP	n-s	n-s	n-s	n-s
VOL	n-s	n-s	n-s	0.138*
PE	0.298***	n-s	0.461***	0.361***
EE	0.331***	0.352***	0.182*	0.255***
SI	0.215**	0.412***	0.239**	n-s
FC	n-s	n-s	n-s	n-s
BI	-	0.201**	-	0.192*
R-sq	0.519	0.695	0.615	0.635
Adjusted R-sq	0.507	0.683	0.604	0.622
Model Significance	***	***	***	***

*p<0.05; **p<0.01; ***p<0.001.

constructs were 0.461 ($p<0.001$); 0.182 ($p<0.05$); and 0.239 ($p<0.01$), respectively, again, supporting hypotheses H1, H2 and H3. Facilitating conditions were found not to be significantly related to intention to use the e-learning system, again, supporting hypothesis H4. On the other hand, all the four moderators, age; gender; computer experience; and voluntariness, were found not to be significantly related to intention to use the e-learning system. The variance explained by the model is comparable to most previous studies on information technology acceptance ($R^2 = 0.615$, $p<0.001$).

Satisfaction was found to be determined by voluntariness (ß = 0.138, $p<0.05$); performance expectancy (ß = 0.361, $p<0.001$); effort expectancy (ß = 0.255, $p<0.001$); and behavioral intention (ß = 0.192, $p<0.05$). Satisfaction was found not to be significant in any of the usage patterns of the e-learning system. The variance explained by the model is comparably high ($R^2 = 0.635$, $p<0.001$).

Regression Analysis Results for Usage of E-Learning Applications

Analysis of usage data collected at Phase A

Usage patterns of the e-learning system were examined with the determinants. Overall total usage of the system was found to be significantly determined solely by behavioral intention (ß = 0.323, $p<0.001$) (see Table 5 below). This result confirmed our measurement of technology acceptance using behavioral intention, and was congruent with most of the previous intention-based theories mentioned above. Further breakdown of the usage patterns provided additional information about individual reactions to e-learning system. USG1, USG2, and USG4 were found to be determined solely by behavioral intention. On the other hand, USG6 and USG7 were found not to be significantly related to any of the intention determinants in the model. Further investigation is required to explain the phenomenon. Both USG3 and USG5 have additional determinants in the regression model. USG3 was determined by age (ß = -0.296, $p<0.001$); computer experience (ß = -0.177, $p<0.05$); social influence (ß = 0.311, $p<0.001$) and behavioral intention (ß = -0.434, $p<0.001$). USG5 was determined by age (ß = 0.182, $p<0.05$); and behavioral intention (ß = 0.407, $p<0.001$). The overall variance explained was low and would be a potential limitation to this study ($R^2 = 0.104$, $p<0.001$).

Analysis of usage data collected in Phase B

Usage patterns of the e-learning system were examined with the determinants. Interestingly, overall total usage of the system was found not to be significantly related to behavioral intention (see Table 5a and 5b below). Instead, overall usage was jointly determined by computer experience (ß = 0.198, $p<0.05$) and performance expectancy (ß = 0.269, $p<0.01$). Further breakdown of the usage pattern provided additional information about individual reactions to the e-learning system. USG1 and USG5 were found to be determined solely by effort expectancy (ß = 0.272, $p<0.01$ and ß = 0.349, $p<0.001$) respectively). USG2 was found to be determined solely by performance expectancy (ß = 0.209, $p<0.05$). USG3 was found to be determined by both age (ß = -0.240, $p<0.01$) and computer experience (ß = -0.242, $p<0.01$). USG4 was found to be determined jointly by voluntariness (ß = 0.203, p<0.05) and effort expectancy (ß = 0.209, p<0.05). Again, USG6 was found not to be significantly related to any of the intention determinants in the model. Further investigation is required to explain the phenomenon. USG7 was determined by age (ß = -0.214, p<0.005); and computer experience (ß = 0.195, p<0.05). USG8 was solely determined by age (ß = -0.198, p<0.05). The overall variance explained was low and would be a potential limitation of this study (R^2=0.131, p<0.001).

