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An empirical investigation into factors influencing the adoption of an e-learning system

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Abstract

Purpose – The purpose of this research is to investigate the factors affecting the adoption of the e-learning system (ELS) in mandatory and voluntary settings, through an extension of the technology acceptance model (TAM).

Design/methodology/approach – Regression analysis was used to observe the associations of proposed constructs.

Findings – The results of the study confirm the original TAM findings. In mandatory settings, students would only intend to use the ELS. Computer self-efficacy demonstrated significant influence on perceived ease of use. Effects of course attributes on perceived usefulness were negatively significant. Effects of content quality on perceived usefulness were significant. This study found that the effects of subjective norm significantly influenced perceived usefulness in both settings. Also, perceived network externality exerts a significant direct effect on usage intentions, perceived usefulness, and perceived ease of use. This research implied that, first of all, mandatory usage is necessary for overall adoption of the ELS. The ELS should be developed to target changes in perceived usefulness, perceived ease of use, and perceived network externality. Practical alternatives included enhancing content quality, developing a simple and easy-to-use system, and enhancing students' computer self-efficacy. Secondly, perceived network externality was important in ELS adoption. That is, promotion of the system should emphasise the popularity of the system and future ELS products and services in order to create bandwagon effects.

Originality/value – These findings suggested an extended model of TAM for the ELS. This research advances theory and contributes to the foundation for future research aimed at improving our understanding of students' adoption behaviour of the e-learning system.

Keywords E-learning, Quality, Computers, Internet, Worldwide web

Paper type Research paper

Introduction

E-learning generally refers to methods of learning which use electronic instructional content delivered via the internet and is a term which is synonymous with Web-based or online learning (Trombley and Lee, 2002). In this age of globalisation knowledge acquisition has become the critical means for gaining competitive advantage, and as such learning has become a crucial element of knowledge acquisition, application and creation (Longworth and Davies, 1996). The widespread proliferation of internet technologies and applications provides incredible opportunities for the delivery of education and training, and with rapidly increasing internet usage e-learning has now become a portable and flexible new method for learners to gain essential knowledge.

Students having access to an e-learning system can now interact with instructional materials in various formats (text, pictures, sound, video on demand, and so on)

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anywhere and at any time, as long as they can log on to the internet. Furthermore, given the functionality of message boards, instant message exchanges and video conferencing, they can even interact with teachers and classmates both individually and on a simultaneous basis. They can also engage in self-paced learning, taking control over both the process and the content of their learning (Trombley and Lee, 2002; Zhang and Zhou, 2003).

A number of studies have already examined e-learning on the internet, with most of these studies investigating the relationship between instructional materials and the structure of such materials, teaching strategies, the personalities of learners and the self-control and behaviour of students (in terms of their self-discipline when using the internet as a main teaching tool). For example, in their investigation of the relationship between self-controlled learning and the online search behaviour of students in universities Eom and Reiser (2000) found that younger students needed a more organised structure of course materials and ongoing help. McManus (2000) concluded that the personalities of learners, the structure of the materials and the teaching strategies each had some influence on the ways in which students self-regulated their learning behaviour. Mason and Weller (2000) experimented a Web-based course, "Your computer and the Net", on a large scale. Students in this course were required to construct their assignments as HTML documents and submit them electronically. They found that Web-creation skills, previous computing experience, group collaboration and input of time are important factors affecting students' acceptance of the long distance education system.

It is clearly of importance to gain an understanding of the success factors contributing to the acceptance of the Web-based e-learning system by learners. With this as the ultimate aim this paper sets out to investigate factors that were rarely tested in e-learning contexts with the technology acceptance model (TAM). The specific objectives of this study are: (i) to develop an extended TAM for the determinants of the acceptance of e-learning; and (ii) to investigate both the direct and indirect effects of these determinants of acceptance.

Literature review

Building on the "theory of reasoned action" model, Davis (1989) proposed the Technology Acceptance Model (TAM) in an effort to explain and predict the adoption and use of information technology at work in 1989. The TAM theorised that perceived usefulness (PU) and perceived ease of use (PEOU) were two key determinants of technology adoption. Davis referred to PU as the degree to which individuals expected that the adoption of a particular technology would enhance their job performance, while PEOU was the degree to which individuals believed that using a particular technology would be simple (Davis, 1989).

According to the TAM (Davis, 1989), both PU and PEOU influence the attitude of individuals towards the use of a particular technology, while attitude and PU predict the individual's behavioural intention (BI) to use the technology. PU is also influenced by PEOU, since PEOU can indirectly affect the acceptance of technology through PU, while BI is also linked to subsequent adoption behaviour. TAM also suggests that external variables intervene indirectly, influencing both PU and PEOU. "Attitude" was subsequently omitted from the model by Davis *et al.* (1989) as a result of its weak correlation with both BI and PU. Figure 1 presents Davis' original version of TAM.

Extended TAM for e-learning systems

The Technology Acceptance Model developed by Davis (1989) has been widely used over the past decade as a means of forecasting the extent to which new technologies will be adopted in the field of information systems (IS), with the findings of many studies being consistent with TAM applications. In their various applications of the TAM, a number of studies have confirmed that user perceptions of usefulness and the ease-of-use of a system are two important antecedents of technology adoption, and have also suggested various ways of broadening the overall applicability of the TAM (e.g., Davis *et al.*, 1992; Igbaria *et al.*, 1997; Gefen and Straub, 1997, 2000; Venkatesh, 2000; Venkatesh and Davis, 2000; Gefen, 2003; Hsu and Lu, 2004; Ong *et al.*, 2004).

As the e-learning system promises a new way of delivering education, TAM could be useful in predicting students' acceptance of an e-learning system (ELS). However, very few studies have adopted the TAM as a model for explaining the use of an ELS designed and provided by schools. A number of studies tended to focus on the acceptance of students by course Websites on quite a small scale. For example, Selim (2002) and Babenko-Mould *et al.* (2004) tested the two TAM constructs of "perceived usefulness" and "perceived ease-of-use" as predictors of user acceptance of course Websites, with the results indicating a good fit for the TAM.

