AIS Transactions on Human-Computer Interaction

Volume 4 | Issue 1 Article 2

Spring 3-27-2012

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Recommended Citation

Islam, A. N. (2012). The Role of Perceived System Quality as Educators' Motivation to Continue E-learning System Use. *AIS Transactions on Human-Computer Interaction, 4*(1), 25-43. Retrieved from https://aisel.aisnet.org/thci/vol4/iss1/2
DOI:

AIS Transactions on Human-Computer Interaction

Transactions on Human-Computer Interaction

THCI

Original Research

The Role of Perceived System Quality as Educators' Motivation to Continue E-learning System Use

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Abstract

This study incorporates perceived system quality into the original expectation-confirmation based information system continuance model in order to investigate the role of perceived system quality in users' motivation to continue e-learning system use. Our proposed model was tested among university educators (n = 175) who use the popular open-source e-learning system, Moodle. The results reveal that perceived usefulness, confirmation of initial expectations, and perceived system quality significantly affected educators' satisfaction. In addition, perceived usefulness and satisfaction significantly affected continuance intention. Unexpectedly, no direct association between perceived system quality and continuance intention was found. The determinants of continuance intention explain around 64% of its total variance. The paper finishes with conclusions and implications for future research and practice.

Keywords: Continued use, e-learning, expectation-confirmation theory, satisfaction

Fred Davis was the accepting Senior Editor. This article was submitted on 6/24/2011 and accepted on 12/31/2011. It was with the author 13 days for 2 revisions.

Islam, A. K. M. N (2012) "The Role of Perceived System Quality as Educators' Motivation to Continue E-learning System Use," *AIS Transactions on Human-Computer Interaction* (4) 1, pp. 25-43.

INTRODUCTION

With the latest development of Internet technologies, universities are investing considerable resources in e-learning systems to support teaching. These systems facilitate educator-to-student communication, the ability to track students' progress, and the secure sharing of course content online. Because of such useful features, e-learning systems are very attractive for universities. However, when evaluating e-learning systems, the educator's perspective must be considered because the success of such systems depends on their willingness to continue utilizing the systems. Moreover, if an educator chooses to discontinue the use of an e-learning system, students generally do not have any other choice than to leave the system and adapt to the educator's alternative choice. Thus, it is plausible that an educator's unwillingness to utilize e-learning possibilities may lead to underutilization by students and possibly reduced learning outcomes (Sorebo et al., 2009).

When conducting research on individuals' e-learning system usage behavior, researchers often depend on different behavioral theories (Davis, 1989; Larsen et al., 2009; Sorebo et al., 2009). Using Fishein and Ajzen's (1975) Theory of Reasoned Action (TRA), two schools of thought have evolved (Larsen et al., 2009). The first addresses initial information system (IS) use (or IS acceptance), while the second addresses subsequent IS use (IS continuance). Initial IS use is an important first step toward achieving success. However, the long-term viability of an IS and its eventual success depend on its continued use rather than initial use (Bhattacherjee, 2001).

A variety of theoretical perspectives have been advanced in order to understand what motivates individuals to continuously use an IS (e.g., Bhattacherjee, 2001; Hsu et al., 2004; Kang et al., 2009; Karahanna et al., 1999; Lin, 2011). Among these theoretical perspectives, the expectation-confirmation theory (ECT) has been dominant since 2001 (Bhattacherjee, 2001; Hsieh and Wang, 2007; Kim, 2010; Lee, 2010; Liao et al., 2007; Lin et al., 2005; Recker, 2010). The ECT based IS continuance model was developed with the argument that the psychological motivation shaping continuance behavior is different from that of acceptance behavior (Bhattacherjee, 2001). According to the ECT based IS continuance model, continuance intention is determined by perceived usefulness (a post-adoption behavioral belief that represents the consequences of utilizing an IS) and satisfaction (the affective attitude toward a specific IS exhibited by someone who interacts with the IS directly). Despite its popularity, this model provides only limited guidance on how to influence usage via design and implementation from the Human-Computer Interaction (HCI) perspective. Benbasat and Barki (2007) argued that to increase practical relevance for the HCI field, design and implementation attributes must be included in the research models. Following this, Benbasat (2010) recommended that such design attributes should be tested as antecedents of the constructs of interest. He further argued that adoption research reflecting only surrogate variables like perceived usefulness cannot generate any specific design advice for HCI practitioners. For example, HCI practitioners receive feedback regarding usefulness in a general sense, but they do not receive actionable feedback about the important aspects of a system's characteristics. Such feedback would be very important, especially for organizations, as online and distance courses using e-learning systems are still evolving. Thus, an extended IS continuance model using factors related to system characteristics may provide more guidance for e-learning system designers and managers.

The motivation for this study therefore derives from two different streams of research: IS continuance and system quality research. Although a significant amount of research has been conducted in these two fields independently, very few studies have tried to integrate them to understand IS continuance, particularly in the e-learning system utilization context. One important point to be noted at this point is that in prior IS literature, system quality has often been measured by soliciting users' subjective evaluations. Thus, we put the word 'perceived' in front of system quality in the rest of this paper to indicate users' perceptual evaluations of system quality. Perceived system quality has been explored in connection with IS continuance research, but only on a limited scale (Chiu et al., 2007; Kang et al., 2009; Roca et al., 2006). Prior research has primarily focused on exploring relationships between perceived system quality and satisfaction. However, little research has been done to examine the influence of perceived system quality on the IS continuance intention (Saeed and Abdinnour-Helm, 2008). Thus, there is no proof of the value of a good system for promoting the continued usage of IS for IS managers. Hence, this study attempts to integrate perceived system quality into the ECT based IS continuance model to explore IS continuance. In practice, we use the ECT based IS continuance model as the main theoretical framework to understand educators' intention to continue using e-learning systems. To highlight the role of perceived system quality in predicting educators' continuance intention to use e-learning systems, we incorporate perceived system quality as an additional variable within the ECT based IS continuance model. This allows us to study the impact of the technological factors on continued usage behavior in the context of e-learning system utilization. Furthermore, it should demonstrate to managers and developers the value of improving system quality to retain existing users.

The paper proceeds as follows. *Theoretical Background* section presents the theoretical background and literature review. *Research Context* section presents the research context. In *Research Model Development* section we develop our research model. *Study Design* and *Method* section is dedicated to the research method, data analysis, results, and discussion. In Implications section we describe the implications of our findings for theory and practice. Finally, *Conclusions* section concludes the paper.

THEORETICAL BACKGROUND

Expectation-Confirmation theory

Since the 1970s, research into consumers' post-purchase behavioral process has been a dominant theme in consumer behavior literature (Churchill and Surprenant, 1982). Among the research frameworks used in this theme, the expectancy-confirmation paradigm has been extensively used to explain consumers' satisfaction and repurchase decisions in a variety of post-purchase contexts (Bhattacherjee, 2001; Churchill and Surprenant, 1982; Oliver, 1980).

