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Assessing e-learning 2.0 system success

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ABSTRACT

Traditional e-learning systems support "one-way" communication. Teachers provide knowledge for learners, but they are unable to use a student's learning experiences to benefit the class as a whole. To address these problems, this study explores e-learning success factors via the design and evaluation of an e-learning 2.0 system. This study develops a theoretical model to assess user satisfaction and loyalty intentions to an e-learning system using communication quality, information quality, system quality, and service quality. The empirical results show that communication quality, information quality, and service quality significantly and positively affect user satisfaction and loyalty intentions to use the e-learning system for sharing experience, communicating with others, and getting feedback.

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1. Introduction

Harasim, Hiltz, Teles, and Toroff (1995) observed that Internet Bulletin Board Systems were powerful tools to enhance educational communication, especially for students too shy to participate in face-to-face classroom activities. However, the interaction between instructors, including teachers and teaching assistants (TAs), and students is constrained in the message board or discussion board formats of traditional e-learning systems. This one-way knowledge transfer from instructors to students should be reconsidered. Currently, on-line discussion boards for e-learning are primarily used for questions and answers between students and instructors. These boards do not encourage learners to also contribute to the content. To draw upon implicit knowledge, on-line discussion boards in an e-learning system should use collaborative learning (Walton, 2010; Walton, Barker, Hepworth, & Stephens, 2007) and foster a collaborative learning environment (Hepworth & Walton, 2009, pp. 198–204) so that students can learn from teachers and from each other.

Palloff and Pratt (1999) indicated that an important feature of the learning process is collaborative interaction, including interaction between teachers and learners, and a collaborative learning environment can motivate interaction among learners. Khalifa and Lam (2002) argued that e-learning systems should support more interactive capabilities to increase user satisfaction. Liaw, Huang, and Chen (2007) also suggested that, to promote mutual interaction, e-learning systems should consider not only affective, cognitive and behavioural components but social components as well. A learning system should provide user-friendly tools and methods for users to easily collaborate and interact with others. Other researchers (Laurillard, 1993; Ramsden, 1992) confirmed that mutual interaction among students can increase learning efficiency. Moreover, collaborative learning can help students share learning experiences and obtain explicit and implicit knowledge. Fischer and Mandl (2005) proposed that collaborative learning can construct a learning community. These arguments consider e-learning systems to be interactive and cooperative environments, a view that corresponds to the basic concept of Web 2.0.

Web 2.0 was first proposed in a brainstorming seminar by Dougherty and Cline (O'Reilly, 2007). In Web 2.0, information flow changes from unidirectional to bidirectional. In recent years, Web 2.0 has grown rapidly by featuring collaborative cooperation and knowledge sharing platforms. Web 2.0 aims to collect information from the entire population instead of only a few experts. Web 2.0 has already been applied to e-learning as "e-learning 2.0" (Downes, 2005). Therefore, the sharing of information and the enrichment of knowledge exchange among learners can be accomplished through using the concepts of interaction, collaborative learning, and compilation of learners' knowledge. The information system success (ISS) model has been used to test e-learning systems (Lee & Lee, 2008), but the factors governing the success of e-learning 2.0 systems remain unresolved. This study aims to design an e-learning 2.0 system and to determine its important features.

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2. Literature review

2.1. E-Learning 2.0 system

Cuene (2005) identified the difference between Web 1.0 and Web 2.0 from the user's perspective: Web 1.0 consists of surfing web pages, whereas Web 2.0 refers to shared "content" over the Web. Comparing Web 1.0 with Web 2.0, the human–computer interaction has changed from "reading" to "writing and contribution," and from a "webpage" to an "article/record." Thus, the sophisticated techniques of Web 2.0 have already initiated a new era of interactive cooperation and sharing. The spirit of Web 2.0 is to encourage users to share information, thereby changing websites from single-source information to diversified linkage and changing users from passive information recipients to active information contributors or collaborative information creators (Terdiman, 2005). Successful examples of Web 2.0 include Wikipedia and blogs. However, scholars have not discussed how to achieve e-learning 2.0 successfully. To understand how to use Web 2.0 for effective e-learning 2.0, an e-learning 2.0 system was designed for evaluation. The e-learning 2.0 system in this study (TeachSys) applies the concepts of Wikipedia and Yahoo Knowledge Plus, including collective wisdom and collaborative features, to help users add or revise discussion content. The system framework is shown below Fig. 1.

Two components of TeachSys, including Question & Answer (Q&A) and external resources, are explained briefly:

1. Q&A:
    A. Post/Reply Article:
        When users issue a new article and click the confirm button after completing the content, the "RSS Service" module sends an e-mail to all registered students. When other users reply to this article, the article authors are contacted by e-mail.
    B. Content revising:
        Once the question has been resolved by any other users, the best answer will be selected by the initial author and stored into a knowledge base using the "QAwiki" module. Meanwhile, this QA knowledge base is ready for other learners to revise the content.
2. External resources:
    C. Reference Source Linkage (Wikipedia):
        After handling organises the words in article pages via the "external resource" module, hyperlinks will appear on important words. By clicking these hyperlinks, users can access detailed content about the words on the Wikipedia website.
    D. Similar article recommendation:
        When users read an article, the system will automatically find related articles from the "article suggestion" by using the vector space model (VSM). These related articles may include the other users' responses and knowledge.

