Literature Review: Reviewing Statistical Data and Findings

2077 EDTC 810 Statistics for Ed Research

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Dowayne Davis

Overview of Article I: Schaffhauser

Annual spending on education continues to account for one of the largest expense areas for the United States government. Studies show that spending on educational technology (ET) in K-12 schools continues to rise at a steady pace along with overall spending on education. The article, "Report: Education Tech Spending on the Rise" was written by Dian Schaffhauser and published online by The Journal in January of 2016. In this article, Schaffhauser shared the results of EdNET Insight's extensive examination of ET spending in K-12 schools. Data results from EdNET Insight's 2015 study revealed that the ranking of ET spending is, 1) hardware, 2) teacher training, 3) technical support, and 4) software.

Schaffhauser's Analysis

According to www.schooldata.com, EdNET Insight uses research and analysis with industry experts to deliver an insightful, comprehensive view of the trends and the influences that impact the K-12 education market. Additionally, EdNET Insight reports are based on a combination of large-scale surveys, secondary research, interviews, and the insight of authors with deep expertise in the field of education (EdNET Insight, 2017). Data results explained in this article were pulled from the "State of the K-12 Market 2015" report which was published by EdNET Insight. The full version of the report if available for purchase via the EdNET Insight website (Schaffhauser, 2016).

Through the study conducted by EdNET Insight, Schaffhauser's article revealed comparative technology spending data from 2013 to 2015 for hardware, teacher training, technical support, and software categories. Data show that the big biggest spending areas for schools are hardware expansion at 46%, teacher training at 38%, technical support at

27%, and software at 27% of overall spending for schools. Hardware spending analysis indicates that 87% of school districts are spending funds on tablets, chromebooks, and desktops. Additionally, over 90% of schools are shifting from print to digital material, prioritizing assessment tools, investing in data analytics systems to help support students and teachers. Overall, Schaffhauser's article indicated that spending in technology shows no signs of slowing down as online testing standards, marketplace demand, and sheer innovation continue to propel schools to invest more in technology (Schaffhauser, 2016).

Schaffhauser's Conclusions

Schaffhauser's article details statically data that generalizes schools in the K-12 market through the feedback and current information of technology administrators and curriculum directors. The data points presented paint a picture of increase spending on ET in all major areas such as hardware, software, teacher training, and technology support. Schaffhauser's article also suggests that increased spending on technology is reflective of the larger landscape of K-12 schools. Schaffhauser's article further suggests that increased spending on ET is a trend that will likely continue in the future.

Schaffhauser's Strengthens & Weaknesses

A major strength of this article is the various ratio-level data presented on areas of ET spending in the K-12 market. Schaffhauser also supports these ratio-level data values with contextual information to help the public understand where school ET spending is occurring and changing. Although the report shared that surveys and phone conversations were conducted with over 500 technology administrators and curriculum personnel, the lack of more statically relevant data points limits the generalizability to the larger population, given the information presented. The original report that includes more

granular data and statistical data points is not readily available to the public, as it is only accessible via the EdNET Insight website for $7,500 (Schaffhauser, 2016).

There are many questions that, if answers, could have strengthened this articles data reporting. Providing these points within the article would provide more certainty in the generalizability of the findings being reported and the underlying assumptions of reflectiveness to the larger population of K-12 school that is being made. These questions include:

1. What is the estimated population size?
2. How significant is the sample size of the participants?
3. Were participants randomly, purposefully, or conveniently selected?
4. Is the data normally distributed?
5. What statistical test was used to examine the generalizability of each survey result?
6. What is the p-value of the each statistic test used in the study?
7. What is the confidence interval (MOE) used in statistical tests?

Since the results presented in this article did not specify the sample size, confidence interval, confidence level, type of statistical test used, and/or the p-value of the test, it is not possible to suggest the results presented are representative of the larger population. Therefore, the reliability and validity of these examinations and data presented in this article have some considerations and limitations.

Overview of Article II: Lee, Hsieh & Chen

After completing a quantitative study that examined factors that impact users' behavioral intentions to use e-learning systems, Lee, Hsieh & Chen (2013) wrote a

research paper titled, "An investigation of employees' use of e-learning systems: applying the technology acceptance model". The Taylor and Francis Group published Lee, Hsieh, and Chen's research paper in the Behaviour and Information Technology journal in 2013. Lee, Hsieh, and Chen's study focused on use of e-learning systems. E-learning systems are tools and resources used within an organization that are generally computer-based, delivered over the Internet or an Intranet and deliver information and/or instruction to individuals (Lee, Hsieh & Chen, 2013). E-learning systems can be found in many business sectors such as software development and education. In the education sector, e-learning systems include student information systems, such as PowerSchool and online classroom tools, such as Google classroom. Lee, Hsieh & Chen's study focus on e-learning systems found in Taiwanese companies that implemented e-learning systems (Lee, Hsieh & Chen, 2013).

To examine factors that impact behavioral intentions of users, Lee, Hsieh & Chen used the Technology Acceptance Model (TAM) as a theoretical basis proven to predict users acceptance of technology through prior studies (Davis, 1986; Davis & Venkatesh 2000). In 1980, Fred Davis began studying the TAM as an empirical model intended to describe the motivational processes that mediate between system characteristics and user behavior towards use of a technology system (Davis, 1986). Davis's original model incorporated Fishbein's (1967) model of behavioral use. Fishbein's behavioral model indicates that 1) user performance is determined by a user's intention and 2) a user's intention is impacted by the combination of the user's attitude towards performing that task and perceived social influences of the people important to the user (Davis, 1986; Davis & Venkatesh 2000). Subsequently, Davis developed the TAM to include 1) design

features, 2) cognitive responses (perceived ease of use and perceived usefulness), 3) affective responses, and 4) behavioral response. Davis's earlier study on technology acceptance examined the causal relationship between the four aforementioned areas (Davis, 1986).

Davis's earlier study found that the most pertinent factors that impact technology acceptance were, a user's perceived ease or use (PEU) and perceived usefulness (PU) of a technology system. Davis found that PU was 2.65 times more impactful than PEU in determining self-predicted use of technology (Davis, 1986). In 2000, Fred Davis teamed with Viswanath Venkatesh to extend the earlier TAM by incorporating additional theoretical constructs spanning social influence processes (subjective norm, voluntariness, and image) and cognitive instrumental processes (job relevance, output quality, result demonstrability, and perceived ease of use). This new extended TAM was called TAM2. Davis and Venkatesh also conducted an examination of TAM2. Davis and Venkatesh's 2000 study of TAM2 found that the results supported prior studies and showed a high correlation between PEU, PU, affects of subjective norms and technology acceptance (Davis & Venkatesh, 2000).

Methodology, Approach & Analysis

Lee, Hsieh & Chen explored employees' intention to use e-learning systems with Davis's (1989) and Davis and Venkatesh's (2000) TAM models to investigate the effects of organizational support, individual characteristics and task characteristics on PU, PEU and attitude (AT). The study employed a quantitative method that tested thirteen null hypotheses related to behavioral intention (BI) to use e-learning systems. The study used convenient sampling to select twelve firms that developed e-learning systems. The study

adopted survey questions from prior studies, sent 400 paper-based surveys, and 200 digital surveys to potential participants. Of the 600 total surveys sent, 332 valid online and physical questionnaires were analyzed.

To examine and validate the variables within the study, Lee, Hsieh and Chen used the Structural Equation Model (SEM) using AMOS 16.0. SEM is a model found in applications such as SPSS that enables a researcher to test a set of regression equations and complex variables simultaneously (Arbuckle & Wothke, 2012). In addition, multiple good-fit indices were used to test the fit of the data gathered within the study. The indices used included Chi-square/degrees of freedom (X^2/df), Goodness-of-fit index (GFI), Adjusted goodness-of-fit index (AGFI), Comparative fit index (CFI), and Root mean square residual (RMSR). Result of all good-fit indices showed that the data collected during the study met the level of acceptable fit. Additionally, both p-value and regression correlation values were calculated for the thirteen hypothesis tests. Data results showed that 10 of 13 hypotheses were supported by the data with significant p-values and path coefficients.

Data analysis showed that PU is significantly impacted by PEU, with a co-efficient of determination (R^2) of .36. This means that 36% of the change in PU can be explained by changes in PEU, and vise versa. Notable associations between PEU and AT were found with an indirect correlation (beta = -.238) and a R^2 of .043. Most pertinently, the analysis showed that BI was significantly impacted by PU and AT, with a co-efficient of determination (R^2) of .52. When PU, PEU, and AT are combined, data analysis suggests that 52% of the change of a user's BI can be explained by changes in PU, PEU,

and AT (Lee, Hsieh & Chen, 2012). This is visualized in Lee, Hsieh & Chen's model path coefficient flowchart found in figure 1.