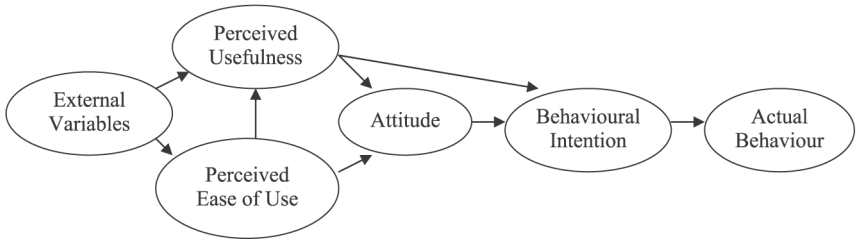
In this paper an extended model is proposed, based on an extension of the TAM approach; the extended model includes constructs and relationships which may prove to be important in the context of e-learning. These constructs are:

- content quality;
- perceived network externality;
- computer self-efficacy;
- course attributes;
- subjective norm; and
- a mechanism of competing behavioural intentions to e-learning.

The theoretical approach is reviewed below.

Determinants of the e-learning system adoption

Behavioural intention (BI). According to the empirical results reported by Ajzen and Fishbein (1980), technology acceptance is determined by BI. Therefore, within an e-learning context the adoption of an ELS is a positive function of the intention (BI) to accept the system.



Source: Davis (1989)

Figure 1.
Technology Acceptance Model

Competing behavioural intentions (CBI). The adoption of a new idea or an innovative technology by any group of people is the result of logical decision making with regard to choice (Chu and Chiu, 2003). Many decision-making theories offer explicit frameworks to assist in making the correct choices (from a logical perspective) from a set of alternatives. Although the TAM has some considerable strength, in terms of predicting about 40 per cent of the use of a system (Venkatesh and Davis, 2000), its main ability to predict individual behaviour fails to deal with behavioural choices when the individual is faced with alternatives.

When considering the use of an ELS, students may also choose to receive instructional material and education within classroom (face-to-face) settings, or to make use of educational videos or educational CD-ROMs. The prediction of technology adoption has to consider alternative settings, which may have some impact on eventual adoption behaviour (Harrison, 1995). In the extended TAM for e-learning, as opposed to simply being an indication of the intention to accept the system, the adoption of the ELS is actually a function of competing intentions (CBI), which is determined by a positive function of intention to use the ELS and the simultaneous negative functions of intention to use competing learning media. In other words actual adoption behaviour is the consequence of a choice between BI and CBI to receive education. We therefore propose the following hypotheses based on the preceding discussion:

H1. The behavioural intention to accept the e-learning system positively affects user adoption.

H2. User adoption is determined by a positive function of intention to use the system and a negative function of other competing behavioural intentions.

Determinants of behavioural intentions to adopt the e-learning system

Perceived usefulness (PU). The perceived usefulness of a system is defined as the extent to which individuals believe that using the new technology will enhance their task performance. Numerous empirical studies have provided support for the proposition that PU is the primary predictor of information technology usage (Davis, 1989; Davis *et al.*, 1992; Igbaria *et al.*, 1997; Gefen and Straub, 1997, 2000; Venkatesh, 2000; Venkatesh and Davis, 2000; Gefen, 2003; Hsu and Lu, 2004; Ong *et al.*, 2004). An ELS can be viewed as an information technology device, and students will use the system only if they perceive that its use will enhance their learning performance. Such performance enhancement may be measured in terms of learning productivity (or learning efficiency), the effectiveness of learning and improvements in grades. In the context of e-learning, therefore, PU refers to the extent to which students believe that using the ELS will enhance their learning performance. Therefore, PU will influence their intention to accept and adopt the ELS, either directly or indirectly (through perceived ease of use).

Perceived ease of us. The perceived ease of use (PEOU) of a system is defined as the degree to which an individual believes that using a particular technology will be free of effort. The results of many of the prior empirical studies have demonstrated that PEOU has a positive correlation with BI, both directly (Davis, 1989; Gefen and Straub, 1997, 2000; Venkatesh, 2000; Venkatesh and Davis, 2000; Gefen, 2003) and indirectly, through PU (Davis, 1989, 1992; Igbaria *et al.*, 1995, 1997; Venkatesh, 2000; Venkatesh and Davis, 2000). In the context of e-learning PEOU is defined as the degree to which a

student believes that the use of an ELS will be free of effort and easy to use. Students' interaction with the e-learning is clear and understandable (Davis, 1989). PEOU will similarly affect a student's intention to accept the ELS directly or indirectly through PU. Based upon the preceding research, the following hypotheses are proposed:

H3. Perceived usefulness positively affects the intention of users to accept an e-learning system.

H4. Perceived ease of use has a positive effect on the perceived usefulness of an e-learning system.

H5. Perceived ease of use has a positive effect on the intention of users to accept the e-learning system.

Perceived content quality

The results of many empirical studies have also indicated that information quality is important in determining users' level of satisfaction with the system, which in turn leads to system utilisation (Delone and McLean, 1992; Katerattanakul and Siau, 1999; McKinney *et al.*, 2002). There are two dimensions of content quality: "content richness", and "update regularity". The first of these, "content richness", positively affects learners' level of satisfaction with the course (Burns *et al.*, 1990; Arbaugh, 2000). The richness of the endorsed course content within an ELS can be provided by educational software on a CD-ROM; however, what makes the ELS different is the extent to which learners can adapt the system, as opposed to simply using traditional learning methods. CD-ROMs should, therefore, have a close association with the content quality available through the latest internet technology. The internet offers content richness far beyond that which any other technology can offer, since the entire information content of the internet is available as complementary course content. The special characteristics of internet hyperlinks and interactivity allow students and teachers to share and access numerous resources, in addition to the fundamental course contents (Boisvert, 2000; Peterman, 2000; Chew, 2002).

An ELS has greater appeal to students because of the richness of content provided by the internet, as compared to traditional learning methods. Students themselves, teachers, and classmates, can search through the related content on the internet and then share it on the system. If a student who was a potential user of the system perceived that the content quality (CQ) on the ELS was high, there would be a high probability of that student regarding the content as having a positive effect on learning, and therefore that the student would adopt the system. It is therefore reasonable to assume that content quality on the ELS has a positive association with students' adoption of the ELS.

The second dimension relates to "update regularity". The internet has become a new focus for major software companies such as Microsoft to improve their product quality, since it attracts many potential customers to accept and buy new software products, largely because they know that the product quality can be continually enhanced simply by downloading the files online (Szajna, 1996). By the same token course content on the ELS can be updated anytime, anywhere. Burns *et al.* (1990), Arbaugh (2000) and Chen *et al.* (2003) each found that learner satisfaction would be enhanced significantly if they could obtain updated e-learning content on a regular basis. Updated content, and new content, may lead students to feel that the ELS is a useful

means of gaining new knowledge and learning. This research, therefore, hypothesises that update regularity positively affects utilisation of the ELS by students.