The expectation-confirmation theory hypothesizes that consumers' level of satisfaction with a product/service determines their repurchase intention. In turn, consumer satisfaction is determined by two major constructs: initial expectations (pre-purchase expectations) about a product/service, and the discrepancies between the expectations and the product/service performance (confirmation). According to this theory, buyers first develop expectations about a product/service before purchase. Second, their experiences with the product/service build perceptions about actual performance. This leads to the buyer either confirming or disconfirming the pre-purchase expectations after assessing the perceived performance against the earlier frame of reference (pre-purchase expectations). A buyer's expectations are confirmed when the product/service performs as expected, are negatively confirmed when it performs worse than expected, or are positively confirmed when it performs better than expected (Churchill and Surprenant, 1982).

Drawing attention to the substantial difference between initial adoption and continued usage, Bhattacherjee (2001) developed and empirically tested the information system continuance model in a voluntary environment using expectation-confirmation theory. Despite the structural adaptation from the expectation-confirmation paradigm, Bhattacherjee's information system continuance model possesses a few differences. First, it focuses on post-adoption expectations rather than pre-adoption expectations, because a user keeps updating expectations of a system as he/she gains more experience of it. After the assimilation of such experiences, the user's expectations can be different from his/her initial expectations prior to using the system (Bhattacherjee, 2001). From this perspective, the information system continuance model posits that post-adoption expectations (rather than pre-adoption expectations) are the relevant determinants of satisfaction. Second, the information system continuance model employs perceived usefulness as a surrogate for post-adoption expectation. The expectation-confirmation paradigm defines expectation as individual belief or sum of beliefs about the level of attributes possessed by a product/service (Churchill and Surprenant, 1982). Following this definition, Bhattacherjee (2001) adopted perceived usefulness as the measure of expectation, since among the cognitive beliefs in IS adoption and usage, perceived usefulness has demonstrated itself to be the most consistent and salient factor in determining users' IS usage intention over time (Davis, 1989; Venkatesh and Davis, 2000). Third, perceived performance was not included in the information system continuance theory with the argument that the effect of perceived performance could be captured by the confirmation construct (Bhattacherjee, 2001).

In summary, the information system continuance model postulates that after an initial acceptance and period of use, users form an opinion about which of their pre-acceptance expectations have been confirmed (confirmation). From this confirmation, users form an opinion about the benefits (perceived usefulness). After a period of time, both confirmation and perceived usefulness form the basis of satisfaction with the IS (satisfaction). Finally, perceived usefulness and satisfaction influence users' IS continuance intention (intention). The information system continuance model is shown in Figure 1.

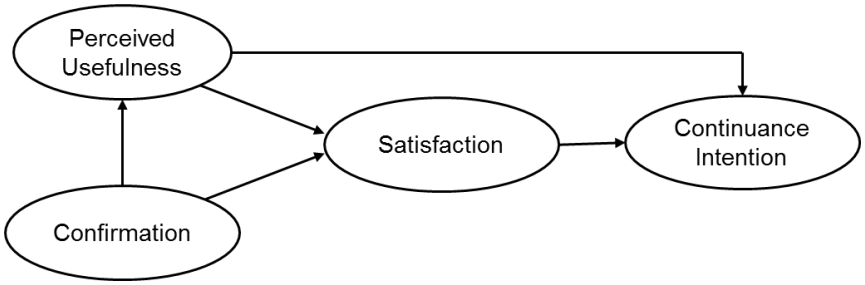


Figure 1: IS Continuance Model (Bhattacherjee, 2001)

Empirical studies on e-learning continuance

To conduct a review of the relevant literature on e-learning continuance, we searched in the following databases: ABI/INFORM, Business Source Complete, Electronic Journals Service, ScienceDirect, and Wiley InterScience. We

selected these databases because they include most IS journals, making it possible to find a significant proportion of the published material on e-learning system continuance. The search was conducted by using keywords: expectation-confirmation, expectation-disconfirmation, information systems continuance, e-learning continuance, and e-learning post-adoption use. Webster and Watson (2002) suggest going through a journal's table of contents with a keyword-based search. Thus, to ensure that the relevant articles were included, we performed a manual search of each issue of the six highest ranked journals from the senior scholar's basket of IS journals: MIS Quarterly; Information Systems Research; Information System Journal; Journal of the Association of Information Systems; Journal of Management Information Systems; and European Journal of Information Systems. In addition, we went through the table of contents of two major IS conferences: International Conference on Information Systems (ICIS) and the European Conference on Information Systems (ECIS). Thereafter, we utilized the references of the articles identified to find additional articles.

Several empirical studies on e-learning continuance exist in the literature; they are summarized in Table 1. These studies were mainly built upon the ECT based IS continuance framework and other complementary theories such as the technology acceptance model (TAM) (Davis, 1989), the unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003), the theory of planned behavior (TPB) (Ajzen, 1991), the attribution theory (Heider, 1958), the diffusion theory (Rogers, 2003), the IS success model (DeLone and McLean, 2003), the fairness theory (Lind et al., 1993), the self-determination theory (Deci and Ryan, 1995), and the task-technology fit (Goodhue and Thompson, 1995). The majority of studies targeted students participating in online courses, who had little or almost no face-to-face interaction. A few studies targeted faculty educators who used an e-learning system to support their face-to-face contact teaching.

The majority of studies concluded that perceived usefulness and satisfaction are the main determinants of e-learning continuance intention (e.g., Liao et al., 2009; Sorebo et al., 2009). However, drawing on TAM, some studies concluded that perceived ease of use is important in predicting the continuance intention (e.g., Roca and Gagne, 2008). A few studies used TPB theory to understand e-learning continuance and concluded that subjective norms and perceived behavioral control are also important in predicting e-learning continuance (e.g., Liao et al., 2007). Some studies also found that indicators of intrinsic motivation (e.g., perceived enjoyment, perceived playfulness) are important in shaping the e-learning continuance intention (e.g., Roca and Gagne, 2008; Sorebo et al., 2009).

Perceived System Quality

System quality is a measure of an IS from the technical and design perspectives (Gable et al., 2008). Thus, perceived system quality can be defined as the users' evaluation of an IS from the technical and design perspectives. Perceived system quality has been operationalized in many different ways in the IS literature. For example, Bailey and Pearson (1983) used convenience of access, flexibility of the system, integration of the system, and response time. Belardo et al. (1982) used reliability, response time, ease of use, and ease of learning. Franz and Robey (1986) used perceived usefulness of the IS. Seddon (1997) used reliability, user interface consistency, ease of use, documentation quality and maintainability of program code. Depending on the target technologies, the variables related to system quality may vary (DeLone and McLean, 2004). In general, the manifest variables of perceived system quality in terms of a web-based system are access convenience, flexibility, integration, response time, sophistication, reliability, accessibility, stability, system speed, usability, ease of use, navigation and network speed (Lee et al., 2009).