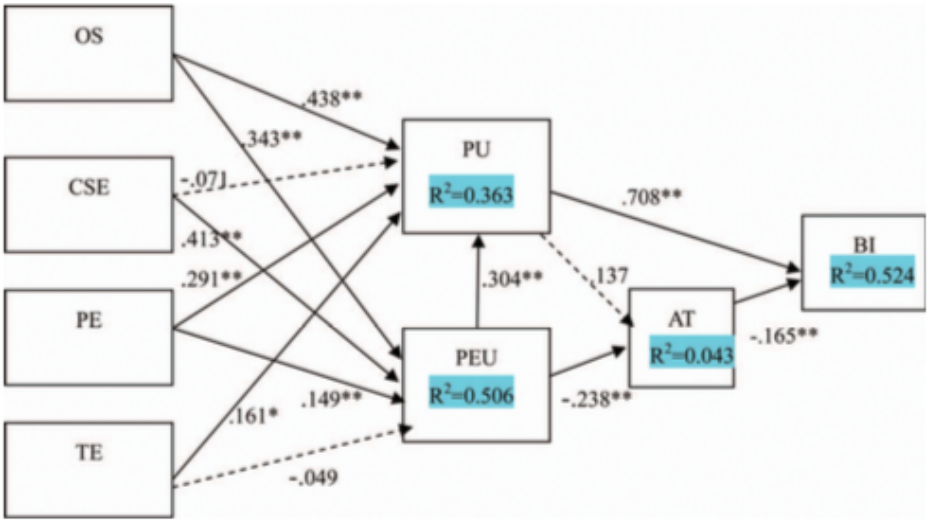

Figure 1. Model path coefficient (Lee, Hsieh & Chen, 2012)

Conclusion of The Test

Lee, Hsieh, and Chen's findings strengthen the earlier finds of TAM by Davis (1989) and TAM2 by Davis & Venkatesh (2000). Additionally, this study strengthened the theory that PU, PEU, and AT are strong determinates of a user's acceptance of technology. The study also strongly supports the finding that attitudes towards using a technology system improve as the systems becomes easier to use. Additionally, e-learning systems are found to be more useful as individuals find systems to be easier to use. Davis & Venkatesh (2000) explain that the impact of PEU on PU support the idea that, management support, professional development, user training are critical components to user acceptance of technology.

Strengthens & Weaknesses

Lee, Hsieh, and Chen's study built on findings of previous studies related to the TAM, TAM2, PU, PEU, and BI. The findings of Lee, Hsieh, and Chen's study aligned with prior studies. This increased both validity of the findings of the study and findings of previous studies. Additionally, Lee, Hsieh, and Chen used multiple indices and calculations to test the fit of their data and statistical significance to the larger population. The study used a combination of good-fit indices, p-values, and regression correlation calculations. In addition, the literature of Davis (1986) and Fishbein (1967) presented by Lee, Hsieh, and Chen served as a foundation for the need of their study.

Although there were many strengthens of this quantitative study. There were some limitations. First, due to the researchers' inability to randomly select samples, the results of this study should be interpreted with considerations (Lee, Hsieh, and Chen, 2012). Additionally, 332 samples were selected. The study did not mention whether or not the sample size was statistically relevant to generalize the population. Furthermore, the researchers suggested that additional variables may be needed to improve the predictability of users BIs toward e-learning (Lee, Hsieh, and Chen, 2012). Additionally, the study measured future BI. However, actual use and adoption were not measured to determine if the study's findings hold true over time. A longitudinal study could better understand and determine actual use and acceptance of technology. Lastly, and possibly most pertinent, the study was limited to quantitative findings. Use of qualitative research methodologies may deepen the exploration of PU, PEU, and AT towards the use and acceptance of technology and further add value knowledge to the body of literature on technology use and acceptance.

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Appendix I: "Report: Education Tech Spending on the Rise" by Schaffhauser, 2016 Link

2/21/2017 Report: Education Tech Spending on the Rise -- THE Journal

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Research

Report: Education Tech Spending on the Rise

By Dian Schaffhauser | **01/19/16**

Spending for education technology is up this school year, continuing a rise that started last year following three years of recession thrift. More districts expect to increase their hardware and software spending from 2014-2015. However, overall teacher training and tech support budgets have dropped slightly. The expansion of instructional technology is being driven by an increase in online testing, "marketplace demand," and sheer innovation.

Those details are tucked inside the considerable findings of this year's 500-plus-page "State of the K-12 Market 2015," published by EdNET Insight.

The report's authors culled data from a number of sources, including the company's own surveys. For the latest report, data was solicited from 287 technology administrators and 280 curriculum directors online and by phone from March through May 2015.

According to the report, while about half of the districts are "holding fast" to last year's technology budget increases with no changes expected, between 27 and 46 percent hope to up their spending this school year. Only 8-12 percent are working with decreased budgets.

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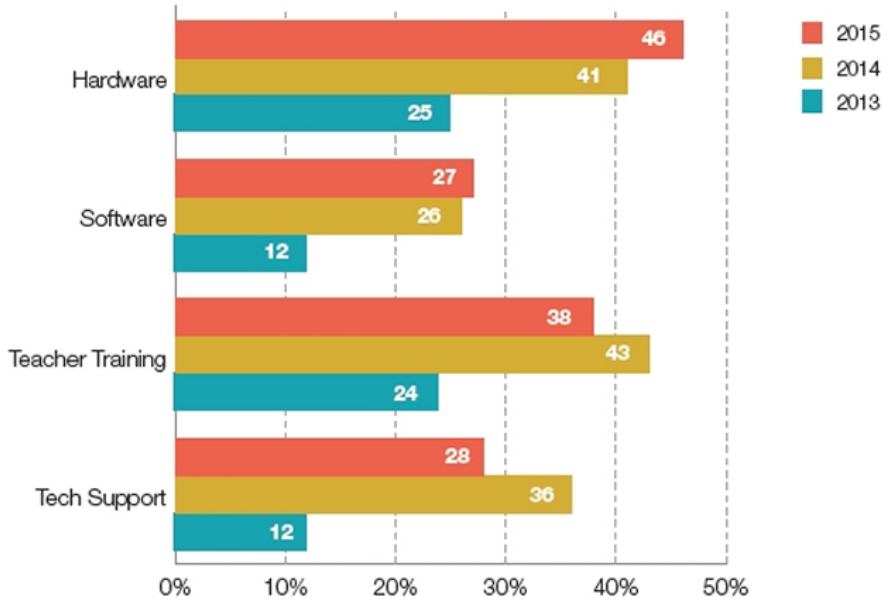


Note: See Table A3.2 in Part III for related data table. Responses of 4 and 5 are defined as budget increases.
EdNET Insight Survey © 2015, Market Data Retrieval. www.ednetinsight.com/AboutTheData

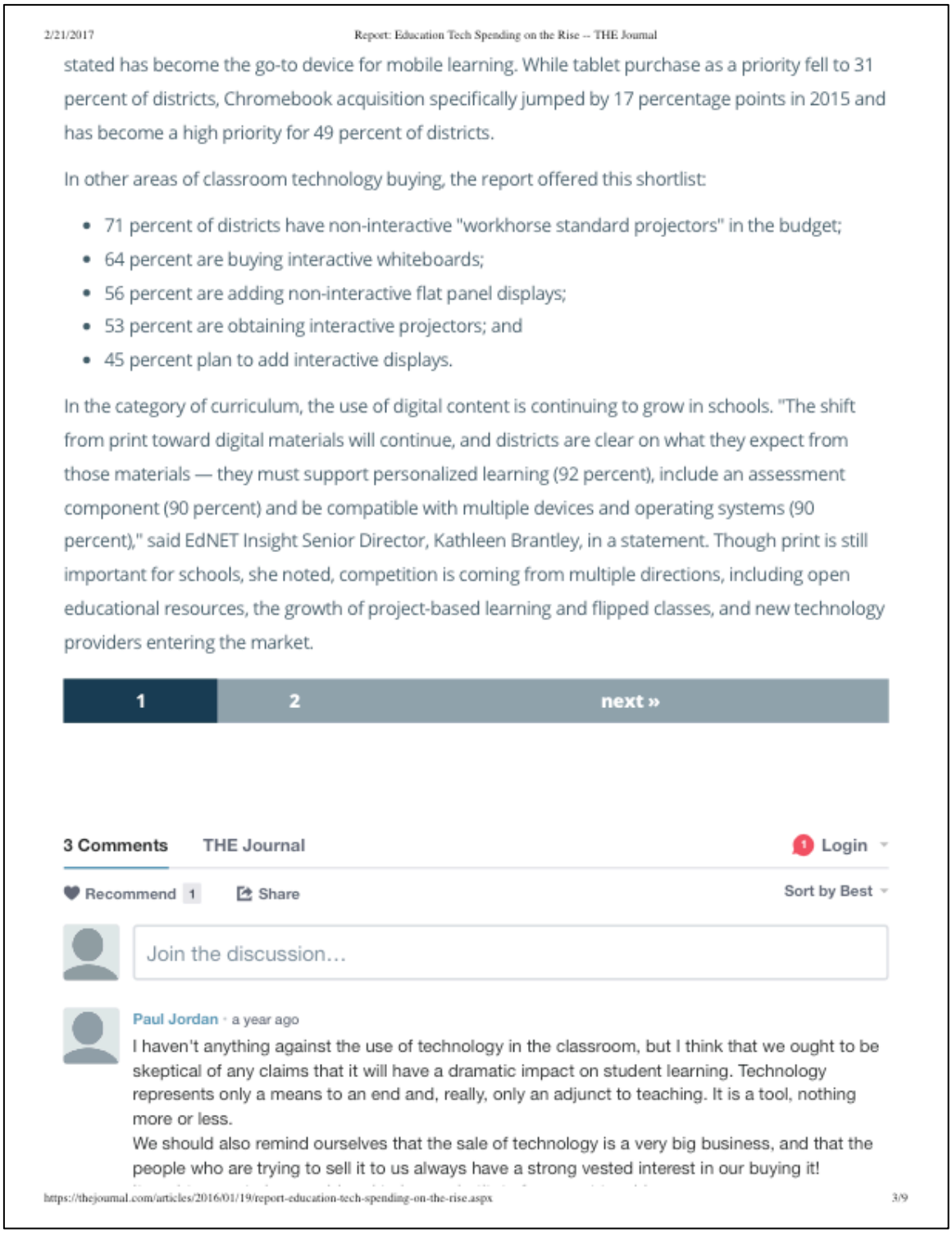
The technology budget outlook for all districts in 2015, 2014 and 2013. Published with permission of EdNET Insight.