H6. Perceived content quality positively affects perceived usefulness.

Perceived network externality

Derived from Metcalfe's law, network externality relates to an increase in the value of a product or service to a consumer, not because of the inherent quality of the product or service, but because of increasing numbers of others adopting it (Katz and Shapiro, 1985). For example, the value of the internet increases as it allows more people to communicate and exchange information with other participants; its popularity, in turn, attracts more users to that technology.

Several studies which have examined the effects of network externality on the adoption of information technology from the aspect of "critical mass" have referred to the level of importance of a consumer's perception of the adoption of the technology by other consumers (Luo and Strong, 2003; Hsu and Lu, 2004). In the context of e-learning this perception can also create bandwagon effects. In other words, if students perceive that increasing numbers of their classmates are using the ELS, they will also try out the system.

However, consideration of critical mass simplifies the indirect effects of network externality on the adoption intentions of users. Consumers' perceptions of the eventual development of related products and services, along with their perceptions of increasing numbers of others supporting that technology, would add value to the technology, which would eventually lead to further increases in the number of others adopting its use (Nault and Dexter, 1994; Wang and Seidmann, 1995; Shapiro and Varian, 1999). Consumers will, therefore, take into consideration related products and future support when deciding whether to adopt a technology. When examining students' perceived network externality (PNE) on an ELS, we must therefore include two additional aspects:

(1) whether potential users of the ELS perceive an increase in the total number of users; and

(2) whether potential users of the ELS perceive that related products and services (such as books, equipment, compatible software and hardware, and training and support) will be available.

Based on the above discussion, the following hypotheses are proposed:

H7. Perceived network externality positively affects perceived usefulness.

H8. Perceived network externality positively affects perceived ease of use.

H9. Perceived network externality positively affects behavioural intention to use the e-learning system.

Computer self-efficacy

Self-efficacy refers to people's judgement of their own ability to perform specific tasks (Bandura, 1982, 1997). Compeau and Higgins (1995) and Compeau and Huff (1999) defined computer self-efficacy as individuals' beliefs with regard to their ability to use

a computer in the context of IT usage. In end-user computing research this internal perception affects the expectations of individuals using the computer to perform a job, and therefore their use of an information system. Self-efficacy has been studied extensively in teaching-learning settings (e.g., Lent *et al.*, 1984; Compeau and Higgins, 1995; Compeau and Huff, 1999; Madorin and Iwasiw, 1999; Hasan and Ali, 2004; Hayashi *et al.*, 2004; Yi and Im, 2004), with the results demonstrating that higher levels of self-efficacy lead to better learning performance.

Computer self-efficacy (CSE) plays a critical role in terms of its effect on PEOU (Madorin and Iwasiw, 1999) and PU (Venkatesh and Davis, 1996; Hayashi *et al.*, 2004), because individuals' confidence in their computer-related knowledge and abilities can influence their judgement of the ease or difficulty of carrying out a specific task using a new IT, and how useful that new IT will be. This study examines whether computer self-efficacy is an antecedent of PEOU by modifying the three distinct, but interrelated, dimensions of computer self-efficacy proposed by Compeau and Higgins (1995). The three dimensions ("magnitude", "strength" and "generalisability") are explained as follows:

(1) The "magnitude of computer self-efficacy" is defined as the extent to which people believe they can accomplish difficult tasks using a computer (Compeau and Higgins, 1995). In the context of e-learning, students with a high magnitude of computer self-efficacy, will believe in their ability to use the ELS to receive education, even though they may face tasks that are more difficult than those faced by others with a lower magnitude of computer self-efficacy. Those students with a higher magnitude of computer self-efficacy will have higher expectations of their ability to operate the system with less reliance upon constant assistance and support. They will, therefore, regard the system as useful in their learning.

(2) The "strength of computer self-efficacy" is interpreted as reflecting the power of self-judgement by individuals (Compeau and Higgins, 1995). Students possessing high levels of strength of computer self-efficacy will be confident in their ability to overcome any obstacles, and to achieve learning, when using the ELS. Those with a lower strength of computer self-efficacy will have lower confidence in their ability to use the system, and will therefore be more easily deterred by the difficulties encountered.

(3) The "generalisability of computer self-efficacy" refers to the perception by people of their ability to use various computer software and hardware devices (Compeau and Higgins, 1995). Students with a lower generalisability of computer self-efficacy will tend to use only certain e-learning software and hardware devices. Conversely, those with a higher generalisability of computer self-efficacy will have greater confidence in their ability to use different e-learning software and hardware devices.

H10. Computer self-efficacy positively affects perceived usefulness.

H11. Computer self-efficacy positively affects perceived ease of use.

Course attributes

Although the TAM can help to provide an understanding of the overall utilisation of information technology, it fails to take into account course attributes which may affect

the acceptance and use of such technology, as well as the subsequent level of performance. In consumer research, a purchasing intention is affected, both directly and indirectly, by product attributes (Holak, 1988; Kotler, 1998; Phau and Poon, 2000), with different product characteristics having the ability to satisfy the needs of various consumers (Kotler, 1998; Phau and Poon, 2000). In the context of the internet various market research studies on e-commerce have reported that not all kinds of products are suitable for online trading. Given the special characteristics of the technology involved, consumers tend to buy only certain kinds of products on the internet, such as travel packages and services, computer software and hardware and telecommunications products. Cars, food, cards, tools and pet products are just a few examples or the sorts of products that consumers are less likely to purchase online.

We may, similarly, assume that not every kind of course will be considered suitable for inclusion in an ELS, since the functionality of an ELS has to correspond with the requirements of a particular course; thus, course attributes (CA) involve the particular course characteristics. Students using the ELS can judge whether the system has desirable system characteristics; therefore, the matching of the capabilities of an ELS to the requirements of the course may have some effect on their decision to adopt the system. Students will use an ELS only if the available functions support the processes and demands required by the courses to accomplish their educational mission. For example, arts students may find that an ELS corresponds less to their needs on an oil-painting course, where the actual practice of painting on a canvas is the core activity. However, the same students may well find that other courses, such as the history of art and art theory, are eminently suitable for inclusion within the ELS, since they can use the system to display text information or to demonstrate art performance in multimedia forms. This study, therefore, hypothesises that the assessment of course attributes by students, will have an effect on their perception of the usefulness and the ease of use of the ELS, as well as on their subsequent adoption decisions. Students who find that the ELS fits the course requirements well, will regard the system both as useful, and easy to use:

H12. Course attributes positively affect perceived usefulness.