Table 5a. Regression analysis on online usage activities (Phase A)

	Phase A							
	USG1	*USG2*	*USG3*	*USG4*	*USG5*	*USG6*	*USG7*	*USG*
AGE	n-s	n-s	-0.296^{+}	n-s	0.182*	n-s	n-s	n-s
GENDER	n-s	n-s	n-s	n-s	n-s	n-s	n-s	n-s
EXP	n-s	n-s	-0.177*	n-s	n-s	n-s	n-s	n-s
VOL	n-s	n-s	n-s	n-s	n-s	n-s	n-s	n-s
PE	n-s	n-s	n-s	n-s	n-s	n-s	n-s	n-s
EE	n-s	n-s	n-s	n-s	n-s	n-s	n-s	n-s
SI	n-s	n-s	0.311^{+}	n-s	n-s	n-s	n-s	n-s
FC	n-s	n-s	n-s	n-s	n-s	n-s	n-s	n-s
BI	0.268$^{\#}$	0.182*	-0.434^{+}	0.278$^{\#}$	0.407^{+}	n-s	n-s	0.323^{+}
SAT	n-s	n-s	n-s	n-s	n-s	n-s	n-s	n-s

**p<0.05; $^{\#}$p<0.01; $^{+}$p<0.001.*

Table 5b. Regression analysis on online usage activities (Phase B)

	Phase B							
	USG1	*USG2*	*USG3*	*USG4*	*USG5*	*USG6*	*USG7*	*USG*
AGE	n-s	n-s	-0.240 **	n-s	n-s	n-s	-0.214 *	n-s
GENDER	n-s	n-s	n-s	n-s	n-s	n-s	n-s	n-s
EXP	n-s	n-s	-0.242$^{\#}$	n-s	n-s	n-s	0.195*	0.198*
VOL	n-s	n-s	n-s	0.203*	n-s	n-s	n-s	n-s
PE	n-s	0.209*	n-s	n-s	n-s	n-s	n-s	0.269$^{\#}$
EE	0.272$^{\#}$	n-s	n-s	0.209*	0.349^{+}	n-s	n-s	n-s
SI	n-s	n-s	n-s	n-s	n-s	n-s	n-s	n-s
FC	n-s	n-s	n-s	n-s	n-s	n-s	n-s	n-s
BI	n-s	n-s	n-s	n-s	n-s	n-s	n-s	n-s
SAT	n-s	n-s	n-s	n-s	n-s	n-s	n-s	n-s

**p<0.05; $^{\#}$p<0.01; $^{+}$p<0.001.*

DISCUSSION

Main findings

The main findings of this study showed that the technology acceptance model UTAUT worked. Performance expectancy, effort expectancy, and social influence were key intention determinants of the e-learning system. Congruent with UTAUT, facilitating conditions were found not to be significantly related to e-learning system acceptance. Behavioral intention, some of the UTAUT beliefs, and age together determined satisfaction with the e-learning system. Moreover, the findings also revealed that behavioral intention was a strong determinant of usage across applications within an e-learning system but its effect diminished over time; while performance expectancy and effort expectancy became strong and significant to usage over time.

Performance expectancy

Performance expectancy is defined as the degree to which an individual learner believes that using the e-learning system will help him or her to attain gains in achieving learning goals. In Phase A, performance expectancy was found to be directly and significantly related to intention to use the e-learning system, with a beta coefficient of 0.298 ($p<0.001$). In Phase B, performance expectancy was also found to be directly and significantly related to intention to use the e-learning system; however, with a sharp increase in coefficient beta value to 0.461 ($p<0.001$). In Phase A, performance expectancy was not found to have any significant relationship with various application usages. However, in Phase B, performance expectancy was found to be directly significant in “Login to Course Module” (USG2). In Phase A, performance expectancy was found not to be significantly related to satisfaction. However, in Phase B, performance expectancy was found to be directly and significantly related to satisfaction, with a beta coefficient of 0.361 ($p<0.001$). The findings suggest that performance expectancy makes a unique and important contribution to the development of acceptance of e-learning system use. The significant relationship between performance expectancy and intention to use explains both current use and future use intentions, which is supported by the findings in Phase B. The significant relationship of performance expectancy to both intention and satisfaction in Phase B suggest that individual users have developed a positive perception of the e-learning system. This positive user perception motivates individual users to a better acceptance of the e-learning system and leads to greater use of the e-learning system. More usage leads to a more positive perception of the e-learning system, which helps students attain gains in achieving learning goals. These observations in the significant relationships between performance expectancy, intention to use, satisfaction, and usage help in drawing the conclusions for the findings.