The biggest areas of expansion are hardware (46 percent of districts will see more in this category) and teacher training (38 percent). At the same time 28 percent of districts are boosting software budgets and 27 percent are increasing tech support over the previous year.

On the hardware front, tablet purchases are planned for nearly nine in 10 (87 percent) districts. As the grade level goes down, the investment in tablets goes up. At the K-2 level, 68 percent of districts intend to purchase tablets; at the 3-5 grade level it's 56 percent; for middle school it's 40 percent; and for high school it's 36 percent.

Laptops will see almost as much buying activity — 86 percent of districts have them on the shopping list. However, the pattern is reversed. While 68 percent expect to buy laptops for high school, only 30 percent are getting them for K-2.

Purchases of desktop computers are holding strong too; 83 percent of districts expect to get more of those this school year; and 77 percent have budgeted to acquire Chromebooks, which the report



2/21/2017 Report: Education Tech Spending on the Rise -- THE Journal

stated has become the go-to device for mobile learning. While tablet purchase as a priority fell to 31 percent of districts, Chromebook acquisition specifically jumped by 17 percentage points in 2015 and has become a high priority for 49 percent of districts.

In other areas of classroom technology buying, the report offered this shortlist:

- 71 percent of districts have non-interactive "workhorse standard projectors" in the budget;
- 64 percent are buying interactive whiteboards;
- 56 percent are adding non-interactive flat panel displays;
- 53 percent are obtaining interactive projectors; and
- 45 percent plan to add interactive displays.

In the category of curriculum, the use of digital content is continuing to grow in schools. "The shift from print toward digital materials will continue, and districts are clear on what they expect from those materials — they must support personalized learning (92 percent), include an assessment component (90 percent) and be compatible with multiple devices and operating systems (90 percent)," said EdNET Insight Senior Director, Kathleen Brantley, in a statement. Though print is still important for schools, she noted, competition is coming from multiple directions, including open educational resources, the growth of project-based learning and flipped classes, and new technology providers entering the market.

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Paul Jordan · a year ago

I haven't anything against the use of technology in the classroom, but I think that we ought to be skeptical of any claims that it will have a dramatic impact on student learning. Technology represents only a means to an end and, really, only an adjunct to teaching. It is a tool, nothing more or less.

We should also remind ourselves that the sale of technology is a very big business, and that the people who are trying to sell it to us always have a strong vested interest in our buying it!

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Research

Report: Education Tech Spending on the Rise

01/19/16

The report also examined numerous trends in schools. Among those findings:

BYOD Has Staying Power

A fifth of districts (21 percent) report that their high schools have bring-your-own-device programs in place, primarily for Internet researching (88 percent), followed by formative assessment activities such as polling and quizzing (84 percent), collaboration (71 percent); skills development and practice problems (60 percent) and accessing online curriculum (56 percent).

Online Course Options Are Becoming the Norm

The survey found that a majority of districts (69 percent) offer online course options, with a 50 percent increase in the number of classes offered this year over last year. The primary model is blended learning, used at 59 percent of districts vs. 41 percent that favor fully online courses.

Districts Are Gravitating to Online Assessments.

In spite of a healthy "opt-out" political movement against the use of the Common Core, one aspect of those state standards that's holding fast is the presumption of online assessment. As the report stated, districts made "significant progress" in shifting to online testing. The number of districts administering the majority of summative assessments for their core subjects online grew by 20 percentage points to 54 percent in 2015. Similar results have surfaced for benchmark assessments (58 percent of districts are using online versions) and formative assessments (56 percent). That doesn't mean paper-and-pencil testing is dead; almost half of districts (49 percent) said this method was still important for the benchmark assessment buying decision.

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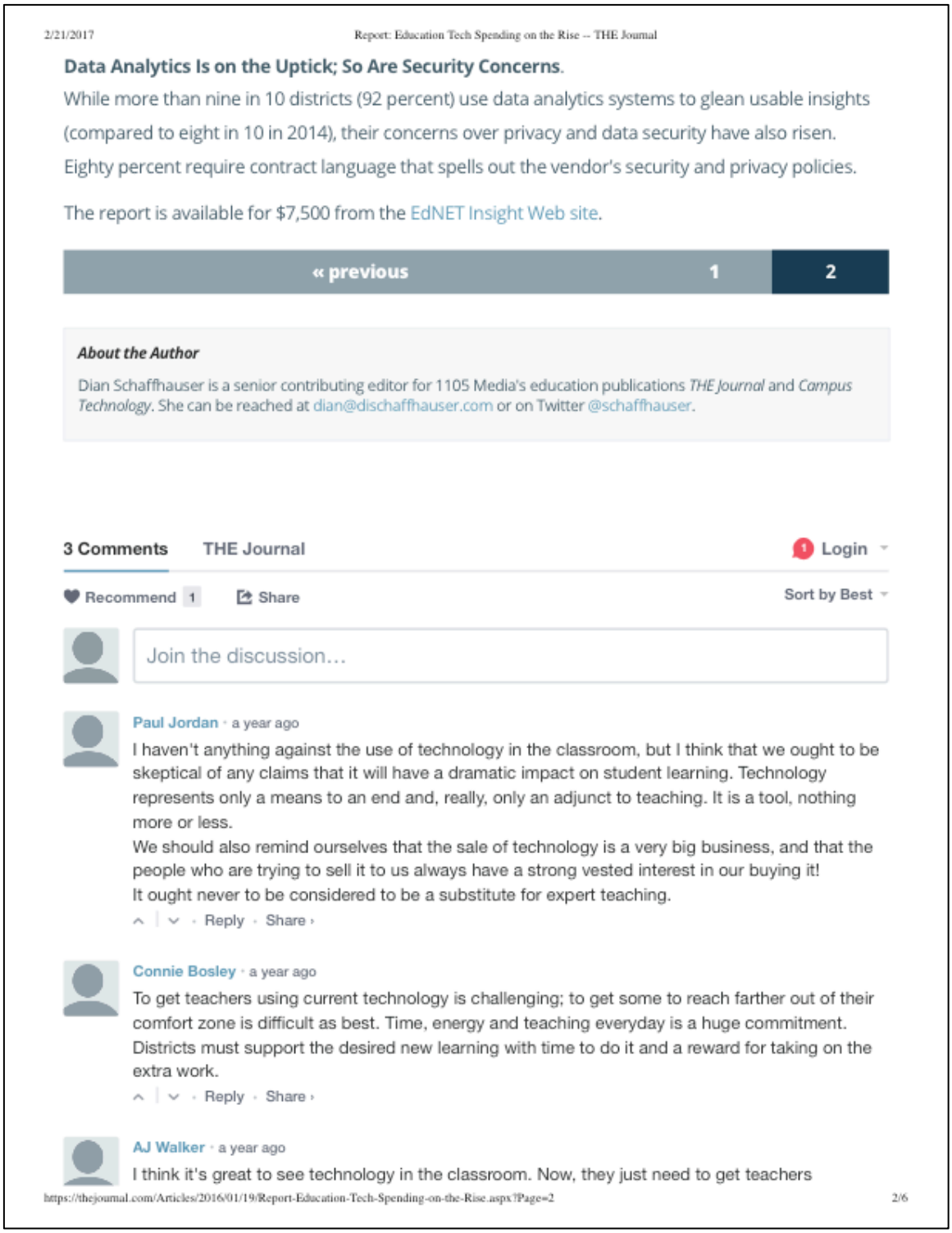

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Data Analytics Is on the Uptick; So Are Security Concerns.

While more than nine in 10 districts (92 percent) use data analytics systems to glean usable insights (compared to eight in 10 in 2014), their concerns over privacy and data security have also risen. Eighty percent require contract language that spells out the vendor's security and privacy policies.

The report is available for $7,500 from the EdNET Insight Web site.

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About the Author

Dian Schaffhauser is a senior contributing editor for 1105 Media's education publications *THE Journal* and *Campus Technology*. She can be reached at dian@dischaffhauser.com or on Twitter @schaffhauser.

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Paul Jordan · a year ago

I haven't anything against the use of technology in the classroom, but I think that we ought to be skeptical of any claims that it will have a dramatic impact on student learning. Technology represents only a means to an end and, really, only an adjunct to teaching. It is a tool, nothing more or less.

We should also remind ourselves that the sale of technology is a very big business, and that the people who are trying to sell it to us always have a strong vested interest in our buying it!

It ought never to be considered to be a substitute for expert teaching.

Reply · Share ›

Connie Bosley · a year ago

To get teachers using current technology is challenging; to get some to reach farther out of their comfort zone is difficult as best. Time, energy and teaching everyday is a huge commitment. Districts must support the desired new learning with time to do it and a reward for taking on the extra work.

Reply · Share ›

AJ Walker · a year ago

I think it's great to see technology in the classroom. Now, they just need to get teachers

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Appendix II: "An investigation of employees' use of e-learning systems: applying the technology acceptance model" by Lee, Hsieh & Chen, 2013 Link

Behaviour & Information Technology, 2013
Vol. 32, No. 2, 173–189, http://dx.doi.org/10.1080/0144929X.2011.577190

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An investigation of employees' use of e-learning systems: applying the technology acceptance model

Yi-Hsuan Lee[a]*, Yi-Chuan Hsieh[b] and Yen-Hsun Chen[a]

[a]*Department of Business Administration, National Central University, No.300, Jhongda Road, Zhongli City, Taoyuan County, Taiwan, R.O.C;* [b]*Department of Applied Foreign Languages, Ching Yun University, No.229, Jianxing Road, Zhongli City, Taoyuan County, Tawan, R.O.C*

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The purpose of this study is to apply the technology acceptance model to examine the employees' attitudes and acceptance of electronic learning (e-learning) systems in organisations. This study examines four factors (organisational support, computer self-efficacy, prior experience and task equivocality) that are believed to influence employees' perceived usefulness, perceived ease of use, attitudes and intention to use e-learning systems. Participants were selected from Taiwanese companies that have already implemented e-learning systems. Three hundred and thirty-two valid questionnaires were collected, and structure equation modelling was conducted to test the research hypotheses. The findings provided practical implications for organisational trainers, educators and e-learning system developers.