H13. Course attributes positively affect perceived ease of use.

Subjective norm

Social influence profoundly affects user behaviour. In TRA (Fishbein and Ajzen, 1975, p. 302) and TPB (Ajzen, 1991) social influence was tested as subjective norms on behavioural intention. A person's subjective norm is determined by her perception that salient social referents think he/she should or should not perform a particular behaviour (Fishbein and Ajzen, 1975, p. 302). That person is motivated to comply with the referents even if he/she herself does not favour the behaviour. The referents may be superiors (e.g., (parents or teachers) or peers (e.g., friends or classmates) (Taylor and Todd, 1995a; Taylor and Todd, 1995b). For example, a student may believe that the teacher thinks that he or she should use the e-learning system. If that student is strongly motivated to comply with the expectations of the teacher, a positive impact on subjective norm may occur. In addition from the theory of group influence processes, an individual tends to conform to the expectations of others to strengthen relationships with group members or to avoid a punishment (Goodwin, 1987; Deutsch and Gerard, 1995).

Though the effect of subjective norms (SN) on intention is inconclusive, from prior research there is a significant body of theoretical and empirical evidence regarding the importance of the role of subjective norm on technology use, directly or indirectly, through perceived usefulness in the workplace (e.g., Taylor and Todd, 1995a; Venkatesh and Davis, 2000; Hsu and Lu, 2004). Therefore, this research includes subjective norms on the utilisation of e-learning systems. The purpose is to predict whether social influence is an important consideration in people's decision to use the system. However, Agarwal and Prasad (1997) and Venkatesh and Davis (2000) found a direct effect of subjective norm on intentions when the use of the information systems was mandatory, because mandating the use enabled users to overcome difficulties of use. Likewise, this research theorises that the direct effect of subjective norm on intentions can only be found when the teacher mandates the use of the e-learning system, because the pressure of mandating the use of the ELS enables students to overcome the hurdle of system utilisation:

H14. Subjective norm is positively associated with perceived usefulness.

H15. Subjective norm will have a positive direct effect on intention to use when the ELS use is perceived to be mandatory.

Figure 2 presents all elements and relations in the extended TAM of the e-learning system.

Methodology

Development of the survey instrument

The survey instrument for this study was developed using validated items from the prior research as a means of assessing the theoretical constructs of the extended TAM model for ELS, using the TAM scales of PU, PEOU, BI and CBI from Davis (1989) and Davis *et al.* (1989). A scale for measuring subjective norms was developed using the measures of Taylor and Todd (1995a, 1995b), while the measurement of voluntariness was adapted from Venkatesh and Davis (2000). The measurement of CBI was adapted

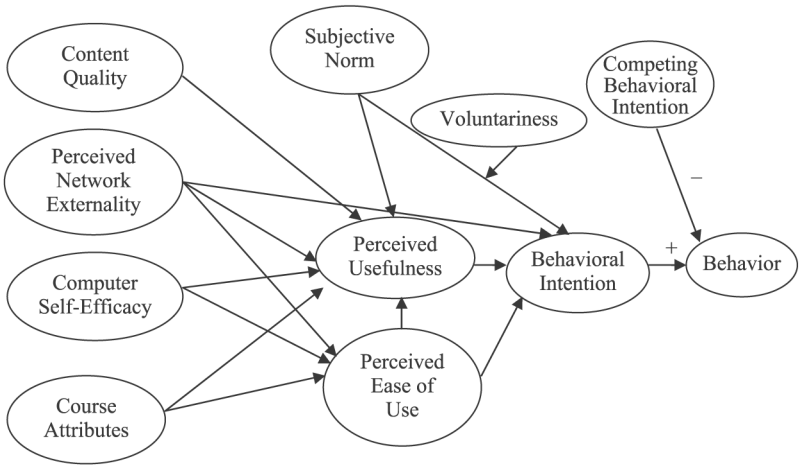


Figure 2.
Extended TAM for the e-learning system

from Chu and Chiu (2003). Following Lee (1986) and Chu and Chiu (2003), actual usage behaviour was measured by asking questions with regard to the actual amount of time spent per week on the ELS on a seven-point Likert scale ranging from (1) "almost never" to (7) "more than 10 hours per week". The subjects were also asked about their frequency of use of the system based on Raymond (1985), again using a seven-point Likert scale ranging from (1) "almost never" to (7) "more than 35 times a week".

The measurement of content quality was developed through an adaptation of the method proposed in Arbaugh (2000), while the measures of perceived network externality was adapted from the studies of Hsu and Lu (2004) and Wang and Seidmann (1995). A three-item scale of computer self-efficacy was also developed using the measures of Compeau and Higgins (1995). The course attributes construct was developed as a means of determining whether respondents felt that all courses were suitable for inclusion within an ELS, and whether they felt that the system could support the requirements of all courses.

All scales were modified to suit the context of e-learning and were measured on a seven-point Likert scale with "1" representing "strongly disagree" and "7" representing "strongly agree". The questionnaires were pre-tested on 22 respondents in order to discuss the length of the instrument, the format, and the clarity and appropriateness of the wording of the scales, which resulted in the revision or removal of some questions regarded as ambiguous. The final list of the items is shown below:

(1) *Behaviour (B)*:
   - On average, how often do you use the e-learning system each week?
   - On average, how much time do you spend on the e-learning system every week?

(2) *Competing Behavioural Intention (CBI)*:
   - I intend to use other means (such as participation in the classroom, educational CD-ROM or video) to learn instead of using the e-learning system to receive education.
   - I intend to learn by participating in the classroom, using CD-ROM or educational video instead of using the e-learning system to receive education.

(3) *Behavioural Intention (BI)*:
   - Assuming I have access to the e-learning system, I intend to use it.
   - Given that I have access to the e-learning system, I plan to use it.

(4) *Perceived usefulness (PU)*:
   - Using the e-learning system improves my learning performance.
   - Using the e-learning system increases my learning productivity.
   - Using the e-learning system enhances my effectiveness in my learning.
   - I find the e-learning system to be useful in my learning.