2.2. Background of e-learning 2.0

In an e-learning system, students can learn anytime and anywhere (Ngai, Poon, & Chan, 2007). Many studies have shown that e-learning produces more positive effects than traditional face-to-face learning (Dutton, Dutton, & Perry, 2002; Koory, 2003). E-learning systems facilitate the establishment of interactive learning communities to enhance the communication and cooperation between learners (Rovai, 2002). To determine the successful factors, an e-learning 2.0 system was designed for users to share information, collaborate with others, and obtain feedback. The factors driving a sytem success are drawn from the areas of interactive learning, cooperative learning, computer-mediated communication and on-line discussion boards. In this study, all factors governing the system success will be examined regarding their influences on user satisfaction and loyalty towards an e-learning system.

● Interactive learning

Interaction is mutual communication among humans or between humans and technology that may include the exchange of knowledge. Interaction among humans is considered mutual impact through media (Wu & Chang, 2005). Interaction between humans and technology includes instant user revisions of web page formats and content (Hoffman & Novak, 1996).

Moore (1989) pointed out that interaction in learning activities could be separated into three types: instructors to learners, learners to teaching materials and learners to learners. In the first type of interaction, instructors assist students' learning by interacting with them,
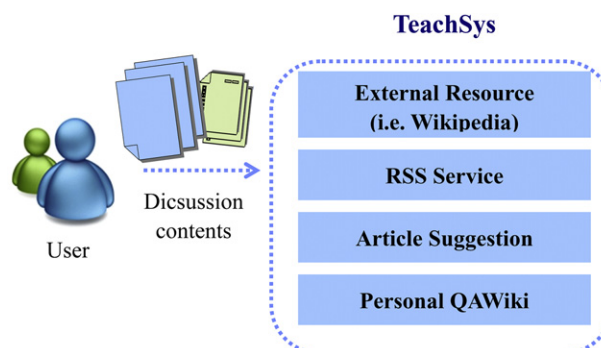

Fig. 1. TeachSys system architecture.

regardless of the teaching strategies or methods. The second type of interaction, between learners and teaching materials, is the most basic interactive mode in teaching. This kind of interaction depends on students' self-motivated learning. By taking advantage of the interactive process with teaching materials, students understand their learning goals, establish knowledge and incorporate new knowledge into previous perceptions. Finally, during the third type of interaction, students learn through cooperation (in groups) or through self-motivation (individually). Studies showed that interaction between students positively contributes to learning (Laurillard, 1993; Ramsden, 1992).

Interactive methods of education usually involve two-way communication between student and teacher or among students during feedback and responses (Parker, 1999). Many scholars (Mayes, 1995; Mayes & de Freitas, 2004) believed that interaction is important to education. However, the type and level of interaction depends on several factors: teaching principles, the nature of the academic content, the maturity of the students, the learning environment and course curriculum of educational organisations or curriculum designers (Moore & Kearsley, 1996).

The universality of media and the Internet makes educational tools to enhance interactive technical media increasingly more convenient. These computer-mediated communication tools benefit group communication and the exchange and sharing of information by encouraging more frequent and equal use among students (Kiesler & Sprouall, 1992; Scovell, 1991). Thus, interactive discussion tools play an important role in the Internet teaching environment. Interaction makes students feel like participants, not just observers. Student use of interactive communication enhances effective learning.

- Collaborative Learning

Collaborative learning is a type of learning that emphasises interactive social processes (Alavi, 1994). Some scholars point out that interaction between students positively contributes to learning (Laurillard, 1993; Ramsden, 1992). Research by So and Brush (2008) revealed that collaborative learning has a positive and prominent influence on students' learning satisfaction. During collaborative problem solving, learners communicate with each other and accumulate learning experiences through discussion, negotiation, and information sharing. This interaction and collaboration simultaneously enhances learning for groups and for individuals.

- Computer-Mediated Communication Learning

Miller (1995) suggested that the purpose of mutual communication is to reach personal and organisational goals by coordinating an organisation's activities. Because of their communication and information exchanging abilities, Rogers (Rogers, 1986) terms the combination of computers and the Internet as "Computer-Mediated Communication Systems" (CMCs). Communication activities performed according to this system are called "Computer-Mediated Communication" (CMC). CMC is a communication technology that emphasises practical use and rapid exchange. An Internet communication system allows people to create, exchange and observe various kinds of information (Romiszowski, 1992), thereby creating a kind of Virtual Community and increasing the opportunity for collaborative and interactive learning.