The role of perceived system quality in the IS acceptance and success literature has been investigated extensively (e.g., Adeyinka and Mutula, 2010; DeLone and McLean, 2003; Halawi et al., 2008; Kamla, 2009; Seddon and Keiw, 1996; Wang and Wang, 2009; Wu and Wang, 2006). According to the IS success model, system quality is a critical success factor that influences user satisfaction and the intention to use (DeLone and McLean, 2003). Petter and McLean (2009) performed a meta-analysis of studies that have used the IS success model to investigate the strengths of different relationships in the model. They found both perceived system quality-user satisfaction and perceived system quality-intention to use relationships were strong. System quality has also been studied with regard to individuals' IS acceptance research. According to TAM, system quality can be viewed as an external variable that affects behavioral beliefs (Davis, 1989).

Despite the significant amount of research on system quality, very few studies have examined the role of users' perceived system quality in relation to e-learning system continuance. Roca et al. (2006) used the ECT based IS continuance model to which they added perceived system quality as an antecedent of confirmation and satisfaction in the e-learning context and concluded that perceived system quality is an important predictor of both confirmation and satisfaction. Freeze et al. (2010) utilized the IS success model and found that perceived system quality significantly affects both satisfaction and e-learning system usage. The results of these studies provide empirical evidence that users' perceived system quality can be utilized to extend the ECT based IS continuance model.

Table 1: Prior Empirical Studies on E-Learning Continuance

Article	Theories used	Target population	Key findings
Chiu et al. (2005)	ECT.	Students taking online courses.	Satisfaction affects continuance intention.
Roca et al. (2006)	ECT, TAM, and TPB.	Students taking online courses.	Satisfaction affects continuance intention.
Pituch and Lee (2006)	TAM.	Students taking mixed (face-to-face lectures and e-learning tool) courses.	System functionality, perceived ease of use, and perceived usefulness affect use of supplementary learning. System functionality, system interactivity, perceived usefulness, perceived ease of use, and use of supplementary learning affect use of distance education.
Chiu et al. (2007)	Fairness Theory.	Students taking online courses.	Satisfaction and utility value affect continuance intention.
Liao et al. (2007)	ECT, TPB.	Students taking online courses.	Satisfaction, subjective norm, and perceived behavioral control affect continuance intention.
Roca and Gagne (2008)	TAM, Self Determination Theory.	Students taking online courses.	Perceived usefulness, perceived playfulness, and perceived ease of use affect continuance intention.
Chiu and Wang (2008)	UTAUT.	Students taking online courses.	Computer self-efficacy, attainment value, utility value, perceived playfulness, performance expectancy, and effort expectancy affect continuance intention.
Liao and Lu (2008)	Diffusion Theory.	Students taking online course.	Compatibility and result demonstrability affect continuance intention.
Liaw (2008)	Self-developed model.	University students taking a mixed (face-to-face lectures and e-learning tool) course.	Satisfaction and usefulness affect continuance behavioral intention.
Limayem and Cheung (2008)	ECT.	University students taking a mixed (face-to-face lectures and e-learning tool) course.	Perceived usefulness and satisfaction affect continuance intention.
Mahdizadeh et al. (2008)	Self-developed model.	University faculty teachers	Perceived added value, opinion about computer-assisted learning, and opinion about web-based activities affect e-learning use.
Cho et al. (2009)	TAM.	Students taking online courses.	Perceived usefulness, satisfaction, and prior experience affect continuance intention.
Liao et al. (2009)	ECT, TAM.	Students taking online courses.	Satisfaction, perceived usefulness (only for initial adopter), and attitude affect continuance intention.
Larsen et al. (2009)	ECT and Task-Technology Fit.	University faculty teachers.	Satisfaction and utilization affect continuance intention.
Sorebo et al. (2009)	ECT and Self Determination Theory.	University faculty teachers	Perceived usefulness and perceived playfulness affect continuance intention.
McGill and Klobas (2009)	Task-Technology Fit.	University students taking a mixed (face-to-face lectures and e-learning tool) course.	Attitude, instructor norm, and expected consequences affect e-learning use.
Lee (2010)	ECT, TAM, TPB, and Fairness Theory.	Students taking online courses.	Satisfaction, perceived usefulness, attitude, concentration, subjective norm, and perceived behavioral control affect continuance intention.
Freeze et al. (2010)	IS Success Model.	University students taking a mixed (face-to-face lectures and e-learning tool) course.	Information quality and system quality affect e-learning system use.
Liu et al. (2010)	TAM.	High school students taking online courses.	Perceived usefulness, perceived ease of use, and perceived interaction affect continuance intention.
Ho (2010)	ECT, TAM, and Self Determination Theory.	Mixed users.	Confirmation, and perceived usefulness affect satisfaction. In turn, satisfaction, attitude, and perceived usefulness affect continuance intention.
Lin (2011)	TAM.	Students taking online courses.	Satisfaction (only for less experienced users), and attitude affect continuance intention.
Karaali et al. (2011)	TAM.	Workers in the automotive industry.	Social influence, perceived usefulness, and attitude affect continuance intention.
Hung et al. (2011)	ECT and Attribution Theory.	School teachers.	Satisfaction, causal attributions, and perceived usefulness affect continuance intention.

RESEARCH CONTEXT

In order to understand the research context of this study, a brief introduction of the target e-learning system and the research environment are presented.

One type of e-learning system that may support the traditional teaching method is a course management system, also known as a learning management system. A course management system is web-based software used for the delivery, tracking and management of education/training. It contains features for distributing courses over the Internet and online collaboration. Educators can also track the progress of students using such software. Furthermore, the students may submit their assignments, download course material, track their grades, etc. by logging into the system. Course management systems are very widely used in higher education. For example, 95% of all higher education institutions in the UK used course management systems in 2005 (Browne et al., 2006).

The course management system used by the educators in this study is Moodle, which has become very popular among educators for creating dynamic online course websites for students (http://moodle.org/about/). Moodle is an open source course management system, or a virtual learning environment, that can be used to conduct online courses and also to augment face-to-face courses. Moodle provides tools such as forums, databases and wikis to build collaborative learning communities. It also provides ways to deliver content to students and assess learning by using assignments and quizzes. To function, it needs to be installed on a web server.

This study has been conducted in an internationally acknowledged, multidisciplinary university located on the southwest coast of Finland. With 21,000 students and 3,000 employees, it is one of the major universities in Finland. The university has seven faculties. Outside of the seven faculties, research activities and learning take place in different special units. Such units offer adult education and promote personal, organizational and regional development. Different university support activities occur at these facilities as well. Special units enable the construction of multi-disciplinary international research environments. The university (both faculties and special units) has been using Moodle since 2007. The faculty educators use Moodle as the platform for creating online course pages that support face-to-face teaching. On the other hand, personnel from special units use Moodle for project management purposes. The educators are free to choose other methods of creating course pages within the university domain. In some faculties, in-house developed course management systems are also available. Thus, using Moodle is not seen as mandatory for educators.