(5) *Perceived ease of use (PEOU)*:
   - Interacting with the e-learning system does not require a lot of my mental effort.
   - I find the e-learning system to be easy to use.

- My interaction with the e-learning system is clear and understandable.
- I find it easy to get the e-learning system to do what I want it to do.

(6) *Perceived content quality*:

- I search and share the related course content from the internet to help my learning.
- My teachers or classmates search and share the related course content from the internet to help my learning.
- Content on the e-learning system is updated on a regular basis.
- The e-learning system often provides the updated information.

(7) *Perceived network externality*:

- Most students in my university use the e-learning system.
- There will be more students using the e-learning system that I am using.
- As more and more students use the e-learning system, I think related services (such as training and support) will soon be developed.
- As more and more students use the e-learning system, I think related software and hardware will soon be developed.

(8) *Computer self-efficacy*:

- I am able to operate the e-learning system with less support and assistance.
- I am confident that I can overcome any obstacles when using the e-learning system.
- I believe that I can use different e-learning software and systems to receive education.

(9) *Course attributes*:

- Functions of the e-learning system support the processes and demands required by the course.
- Available functions on the e-learning system support requirements of the course.

(10) *Subjective norm*:

- My teachers think that I should use the system.
- My friends think that I should use the system.

(11) *Voluntariness*:

- My teachers do not require me to use the e-learning system.

Data collection procedures

An online field survey Website was created for the purpose of collecting empirical data. We first of all identified nine universities in Taiwan which had developed a unified Web-based ELS, then solicited volunteers to visit the Website by placing messages on campus bulletin boards within those universities from 13 October 2005 to 15 October 2005. The message clearly stated the purpose of the study and asked for the viewers' participation in the study by clicking a hyperlink to the survey form. As an incentive, respondents were offered an opportunity to participate in a draw for several prizes. The

online survey was conducted from 13 October 2005 to 13 November 2005. A total of 1,125 questionnaires were returned, with just 40 of these being omitted as a result of the forms being incomplete. The online survey, therefore, yielded 1,085 usable responses.

Results

Profile of the respondents

Of the total of 1,085 students participating in this research, 531 (48.9 per cent) were male, and 554 (51.1 per cent) were female, with most of these respondents (791 (72. 9 per cent) being undergraduate students. In terms of online experience, 32.2 per cent had five to six years experience. Most of the respondents reported that they were using the ELS about 22-28 times per week (49.3 per cent) and 7-8 hours per week (52.4 per cent). Based on measures of voluntariness, voluntariness ratings ranging from 1 to 3.5 were grouped as voluntary use of the ELS; voluntariness ratings ranging from 4.5-7 were grouped as mandatory use of the ELS. Of the 1,085 students, 77 respondents' use of the ELS were voluntary, 1,008 students' use of the ELS were mandatory (see Table I).

Measure	Items	Frequency	%
Gender	Male	531	48.9
	Female	554	51.1
Age (years)	18-22	740	68.2
	23-30	324	29.9
	31-35	9	0.8
	>36	12	1.2
Education	High school	22	2.0
	Some college	12	1.1
	Bachelor's degree	830	76.5
	Graduate degree	221	20.4
Years of online experience	<1	105	9.7
	1-2	105	9.7
	3-4	133	12.3
	5-6	349	32.2
	7-8	302	27.8
	>9	91	8.4
Hours of using e-learning systems	>1	16	1.5
	1-2	24	2.2
	3-4	32	2.9
	5-6	87	8.0
	7-8	569	52.4
	9-10	338	31.2
	>10	19	1.8
Frequency of using e-learning systems	>1	14	1.2
	1-7	17	1.6
	8-14	28	2.6
	15-21	90	8.3
	22-28	535	49.3
	29-35	346	31.9
	>35	55	5.1

Table I.
Profile of respondents

Psychometric properties of measures

The operationalisation of the construct followed the previous research. The survey instruments were adapted from those prior studies that had demonstrated evidence of the reliability and validity of each measurement, with each measurement scale showing strong psychometric properties (see Table II). All of the measurement scales exhibited high reliability, with Cronbach alpha coefficients exceeding 0.75 (see Table III). This pattern of high reliability is consistent with much of the prior research. Construct validity was verified by conducting confirmatory factor analysis. Table III demonstrated that the items were properly loaded on each factor, as expected. PU explained 24.61 per cent of all the variances. Varimax rotation methods were used, as any multiple constructs identified were expected to be correlated, rather than orthogonal. Because the results were the same, Varimax rotation method was used. It shows that the inter-item correlations were high and there were many items that correlated with other factors. Each construct could be distinguished at eigenvalues over 1.0. Tables IV and V present cross-sectional correlations among these constructs at voluntary setting and mandatory setting.

Analysis of the extended model

Structural equation modelling has been widely used to capture the fitness of the entire model. It also allows description of the direct and indirect effects of each construct, from the perspective of the entire model. However, regression analysis (forward) based on forced entry was used in this study to observe the inter-item correlations, at the cost of failing to capture the fitness of the entire model. This was because, as noted, the inter-item correlations were high, and there were more measurement items that significantly explained PU and PEOU than the number of exogenous variables originally used for measuring these constructs. In this condition the fitness of the original model would have been poor, if not manipulated in other ways. To observe high inter-item correlations regression analyses were performed to determine the relationship between constructs from these analyses. Stepwise regression analyses were performed in order to determine the significance and strength of each of the posited effects.