Walther (1992) pointed out that CMC is not a single interactive situation. The quality of communication depends on whether both parties are motivated to continue interacting. As an interactive field, CMC produces and develops relationships via words and language. Words and language are "social information" on the Internet. Through language, participants can both search for information and transmit information about their attitudes and opinions. This kind of language communication can reduce uncertainty for participants, thereby fostering the development of human relationships. Walther (1996) indicated that the process of feedback allows both sides to impact upon each other, strengthening an interactive loop through continuous behavioural confirmation. Chiu, Huang, and Chang (2000) discovered that the co-negotiation in this process produces significant results.

Alavi (1994) defined "Computer-mediated Collaborative Learning" (CMCL) as collaborative learning using computers as mediated media. In a remote teaching environment, however, learning mediated by technology, such as computers and the Internet, is also collaborative learning. Alavi (1994) also suggested that the effects of collaborative learning are only produced through interactive cooperation between group members. Soller (2002) observed that "knowledge sharing" is an important part of effective collaborative learning. In e-learning, students can gain knowledge and develop skills through interactive learning, if they take the initiative to use collaborative learning methods such as sharing, negotiation and feedback.

- On-line Discussion Boards

Thomsen (1996) discovered that the Internet could potentially enhance the mutual exchange of information, establish forums for discussion, strengthen self-perceptions and increase individuals' professional abilities. Forums are on-line discussion boards that can be defined as "A text-based human-to human communication via computer networks that provides a platform for the participants to interact with one another to exchange idea, insights and personal experience with the hope of gaining multiple views on any topic and constructing new knowledge." (Hew & Cheung, 2003).

On-line discussion boards have gradually been integrated into educational websites. These discussion boards can broaden learning activities because they are free from the time and space limitations of traditional classrooms (Xie, DeBacker, & Ferguson, 2006). Students writing on a discussion board can be encouraged to achieve higher levels of learning such as analysis, integration and assessment (Newman, Johnson, Webb, & Cochrane, 1997). Collaborative learning is the main characteristic of discussion boards, but traditional electronic discussion boards separate the questions from responses in different documents, which are difficult to organise. Web2.0 can solve this problem.

2.3. Communication quality

Many researchers argued that the communication medium or quality affects system success (Chen & Yen, 2004; Davison, 1997; Hrastinski, 2008; Kock, 1998; Milgram, Spector, & Treger, 1999; Suh, 1999; Thompson, Smith, & Iacovou, 2007). Particularly in higher
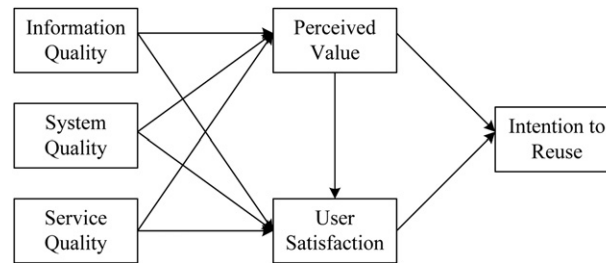
Fig. 2. Wang's (2008) IS/e-Commerce Success Model.

education, a community for learning is beneficial to learning outcomes (Thompson & MacDonald, 2005). A strong sense of community can increase the communication frequency and repeated use intention. Thus, communication quality should be taken into consideration when the e-learning 2.0 is applied.

2.4. Wang's (2008) information systems/e-Commerce success model

Many researchers (McGill, Hobbs, & Klobas, 2003; Molla & Licker, 2001; Rai, Lang, & Welker, 2002; Seddon, 1997; Seddon & Kiew, 1994) have argued that the D&M model proposed by DeLone and McLean (2003) had not been empirical validated. Wang (2008) proposed a new model by integrating the D&M model (DeLone & McLean, 2003), the Seddon model (Seddon, 1997) with the Technology Acceptance Model (TAM)(Davis, 1989) in the context of e-commerce (shown in Fig. 2).

3. Research model and hypotheses

This study develops a research model (Fig. 3.) by modifying Wang's information systems/e-commerce success model (Wang, 2008). In this model, "perceived value" is replaced by "communication quality" and "intention to reuse" is changed to "loyalty intention." Following the D&M model, "information quality" refers to the assessment of the system's quality. "system quality" refers to the assessment of the system itself, and "service quality" refers to the assessment of the service provided via the system. The "communication quality" aspect is used to assess whether users can benefit from interactive communications, such as the sharing, feedback and negotiation on the discussion board. Originally, the reuse intention as proposed by Wang (2008) was a dimension of user loyalty. Thus, this study reframes the reuse intention as the loyalty intention (whether the user will maintain loyalty through repeated usage and recommendation to their friends). The proposed theoretical framework is similar to the Quality→Satisfaction→Loyalty Chain (Cronin, Brady, & Hult, 2000; Durvasula, Lysonski, Mehta, & Tang, 2004; Hellier, Geursen, Carr, & Rickard, 2003; Parasuraman & Grewal, 2000; Zeithaml, 1988).