RESEARCH MODEL DEVELOPMENT

We have identified two research gaps in the literature. First, very few studies have extended the ECT based IS continuance model by using perceived system quality in an e-learning context. Second, one limitation of the ECT based IS continuance model, which is often noted in the literature, is that it uses only one post-adoption belief (perceived usefulness) as the surrogate for post-adoption expectation (Hong et al., 2006; Thong et al. 2006). To fill these research gaps, we decided to extend the IS continuance framework by using perceived system quality. Extending the IS continuance model using perceived system quality not only helps to fill the research gaps but also can provide actionable guidance to HCI practitioners. We conceptualize and model perceived system quality, in addition to perceived usefulness, as another post-adoption belief which might address the limitations of the information system continuance model. Following Wixom and Todd (2005), we view perceived usefulness as a behavioral belief and perceived system quality as an object-based belief. The research model is shown in Figure 2.

An exploratory study to probe perceived system quality factors

As explained earlier, there are many system quality-related features for a web-based system. However, not all variables are equally important in relation to an educators' usage of an e-learning system. To explore this, we conducted an exploratory study to probe the system quality-related factors that affect e-learning technology use during the post-adoption stage. Using open-ended questions, we interviewed seven educators from different departments of the university about their Moodle usage. The list of questions is shown in the Appendix A. The participating users had different levels of experience with the target system. Each interview lasted around 30 minutes. Short notes were taken during the interviews, and the interviews were also recorded for future analysis. Based on the exploratory study and existing literature review, we deemed access, ease of use, integration, and reliability to be the salient traits that help to encourage an educator's continued usage of an e-learning technology. Their operational definitions along with evidence from the interview data are given in Table 2.

Table 2: Perceived System Quality Factors

Factor	Definition	Sample evidence
Access	"refers to the degree of accessibility, responsiveness, and availability of the e-learning system" (Lee et al., 2009)	"I find Moodle often inaccessible and slow to respond, but when it works, it is a good tool to conduct courses "
Ease of use	"refers to the degree to which an individual perceives using the e-learning system is free of effort" (Davis, 1989)	"When I started to use Moodle, I felt it is impossible to use, however when I got into it, I found it is not that complex. But still I would say things could be much more easier with more careful layout design"
Integration	"refers to the way the e-learning system allows data to be integrated from various existing course pages" (Wixom and Todd, 2005)	"I can use my old course pages to be integrated in the new course pages and it makes easy to develop the new pages"
Reliability	"refers to the dependability of the e-learning system operation" (Wixom and Todd, 2005)	"Last year, all of the student enrollments were deleted due to some reasons, probably server update, and we had a lots of trouble because of that"

By considering these system quality-related factors carefully, HCI designers should be able to facilitate the building or improving of an e-learning system in the following ways.

First, designers should keep in mind that an e-learning system is hosted on a web-server and that many students and educators use that system. Hence, they need to ensure that the e-learning system is hosted on a web-server that can meet the demands of the users connecting to the service. The response time of the server during its busiest time period needs to be analyzed in order to select the most appropriate web-server.

Second, usability is considered to be one of the major concerns of HCI designers. Usability is considered to be part of system acceptability and relates to how well users are able to use the system (Nielsen, 1993). Ease of use can be regarded as a measure of usability (Zhang et al., 2005). Prior research has also highlighted the importance of ease of use in technology acceptance (Davis, 1989) and technology continuance (Hong et al., 2006). When designing an e-learning system, HCI designers need to remember that perceptions of ease of use vary according to the user group as stated in prior adoption studies (Venkatesh et al., 2003).

Third, integration is also an important issue for e-learning systems. Educators usually have a limited amount of time to spend on building new course pages from scratch, so they look for ways to use their old course pages to build new ones. Hence, it would be beneficial for educators if e-learning systems could provide features that would enable the integration of older material.

Finally, reliability is another concern that needs to be discussed. Course registration, the delivery of learning materials, and communication amongst the participants are all implemented online in the e-learning system. Consequently, the e-learning system must be viewed as a repository of large amounts of information and should therefore be reliable and be backed up.

The development of hypotheses

As the relationships of the IS continuance theory have been verified extensively in the literature in different contexts i ncluding e-learning system continuance (e.g., Hong et al., 2006; Larsen et al., 2009; Liao et al., 2009; Limayem and Cheung, 2008; Roca et al., 2006), we argue that these hypotheses are valid for our context also. Thus, we propose th e following expectation-confirmation theory related hypotheses without further argument:

- H1. Educators' satisfaction with an e-learning technology positively affects their continued e-learning technology usage intention.
- H2. Educators' confirmation of expectations positively affects their satisfaction with e-learning technology.
- H3. Educators' perceived usefulness of an e-learning technology positively affects their satisfaction with e-learning technology.
- H4. Educators' perceived usefulness with an e-learning technology positively affects their continued e-learning technology usage intention.
- H5. Educators' confirmation of expectations positively affects their perceived usefulness of e-learning technology.

Lee et al. (2009) argued that perceived system quality can be modeled as a second-order factor. Thus, we modeled perceived system quality as a second-order construct with the four reflective factors identified in our exploratory

study: access, ease of use, integration and reliability. DeLone and McLean (2003) describe system quality as having a direct effect on user satisfaction and IS use. This has been confirmed by many studies in different contexts (e.g., Chen, 2010; McKinney et al., 2002; Nagash et al., 2003; Seddon and Kiew, 1996). Roca et al. (2006) tested the impact of perceived system quality on satisfaction in the e-learning context and found it to be significant. Recently, Freeze et al. (2010) found a significant relationship between perceived system quality and e-learning system use. Thus, we hypothesize the following:

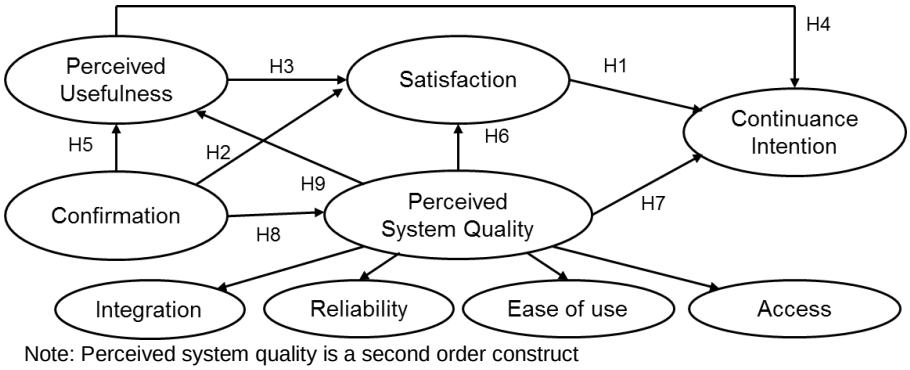
- H6. Educators' perceived system quality of an e-learning technology positively affects their satisfaction with the e-learning technology.
- H7. Educators' perceived system quality of an e-learning technology positively affects their continued e-learning technology usage intention.