Explaining behaviour. A stepwise regression was first of all undertaken for behaviour and its determinants (BI and CBI). In Table VI the extended model for the ELS explained up to 17 per cent of the variance in usage. In both settings BI was a stronger predictor than the CBI. Contrary to the literature, the use of the ELS comes as

Construct	Number of items	Cronbach's α
Behaviour (B)	2	0.8429
Competing Behavioural Intention (CBOMBI)	2	0.8771
Behavioural Intention (BI)	2	0.8893
Perceived Usefulness (PU)	4	0.8247
Perceived Ease Of Use (PEOU)	4	0.7806
Content Quality (CA)	4	0.7920
Perceived Network Externality (PNE)	4	0.7307
Course Attributes (CA)	2	0.7968
Computer Self-Efficacy (CSE)	3	0.7134
Subjective Norm (SN)	2	0.7236
Voluntariness	2	0.8218

Table II.
Reliability of the measurement

	Component									
	1	2	3	4	5	6	7	8	9	10
PU2	0.810									
PU3	0.798									
PU4	0.741									
PU1	0.618									
CA4		0.792								
CA3		0.762								
CA2		0.710								
CA1		0.706								
PEOU2			0.758							
PEOU3			0.725							
PEOU4			0.703							
PEOU1			0.660							
CSE2				0.773						
CSE1				0.756						
CSE3				0.709						
PNE4					0.800					
PNE3					0.763					
PNE2					0.751					
PNE1					0.703					
SN2						0.783				
SN1						0.735				
CBI1							0.935			
CBI2							0.930			
BI2								0.862		
BI1								0.857		
CA1									0.907	
CA2									0.900	
B2										0.823
B1										0.792
Eigenvalue	7.138	2.052	1.891	1.760	1.687	1.458	1.226	1.149	1.026	1.013
% variance explained	24.613	7.077	6.522	6.070	5.817	5.026	4.229	3.962	3.538	3.492
Cumulative %	24.613	31.690	38.212	44.282	50.099	55.125	59.355	63.317	66.854	70.347

Table III.
Confirmatory factor analysis

Note: The extraction method was principal component analysis and the rotation method was Varimax with Kaiser normalization

a consequence of the intention to adopt and use the system to receive education, as well as the intention to use other means, since students may also wish to simultaneously use the ELS while using educational videos and CD-ROMs in voluntary usage contexts. In mandatory usage contexts adoption of the ELS was determined by a positive function of intention to use the ELS, while competing intentions had no effects on behaviour. Therefore, *H1* is supported, while *H2* is rejected.

Explaining intention. A further stepwise regression was carried out for BI and its determinants (PU, PEOU, PNE, and SN) (Table VI). The extended model for the ELS explained up to 53 per cent of the variance in perceived usefulness. The effects of perceived network externality and subjective norm on perceived usefulness was significant across the two settings (supporting *H14*). In mandatory settings (Table VI) this model explained 32 per cent of the variance in usage intention. Consistent with

Table IV. Cross-sectional correlation matrices

	Voluntary setting								
	PU	CQ	PEOU	CS	PNE	SN	CBI	BI	CA
PU									
CQ	0.537***								
PEOU	0.567***	0.706***							
CS	0.490***	0.547***	0.651***						
PNE	0.602***	0.464***	0.570***	0.433***					
SN	0.461***	0.329**	0.386***	0.281*	0.255**				
CBI	0.070***	0.306**	0.200	0.118	0.029	0.048			
BI	0.647***	0.470***	0.569***	0.513***	0.594***	0.451***	−0.124		
CA	−0.111	−0.030	−0.060	−0.040	−0.078	−0.165	0.007	−0.090	
B	0.432***	0.321***	0.310***	0.372***	0.308**	−0.380***	0.170	0.355**	−0.030

Notes: $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$

Table V. Cross-sectional correlation matrices

	Mandatory setting								
	PU	CQ	PEOU	CS	PNE	SN	CBI	BI	CA
PU									
CQ	0.344***								
PEOU	0.378***	0.322***							
CS	0.254***	0.239***	0.448***						
PNE	0.412***	0.373***	0.348***	0.254***					
SN	0.412***	0.221***	0.300***	0.190***	0.345**				
CBI	0.050	0.114***	0.036	0.149***	0.053	0.069*			
BI	0.429***	0.259***	0.359***	0.244***	0.374***	0.225***	−0.037		
CA	0.000	0.031	0.082**	0.111***	0.114***	0.051	0.069*	0.025	
B	0.249***	0.256***	0.263***	0.181***	0.269***	0.192***	0.033	0.181***	−0.045

Notes: $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$

	Voluntary setting		Mandatory setting	
	R^2	ß	R^2	ß
Behavioural intention and competitive behavioural intention against behaviour	0.17		0.03	
Behavioural intention		0.38***		0.18***
Competing behavioural intention			22*	0.04
Perceived usefulness, perceived ease of use, subjective norm, and perceived network externality against behavioural intention	0.54		0.26	
Perceived usefulness		0.31**		0.28***
Perceived ease of use		0.18		0.19***
Perceived network externality		0.26*		0.20***
Subjective norm		0.17		−0.02
Perceived ease of use, content quality, computer self-efficacy, perceived network externality, and course attributes against perceived usefulness	0.53		0.32	
Perceived ease of use		0.05		0.16***
Content quality		0.18		0.15***
Computer self-efficacy		0.13		0.05
Perceived network externality		0.37***		0.21***
Course attributes		−0.03		−0.06*
Subjective norm		0.25**		0.25***
Computer self-efficacy, perceived network externality, and course attributes against perceived ease of use	0.53		0.26	
Computer self-efficacy		0.50***		0.38***
Perceived network externality		0.35***		0.25***
Course attributes		−0.01		0.01

Notes: ß Standardised regression coefficients; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table VI.
Results of the regression analysis

much prior research, perceived usefulness was the strongest of the four predictors of intention to adopt the ELS (ß = 0.31 in voluntary settings; ß = 0.28 in mandatory settings). In both settings, perceived network externality was second (ß = 0.26 in voluntary settings; ß = 0.20 in mandatory settings). For both settings, intention fully mediated the effects of perceived usefulness and perceived network externality. The results provided support for *H3* and *H9*. Perceived ease of use had significant effects on BI only in mandatory settings, thus partially providing support for *H5*. The effects of subjective norm on intentions were not consistent with our expectations. That is, contrary to the study by Venkatesh and Davis (2000), subjective norm did not have a direct effect on intention. *H15* was rejected.

Explaining perceived usefulness. In the next stage perceived ease of use, content quality, computer self-efficacy, perceived network externality, course attributes and subjective norm were regressed against perceived usefulness. In Table VI this extended model explained up to 54 per cent of the variance in perceived usefulness. The effect of perceived network externality and subjective norm were significant across both settings (supporting *H7* and *H14*). The influences of perceived ease of use and content quality on perceived usefulness were significant when the use of the ELS was mandatory (partially supporting *H4* and *H6*). Note that the effects of course

attributes were found to be negatively significant in mandatory settings. *H12* was, therefore, rejected.

However, computer self-efficacy (ß = 0.5) had no significant effects on perceived usefulness. Thus *H10* was rejected.