Recent studies suggested that increasing the quality of websites can enhance mutual interaction (Coyle & Thorson, 2001; Macias, 2003; Sicilia, Ruiz, & Munuera, 2005). Walther (1992) pointed out that human relationships are sustained through the interaction of words and language. An e-learning system can support the exchange of information for collaborative learning (Kiesler & Sprouall, 1992; Scovell, 1991). Web-based systems not only support the creation, exchange and perception of information (Romiszowski, 1992), but also create a virtual community to support the opportunity for collaborative and interactive learning (Nonis, Bronack, & Heaton, 2000). Different services within an information system (IS) may affect the method of interactive communication. This study proposes that information quality, system quality and service quality influence communication quality and user satisfaction, which in turn influence loyalty intentions. Thus, according to the research model, the following hypotheses are proposed:

H1a. Information quality (IQ) positively impacts upon communication quality (CQ)in the e-learning 2.0 system.

H2a. System quality (SQ) positively impacts upon CQ in the e-learning 2.0 system.

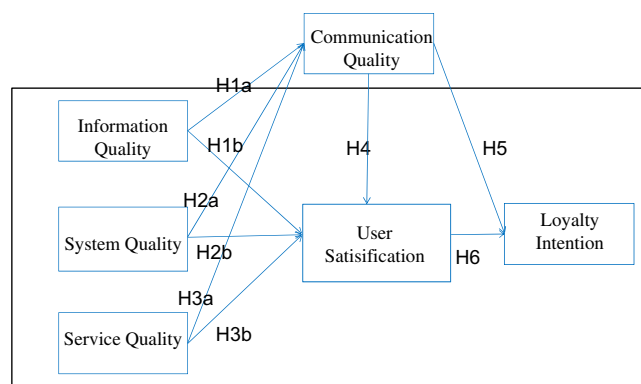**H3a.** Service Quality (SEQ) positively impacts upon CQ in the e-learning 2.0 system.

Fig. 3. Research model diagram.

Table 1
Reliability Analysis Table of each aspect.

Aspects(Cronbach's alpha)	Questions		Total Relation of Fixed Item
Information Quality(0.884)	IQ1	TeachSys On-line Discussion Board can support enough information when I request.	0.732
	IQ2	The searching mechanism of TeachSys On-line Discussion Board helps me find out the suitable answer	0.697
	IQ3	Information provided by TeachSys On-line Discussion Board is easy to understand	0.674
	IQ4	Personalized recommendation mechanism on TeachSys On-line Discussion Board helps me search information I want quickly	0.681
	IQ5	Information contents provided by TeachSys On-line Discussion Board are mutual related.	0.655
	IQ6	The searching mechanism of TeachSys On-line Discussion Board can provide information I want	0.733
System Quality(0.856)	SQ1	TeachSys On-line Discussion Board is easy to use	0.727
	SQ2	TeachSys On-line Discussion Board interface is humanized	0.756
	SQ3	TeachSys On-line Discussion Board is very friendly	0.638
	SQ4	TeachSys On-line Discussion Board is suitable for me to use	0.674
Service Quality(0.794)	SEVQ1	TeachSys On-line Discussion Board helps me get problem solutions	0.687
	SEVQ2	The information provided by TeachSys On-line Discussion Board is reliable	0.588
	SEVQ3	TeachSys On-line Discussion Board provides services from users' perspective	0.634
Communication Quality(0.912)	IC1	I feel TeachSys On-line Discussion Board can easily share my opinions with other users	0.631
	IC2	I feel that other users will share information, opinions, questions and answers with me by using TeachSys On-line Discussion Board	0.650
	IC3	I feel TeachSys On-line Discussion Board enable me to get other users' feedbacks easily	0.680
	IC4	I feel TeachSys On-line Discussion Board enable me to interchange opinions with other users easily	0.726
	IC5	I feel TeachSys On-line Discussion Board enable me to review my opinions in classes more easily	0.734
Communication Quality(0.912)	IC6	I feel TeachSys On-line Discussion Board enable me to review instructors' opinions in classes more easily	0.714
	IC7	I feel TeachSys On-line Discussion Board enable me to comment my opinions in classes more easily	0.706
	IC8	I feel TeachSys On-line Discussion Board enable me to integrate opinions from other users and myself more easily	0.716
	IC9	I feel TeachSys On-line Discussion Board enable me to integrate opinions from instructors and myself more easily	0.701
User Satisfaction(0.924)	US1	I thought TeachSys On-line Discussion Board is practical in general performance	0.798
	US2	I admire the performance of TeachSys On-line Discussion Board	0.779
	US3	Using TeachSys On-line Discussion Board is pleasant for me	0.762
	US4	The performance of TeachSys On-line Discussion Board reaches my expectation	0.841
	US5	In general, TeachSys On-line Discussion Board is satisfactory for me	0.835
Loyalty Intention(0.906)	LI1	I'm willing to continue using TeachSys On-line Discussion Board in the future	0.759
	LI2	In the future, if I have any question, I will use TeachSys On-line Discussion Board again	0.722
	LI3	The willing for me to use TeachSys On-line Discussion Board is higher than other course-related system	0.742
	LI4	I'm willing to encourage other people using TeachSys On-line Discussion Board	0.809
	LI5	I'm willing to recommend other people using TeachSys On-line Discussion Board	0.794