Roca et al. (2006) proposed a causal relation from system quality to confirmation. However, we propose a causal relation from confirmation to perceived system quality in this paper and put forward the following argument in support of our hypothesis. Oliver (1980) did not use any determinant of confirmation in testing the proposed expectation-confirmation model. According to expectation-confirmation theory, confirmation is the difference between perceived performance (p) and pre-expectations (e). Hence, Oliver (2009) noted that researchers can use either (p-e) as a measure of confirmation or simply the subjective evaluation of confirmation. In either case, confirmation captures an abstraction of both pre-expectations and perceived performance. Following this, Bhattacherjee (2001) did not include perceived performance in his adaptation of expectation-confirmation theory in the IS continuance model he developed. He further argued that post-adoption expectations, rather than pre-adoption expectations, are important in predicting users' satisfaction and continuance intention. Although the original expectation-confirmation theory contains variables related to both pre- and post-adoption, the IS continuance model contains only post-adoption variables. This makes the IS continuance model a pure post-adoption model. At the post-adoption stage, actual interaction with the IS shapes users' mental representations of its characteristics. We argue that the users of a system, during the post-adoption stage, may change expectations about system quality. This argument is supported by both the expectation-confirmation theory and the theory of reasoned action paradigms. Specifically, these paradigms have defined expectation as individual beliefs or the sum of beliefs about the levels of attributes possessed by a system (Churchill and Surprenant, 1982; Davis, 1989). Repeated interaction with the IS could possibly help the users to identify the gaps between their expectations and the capabilities of the IS (Saeed and Abdinnour-Helm, 2008). This helps the users to build more concrete expectations about the capabilities of the IS even after confirming pre-adoption expectations. It suggests a causal flow from confirmation to perceived system quality during post-adoption stage instead of from perceived system quality to confirmation. Bhattacherjee and Premkumar (2004) also argued that pre-adoption beliefs are antecedents of confirmation while post-adoption beliefs are the consequences of confirmation. Thus, we propose the following hypothesis:

- H8. Educators' confirmation of expectations positively affects their perceived system quality of an e-learning technology.

We argue that experience with using the IS to conduct various tasks can produce a better understanding of its characteristics, which can assist the user in forming cognitions about its overall usefulness. We argue that if the users of a system develop cognitions about its perceived system quality, it would, in turn, affect their cognitions about its perceived usefulness. Seddon (1997) proposed an association between system quality and perceived usefulness in his modified IS success model. Lee and Lee (2008) found a significant causal relationship between e-learning environment quality and perceived usefulness. Thus, we propose the following hypothesis:

- H9. Educators' perceived system quality positively affects their perceived usefulness of an e-learning technology.



Note: Perceived system quality is a second order construct

Figure 2: Research Model

STUDY DESIGN AND METHOD

Questionnaire development

Each item corresponding to the constructs was measured using the seven-point Likert scale, with answer choices ranging from "Strongly disagree (1)" to "Strongly agree (7)." Most of these items were adapted from the literature with minor changes in wording reflecting the target technology. The measures of confirmation, perceived usefulness, satisfaction, and continuance intention were adapted from Limayem et al. (2007) and Bhattacherjee (2001). The measures of reliability and integration were adapted from Wixom and Todd (2005) while the measures of access and ease of use were adapted from Lee et al. (2009) and Hong et al. (2006) respectively. After the questionnaire was drafted, it was first sent to two academic researchers for their review, and then it was revised according to their comments and suggestions to make the wording of the items more precise. Then, the questionnaire was sent to 30 educators in the university for further review. Overall, the educators indicated that the questionnaire was relatively clear and easy to complete. A number of suggestions were made concerning the wording of several items and the overall structure of the questionnaire. The questionnaire was revised according to the given suggestions. The final questionnaire is presented in Appendix B. To avoid the common method bias problem to some extent, we decided to randomize the questions in the questionnaire during data collection (Straub et al., 2004).

Data collection

Data was collected via a web-based survey from the educators who use Moodle for their teaching purposes. A total of 1012 users were registered with Moodle as instructors during August, 2010. Two important points need to be noted. First, many of the registered Moodle users were from special units of the university. As explained in section 3, such users use Moodle for project management purposes. It was not possible to distinguish between faculty educators and special units' personnel from the registered Moodle user database. Second, many faculty educators registered in Moodle do not use the service because they are busy with other tasks and have assistants perform Moodle-related tasks. It was also difficult to filter out such users. Thus, a total of 1012 registered Moodle users received email invitations. Nevertheless, only faculty members who had used Moodle recently for conducting their courses were asked to respond. Two reminders were sent to increase the response rate after gaps of two weeks. The survey ran for approximately one and half months. After filtering invalid and incomplete responses, a total of 207 survey responses were received. For this particular study, we were interested in those users who had conducted at least one course using Moodle during the academic year. After filtering the survey responses according to this criterion, 175 usable responses remained. Table 3 shows the detailed demographic information of the participants. A total of 42.3% of the respondents were male. About half of the respondents (51.4%) were between 21 and 40 years old, while the rest (48.6%) were over 40 years of age. A total of 30.9% of the respondents had between 0 and 18 months of experience with Moodle, while 47.4% respondents had more than 18 months but less than 36 months of experience with Moodle. The rest of the respondents (21.7%) had more than 36 months of experience with Moodle. The low response rate in this study can be explained by the presence of many special units' users and educators who do not actually use Moodle in the survey invitation list. However, to increase reliability, we assessed the non-response bias by following the procedure developed by Armstrong and Overton (1977). This procedure is widely used in research studies from different disciplines including Information Systems (Karahanna et al., 1999). We treated responses received after the first deadline (two weeks after the questionnaire was sent to the respondents) as being representative of non-respondents. T-tests on the demographics and key constructs of the study showed no significant differences between the respondents and non-respondents. Although it is a commonly used method to test non-response bias, the possibility of bias is not entirely eliminated (Karahanna et al., 1999), thus results should be interpreted accordingly.

Table 3: Demographic Information

		Frequency	Percent
Gender	Male Female	74 101	42.29 57.71
Age	21-40 years >40 years	90 85	51.43 48.57
Experience with the target technology	0 – 18 months >18 – 36 months >36 months	54 83 38	30.86 47.43 21.71

Data analysis

We employed partial least squares (PLS) as the approach for our analysis and utilized the tool smartPLS (Ringle et al., 2005). PLS is a second generation regression method that combines confirmatory factor analysis with linear regression, and this makes it possible to run the measurement and structural models simultaneously. PLS has enjoyed increasing popularity in IS research for its ability to model latent constructs under the condition of non-normality (Chin, 1998). The variables in this study are non-normal. Thus, PLS is an appropriate tool for conducting the analysis in this study. A rule of thumb for the required sample size in PLS is that the sample should be at least ten times the number of independent variables in the most complicated multiple regression in the model (Barclay et al., 1995). The sample size in this study meets the minimum sample size requirement.