Keywords: technology acceptance model; e-learning systems; computer self-efficacy; prior experience; task equivocality; organisational support

1. Introduction

Information technology has dramatically altered the way people teach and learn (Leonard and Delacey 2002). Electronic learning (e-learning), a new approach in education, highlights learner-oriented life-long teaching-learning processes. E-learning generally refers to the use of computer network technology, primarily over an intranet or through the Internet, to deliver information and instruction to individuals. In organisational or corporate contexts, e-learning systems have been broadly used to generate and disseminate information and are designed to improve performance (Rosenberg 2001).

The characteristics of e-learning fulfil the requirements for learning in a technologically advanced society and have created great demand for e-learning from businesses. E-learning allows training to reach diverse and geographically dispersed workforces in a cost-efficient manner. Learning can take place on-demand, at any time, at any place and at a lower cost than for on-site training (Govindasamy 2002).

E-learning systems have become popular tools for facilitating teaching and learning processes that allow flexible learner-centred education. In this case, the e-learning system in this study refers to the information system that can integrate a wide variety of instructional material (via audio, video and text mediums) conveyed through email, live chat sessions, online discussions, forums, quizzes and assignments. Additionally, e-learning encompasses Internet, intranet, extranet, satellite broadcasts, interactive TV and CD-ROMs. Such a system allows synchronous and asynchronous communication and instructional delivery between instructors and students. Consequently, these e-learning systems may better meet the needs of learners who are demographically dispersed or have conflicting schedules.

To meet the needs of today's highly competitive global economy, employees must have the latest knowledge and technological skills. Therefore, to cultivate a highly trained and educated workforce, organisations have invested substantial resources towards developing e-learning alternatives to traditional types of education and training systems (DeRouin *et al.* 2005, Bassi and Van Buren 1999, Rossett 2002). Training is considered to be a key educational practice and strategic organisational tool that is associated with higher profits and lower employee turnover. Many organisations have adopted e-learning solutions for their corporate training (DeRouin *et al.* 2005). As a result, organisations are increasingly relying on e-learning as a solution to reach immediacy, convenience and consistency. E-learning therefore has played a significant role in training and development within the organisational environment.

*Corresponding author. Email: ychsieh@cyu.edu.tw

The benefits of e-learning applied in organisations and educational institutions have been discussed by many researchers (Bouhnik and Marcus 2006, De-Rouin *et al*. 2005, Capper 2001, Katz 2000, Katz 2002, Piccoli *et al*. 2001). Nevertheless, there is limited research literature that addresses employees' intention to use, as well as acceptance of e-learning systems in organisational contexts. Acceptance behaviour among employees remains critical for the adoption of e-learning systems. In existing research, the technology acceptance model (TAM) has been successfully applied to investigate users' intent to use the technology system and adoption decision across various contexts and user populations (Venkatesh 2000, Venkatesh and Davis 2000, Pituch and Lee 2006). However, research on the TAM application in the use of e-learning systems within organisational settings is limited. Besides, the existing parameters of the TAM are not sufficient to fully reflect the end-users' acceptance of e-learning systems within organisations, so further examination of additional factors is required (Ong *et al*. 2004). Additional factors that would affect e-learning system usage behaviour and intentions in organisational contexts have thus far not been clearly stated. Studies investigating the determinants related to e-learning systems use have not been empirically tested from the perspectives of individual, organisational and task characteristics in the organisational context (Kim *et al*. 2007, McFarland and Hamilton 2006, Lin and Wu 2004, Konradt *et al*. 2006).

Thus, the purpose of this study is to apply the TAM model to examine employees' attitudes and acceptance of e-learning systems in organisations. First, this study uses TAM as a baseline model to predict the employees' usage of e-learning systems within organisations. To accomplish this, structural equation modelling (SEM) was applied to examine and validate the hypothesised relationships of employees' perceptions and attitudes towards behavioural intention (BI) to use e-learning systems. This study contributed to TAM research by using attitude as one of dependent variables that was hypothesised to be predictive of the intention to use. Next, this study extended TAM by including additional user-related variables, such as computer self-efficacy, prior experience, task-related variables and organisational-related variables. Last, this study has the potential to influence the use of e-learning systems in organisations, an area of crucial importance in view of the increasing role that e-learning systems play in organisational training.

A variety of research studies were conducted on e-learning systems (Beam and Cameron 1998, Carswell 1997), but little research has been done to address the conceptualisation of e-learning systems acceptance within organisations. It is believed that the more users' perceived usefulness (PU) of e-learning systems within an organisation, the more positive their acceptance of e-learning systems. This in turn improves their learning experiences and satisfaction and further increases their chances for using e-learning systems in the future (Arbaugh 2002, Arbaugh and Duray 2002, Pituch and Lee 2006).

The TAM (Davis *et al*. 1989, Davis 1989), adapted from a theory of reasoned action (TRA) (Ajzen and Fishbein 1980, Fishbein and Ajzen 1975), has been used as a theoretical basis for many empirical studies of user technology acceptance (Venkatesh 2000, Venkatesh and Davis 2000). The TAM (Ajzen and Fishbein 1977, Davis *et al*. 1989, Arbaugh 2002, Arbaugh and Duray 2002, Atkinson and Kydd 1997, Wu *et al*. 2006) has partially contributed to the understanding of users' acceptance of e-learning systems. TAM could be useful in predicting users' acceptance of e-learning systems in organisations. However, very few studies have adopted the TAM as a model for explaining the use of e-learning systems designed and provided by organisations. A number of studies tend to focus on the acceptance of students in educational institutions (Lau and Woods 2008, Chang and Tung 2008, Sivo *et al*. 2007, Wang *et al*. 2009), but little research has been conducted to provide solid evidence regarding the employees' acceptance of the e-learning systems within organisations. Thus, the main purpose of this study is to empirically investigate the antecedents of PU and perceived ease of use (PEU) and to explore the attitudes towards the e-learning systems further determine the employees' acceptance of e-learning systems. Based on prior literature, this study identifies three main categories of external antecedent variables of PU and PEU – individual characteristics, task equivocality and organisational support – to enhance understanding of employees' acceptance of the learning system. This empirical study can be beneficial to researchers in developing and testing theories related to e-learning system acceptance in organisations and may prove valuable to practitioners in understanding the strategies for designing and promoting e-learning systems in organisations.

In the next section, we provide the rationale for adopting the proposed model as the theoretical framework of this study, followed by a description of the survey instruments and methods used. We then present testing results for the hypotheses. Finally, we discuss the implications, limitations and recommendations for future research.

2. Theoretical background

The TAM (Davis *et al*. 1989) is a specific model developed to explain and predict users' computer usage behaviour. Derived from the TRA (Ajzen and Fishbein

1980, Fishbein and Ajzen 1975), the TAM asserts that two salient beliefs—PU and PEU—determine technology acceptance and are the key antecedents of BIs to use information technology. The first key belief, PU, is the degree to which an individual believes that a particular system would enhance job performance within an organisational context (Davis *et al*. 1989). PEU, the second key belief, is the degree to which an individual believes that using a particular system would be free of effort (Davis 1989). The TAM model shown in Figure 1 assumes that BI determined actual use and is determined by both attitude (AT) and PU. Attitude and BI are two internal psychological variables that directly affect user behaviour. By definition, attitude refers to 'the degree of a person's positive or negative feelings about performing the target behaviour (Davis *et al*. 1989, p. 984).' PU and PEU both have direct relationships with attitude (AT). Attitude is postulated to partially mediate the effect of PEU and PU on BI. PEU also influences PU. Furthermore, it indicates that the system usage is affected by both PEU and PU through AT. Other external variables affecting an individual's acceptance of new technology are mediated by these two key beliefs (see Figure 1).

Several empirical studies demonstrate the efficiency, effectiveness and validity of the TAM across various domains and broaden the overall applicability of the TAM (Adams *et al*. 1992, Chau 1996, Davis 1986, Davis *et al*. 1989, Hendrickson *et al*. 1994, Hubona and Cheney 1994, Igbaria *et al*. 1995, Mathieson 1991, Segars and Grover 1994, Igbaria *et al*. 1997, Brown and Ford 2002, Townsend *et al*. 2001, Chen *et al*. 2002, Koufaris 2002, Dillon and Morris 1996, Legris *et al*. 2003, Davis *et al*. 1992, Gefen and Straub 1997, 2000, Venkatesh 2000, Venkatesh and Davis 2000, Hsu and Lu 2004, Ong *et al*. 2004). Empirical evidence to support the core assumptions of the TAM has been proven (Szajna 1996, Al-Gahtani and King 1999, Lederer *et al*. 2000, Horton *et al*. 2001, Anandarajan *et al*. 2000).

However, TAM is considerably narrower in focus than TRA. It was designed to apply only to computer usage behaviour. Many researchers have conducted empirical studies to examine the explanatory power of TAM and yielded relatively consistent results on the acceptance behaviour of IT end users (Adams *et al*. 1992, Hendrickson *et al*. 1993, Igbaria *et al*. 1997, Keil *et al*. 1995, Straub *et al*. 1995, Straub *et al*. 1997, Szajna 1994, Lau and Woods 2008, Wang *et al*. 2009, Wang and Wang 2008, Sivo *et al*. 2007).