The hypotheses related to the associations between Web quality and user satisfaction were developed based on the information systems/commerce success models from DeLone & McLean and Wang (DeLone & McLean, 2003; Wang, 2008). Previous studies suggested that IQ, SQ and SEQ also affected user satisfaction (Cronin et al., 2000; Durvasula et al., 2004; Hellier et al., 2003; Lewis & Soureli, 2006; Spreng, MacKenzie, & Olshavsky, 1996). This study therefore posits that:

H1b. IQ positively impacts upon user satisfaction (US) in the e-learning 2.0 system.

H2b. SQ positively impacts upon US in the e-learning 2.0 system.

H3b. SEQ positively impacts upon US in the e-learning 2.0 system.

So and Brush (2008) found that collaborative learning interaction is positively and prominently related to students' learning satisfaction and social performance. Previous studies (Laurillard, 1993; Mayes & de Freitas, 2004; Ramsden, 1992) also indicated that interaction between students positively enhances learning effectiveness.

H4. CQ positively impacts upon US in the e-learning 2.0 system.

Barwise and Farley (2005) indicated that websites are most often used as interactive tools. Berthon, Pitt, and Watson (1996) pointed out that good on-line interaction may increase user loyalty. The interactive quality of a website is positively associated with its use (Tremayne, 2005). Increasing the interactive quality can influence user perceptions of media use and thereby enhance their loyalty intentions. The following hypotheses are tested:

H5. CQ positively impacts upon loyalty intention (LI) in the e-learning 2.0 system.

Table 2
Fit indices for measurement model.

Fit indices	Recommended value	Measurement model
x^2/df	≤ 3	1.864
GFI	≥ 0.8	0.85
RMSR	≤ 0.05	0.024
SRMR	≤ 0.08	0.043
RMSEA	≥ 0.08	0.055
NFI	≥ 0.9	0.98
CFI	≥ 0.9	0.99
AGFI	≥ 0.8	0.82
PNFI	≥ 0.5	0.88
PGFI	≥ 0.5	0.72

Enhancing personal feelings or emotion will increase user loyalty. Some studies have found that loyalty can be used to assess user behaviour (Lin & Wang, 2006; Wang, 2003). Previous studies have also shown that satisfaction is a factor of loyalty or reuse intentions (Bitner, 1990; Caruana & Fenech, 2005; Cronin et al., 2000; Eggert & Ulaga, 2002; LaBarbera & Mazursky, 1983; Lam, Shankar, Erramilli, & Murthy, 2004; Patterson & Spreng, 1997; Wang, Tang, & Tang, 2001). Customer satisfaction is a significant determinant of customer loyalty (Ganesh, Arnold, & Reynolds, 2000; HennigThurau & Klee, 1997; Oliver, 1999).

H6. US positively affects LI towards an e-learning 2.0 system.

4. Research method

In this research, to establish the best fit model, structural equation modelling (SEM) was used to examine complex multi-variable data. This study developed a questionnaire using a five-point Likert scale ranging from "1-strongly disagree" to "5 -strongly agree." The first part of the questionnaire requested students' basic information and Internet usage experience. The second part contained questions about the measurement items of the research framework. With this fixed-format questionnaire, students were asked to choose from the provided answers (Bentley & Whitten, 2007). This study applies SPSS (16th edition) and LISREL (version 8.72) to analyse the collected data.

This study also used semi-structured interviews to survey instructors due to the small sample size of instructors. In addition to receiving simple and direct answers corresponding to the each question, the interviews were performed using open questions and answers to achieve the greatest freedom of responses from the interview subjects (Bentley & Whitten, 2007).

4.1. Data collection

The formal questionnaire of this study was posted on the Web. In total, 311 samples were received with an effective ratio of 92.6% (288 valid questionnaires). Participants included students from 12 course categories, including System Simulation, Organisational Behaviour, Random Process, Introduction to Computers, Consumer Behaviours, Network Management, Business Communication Networking, Windows Software Design, Decision Making under Uncertainty, Management of Production and Operation, and System Analysis and Design. According to Tanaka's (1987) argument, the sample size should be at least five times the number of instruments. Hair, Anderson, Tatham, and Black (2006) suggested a sample size between 100 and 400. Based on these references, the sample size should be adequate.