Table 4 shows the means and standard deviations of construct items. For each construct, the assessment of convergent validity or internal consistency is also included. Convergent validity indicates the extent to which the items of a scale that are theoretically related are also related in reality. As shown in Table 4, all items have significant ($p < 0.001$) path loadings exceeding the threshold value of 0.7 recommended by Fornell and Larcker (1981). All of the constructs have composite reliability values between 0.81 and 0.94, fulfilling the recommended value proposed by Nunnally (1978). Finally, the average variance extracted (AVE) values exceed the threshold of 0.5 as recommended by Fornell and Larcker (1981).

Testing for discriminant validity involves determining whether the items measure the construct in question or other (related) constructs. Discriminant validity was verified with both a correlation analysis and a factor analysis as recommended by Gefen and Straub (2005). The inspection of discriminant validity among the variables is based on the correlation between the variables and the square root of their respective average variance extracted (Fornell and Larcker, 1981). As Table 5 shows, there are some high correlations among some variables. However, the square root of average variance extracted values for the variables is consistently greater than the off-diagonal correlations, suggesting satisfactory discriminant validity among the variables (Gefen and Straub, 2005). Furthermore, prior studies also found such high correlations among the IS continuance model's constructs in the e-learning context (e.g., Liao et al., 2007). Finally, Table 6 shows that all items have cross loading coefficients lower (at least 0.1) than the factor loading on their respective assigned latent variable, suggesting that discriminant validity on the item level is met for all constructs (Gefen and Straub, 2005).

Table 4: Item Means, Standard Deviation and Internal Consistencies

Construct	Item	Mean	std	Loading	t-stat
Continuance intention (Composite Reliability = 0.92; AVE = 0.76)	INT-1	6.00	1.20	0.91	71.67
	INT-2	5.23	1.32	0.87	54.04
Satisfaction (Composite Reliability = 0.95; AVE = 0.81)	SAT-1	4.84	1.49	0.91	61.66
	SAT-2	4.74	1.51	0.93	76.99
	SAT-3	4.27	1.50	0.93	72.18
Perceived usefulness (Composite Reliability = 0.92; AVE = 0.69)	PU-1	5.18	1.28	0.87	24.99
	PU-2	5.31	1.23	0.90	40.10
	PU-3	5.65	1.22	0.82	21.58
Confirmation (Composite Reliability = 0.94; AVE = 0.76)	CON-1	4.55	1.39	0.94	102.74
	CON-2	4.59	1.25	0.93	54.98
Integration (Composite Reliability = 0.90; AVE = 0.81)	INTGR-1	4.15	1.19	0.90	36.06
	INTGR-2	3.93	1.22	0.90	29.49
Reliability (Composite Reliability = 0.95; AVE = 0.67)	REL-1	4.35	1.45	0.95	106.69
	REL-2	4.42	1.52	0.96	169.38
Ease of use (Composite Reliability = 0.94; AVE = 0.76)	PEOU-1	4.46	1.52	0.89	47.25
	PEOU-2	4.59	1.52	0.94	128.09
	PEOU-3	4.27	1.61	0.93	73.96
Access (Composite Reliability = 0.88; AVE = 0.77)	ACCESS-1	3.96	1.79	0.83	30.42
	ACCESS-2	4.81	1.39	0.83	29.30

Table 5: Correlation among Variables and Square Root of Average Variance Extracted

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Access (1)	**0.88**							
Confirmation (2)	0.60	**0.94**						
Ease of Use (3)	0.60	0.50	**0.92**					
Integration (4)	0.27	0.24	0.30	**0.90**				
Intention (5)	0.58	0.65	0.60	0.20	**0.93**			
Perceived usefulness (6)	0.62	0.69	0.62	0.25	0.76	**0.89**		
Reliability (7)	0.65	0.44	0.47	0.22	0.33	0.41	**0.95**	
Satisfaction (8)	0.71	0.76	0.74	0.44	0.73	0.75	0.58	**0.92**

Note: The bold elements on the diagonal represent the square roots of the average variance extracted, and off-diagonal elements are the correlation estimates.

Table 6: Factor Analysis Results

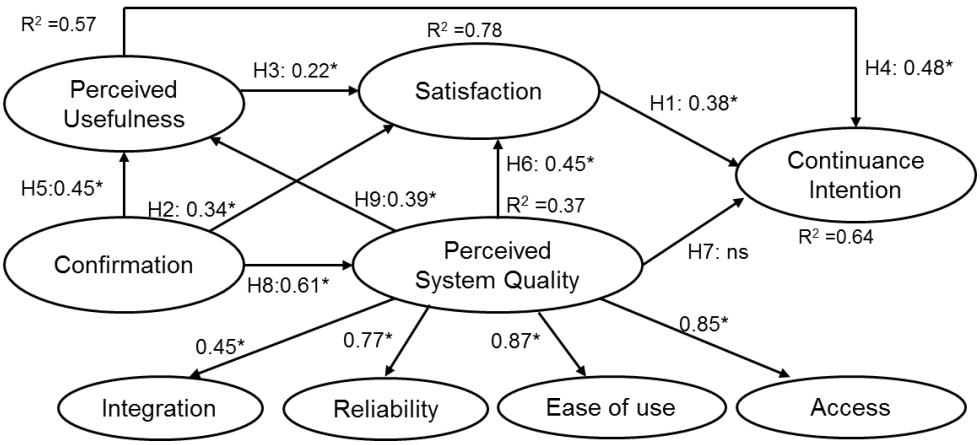
	Access	CON	Integration	Intention	PEOU	PU	Reliability	SAT
ACCESS-1	**0.88**	0.47	0.22	0.43	0.51	0.47	0.61	0.57
ACCESS-2	**0.88**	0.58	0.24	0.59	0.55	0.62	0.53	0.68
CON-1	0.59	**0.94**	0.25	0.64	0.50	0.65	0.47	0.64
CON-2	0.52	**0.93**	0.21	0.57	0.44	0.64	0.35	0.68
INTGR-1	0.23	0.25	**0.91**	0.20	0.28	0.28	0.18	0.19
INTGR-2	0.24	0.19	**0.90**	0.16	0.24	0.16	0.20	0.17
INT-1	0.54	0.63	0.16	**0.92**	0.56	0.69	0.31	0.68
INT-2	0.53	0.57	0.21	**0.93**	0.54	0.61	0.29	0.66
PEOU-1	0.48	0.37	0.25	0.52	**0.89**	0.49	0.37	0.61
PEOU-2	0.61	0.49	0.23	0.54	**0.94**	0.59	0.48	0.61
PEOU-3	0.56	0.51	0.33	0.59	**0.93**	0.62	0.44	0.60
PU-1	0.49	0.62	0.27	0.65	0.54	**0.88**	0.36	0.67
PU-2	0.58	0.59	0.20	0.65	0.58	**0.90**	0.35	0.67
PU-3	0.57	0.62	0.18	0.61	0.53	**0.89**	0.37	0.65
REL-1	0.58	0.40	0.20	0.30	0.41	0.38	**0.95**	0.53
REL-2	0.65	0.44	0.20	0.33	0.48	0.39	**0.96**	0.58
SAT-1	0.67	0.70	0.21	0.68	0.64	0.69	0.58	**0.91**
SAT-2	0.65	0.69	0.16	0.66	0.73	0.68	0.51	**0.93**
SAT-3	0.65	0.71	0.19	0.67	0.66	0.70	0.52	**0.93**

Note: Confirmation (CON), Ease of Use (EOU), and Perceived Usefulness (PU).