Effort expectancy

Effort expectancy is defined as the degree of ease associated with the use of the e-learning system. In Phase A, it was found that effort expectancy was both directly related to intention to use ($\beta=0.331$, $p<0.001$) and satisfaction ($\beta=0.352$, $p<0.001$) of the e-learning system. In Phase B, although the significant relationships persist, both beta coefficients drop: $\beta=0.182$ ($p<0.05$) for intention to use, and $\beta=0.255$ ($p<0.001$) for satisfaction. Moreover, in Phase A, effort expectancy was not significantly related to any of the individual application usages. Effort expectancy was found to be significantly related to “Announcement” (USG1) ($\beta=0.272$, $p<0.01$); “My Folder” (USG4) ($\beta=0.209$, $p<0.05$); and “Resources” (USG5) ($\beta=0.349$, $p<0.001$). The consistent significant relationships in Phase A and in Phase B suggest that effort expectancy made a unique and important contribution to the development of acceptance of the e-learning system. In other words, individual users would first of all probably accept and adapt to using the e-learning system if they perceived the e-learning system as easy to use. In Phase A, effort expectancy became a strong factor in affecting both current use and future use intentions. Throughout the semester, individual users had lots of chances to try the e-learning system. The significant findings between effort expectancy and several applications usage suggest that the individual users had developed a positive perception of the ease of use of the e-learning system. This became a motivation for more usage behavior. Hence, usage behavior reinforced the self-perception of positive intention and satisfaction in current and future e-learning system use.

Social influence

Social influence is defined as the degree to which an individual user perceived that important others believed he or she should use the e-learning system. In Phase A, social influence was found to be significantly related to both intention to use ($\beta=0.215$, $p<0.01$) and satisfaction ($\beta=0.412$, $p<0.001$). Social influence was also found to be significantly related to usage, "Upload Assignment" (USG3) ($\beta=0.311$, $p<0.001$). However, in Phase B, social influence was solely significantly related to intention to use ($\beta=0.239$, $p<0.01$). The findings suggest that social influence is another important factor influencing the development of acceptance of e-learning system use. Social influence not only affects current and future use of the e-learning system, but also affects how individual users evaluate (satisfaction) the e-learning system. However, the longitudinal findings also reveal that, as time passed and as more practical experience was gained, the effects of social influence diminished to only a limited scope with respect to current and future use intentions; irrespective of the evaluation (satisfaction) of the e-learning system, or of individual application usage. Although the scope of the effects of social influence diminished, their strength was comparably the same, similar in value of beta coefficients, in Phase A and Phase B.

Facilitating conditions

Facilitating conditions are defined as the degree to which an individual user believed that an organizational and technical infrastructure existed to support use of the e-learning system. Consistent with prior literature (Venkatesh et al., 2003), facilitating conditions were found not to be significantly related to intention, either in Phase A or in Phase B. In this study, facilitating conditions were found not to be significantly related to satisfaction, either.

Post hoc analysis - Extent of knowledge sharing

The acceptance of technology could mainly be measured by its use or its intention to use. However, e-learning systems are a collection of various tools aimed at achieving the common goals in effective teaching and learning purposes. Key areas of the use of e-learning systems are to facilitate shared work space, participation opportunity, collaboration and group learning. Only if a more in-depth analysis to the various applications and their use, should therefore the degree of acceptance be concluded. The findings in this study provide such clues for further discussion in this aspect.

For example, Announcement could be regarded as one-way communication through broadcasting technologies. Resources serve as a shared work space for easy exchange of information. This application is regarded as a step further towards knowledge sharing as individual users are required to proactively check and acquire (download) the exchanged resources.