4.2. Demographics and descriptive statics

The participants of this study included 60.4% males and 39.6% females. The majority of participants (64.9%) were aged between 19 and 22 years old. Undergraduates comprised a majority of the sample (70.1%). Additionally, 84.4% of participants majored in business/management. Most participants (71.9%) have been using the Internet for six to ten years, and 69.4% surf the Internet for about two to 5 h on average every day. Only eight students were not familiar with the communication tool. Most participants (82.3%) participated in discussions on BBS, forums or blogs, and 92.7% read on-line news. Overall, nearly 90% had used e-learning systems at school. Most participants had used the

Table 3
Convergent validity for CFA.

Aspect	Composite Reliability	Average Variance Extracted
Information quality	0.884	
		0.559
System quality	0.858	
		0.602
Service quality	0.797	
		0.568
Communication quality	0.912	
		0.537
User satisfaction	0.925	
		0.711
Loyalty intention	0.908	
		0.665

Table 4
Reliability, average variance extracted and discriminant validity.

Factor	Information quality	System quality	Service quality	Communication quality	User satisfaction	Loyalty intention
Information quality	**0.884**					
System quality	0.714	**0.856**				
Service quality	0.778	0.714	**0.794**			
Communication quality	0.750	0.632	0.714	**0.912**		
User satisfaction	0.731	0.775	0.733	0.696	**0.924**	
Loyalty intention	0.696	0.639	0.671	0.713	0.806	**0.906**

The bold values are the average values.

Internet extensively, or they had used e-learning systems before the survey. Thus, the participants can be considered appropriately to meet the survey context of this study.

4.3. Interview

Due to a small sample size of instructors, interviews were conducted instead of questionnaires. These interviews sought to understand whether instructors could benefit from using e-learning 2.0 and to acquire successful factors for the system. The interviewer asked questions based on questionnaire categories. If the interview subject responded as strongly agreeing or disagreeing with a point, the interviewer asked follow-up questions, such as: Do you benefit from this e-learning 2.0 system? How was it different? What different experiences did you have experienced from this system? What would you suggest for that? All the interviews were audio-recorded for analysis.

5. Data analysis and results

A two-phased approach for SEM analysis, consisting of a measurement model and a structural model, (Hair et al., 2006) was adopted for data analysis.

5.1. Measurement model

The reliability of the six constructs of the proposed research model can be examined using Cronbach's alpha, including 0.884 for IQ, 0.856 for SQ, 0.794 for SEQ, 0.912 for CQ, 0.924 for US and 0.906 for LI. A Cronbach's alpha coefficient exceeding the 0.7 threshold indicates a high level of consistency among the aspects; a Cronbach's alpha coefficient exceeding 0.9 indicates a much higher level of consistency among the aspects. The Cronbach's alpha coefficients of the six constructs all exceed 0.7, and three aspects had Cronbach's alpha coefficients higher than 0.9, which indicates high consistency among these study constructs. The tests are shown in Table 1.

The first-order confirmatory factor analysis (CFA) was conducted using LISREL 8.72 to test the measurement model. Several common model-fit indices were used to evaluate the overall goodness-of-fit. The fit indices are shown in Table 2.

Two additional tests were performed: convergent validity and discriminant validity. For the assessment of convergent validity, this study drew upon the suggestions from Bagozzi and Yi (1988) and tested the measurement model using three indices: reliability of respective question item, composite reliability and average variance extracted (AVE). The recommended values are also listed for reference. The common acceptance levels, as suggested by previous research, are 0.5 (Hair et al., 2006), 0.6 (Bagozzi & Yi, 1988; Fornell & Larcker, 1981; Hair et al., 2006), and 0.5 (Bagozzi & Yi, 1988; Fornell & Larcker, 1981; Hair et al., 2006).

The results of the convergent validity using CFA are shown in Table 3. Thus, the research model can be considered to have acceptable convergent validity.

To examine discriminate validity, the study considered whether the correlation coefficient between two measured aspects was lower than 1, and whether the correlation coefficient between two measured aspects was lower than Cronbach's alpha (Churchill & Iacobucci, 2004; Gaski & Nevin, 1985).

First, Pearson correlation analysis was performed using the average value of each aspect. According to the correlation coefficient, each aspect can reach a significant positive correlation under the conditions when the significant standard is 0.01. Cronbach's alpha coefficient for each aspect was examined. As shown in Table 4, the correlation coefficient between any two aspects of IQ, SQ, SEQ, CQ, US and LI ranged from 0.632 to 0.806, all of which were less than 1. The tests meet the first standard of deciding discriminant validity in this study. The correlation

Table 5
Fit indices for structural model.