Explaining perceived ease of use. Computer self-efficacy, perceived network externality and course attributes were then regressed against PEOU. The extended TAM for the ELS explained up to 53 per cent of the variance of perceived ease of use (Table VI). Computer self-efficacy was the strongest predictor of PEOU (ß = 0.431), followed by perceived network externality (ß = 0.50 in voluntary settings; ß = 0.38 in mandatory settings). The results, which provide support for *H8* and *H11*, are consistent with the prior research (Nault and Dexter, 1994; Wang and Seidmann, 1995; Madorin and Iwasiw, 1999; Shapiro and Varian, 1999; Luo and Strong, 2003; Hsu and Lu, 2004), that computer self-efficacy and perceived network externality had positive effects on perceived ease of use. However, course attributes had no significant effect on perceived ease of use. Thus *H13* was rejected.

Dimensions of perceived network externality, content quality, and subjective norm. A post hoc analysis was performed to better understand how dimensions of content quality, perceived network externality, and subjective norm, affect students' perception of the ELS. A regression was carried out for the two dimensions of perceived network externality and PU, PEOU and BI. In Table VII critical mass and eventual development of related products and services were both important for the ELS adoption. In mandatory settings the former was the stronger predictor of PU, PEOU and BI than the latter. The perception of increasing users of the ELS makes students think the e-learning system is useful and easy to use (Luo and Strong, 2003; Hsu and Lu, 2004).

In voluntary settings critical mass was the stronger predictor of PU than future development of related products and services. However, future development of related products and services was the stronger predictor of PEOU and BI than critical mass. Students placed more importance in eventual development of products and services related to the ELS than in critical mass when they intended to use the ELS. Students' perceptions of the eventual development of related products and services would add

	Voluntary setting		Mandatory setting	
	R^2	ß	R^2	ß
Critical mass and future services and products against perceived usefulness	0.41		0.17	
Critical mass		0.43^{***}		0.32^{***}
Future services and products		0.37^{***}		0.17^{***}
Critical mass and future services and products against perceived ease of use	0.35		0.12	
Critical mass		0.29^{**}		0.24^{***}
Future services and products		0.44^{***}		0.18^{***}
Critical mass and future services and products against behavioural intention	0.40		0.14	
Critical mass		0.33^{**}		0.23^{***}
Future services and products		0.45^{***}		0.22^{***}

Notes: $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$

Table VII.
Regression results for perceived network externality

value to the technology, because it may eventually lead to further increases in the number of others adopting its use (Nault and Dexter, 1994; Wang and Seidmann, 1995; Shapiro and Varian, 1999).

Another regression was carried out for PU and the two dimensions of content quality, namely "content richness" and "update regularity". Table VIII demonstrated that content richness was the stronger predictor of PU than update regularity. Content richness was especially important (ß = 0.44) in affecting students' perception of usefulness when the ELS use was voluntary. In mandatory settings both content richness and update regularity were antecedents of PU.

A further regression (Table IX) was carried out for the two dimensions of subjective norm. In voluntary settings effects of superiors were significant on PU and BI, but not peers. In mandatory settings effects of both superiors and peers were significant on PU and BI. Peer pressure seemed to be a stronger determinants than superiors.

Summary of results in voluntary settings and mandatory settings. Figure 3 provides a summary presentation of the results for the extended TAM for the ELS when data are pooled across voluntary settings and mandatory settings. Pooling yielded a sample of 1,085, which was used to estimate the summary model. Regression analyses were done to test the summary model, which yielded results that supported the basic TAM (i.e. intention-usage, usefulness-intention, ease of use-intention and ease of use-usefulness). Consistent with prior research, perceived usefulness was the strongest predictor of behavioural intention. Though the effects of competing behavioural intention on behaviour were not significant, the use of the ELS comes as a consequence of the intention to adopt and use the system to receive education, as well as the intention to use other means, since students may also wish to simultaneously use the ELS while using educational videos and CD-ROMs. As theorised, perceived network externality-intention relationship was significant. Consistent with our expectations, content quality, perceived network externality, computer self-efficacy, subjective norm and perceived ease of use

	Voluntary setting		Mandatory setting	
	R^2	ß	R^2	ß
Richness and update against perceived usefulness	0.31		0.12	
Richness		0.44^{***}		0.25^{***}
Update		0.13		0.16^{***}

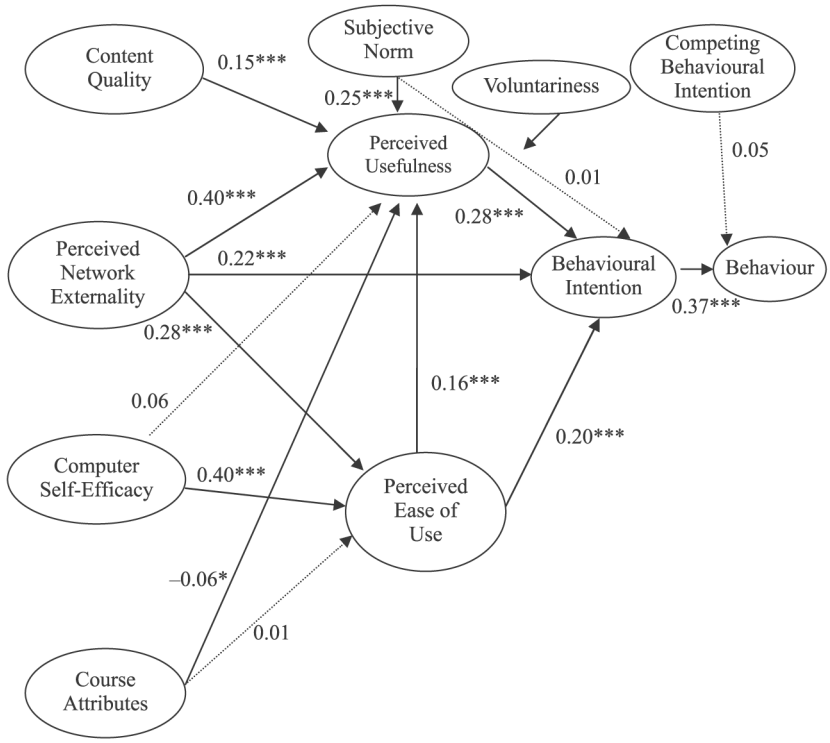
Notes: $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$

Table VIII. Regression results for content quality

	Voluntary setting		Mandatory setting	
	R^2	ß	R^2	ß
Friends and superior against perceived usefulness	0.26		0.18	
Friends/classmates		0.03		0.32^{***}
Superior		0.49^{***}		0.15^{***}
Subjective norm against behavioural intention	0.21		0.05	
Friends/classmates		0.16		0.14^{***}
Superior		0.36^{**}		0.12^{***}

Notes: $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$

Table IX. Regression results for subjective norm



Notes:
1. R^2 for BI is 0.30; R^2 for PU is 0.35; R^2 for PEOU is 0.30
2. *p<0.05 **p<0.01 ***p<0.001

Figure 3.
Research result

significantly and positively affected perceived usefulness. Also consistent with the literature, perceived network externality and computer self-efficacy significantly affected perceived ease of use. Course attributes negatively affected perceived usefulness and had no influence on perceived ease of use.