Overall, these tests of validity and reliability provide us with a high degree of confidence about the scale items used in testing our research model.

Results and discussion

The test of the structural model using PLS includes estimates of the path coefficients, which indicate the strengths of the relationships between the dependent and independent variables, and the R-square values, which represent the amount of variance explained by the independent variables. Figure 3 shows the results of the hypothesized structural model. As expected, confirmation (β=0.45, t = 5.84, p < 0.001) and perceived system quality (β=0.39, t = 6.78, p < 0.001) had a significant effect on perceived usefulness, accounting for 57% of the variance in that measure. Confirmation (β=0.61, t = 13.53, p < 0.001) had a significant influence on perceived system quality, explaining 37% of its variance. Confirmation (β=0.34, t = 6.22, p < 0.001), perceived usefulness (β=0.22, t = 4.22, p < 0.001) and perceived system quality (β=0.45, t = 8.87, p < 0.001) significantly influenced satisfaction, accounting for 78% of its variance. Perceived usefulness (β=0.48, t = 7.86, p < 0.001) and satisfaction (β=0.38, t = 5.85, p < 0.001) had a significant influence on intention. Interestingly, perceived system quality (β=0.07, t = 1.06, ns) had no significant influence on intention. Perceived usefulness, satisfaction and perceived system quality together accounted for around 64% of the variance in intention. The explained variances in this study are high. However, prior studies employing the IS continuance model in different contexts explained similar amount of variances. For example, Larsen et al. (2009) explained 68% of the variance of intention in e-learning context. Liao et al. (2007) explained 79% of the variance of satisfaction and 70% of the variance of intention in e-learning context. Furthermore, Bhattacherjee et al. (2008) explained 74% of the variance of intention in the context of document management system utilization. Thus, the amount of variances explained of the dependent variables in our study is in line with prior literature.



Note: Perceived system quality is a second order construct
*p < 0.001; ns: non-significant

Figure 3: PLS Analysis Results

We found support for three out of the four added hypotheses in our extended information system continuance model. All of the hypotheses of the original continuance model were also supported. The proposed model expands our understanding of the phenomenon of IS continuance at the individual level by virtue of the inclusion of perceived system quality in the research model.

We found perceived usefulness and satisfaction to be the significant determinants of educators' e-learning system continuance intention. Unexpectedly, perceived system quality had no direct impact on continuance intention. The lack of a significant relationship between perceived system quality and intention is somewhat surprising as there should be a significant relationship according to the IS success model (DeLone and McLean, 2003). However, our finding is in line with the IS acceptance research (Davis, 1989) and the modified IS success model proposed by Seddon (1997). In both research streams, system quality is viewed to have an indirect impact on behavioral intention via behavioral beliefs such as perceived usefulness and perceived ease of use. Our finding is also in line with Wixom and Todd (2005) who argued that object-based beliefs (e.g., perceived system quality) are not good predictors of behavioral intention. According to our study's findings, the educators placed most importance on perceived usefulness when deciding to continue the use of the e-learning system. Many studies found perceived usefulness to be the most dominant predictor of intention to use (e.g., Hong et al., 2006; Limayem and Cheung, 2008). In support of this conclusion, we also found that perceived usefulness strongly predicts continuance intention. In fact, the interviews revealed that, in general, educators reported that they had been using Moodle for its usefulness. For example, an educator commented, "I use Moodle because I do not need to send individual emails to the students attaching lecture materials." Another educator commented, "I use Moodle because it has lots of possibilities to make my teaching tasks easier."

We found that confirmation, perceived usefulness and perceived system quality all had significant positive effects on user satisfaction in the e-learning usage context. Perceived system quality was the most dominant factor in shaping user satisfaction, although, in many prior studies, confirmation had been found to be the most dominant factor influencing user satisfaction (e.g., Bhattacherjee, 2001). Our study found confirmation to be the second most dominant predictor of satisfaction after perceived system quality. This finding shows the importance of perceived system quality in relation to the IS post-adoption. According to the IS continuance model, perceived usefulness is supposed to represent post-adoption expectation, because perceived usefulness has been the most salient cognitive belief that forms expectation (Bhattachejee, 2001). However, the scope of the expectation can be much broader, encompassing many different cognitive beliefs (Hong et al., 2006). This line of reasoning supports the findings of our study. Our study shows that only one post-adoption belief (perceived usefulness) is not adequate to shape satisfaction in the e-learning context. Perceived usefulness only provides a little contribution in developing educators' satisfaction with an e-learning system.

We also observed that confirmation had an effect on perceived system quality. This suggests that perceived system quality is a post-adoption belief that is determined by the confirmation of initial expectations.

Furthermore, we found that perceived usefulness can be predicted by confirmation and perceived system quality. These findings are also in line with prior findings. First, prior studies on IS continuance have supported the associations between confirmation and perceived usefulness (Bhattacherjee, 2001). Second, our finding regarding the association between perceived system quality and perceived usefulness is supported by both IS success (e.g., Seddon, 1997) and IS acceptance (e.g., Davis, 1989) studies.

Finally, all of the second-order factors were found to be important features of perceived system quality. These second-order factors include: access, ease of use, reliability and integration. Specifically, our results suggest that access, reliability, and ease of use are the three most important perceived system quality features in the e-learning context.

IMPLICATIONS

Theoretical implications

Our study has three main theoretical implications. First, this study is an extension of the ECT based IS continuance theory with the IT artifact's system characteristics. We encourage researchers to investigate the effects of the IT artifact itself as an antecedent to perceived usefulness, satisfaction, and continuance intention. If one is interested in understanding how system design and implementation attributes might influence continued use, then variables related to the design and implementation of the artifact should be measured. Researchers should investigate the effect of these variables on behavioral beliefs, satisfaction, and continuance intention. Such studies would also provide useful guidance to HCI designers. This recommendation is supported by the work of Wixom and Todd (2005) who encourage similar research within the IT acceptance context.

Second, we identified four perceived system quality related factors that are salient for e-learning system continuance based on an exploratory study. It would be useful for researchers to investigate whether there is a core set of perceived system quality features that apply broadly across a wide range of systems. Future studies should systematically investigate various technologies that differ in relation to important features, such as systems with high analytical capabilities vs. systems with high information richness. It may allow us to compare how information system continuance might differ between such systems.