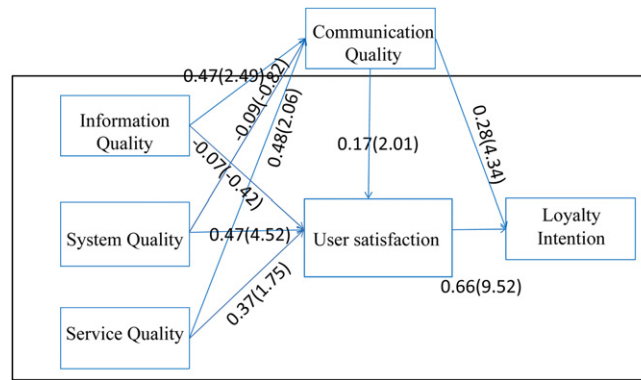| Fit indices	Recommended value	Structural Model
x^2/df	≤ 3	1.861
GFI	≥ 0.8	0.85
RMSR	≤ 0.05	0.024
SRMR	≤ 0.08	0.044
RMSEA	≤ 0.08	0.055
NFI	≥ 0.9	0.98
CFI	≥ 0.9	0.99
AGFI	≥ 0.8	0.82
PNFI	≥ 0.5	0.89
PGFI	≥ 0.5	0.72

Fig. 4. Hypotheses testing results (Note: t-values for standardised path coefficients are described in parentheses). ⋯⋯⋯⋯▸ not prominent

coefficient between IQ and SQ is 0.714, which is less than the Cronbach's alpha coefficient of IQ (0.884) and SQ (0.856). The other correlations, between IQ – SEQ, IQ – CQ, IQ – US and IQ – LI, all fit the second standard of deciding discriminant validity.

5.2. Structural model

A similar set of goodness-of-fit indices was used to examine the structural model (see Table 5). The Absolute Fit Measures (χ^2/df, GFI, RMSR, SRMR, RMSEA), Incremental Fit Measures (NFI, CFI, AGFI) and Parsimonious Fit Measures (PNFI, PGFI) all exceeded the recommended values. It was concluded that the structural model of this study exhibited good fit.

After confirmation by the measurement model, structural model was then evaluated. Using T-values to examine each path and the nine hypotheses, most hypotheses pass the standard $\alpha < 0.05$ (H1a, H2b, H3a, H4, H5 and H6). The coefficient of the hypothesis in this study and the R^2 value of each aspect are shown in Fig. 4. The standardised path coefficient indicates the strengths of the relationships between the independent and dependent variables. The R^2 value indicates the percentage of variance explained by the independent variables. Non-parentheses values on the path are estimated values of the standardised coefficient. It explained variance for three constructs, including 72% for CQ, 79% for US and 79% for LI.

Using the empirical results above, the associations between any two distinct constructs, including direct and indirect effects, were examined and shown in Table 6.

5.3. Interview

In this study, instructors' viewpoints regarding the possible successful factors for e-learning 2.0 system were analysed through interviews. Thirty-minute interviews with three professors and two TAs were conducted, and the success of the e-learning 2.0 system from instructors' perspectives was revealed through the interview responses. The categories and supporting quotations are presented in Table 7.

6. Discussion

This study adapts Wang's e-commerce/information systems success model (Wang, 2008) to examine the important factors for use in an e-learning 2.0 system. This study assesses how communication quality drives user satisfaction and loyalty intentions. High information quality and service quality encourage users to enhance their communication quality when using the e-learning system. However, high system quality cannot improve users' communication quality. High system quality and service quality can increase user satisfaction, whereas high information quality fails to improve satisfaction.

1. The influence of IQ, SQ and SEQ for CQ.
   ➢ The empirical results show that the two paths from IQ and SQ to CQ are significant. Thus, the completion, personalisation and relation of Information and the guaranteed response of SQ can improve the CQ between users in using the e-learning system.
   ➢ SQ was insignificant in enhancing CQ, the UK Government Department of Trade and Industry (DTI) suggesting that interactive collaboration should be improved by providing easy-to-use tools (DTI, 2006). That is, current system functions should be simplified by

Table 6
Direct and indirect effects between potential aspects.

	Communication quality	User satisfaction			Loyalty intention		
	Direct	Direct	Indirect	Total Effect	Direct	Indirect	Total Effect
Information quality	0.47	–	0.08	0.08	–	0.18	0.18
System quality	–	0.47	–	0.47	–	0.31	0.31
Service quality	0.48	–	0.08	0.08	–	0.19	0.19
Communication quality	–	0.17	–	0.17	0.28	0.11	0.39
User satisfaction	–	–	–	–	0.66	–	0.66
Explanatory power	0.72	0.79			0.79		

Table 7
Category of e-learning 2.0 success: Instructors' points of view and interview examples.