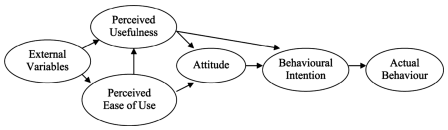

Figure 1. Technology acceptance model (TAM). Source: Davis (1989).

TAM specifies usefulness and ease of use as beliefs that determine attitudes towards IT and actual system use. A number of researchers have extended TAM by exploring other constructs, such as computer self-efficacy (Compeau and Higgins 1995, Hayashi *et al*. 2004, McFarland and Hamilton 2006, Wang and Wang 2008, Hussein *et al*. 2007, Chang and Tung 2008, Li *et al*. 2004), Internet self-efficacy (Igbaria and Iivari 1995, Eastin and LaRose 2000, Hsu and Chiu 2004a) and the subjective norm (Venkatesh and Davis 2000, Bhattacherjee 2000, Teo *et al*. 2008, Sivo *et al*. 2007, Kim *et al*. 2007). However, task focus and other significant factors are not included in TAM (Dishaw and Strong 1999, Legris *et al*. 2003, Kim *et al*. 2007). Therefore, to increase the external validity of the TAM model and to better understand what influences PU and PEU, many studies have extended the TAM model by adding external variables that were selected based upon technological features, research situations and research goals, etc. External variables considered in other studies on the individual acceptance of IT include computing, training and management support (Igbaria *et al*. 1997, Konradt *et al*. 2006, Marler and Dulebohn 2005, McFarland and Hamilton 2006, Kim *et al*. 2007, Lin and Wu 2004), level of education and prior experience (Agarwal and Prasad 1999, McFarland and Hamilton 2006), task technology fit and task characteristics (Dishaw and Strong 1999, Marler and Dulebohn 2005, Kim *et al*. 2007).

Based on prior literature, external variables in this study are classified into individual factors (prior experience and computer self-efficacy), task factors (task equivocality) and organisation factors (organisational support). Individual factors were chosen because acceptance of the e-learning system is affected by individual's prior computer experience and personal traits; task factors, because acceptance of the e-learning systems in organisations has a strong relationship with employees' task characteristics and organisation factors, because they reflect the support and promotion of the organisation in the acceptance of the e-learning systems.

3. Research model and hypothesis

This study examines four factors that were believed to influence employees' acceptance of e-learning systems: organisational support, computer self-efficacy, prior experience and task characteristics (task equivocality).

In information system studies, many researchers attempted to extend the TAM with other external variables (Lee *et al*. 2003). Factors such as individual, organisational and task characteristics have long been identified as external variables that may influence PEU and PU of an information system. This study attempts to investigate the effects of external variables on technology acceptance variables. The proposed model (see Figure 2) shows the relationships between the external factors, namely, organisational support, computer self-efficacy, prior experience, task characteristics (task equivocality) and the e-learning acceptance factors, namely, PEU, PU, attitude and intention to use. We discuss the relationships among variables and consequently developed the hypotheses of this study.

3.1. Perceived usefulness (PU)

PU is defined as the degree to which an individual believes that a target system will enhance his job performance within an organisational context (Davis *et al*. 1989). Researchers assert that PU is a good indicator to predict the individual's acceptance of various systems (Chin and Todd 1995, Doll *et al*. 1998, Segars and Grover 1993, Venkatesh and Davis 2000, Davis 1989, Davis *et al*. 1992, Igbaria *et al*. 1997, Gefen and Straub 1997, 2000, Venkatesh 2000, Hsu and Lu 2004, Ong *et al*. 2004). Previous studies revealed that PU positively affects end-users' BI to use systems (Chin and Todd 1995, Doll *et al*. 1998, Marle and Dulebohn 2005). Furthermore, Pillips *et al*. (1994), indicating that PU reflects the end-users' subjective probability that using the new technology will be beneficial to personal and organisational well being. In the context of e-learning within organisations, PU refers to the extent to which employees believe that using e-learning systems would enhance their learning performance. Therefore, PU will influence their intention to accept and adopt the e-learning systems, either directly or indirectly (through PEU). Therefore, we hypothesised:

H1: PU would affect BI to use the e-learning system.

3.2. Perceived ease of use (PEU)

PEU refers to the degree to which an individual believes that using a particular system would be effortless (Davis 1989). Previous studies showed that PEU has a positive effect on users' BI and PU to use systems (Chin and Todd 1995, Doll *et al*. 1998, Konradt *et al*. 2006, Teo *et al*. 2007, Kwon *et al*. 2007, Henderson and Divett 2003). In the context of e-learning within organisations, PEU is defined as the degree to which end-users believe that the use of e-learning systems will be free of effort and easy to use. End-users' interaction with the e-learning system is clear and understandable (Davis 1989). PEU would similarly affect the intention to accept the e-learning system directly or indirectly through the PU.

Thus, we hypothesised:

H2: PEU would affect PU of the e-learning system.

3.3. Attitude towards e-learning system use (AT)

AT was regarded as the degree to which an individual perceived a positive or negative feeling related to the e-learning system (Davis *et al*. 1989). The attitude towards use of the e-learning system, combined with PU and PEU, would affect both actual technology use and the duration of use in a given setting (Davis 1993).

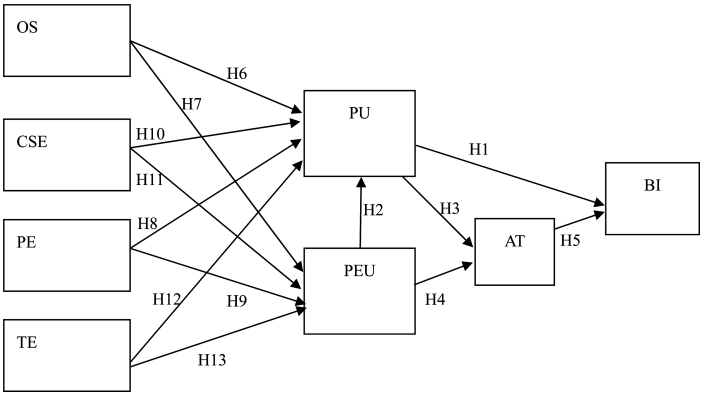

Figure 2. Proposed research model.

To elaborate, both PU and PEU are assumed to have significant effects on a user's attitude towards use of the e-learning system. BIs to use (BI) are jointly determined by an individual's attitude towards use of the e-learning system and its PU (Davis *et al*. 1989, Davis 1993, Sivo *et al*. 2007, Lau and Woods 2008, Sivo *et al*. 2007).

Also in line with previous studies, the results revealed that PU and PEU correlated well with AT across various information systems (Moon and Kim 2001, Sivo *et al*. 2007, Lau and Woods 2008). Likewise, empirical research provided evidence that AT is the strongest predictor of BI (Sivo *et al*. 2007, Sanders and Morrison-Shetlar 2001, Duggan *et al*. 1999). Therefore, we hypothesised:

H3: PU would have a positive effect on attitudes towards e-learning system use.

H4: PEU would have a positive effect on attitudes towards e-learning system use.

H5: Attitudes towards e-learning system use would have a positive effect on the BI to use the e-learning system.

It should be noted that because of the rhetorical format of AT, the path coefficients of the structural equation modelling would be negative even though the relationships were predicted to be positive.

3.4. Organisational support (OS)

In the context of our study, organisational support is defined as the extent to which top and middle management allocate adequate resources to help employees achieve organisational goals (e.g. top and middle management encouragement, technical support facilities (Mirvis *et al*. 1991, Grover 1993, Konradt *et al*. 2006)). Previous literature indicates the existence of positive relationships between organisational support and computer system usage (Igbaria *et al*. 1997, Sharma and Yetton 2003, Compeau and Higgins 1995, Injai 1996). The results of these studies concluded that organisational support positively affected computer utilisations through beliefs and behaviours (Davis 1989, Igbaria *et al*. 1989, Eisenberger *et al*. 1986, Igbaria *et al*. 1995, Igbaria *et al*. 1996).

It was also found that the lack of organisational support negatively impacted effective computer usage or utilisation (Igbaria and Iivari 1995, Igbaria 1990). Furthermore, according to Kim *et al*. (2006) and McFarland and Hamilton (2006), organisational support was associated with PU and PEU.

Moreover, top management support, as one form of organisational support, plays a facilitative role in encouraging the use of computer technology programs and training by providing required resources and computer systems upgrades. Top management support enhances favourable attitudes and changes perception towards computer usefulness and ease of use (Davis *et al*. 1989, Leonard-Barton and Deschamps 1988, Rogers 1983, Fulk *et al*. 1990, Konradt *et al*. 2006, Sharma and Yetton 2003). Therefore, organisational and top management support enhances employees' trust of the organisation, which enables them to take risks to integrate computer technology into practice (Igbaria and Iivari 1995). Based on the above discussion, the following hypotheses were posited:

H6: Organisational support would affect PU of the e-learning system.

H7: Organisational support would affect PEU of the e-learning system.

3.5. Individual characteristics

The individual characteristics included in this study are the employees' prior experiences in using computer technology and computer self-efficacy (CE). Two reasons for the inclusion of individual characteristics are: one, it seemed reasonable to assume that adult e-learners may form different perceptions of e-learning systems due to individual attributes, and that such attributes may be related to technology usage. As such, Heinich *et al*. (1996) contended that learners' characteristics must be considered so that instructional technology can be used effectively. Two, in empirical studies, user characteristics have been found to impact BI to use technology (Davis *et al*. 1989). In the e-learning context, users' success was found to depend on abilities to cope with technical difficulty and technical skills in computer operation and Internet navigation (Kerka 1999). Therefore, in this study, prior experience in using computer technologies and computer self-efficacy were posited as the factors that were most expected to influence the acceptance of e-learning systems.