Discussion

The extended TAM for an ELS, incorporating the notion of competing behavioural intention, content quality, computer self-efficacy, perceived network externality, course attributes and subjective norm, provides a detailed account of the key forces underpinning decision making with regard to ELS adoption, explaining up to 54 per cent of the variance in this important driver of usage intentions. Contrary to Harrison's (1995) theory supporting that the adoption of the ELS was determined by a positive function of intention to use the ELS and the simultaneous negative functions of intention to use competing learning media, the intention to use the ELS is also complemented by the intention to engage in the use of educational videos and CD-ROMs in voluntary settings. In mandatory settings students would intend to use only the ELS.

Moreover, this extended TAM shows that perceived network externality exerts a significant direct effect on usage intentions, perceived usefulness and perceived ease of

use (Nault and Dexter, 1994; Wang and Seidmann, 1995; Shapiro and Varian, 1999; Luo and Strong, 2003; Hsu and Lu, 2004). This study found that critical mass was the stronger predictor of PU, PEOU and BI in mandatory settings, and of PU in voluntary settings. However, students placed more value on the future development of related products and services when deciding whether the ELS was easy to use, and whether to adopt the ELS in voluntary settings.

Computer self-efficacy demonstrated no significant influence on perceived usefulness, but on perceived ease of use in both kinds of settings. It might be because individuals' confidence in their technology-related knowledge and abilities is more associated with their judgement of the ease or difficulty of the usage of the system (Madorin and Iwasiw, 1999).

Course attributes also demonstrated no significant influence on PEOU. Their effects on PU did not show any significance, except in mandatory settings. Note that the course attributes-usefulness relationship was negatively associated. One interpretation of this may be that, although functionalities provided by the ELS may fit the course requirements, different courses may yield different degrees of perceived usefulness. For example, a computer course on an ELS may provide functions for developing source codes, compiling object codes, planning logic, encoding and decoding programs, debugging software, encrypting files, and so on. Students in such courses may find it very useful because the computer helps them to perform complicated operations. On the other hand, courses offered by arts and science departments usually offer multimedia and interactive functions on the ELS. They do not find the system useful as the material on the system is considered supplementary or secondary.

Effects of content quality on perceived usefulness were significant in mandatory settings. When the ELS use is required by the teacher, students may perceive that the teacher, classmates, and themselves would spend more time in managing the content and sharing information on the ELS. Students may, therefore, perceive that content on the system is richer, and updated regularly. Hence students find content on the ELS useful because it may affect their learning performance.

The effects of subjective norm significantly influenced perceived usefulness (Taylor and Todd, 1995a; Venkatesh and Davis, 2000; Hsu and Lu, 2004). However, it had no direct effect on intentions in either mandatory usage contexts, as suggested in the study by Agarwal and Prasad (1997) and in the study by Venkatesh and Davis (2000), or in voluntary usage contexts, as suggested in the study by Davis *et al.* (1989). In voluntary settings, the teacher was the important referent to encourage the use of the ELS. Students may use the system in order to please the teacher. In mandatory usage contexts students not only complied with the expectations of the teacher, but also conformed to the expectations of peers to strengthen relationships with group members or to avoid a punishment (Goodwin, 1987; Deutsch and Gerard, 1995).

Contributions and implications

In terms of a theoretical contribution, the results of this research lend support to the TAM research findings that perceived usefulness and perceived ease of use are important variables affecting acceptance. The current research also represents an important contribution to TAM with the suggestion of a model for addressing several antecedents of perceived usefulness and perceived ease-of-use constructs. Behavioural intention and competing intentions possibly compensate each other to provide a better learning

environment, if the use of the ELS is voluntary. Mandatory approaches to require students to use the ELS appear to be effective in promoting the ELS as a main learning means and in discouraging students from using other means to receive education.

The results of this study also have some implications. First, in order to increase the overall adoption of the ELS by students mandatory usage is necessary. The ELS should be developed to target changes in perceived usefulness, perceived ease of use and perceived network externality. Practical alternatives to usage mandates should be developed and tested, such as enhancing content quality and developing a simple and easy-to-use system so that potential users would have greater levels of computer self-efficacy once they found that the innovation was quite easy to operate. Second, promotion of the system, with a particular focus on emphasising the popularity of the system, as well as details of planned future ELS products and services, is a prerequisite in order to create bandwagon effects with regard to the adoption of the ELS. Such promotion activities may also have a positive influence on the adoption through perceived usefulness and perceived ease of use.

Limitations and additional research direction

There are several limitations of the present study that should be noted and addressed in any future research. First, the impact of changes in perception, with regard to the adoption of a new technology, has not been investigated in this research over any significant period of time. However, it has been demonstrated in some of the prior studies, such as Venkatesh and Davis (2000), that those factors having an influence on the acceptance of technology may have different predictive power over time. For example, the effects on intentions from subjective norms may well subside over time with increasing experience (Venkatesh and Davis, 2000). It is therefore recommended that further research should be undertaken to examine whether, with increasing experience over time, there is any reduction in the strength of the factors influencing technology acceptance at the initial stage of adoption.

Second, this research has employed only self-reported usage; however, while self-reported usage has often been used in the past as a means of measuring consumer behaviour, we should be aware of the potential presence of the issues affecting self-reporting and objective usage measures.

Finally, although most of the subsequent additions and expansions contained within the extended TAM for the ELS have been supported in this study, they have not been rigorously tested over time as stable components and influences. Experimental tests for these new constructs and their relationships are clearly avenues for future research. Further research on the TAM for the ELS should, therefore, aim to continually refine the determinants of perceived usefulness, perceived ease of use, usage intentions and behaviour within the model.

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