Third, our results provide support for the idea that confirmation and perceived usefulness do not solely shape users' satisfaction in the post-adoption stage, as has been previously indicated in IS continuance theory. In fact, our study suggests that perceived system quality is the most critical factor in shaping user satisfaction.

Implications for practice

In a broad sense, the extended IS continuance model can help managers assess system characteristics and then investigate their impacts on continuance intention by use of the proposed causal chain. This should then help with management activities, such as task prioritization and resource allocation, especially in cases where management discovers that users have become extremely dissatisfied with a system. The findings of this study may help management focus on the most important system characteristics to be examined when aiming to improve user satisfaction.

The results highlight the importance of perceived usefulness in predicting continuance intention with regard to using e-learning systems to support teaching. The dominant effect of perceived usefulness on intention provides potential fruitful avenues to HCI designers for affecting users' continuance intention to use e-learning technologies. The research results suggest that designing and developing a useful system helps to prevent IS discontinuance in the e-learning context. Educators will discontinue using an e-learning technology if it is not useful for their purpose, even if they are satisfied with the technology. Thus, organization managers should take appropriate action to advertise the technology among educators in order to develop an appropriate level of expectation about the particular e-learning technology. In addition, managers should note that educators' expectations about e-learning technology use will be adjusted during their use of the technology. Furthermore, their expectations will become concrete and clear through frequent use of the e-learning technology, helping educators to set their post-consumption expectations (perceived usefulness and perceived system quality) to an appropriate level.

In accordance with prior literature, we also found that user satisfaction is another important determinant of continuance intention. Thus, HCI practitioners should devise strategies that will help increase user satisfaction with e-learning technology, and help to retain existing users and increase the usage of the technology. Our results suggest that perceived system quality strongly affects user satisfaction. The evaluation of the proposed extended IS continuance model highlights reliability, integration, ease of use, and access as important perceived system quality-related features that should be designed to the highest standards possible by practitioners. The extended model provides a mechanism for understanding and assessing the relative influence of system characteristics for HCI designers. For example, it can facilitate the understanding of which characteristics (ease of use, reliability, integration, and access) are of most importance within the context of interest. Based on this understanding, HCI designers can look at the mean scores for these characteristics and determine the changes that should help improve a system. For example, if the educators face significant problems with the accessibility of the e-learning system, the problems can be addressed by hosting the e-learning service on a faster web-server, increasing Internet speed, and using

lightweight content in the e-learning system's home pages. Overall, the mean scores of perceived system quality-related variables in this study suggest that there is a need to have set strategies in order to improve such features and influence satisfaction and perceived usefulness.

The relative influences of system characteristics may provide an additional practical implication for HCI practitioners. If the proposed IS continuance model is tested in different contexts, the HCI designers can pool their accumulated knowledge about the relative influences of factors from across the different contexts. Such accumulated knowledge might provide the basis for important design guidelines and standards for building effective systems.

Furthermore, the extended IS continuance model has a diagnostic value at all stages of the system implementation and usage process. An e-learning system like Moodle evolves over time; new functionalities are added and architectural changes occur. In addition, as Moodle is an open source system, local designers also have the option to customize it according to organizational needs. Therefore, it is important to diagnose design-related issues and their effects on continued usage at any point within the system lifecycle.

CONCLUSIONS

This study extended the expectation-confirmation based IS continuance theory by using perceived system quality. Based on an exploratory study, we identified the factors of perceived system quality. We developed an integrated research model using IS continuance theory and perceived system quality. Then, we conducted a survey and received usable answers from 175 university educators and analyzed the data using PLS analysis. The findings reveal that IS continuance was mainly determined by perceived usefulness and satisfaction. Perceived system quality was also found to affect IS continuance intention indirectly via perceived usefulness and satisfaction. The lack of a direct association between perceived system quality and IS continuance intention was unexpected and requires further research to confirm this finding. However, the results were largely consistent with the hypotheses contained in the model, and they demonstrate the potential to integrate the concept of perceived system quality and IS continuance theory into a single unified model. The combined model explained around 64% of the total variance of continuance intention.

This study has some limitations that need to be acknowledged. First, this study was cross-sectional. However, usage behavior is dynamic and changes over time due to changes in cognition as the users become experienced with the target system, and such changes in cognition and attitude cannot be captured with a cross-sectional study. A longitudinal design would capture such changes and provide deeper insights into how changes in user cognition influence usage behavior. Second, this study was conducted in a university setting and caution should be taken when generalizing the findings of this study to business organization settings. It would therefore be useful to replicate this study in different contexts to further validate the extended IS continuance model proposed in this paper.

ACKNOWLEDGEMENTS

We thank Dr. Timo Lainema, Dr. Jonna Järveläinen, and Dr. Matti Mäntymäki from the University of Turku for their valuable comments during several stages of this article. We also thank the two anonymous reviewers and the Senior Editor of AIS THCI, Dr. Fred Davis, for comments from which this article benefited greatly.

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APPENDIX A: INTERVIEW QUESTIONS

How did you feel about Moodle when you used it as a teacher for the first time?
How do you feel about your ability about the general computer/Internet user?
Tell me about your use of Moodle in teaching.
Tell me about your general feelings on Moodle.
Tell me a positive and a negative experience with Moodle.

APPENDIX B: SURVEY QUESTIONNAIRE

Construct	Item
Satisfaction (Bhattachejee, 2001)	SAT-1:My overall experience of using Moodle is very satisfied
	SAT-2:My overall experience of using Moodle is very pleased
	SAT-3:My overall experience of using Moodle is absolutely delighted
Perceived usefulness (Limayem et al. 2007)	PU-1: Using Moodle is of benefit to me
	PU-2: The advantages of Moodle outweigh the disadvantages
	PU-3: Overall, using Moodle is advantageous
Ease of use (Venkatesh and Davis, 2000)	PEOU-1: My interaction with Moodle is clear and understandable
	PEOU-2: I find Moodle to be easy to use
	PEOU-3: I find it easy to get Moodle to do what I want to do
Access (Lee et al. 2009)	ACCESS-1: Moodle quickly loads all the text and graphics
	ACCESS-2: Moodle provides good access
Reliability (Wixom and Todd, 2005)	REL-1:Moodle is stable
	REL-2:Moodle operates reliably
Confirmation (Limayem et al. 2007)	CON-1:My experience with using Moodle was better than what I expected
	CON-2:The benefit provided by Moodle was better than what I expected
Integration (Wixom and Todd, 2005)	INTGR-1:Moodle effectively integrates data from existing course pages to a new course page
	INTGR-2:Moodle pulls together information from different existing course pages to a new course page
IS continuance intention (Limayem et al. 2007)	INT-1:I intend to continue using Moodle rather than discontinue its use
	INT-2:My intentions are to continue using Moodle than use any alternative means

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ISSN: 1944-3900

Transactions on Human-Computer Interaction