3.6. Prior experience (PE) in using computer technology

Individual characteristics, such as experience in using computers and information systems, would directly and indirectly affect system usage through beliefs. Thus, more experiences improved end-users' belief in the system (Igbaria 1990, Igbaria 1993). Computer experience was also found to be positively associated with system usage (Igbaria *et al*. 1995, Igbaria *et al*. 1996). User training and experience, which represent individual skills and expertise, were related to user beliefs and usage. Therefore, the acceptance of computer technology not only depended on the technology itself, but also on the skill level or expertise of the individual using the technology (Nelson 1990).

Developing the users' technology-related knowledge, skills and attitudes can be a major prerequisite for performance and acceptance of e-learning systems (Rothwell and Kazanas 1998).

Related research indicates that prior computer experience as well as distance education (Kerka 1999) influence the intention to use various technology applications (Igbaria *et al*. 1995, Tan and Teo 2000). Experimental studies state that prior experience in using computers had a positive, direct relationship with PEU and PU (McFarland and Hamilton 2006). Furthermore, it is shown that computer-related experience, such as Internet experience, directly influence PU and PEU (Kim *et al*. 2007). As explained above, we proposed the following hypotheses:

H8: Prior experience would affect PU of the e-learning system.

H9: Prior experience would affect PEU of the e-learning system.

3.7. Computer self-efficacy (CSE)

Computer self-efficacy is defined as 'an individual's perceptions of his or her ability to use computers in the accomplishment of a task rather than reflecting simple component skills' (Compeau and Higgins 1995, p. 192). Empirical studies show that computer-efficacy influences technology adoption (Burkhardt and Brass 1990, Igbaria and Ivari 1995), system usage (Compeau and Higgins 1995, Igbaria and Ivari 1995), BI to use systems (Vijayasarathy 2004) and system ease of use perceptions (Vankatesh and Davis 1996, Agarwal *et al*. 2000, Chau 2001).

Davis (1989) theorised that computer efficacy was distinctive when considering the PEU and PU, and subsequent empirical research has demonstrated this distinctiveness (Igbaria and Ivari 1995, Vankatesh and Davis 1996). Hence, there is a causal flow from computer self-efficacy to system-specific PEU and PU (Venkatech and Davis 1996, Chau 2001, Compeau and Higgins 1995, Compeau *et al*. 1999, Wang and Wang 2008, Chang and Tung 2008, Li *et al*. 2004, Hayashi *et al*. 2004, Hussein *et al*. 2007). Research findings demonstrate the significance of computer efficacy in explaining users' computing behaviours (Fenech 1998, Igbaria and Ivari 1995, Vankatesh and Davis 1996). Since computer self-efficacy, PEU and PU have been found to be connected, we argue that it is reasonable to predict a relationship between computer self-efficacy, PEU and PU. We hypothesised:

H10: Perceived computer self-efficacy would affect PU of the e-learning system.

H11: Perceived computer self-efficacy would affect PEU of the e-learning system.

3.8. Task characteristics

Task characteristics and their impact on information use have been studied by many researchers (e.g. Daft and Macintosh 1981, O'Reilly 1982, Goodhue 1995). However, when applying TAM, one of the problems is that its constructs do not fully reflect the various task environments of users. The lack of task focus in evaluating information technology (IT) and its acceptance, use and performance could lead to mixed results (Kim *et al*. 2007). Employees usually use information technology as a tool to accomplish organisational tasks. Although TAM's usefulness concept implicitly includes tasks, more explicit inclusion of task characteristics is needed to better understand the usage of IT (Dishaw and Strong 1999).

Additionally, research on task characteristics and their impact on information systems indicates that task uncertainty and task interdependence affected the usage of and the attitude towards information technology (Goodhue 1995, Goodhue and Thompson 1995, Igbaria 1990, Nelson 1990). Furthermore, according to McFarland and Hamilton's (2006) study, task structure had a positive and direct relationship with PEU and PU. Task equivocality, one component of task characteristics, refers to the level of ambiguity or confusion that occurs during the task (Daft *et al*. 1987). According to Kim *et al*. (2007), task equivocality was found to have a positive effect on individuals' PU of e-learning system. On the other hand, researchers also assumed that task equivocality and task interdependence influenced an individual's acceptance of the e-learning systems. However, the results showed that only task equivocality affected PU (Kim *et al*. 2007). We also argued when task equivocality is high, employees require challenging, new or difficult tasks, creating the perception that e-learning system is a stable system that is relatively easy to use. Therefore, we built hypotheses about the effects of task equivocality on the acceptance of the e-learning system.

H12: Task equivocality would affect PU of the e-learning system.

H13: Task equivocality would affect PEU of the e-learning system.

4. Research methodology

SEM (using AMOS 16.0) was employed to examine and validate the hypothesised relationships of variables in the proposed model to accomplish the purpose of this study.

4.1. Subjects and procedures

This study utilised web-based and mailed surveys to collect data for quantitative testing of the research

model. We assured participants that confidentiality and anonymity would be protected. Because of the lack of a reliable sampling frame, it is difficult to conduct a random sampling for all the end users in the organisations using e-learning systems in Taiwan. Thus, in this study, we adopted a non-random sampling technique (i.e. convenience sampling) to collect the sample data. To generalise the results, we gathered sample data from four industries: manufacturing, marketing and service, information technology and government agencies in Taiwan. Twelve firms that have developed e-learning training systems for employees were randomly selected (three firms in each industry).

The web-based questionnaire was distributed to employees at different job levels within these organisations. The questionnaire clearly stated the purpose of the study and asked for their participation in the study by clicking a hyperlink to the survey form. In addition, the mailed survey was distributed through an officer/coordinator from the Human Resources Department among the selected firms.

As an incentive, respondents from the web-based questionnaire and mailed survey were offered a fast-food restaurant coupon. The web-based questionnaire and mailed survey were conducted from March to May 2009.

Of the 400 mailed questionnaires and 200 electronic questionnaires, 365 were completed and returned. Thirty-three questionnaires were incomplete and not used, leaving the number of valid questionnaires at 332. Consequently, 332 completed questionnaires were analysed, with a response rate of 55.33%. Approximately, 88.6% of the respondents had 6 years of experience in using computers. The male-to-female ratio was approximately 49.1 to 50.9. A majority of respondents (61.1%) were frontline staff. Most of those replying to the questionnaire had greater than 3 years work experience, making up 61.1% of the samples. Sample demographics are depicted in Table 1. Respondents rated each statement on a five-point Likert scale anchored at Strongly Agree and Strongly Disagree. These statements were adapted from prior studies. Measures for each variable in the proposed model were obtained using the questionnaires. Table 1 showed the demographics of the respondents.

4.2. Measures

We conducted a series of in-depth interviews with various experienced e-Learning students to examine the validity of our research model. After that, we developed questionnaire items based on the previous literature and comments gathered from the interviews. Questionnaires were revised with the help from e-learning experts, including academics and practitioners.

To ensure content validity of the scales, the items selected represented the constructs that generalisations could be made. Items chosen for the constructs were adapted mainly from previous research to ensure content validity.

The questionnaire includes five parts. The first part is on a nominal scale and the rest are 5-point Likert scales with 1 representing strongly disagree and 5 representing strongly agree. Part 1 is a collection of interviewees' demographic data. Part 2 is based on the constructs of PU, PEU (PEOU), attitude (AT) (attitude questionnaire items are all in rhetorical format) and intention to use in the TAM model and was adapted from the measurement defined by Davis (1989), Davis *et al.*(1989), and Venkatesh and Davis (1996, 2000), containing 12 items for above constructs. Part 3 is based on the construct of organisation support. The five items that measured organisational support were adopted from the studies of Igbaria *et al.* (1995) and Kleintop (1993). Part 4 is based on the construct of individual characteristics with computer self-efficacy and prior experience. The items that measured computer self-efficacy were adapted from Compeau and Higgins (1995), containing six items. The items measured the prior experience were derived from Barbeite and Weiss (2004), containing four items. Part 5

Table 1. Demographics of the respondents.

Demographics	Number	Percent
Gender		
Female	169	50.9
Male	163	49.1
Age		
<29	145	43.7
30–39	119	35.8
40–49	44	13.3
>50	24	7.2
Education		
High school	12	3.6
College/University degree	174	52.4
Master degree	142	42.8
Doctoral degree	4	1.2
Experience in using computers		
<1 year	1	.3
1 to 3 years	6	1.8
3 to 6 years	31	9.3
6 to 9 years	66	19.9
>9 years	228	68.7
Job positions		
Top and middle managers	51	15.4
Line managers	61	18.4
Frontline staff	203	61.1
Others	17	5.1
Industries		
Manufacturing	17	5.1
Marketing and service	103	31.0
Information technology	91	27.4
Government agencies	46	13.9
Others	75	22.6

is based on the construct of task characteristics and was adapted from the study of Goodhue (1995), containing two items. Questionnaire items are listed in Table 2.

4.3. Results

4.3.1. Instrument validation

In this study, scale reliability and validity were assessed via confirmatory factor analysis (CFA). Convergent validity of scale items were estimated by reliability, composite reliability and average variance extracted (Fornell and Larcker 1981). The standardised CFA loadings for all scale items exceeded the minimum loading criterion of 0.50, and the composite reliabilities of all factors also exceeded the recommended 0.60 level (Fornell and Larcker 1981). In addition, the average variance-extracted values were all above the threshold value of the 0.50 level, except for the PU and AT (Hair *et al*. 1992). However, according to Jiang *et al*. (2002), the variance extracted estimates normally can be found below 0.5 even when reliabilities are acceptable. Hence, all three conditions for convergent validity were met for the four measurement models, as shown in Table 3.