Category	Supporting quotation	Interpretation
Information quality	● Many additional materials may not be presented in lecture. I can easily distribute them through this system. ● Good information on the Wiki may be provided to students through this system.	The system can help an instructor to spread helpful information.
System quality	This system is easier to use than the one I used before.	The system quality fits the instructor's expectation.
Service quality	I like the function of discussion board 2.0 because student responses will let me know which part should put more efforts. Moreover, the Wiki web page links provide extra information which I may not know.	The service quality is acceptable. It achieves the goal of improving teaching quality and retrieving more information.
Communication quality	Discussion board 2.0 is convenient for me to share knowledge more quickly and more easily when I have something to add.	Good communication quality will increase the possibility of sharing knowledge.
User satisfaction	Students will respond within a short time when I post any information while I am not in lecture.	The instructor is satisfied with the system performance.
Loyalty intention	The system will notify me when any question is submitted. It pushes me to answer the questions ASAP, and I would like to see any further questions when I response.	It increases the instructors' frequency of use.

focusing on the operation. An e-learning system should enhance the interaction, communication and collaboration among users. As noted by Liaw, Chen, and Huang (2008), improving system quality in the interactive and collaborative learning environment can enhance user perceptions and increase their intentions to reuse the learning system. Wang and Liao (2008) evaluated the e-Government system and found that system quality is not a key factor for experienced Internet users. According to our interview, instructors pointed out some important functions of this system that should be improved. For example, answer editing in the QAwiki and the accuracy of the article recommendation feature should be enhanced, and the best answer decision should be made by teachers.

2. The influence of IQ, SQ and SEQ on user satisfaction.

⮞ The empirical results show that two relationships, from SQ and SEQ to US, were identified, suggesting that better design functions in an e-learning 2.0 system and e-service quality enhance user satisfaction. However, better information quality did not satisfy users in the learning process. The insignificant influence may be due to the limited capabilities of users who have less experience in using an e-learning system for cooperative learning. A survey of team learning, rather than one of individuals, might provide more helpful insights.

⮞ Additionally, scholars indicate that information recipients need to decide what information they want. Therefore, the motivations and attitudes of information recipients will become more important. Too much information could cause information overload or over-rejection (DTI, 2006), and even dissatisfaction. If there are too many information resources, users will focus on the target that attracts them, which may be unrelated to learning (DTI, 2006). According to Lee and Lee (2008), their hypothesis of satisfaction from contextual information quality to learning environment was not established, which means that learners were not able to judge if the information content was irrelevant to their educational purposes. It means that information quality requires an instructor's assistance.

⮞ Learning is an interactive process between instructors and learners, not the interaction between information systems and users. Thus, technical support from IS staff is very important for both instructors and learners. Such technical support can increase service quality that helps users receive fast feedback, leading to increased user satisfaction with the e-learning 2.0 system.

3. The influence of CQ on US.

⮞ The empirical results show that the connection between CQ to US was significant, indicating that information sharing, feedback, negotiation and integration between users could help users interact, and could thereby increase user satisfaction with the e-learning system.

⮞ The positive association between CQ and US is consistent with previous studies (Alavi, 1994; Bench-Capon & Leng, 2000; So & Brush, 2008). CQ in terms of better interaction and collaboration obviously motivates users to use the e-learning system in course learning.

4. The influence of CQ and US on LI.

⮞ The empirical results indicate that the connections from CQ and US to LI are significant. Thus, high interaction quality between users and high user satisfaction can enhance user intentions to continue using the e-learning system in course learning.

⮞ If users are satisfied with the knowledge received from others through CQ, they will continue to use the system. Some scholars supported the concept of a satisfaction-reuse chain (Lin & Wang, 2006; Wang, 2003) and emphasised that user satisfaction can drive users to use the system frequently. In contrast, it is likely that communication quality, not user satisfaction, initially encourages users to use the e-learning system.

7. Conclusion

This study applied the D&M IS/e-commerce success model to explore how to retain users and motivate them to continue using an e-learning 2.0 system. Our empirical findings indicate that the improvement of IQ, SQ, SEQ, and CQ is very useful for sustaining loyal users of e-learning systems.

This study has its limitations. It is suggested that system functions can be improved by providing efficient, quality service to users. By assisting user requests, collaboration between users can be enhanced, thereby further enhancing their satisfaction and continued use of the system. Several possible future research topics are suggested. This study presents the evidence that communication quality plays an important role in an e-learning 2.0 system. It corresponds to the argument that communication media or quality will affect the system's success (Chen & Yen, 2004; Thompson et al., 2007). To improve communication quality, the study suggests that greater emphasis should be

placed on IQ and SQ. Studies also have found that user experience of the system and system characteristics affect their confidence in using the e-learning system. With regard to communication quality, many students will not propose an idea even they have the correct answer in mind. Zhao (2007) considers that self-confidence plays an important role in system utilisation behaviour. Thus, future studies should consider whether self-confidence affects communication quality when using an e-learning 2.0 system. In the process of interviewing instructors, this study found that academic characteristics and culture also influence the learning behaviour. This finding corresponds to the argument of Yu, Tian, Vogel, and Kwok (2010). Therefore, course characteristics and culture should be considered as controlled variables in future research.

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