Synchronous (chatroom) and asynchronous communication (discussion forum) tools facilitate collaborative or group learning in a peer-support and exchange of ideas environment. These tools greatly enhance knowledge sharing through social interaction among individual users. From the findings of the study, it was found that individual users showed actual usage behavior in using "Discussion Forum" (USG6), and there was an increase in usage throughout the semester, with a mean of 89.24 in Phase A rising to a mean of 144.93 in Phase B. However, the usage pattern had no significant relationship with any of the acceptance factors discussed above, nor to intention or satisfaction. The findings suggest that a high level of knowledge sharing has no relationship to motivational factors in e-learning system use. In Phase A, only "Upload Assignment" (USG3) had significant relationships with social influence. Applications included announcement, login to course module, manage user folders, and resources are irrelevant to knowledge sharing as they are only intended to fulfill the requirements of the instructors to manage the course. However, in Phase B, various applications showed significant relationships between motivational factors and usage behavior. These applications, including announcement, login to course module, manage user folders, and resources, reflect a certain extent of knowledge sharing, from the purely one-way communication involved in receiving messages from instructors, to proactive participation to login course, and to proactive checking and acquiring exchange information.

With the data for each individual application, the present study facilitates a more in-depth analysis of the effects of usage. This provides an alternative perspective to prior studies, which only include composite usage patterns.

Limitations and Future Studies

There are several limitations in the study. First, the study was conducted in the second semester. There might be differences in the instructors and the available courses that affect the generalizability of the findings. However, the study was distributed to the university as a whole, and respondents came from various departments. Therefore, the findings were, to some extent, representative of the overall population, with respect to both the students and the instructors. Second, the study was based on a specific e-learning system adopted by the sample university. The findings may not be generalizable to other universities using different e-learning systems; for example, the interface design that affects the effort expectancy, or the collaborative support that affects the collaborative or group learning process. Further studies with different e-learning systems would increase the generalizability of the findings.

CONCLUSION

In conclusion, the present study applied the UTAUT model in exploring the acceptance of the e-learning system. The empirical data revealed significant relationships between the motivational factors, including performance expectancy; effort expectancy; and social influence; and intention and satisfaction. The study further provides significant usage data in a longitudinal manner for various applications in e-learning systems. Interestingly, behavioral intention was a strong determinant of usage but its effect diminished over time; while performance expectancy and effort expectancy became strong and significant to usage only after a certain period of use. This provides a fuller picture of how motivational factors affect the extent of acceptance of individual users using an e-learning system.

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APPENDIX: INSTRUMENT ITEMS (ADAPTED FROM VENKATESH ET AL., 2003)

Items	
Performance Expectancy (PE)	
PE1:	I would find the system useful.
PE2:	Using e-learning system enables me to accomplish tasks more quickly.
PE3:	Using e-learning system increases my productivity.
PE4:	If I use the system, I will increase my chances of getting better performance.
Effort Expectancy (EE)	
EE1:	My interaction with the e-learning system would be clear and understandable.
EE2:	It would be easy for me to become skillful at using the e-learning system.
EE3:	I would find the e-learning system easy to use.
EE4:	Learning to operate the e-learning system is easy for me.
Social Influence (SI)	
SI1:	People who influence my behavior think that I should use the e-learning system.
SI2:	People who are important to me think that I should use the e-learning system.
SI3:	People who are important to me have been helpful in the use of the e-learning system.
SI4:	In general, my organization has supported the use of the e-learning system.
Facilitating Conditions (FC)	
FC1:	I have the resources necessary to use the e-learning system.
FC2:	I have the knowledge necessary to use the e-learning system.
FC3:	The e-learning system is compatible with other systems I use.
FC4:	A specific person or group is available for assistance with the e-learning system difficulties.
Behavioral Intention (BI)	
BI1:	I intend to use the e-learning system in the coming future.
BI2:	I predict I would use the e-learning system in the coming future.
BI3:	I plan to use the e-learning system in the coming future.
Satisfaction (SAT)	
SAT1:	As a whole, I am satisfied with using the e-learning system.
SAT2:	As a whole, e-learning system is successful.

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