To examine discriminant validity, the results were obtained by comparing the shared variance between factors with the average variance extracted from the individual factors (Fornell and Larcker 1981). This analysis manifested that the shared variances between factors were less than the average variance extracted from the individual factors. Hence, discriminant validity was assured (see Table 4). In summary, the measurement model reached the satisfactory levels of

Table 2. Questionnaire items.

Behavioural intention (BI)	
BI2	I will strongly recommend others to use it.
BI3	I intend to use the e-learning system in the next few months.
BI5	I intend to use e-learning to assist my learning.
Attitude (AT)	
AT1	I believe that working with computers is very difficult.
AT2	I believe that working with computers is very complicated.
AT3	I believe that working with computers let me feel psychological stress very greatly.
Perceived usefulness (PU)	
PU1	Using the e-learning system enhances my effectiveness in my learning.
PU4	I believe e-learning contents are informative.
PU5	I believe e-learning is a useful learning tool.
Perceived ease of use (PEU)	
PEU1	I find the e-learning system to be easy to use.
PEU2	I find that interacting with the e-learning system doesn't demand much care or attention.
PEU3	It is easy to perform work using the e-learning system.
Organisational support (OS)	
OS1	My boss understands the benefits to be achieved by using e-leaning system.
OS2	I am always supported and encouraged by my boss to e-leaning system to perform my job.
OS3	I am convinced that my colleagues are aware of the benefits of the e-learning system.
OS4	I am always supported and encouraged by my colleagues to use the e-learning system to enhance the performance of my job.
OS5	The administration has provided most of the necessary help and resources to get us used to the e-learning system quickly.
Computer self-efficacy (CSE)	
CSE1	I am confident of using e-learning system even if I have only the system manuals for reference.
CSE2	I am confident that I can overcome any obstacles when using the e-learning system.
CSE3	I am confident of using different e-learning systems to learn other subjects.
CSE4	I am confident of using e-learning system: even if I have never used such a system before.
CSE5	I am confident of using e-learning system: as long as I have just seen someone using it before trying it myself.
CSE6	I am confident of using e-learning system: as long as I have a lot of time to complete the job for which the software is provided.
Prior experiences (PE)	
PE1	I enjoy using computers.
PE2	I am comfortable using the Internet.
PE3	I am comfortable saving and locating files.
PE4	I enjoy using e-mail.
Task equivocality (TE)	
TE1	The content of my job usually changes.
TE3	I usually have to adopt different methods or procedures to perform my job.

Note: The survey items were rated in a five-point Likert-type scale with 1 representing exceptionally disagree and 5 representing exceptionally agree.

Table 3. Convergent validity.

Constructs/factors	Indicators	Standardised loadings (>0.50)	Composite reliability (>0.60)	Average variance extracted (>0.50)
Behavioural intention (BI)	BI2	0.768	0.905	0.683
	BI3	0.920		
	BI5	0.783		
Attitude (AT)	AT1	0.548	0.615	0.389
	AT2	0.509		
	AT3	0.780		
Perceived usefulness (PU)	PU1	0.698	0.862	0.482
	PU4	0.692		
	PU5	0.693		
Perceived ease of use (PEU)	PEU1	0.794	0.821	0.515
	PEU2	0.646		
	PEU3	0.706		
Organisational support (OS)	OS1	0.701	0.905	0.563
	OS2	0.746		
	OS3	0.695		
	OS4	0.825		
	OS5	0.777		
Computer self-efficacy (CSE)	CSE1	0.745	0.920	0.546
	CSE2	0.693		
	CSE3	0.772		
	CSE4	0.782		
	CSE5	0.750		
	CSE6	0.685		
Prior experience (PE)	PE1	0.837	0.877	0.514
	PE2	0.842		
	PE3	0.555		
	PE4	0.583		
Task equivocality (TE)	TE1	0.741	0.797	0.542
	TE3	0.671		

Table 4. Discriminant validity.

	Interconstruct correlations							
Construct	BI	AT	PU	PEU	OS	CSE	PE	TE
BI	0.683							
AT	0.022	0.389						
PU	0.364	0.000	0.482					
PEU	0.248	0.038	0.240	0.515				
OS	0.248	0.000	0.234	0.155	0.563			
CSE	0.095	0.045	0.044	0.317	0.006	0.546		
PE	0.152	0.025	0.132	0.139	0.015	0.159	0.514	
TE	0.014	0.005	0.005	0.007	0.003	0.054	0.013	0.542

Note: Diagonals represent the square root of average variance extracted, and the other matrix entries are the factor correlation.

reliability, convergent validity and discriminant validity.

4.3.2. Structural model estimation and hypotheses testing

4.3.2.1. Descriptive statistics. The means and standard deviations for all constructs that were determined are displayed in Table 5. The highest mean of 3.99 is for the learning prior experience, on a scale of 1 to 5. The means for PU, PEU and intention to use are 3.95, 3.52 and 3.56, respectively, while the mean for the attitude towards using is 3.36.

4.3.2.2. Structural equation modelling (SEM). Structural equation modelling was performed to test the fit between the research model (Figure 2) and the obtained data. This technique was chosen for its ability to simultaneously examine a series of dependent relationships, especially where there were direct and indirect effects among the constructs within the model

(Hair *et al*. 2006). Amos 16.0 (Arbuckle 2005) is employed in this study, and the SEM estimation procedure is the maximum likelihood estimation. A similar set of fit indices is used to examine the structural model. Comparison of all fit indices with their corresponding recommended values provides evidence of a good model fit ($\chi^2/df = 1.571$, GFI = 0.90, AGFI = 0.87, CFI = 0.95 and RMSEA = 0.04). Table 6 shows the level of acceptable fit and the fit indices for the proposed research model in this study. The next step in data analysis is to examine the significance and strength of hypothesised relationships in the research model (Figure 3). The results of the analysis of the structural model, including path coefficients, path significances and variance explained (r^2 values) for each dependent variable are presented in Figure 3.

Table 5. Descriptive statistics.

Construct (# items)	Mean	Standard deviation
Behavioural intention (three items)	3.56	0.837
Attitude (three items)	3.36	1.071
Perceived usefulness (three items)	3.95	0.669
Perceived ease of use (three items)	3.52	0.823
Organisational support (five items)	3.50	0.824
Computer self-efficacy (six items)	3.64	0.789
Prior experience (four items)	3.99	0.729
Task equivocality (two items)	3.34	0.947

Table 6. Fit indices of the proposed research model.

Fit index	Level of acceptable fit	Proposed research model
Chi-square/degree of freedom (χ^2/df)	≤3.00	1.57
Goodness-of-fit index (GFI)	≥0.90	0.90
Adjusted goodness-of-fit index (AGFI)	≥0.80	0.87
Comparative fit index (CFI)	≥0.90	0.95
Root mean square residual (RMSR)	≤0.10	0.04

Figure 3 illustrates the resulting path coefficients of the proposed research model. Overall, 10 out of 13 hypotheses are supported by the data. Four endogenous variables were tested in the model. The results show that PU significantly influences BI ($\beta = 0.708$, $p < 0.01$) but not AT ($\beta = 0.137$, not significant). Thus, H1 is supported and H3 is not. PEU was found to be significant in influencing both PU ($\beta = 0.304$, $p < 0.01$) and AT ($\beta = -0.238$, $p < 0.01$), supporting hypotheses H2 and H4. AT significantly influences BI ($\beta = -0.165$, $p < 0.01$), supporting hypothesis H5. OS was found to be significant in influencing PU ($\beta = 0.438$, $p < 0.01$) and PEU ($\beta = 0.343$, $p < 0.01$), thus supporting hypotheses H6 and H7. CSE was found to be significant in influencing PEU ($\beta = 0.413$, $p < 0.01$) but not PU ($\beta = -0.071$, not significant), thus supporting hypotheses H11 but not H10. PE was found to be significant in influencing both PU ($\beta = 0.291$, $p < 0.01$) and PEU ($\beta = 0.149$, $p < 0.01$), supporting hypotheses H8 and H9. TE was significant in influencing PU ($\beta = 0.161$, $p < 0.05$) but not PEU ($\beta = -0.049$, not significant). Therefore, H12 is supported and H13 is not. PU was found to be significantly determined by the three

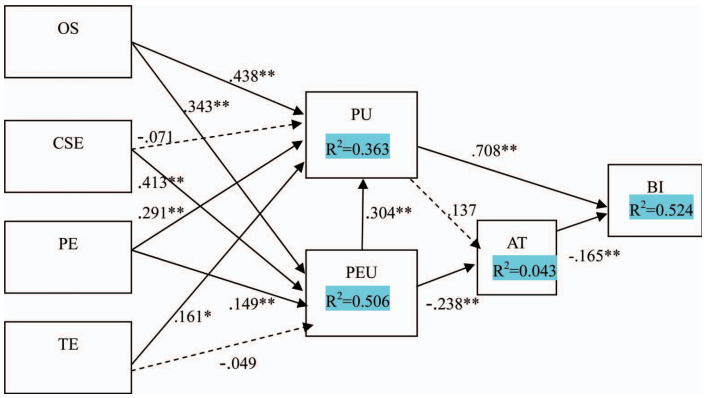

Figure 3. Model path coefficients. *$p < 0.05$; **$p < 0.01$.

exogenous variables (OS, PE and TE) and through the direct effect of PEU, resulting in R^2 of 0.363. This means that the above variables explain 36.3% of variance in PU. Likewise, PEU was found to be significantly determined by the three exogenous variables (OS, CSE and PE), resulting in R^2 of 0.506. This means that the above exogenous variables explain 50.6% of variance in PEU. AT was significantly determined by PEU, although the percent of variance explained was low ($R^2 = 0.043$). The dependent variable BI was significantly determined by PU and AT, resulting in an $R^2 = 0.524$. In other words, the combined effects of PU and AT explained 52.4% of the variance of BI. A summary of the hypotheses testing results is shown in Table 7.

5. Discussions

This study intends to explore employees' intention to use e-learning systems with the TAM model and investigate the effects of organisational support, individual characteristics and task characteristics on PU and PEU. Participants were selected from companies that have already implemented e-learning systems. Three hundred thirty-two valid questionnaires were collected, and SEM was conducted to test the research hypotheses.

The study results clearly indicate that the TAM appears to provide researchers with a theoretically sound and parsimonious model, which can be used to predict employees' BI to use e-learning systems in organisations. Results show that PU and PEU affect employees' intention to use e-learning systems. With the agreement of prior findings, it was found that both usefulness and ease of use are important factors in determining the acceptance of e-learning systems in organisations.

Table 7. Hypothesis testing results.

Hypotheses	Path	Path coefficient	Results
H1	PU → BI	0.708**	Supported
H2	PEU → PU	0.304**	Supported
H3	PU → AT	0.137	Not supported
H4	PEU → AT	−0.238**	Supported
H5	AT → BI	−0.165**	Supported
H6	OS → PU	0.438**	Supported
H7	OS → PEU	0.341**	Supported
H8	PE → PU	0.291**	Supported
H9	PE → PEU	0.149**	Supported
H10	CSE → PU	−0.071	Not supported
H11	CSE → PEU	0.413**	Supported
H12	TE → PU	0.161*	Supported
H13	TE → PEU	−0.049	Not supported

Note: *$p < 0.05$; **$p < 0.01$.

Consistent with the findings from previous studies (Sivo *et al.* 2007, Lau and Woods 2008), employees' attitudes towards the use of e-learning systems are significantly influenced by his/her perception about the ease of use and usefulness. Employees' perceptions of ease of use had even stronger influences on attitudes than employees' perceptions of usefulness. With a direct relationship between attitude and BI to use, PEU is found to be the most significant factor affecting employees' intentions to use e-learning systems. Concurrently, BIs to use the e-learning system is strongly related to attitude and PU. This finding supports existing studies showing a strong relationship between PEU and PU, as originally proposed by Davis *et al.* (1989). If e-learning systems are perceived to be easy to use, employees may perceive them as being useful. E-learning systems are perceived to be useful, if employees believe that they know how to use them. The significant relationship between PEU and AT is a logical one and supports current research that AT is strongly associated with PEU. Such findings are also in agreement with the conclusions reported by Sime and Priestley (2005) whose results indicate that attitude towards the use of the IT tool is influenced by how easy it is to use the tool.

The findings of this study show that organisational support is significantly associated with PEU and PU and in turn related to intention to use. Consistent with previous findings (Essex and Magal 1998), this study finds that given the assistance and other resources from top management, employees are likely to believe that e-learning systems are useful and easy to use. These results also echo research findings suggesting that organisational support affect the ability to achieve both individual and organisational goals (Igbaria *et al.* 1997, Sharma and Yetton 2003). Therefore, to enhance the employees' perception of ease of use, managers should provide employees with organisational support for using e-learning systems. With upper management support, organisations are more likely to show determination to use e-learning systems, which, in turn, lead other management levels from different sectors to follow and then strengthen employees' confidence and determination. Moreover, as discussed by Sharma and Yetton (2003), relevant literature in general suggests strong effects of organisational and management support on information technology implementations without much empirical data available to support of such a conjecture. Thus, our result adds empirical evidence to support this relationship.

The results of this study also indicate that computer self-efficacy has positive effects on employees' PEU of e-learning systems. Consistent with previous findings (Chang and Tung 2008, Hu *et al.*

2003, Yuen and Ma 2008, Kwon *et al*. 2007), employees with high computer self-efficacy tended to have higher expectations to use computers to perform their jobs. Namely, those who were highly confident in their computer skills were more likely to perceive e-learning systems easy to use, which, in turn, led to higher BIs to use e-learning systems.

On the other hand, insufficient knowledge of information technology or limited computer literacy negatively impacts the PEU of information technology (Kim *et al*. 2007). In other words, if employees believe that they have the abilities to use e-learning systems and they are given the opportunity experience to try out the computer software and equipment, then they tend to believe in the ease of use of e-learning systems.

This study found that prior experience significantly affected PEU and PU of the e-learning system, which is consistent with existing research showing that prior experience influences users' intentions to use various technology applications (e.g. e-learning) (Tan and Teo 2000, McFarland and Hamilton 2006). It may be inferred that users employ the knowledge gained from prior computer experience to perceive the ease of use and usefulness of the system, which in turn enhances their intentions to use the e-learning systems.

From a management perspective, our findings suggest that computer self-efficacy is of great importance and trainers must overcome certain baseline learning curves beyond which technology acceptance can be facilitated by training employees on more sophisticated technologies (Hu *et al*. 2003). In essence, this suggests that there may be some efficacy antecedents that influence employees' willingness to adopt e-learning systems in organisations. This insight is particularly important for research into e-learning system acceptance, which aims at the acceptance decisions by those employees who do not feel comfortable about new e-learning technologies.

Consistent with previous studies (Kim *et al*. 2007, Lee and Kim 2009), these findings indicated that task equivocality significantly affected PU because a majority of the participants of this study were experienced workers. As Dishaw and Strong (1999) noted, experienced employees often choose tools or approaches that can accomplish their tasks more efficiently. Accordingly, participants perceived the e-learning systems to be useful in helping them deal with job uncertainty. When employees encounter a high level of task uncertainty, predetermined organisational procedures would be difficult to implement. Therefore, employees are more likely to search for a useful channel (i.e. e-learning system) to assist them in performing uncertain tasks (Huang 2000). While this might explain the reason why task equivocality has a significant effect on PU, it did not have a significant effect on PEU. PEU is mostly determined by whether or not the e-learning system is easy to use. Therefore, task equivocality is not a major factor that influences PEU, which is consistent with the results reported by Kim *et al*. (2008).

6. Limitations and suggestions for future studies

The results of this study have theoretical implications for TAM and e-learning research. We provide strong support for the view that TAM and its antecedent variables predict employees' BIs to use e-learning systems. The present findings also add to the existing body of research examining the effects of organisational support, computer self-efficacy, prior experience and task equivocality on PU and ease of use. These findings may have practical implications to organisations planning to design and implement e-learning systems.

First, rigorous research procedures are used, but this research has some limitations that could be addressed in future studies. The results of this study should be interpreted with some caution due to the lack of random selection from the population (Sivo *et al*. 2006). Our findings and implications are inferred from a very limited number of organisations in Taiwan that use different e-learning systems. Thus, one should exercise caution in interpreting the results when generalising the findings and extending the discussion to other organisations. Moreover, a cross-cultural validation involving another sample pool is strongly suggested for further examination of the present results.

Next, there may be a need to search for additional variables that will improve our predictability to determine the factors that affect the employees' acceptance of e-learning systems. Future researchers can investigate other variables, such as organisational structure, prior training regarding specific technologies and user satisfaction. For instance, more effort can be made to explore the relationship between the BIs and satisfaction of those who use e-learning systems. However, additional variables should be selected with reference to appropriate theories.

Third, self-reported measurement was used in this study. In reality, there could be differences between how the participants responded and what they actually did in terms of actual use of the e-learning system. Hence, other methods of data collection (i.e. interviews and focus groups) and appropriate qualitative analyses should be conducted to provide a holistic understanding of the results of the current study.

Finally, our model is cross-sectional and measures perceptions and intentions to use at a single point of time. It must be noted that individuals' perceptions

change over time as they gain more experience (Mathieson *et al*. 2001, Venkatesh and Davis 1996, Venkatesh *et al*. 2003). Therefore, longitudinal research should be conducted to evaluate the validity of the proposed model and our findings. Longitudinal evidence would not only help predict users' behaviours over time, but would also enhance our understanding of the causality and the interrelationships among variables that are critical to the acceptance of e-learning systems by organisational employees.

Despite its limitations, this study has value as the findings provided several important implications for organisational trainers, educators and e-learning system developers.

7. Conclusions and implications

This study conducted an empirical investigation of the antecedents of PU and ease of use in acceptance of e-learning systems. The findings provide several important implications for e-learning researchers and practitioners. Through the antecedent variables of PU and PEU, e-learning systems practitioners and trainers can better predict users' attitudes towards e-learning systems, and then suggest new strategies for improving intentions. The results of this study also suggest that educational technology researchers should take individual characteristics, organisational factors and task attributes into consideration in the development and validation of the theories of educational technology acceptance.

New technologies have been implemented in organisations with the hope that they can increase productivity of their business processes and improve employee participation and satisfaction (Larsen 2003, Marler and Dulebohn 2005). However, how to gain user acceptance and system adoption remain important in the initial stage of the design and implementation. The results of this study suggest that acceptance and adoption are mainly determined by the usefulness of e-learning systems and the ease with, which learners can operate the systems. When implementing e-learning systems, it is therefore essential to focus on both usefulness and ease of use.

Additionally, the results of this study also suggest that ease of use and usefulness can be positively influenced by organisational support, computer self-efficacy, prior experience and task equivocality. As Konradt *et al*. (2006) noted, management support is positively related to employees' acceptance of computer technology programs. It is suggested that senior executives provide organisational support in the process of adopting e-learning systems. Alternately, it is advisable to prioritise employees' characteristics (i.e. computer self-efficacy, computer experience and task characteristics) in the selection of potential e-learning systems. Consideration of employees' attributes should be an essential step in the system adoption process, for example by surveying employees regarding their computer self-efficacy, computer experience and task characteristics. As social cognitive theorists note, BI is a function of an individual's characteristics and prior experience as related to a specific situation. It is, therefore, suggested that researchers should cautiously investigate the role of antecedent variables as they are associated with user acceptance behaviours.

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