Factors Influencing Self-Regulation in E-learning 2.0: Confirmatory Factor Model

Facteurs qui influencent la maîtrise de soi en cyberapprentissage 2.0 : modèle de facteur confirmative

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Abstract

The importance of self-regulation in e-learning has been well noted in research. Relevant studies have shown a consistent positive correlation between learners' self-regulation and their success rate in e-learning. Increasing attention has been paid to developing learners' self-regulated abilities in e-learning. For students, what and how to learn are largely predetermined by the learning environment provided by their institutions. Environmental determinants play a key role in shaping self-regulation in the learning process. This paper reports a study on the influences of the e-learning 2.0 environment on self-regulation. The study identified the factors that influence self-regulation in such an environment and determine the relationships between the factors and self-regulation. A theoretical model to categorize the success factors for self-regulated learning was proposed for this kind of environment. Based on the model, a questionnaire was designed and administered to more than two hundred and fifty distance learning students in Beijing and Hong Kong. Through structural equation modeling (SEM) technique, relationships between environmental factors and self-regulation were analyzed. Statistical results showed that several factors affect self-regulation in the e-learning 2.0 environment. They include system quality, information quality, service quality, and user satisfaction.

Résumé

L'importance de la maîtrise de soi en cyberapprentissage a été bien étudiée. Les études pertinentes ont démontré une corrélation positive uniforme entre la maîtrise de soi des apprenants et leurs taux de réussite en apprentissage en ligne. Une attention croissante a été portée au développement des aptitudes de maîtrise de soi des élèves en cyberapprentissage. Pour les élèves, quoi apprendre et comment sont des questions principalement prédéterminées par l'environnement d'apprentissage qu'offrent leurs établissements. Les déterminants environnementaux jouent un rôle clé pour modeler la maîtrise de soi dans le processus

d'apprentissage. Cet article rapporte une étude sur les influences de l'environnement de cyberapprentissage 2.0 sur la maîtrise de soi. L'étude a cerné les facteurs qui, dans un tel environnement, influencent la maîtrise de soi et déterminent les relations entre les facteurs et la maîtrise de soi. Un modèle théorique de catégorisation des facteurs de réussite pour l'apprentissage autogéré a été proposé pour ce type d'environnement. Un questionnaire a été conçu selon ce modèle et plus de deux cent cinquante élèves en téléapprentissage à Beijing et à Hong Kong y ont répondu. À l'aide d'une technique de modélisation par équation structurelle, les relations entre les facteurs environnementaux et l'autogestion ont été analysées. Les résultats statistiques ont démontré que plusieurs facteurs affectent l'autogestion dans l'environnement de cyberapprentissage 2.0. Ceux-ci comprennent la qualité du système, la qualité de l'information, la qualité du service et la satisfaction de l'usager.

Introduction

E-learning is the latest form of distance education. It is conducted through the internet, using a variety of synchronous and/or asynchronous communication forms. These communication technologies have expanded the scope of learning by removing the limitations of time and space (Liaw & Huang, 2013).

As e-learning has developed, researchers have turned their attention from specific learning technologies and environments to the relationship between learning and its environment. Many studies have been conducted to identify key factors that enhance e-learning success. Among the factors identified, self-regulation has proven to be a critical factor affecting learning performance in e-learning (Liaw & Huang, 2013; Zimmerman & Schunk, 2001).

In recent years, a number of internet applications including blogs, Facebook, Twitter and wikis, have become popular in e-learning. These applications, known collectively as Web 2.0 applications, allow learners to be more participatory and collaborative in their dynamic interactions. However, not much research is available on the relationship between Web 2.0 based learning environments and student self-regulation. What factors influence self-regulation in Web 2.0 based learning environments? What are the relationships between these factors and student self-regulation? This study aims to categorize the Web 2.0 based learning environment success factors for self-regulated learning, and identify the interrelationship using the confirmatory factor model.

Web 2.0, E-learning 2.0, and Self-Regulation

The evolution from Web 1.0 to 2.0 has brought significant changes to learning, as well as to technology applications. As a paradigm of dynamic and interactive knowledge creation on the internet, Web 2.0 further extends the learning model that had already evolved from the traditional face-to-face model to synchronous and asynchronous, interactive, and collaborative learning (Gunawardena, Hermans, Sanchez, Richmond, Bohley, & Tuttle, 2009).

Web 2.0 was first proposed by Dougherty and Cline in a brainstorming seminar (O'Reilly, 2005). Past research has identified many definitions and descriptions of Web 2.0. For example, O'Reilly defined Web 2.0 as "a platform that delivers social software as a service that

is continually updated through new user content, where information is delivered through searching and collating data from a multitude of sources delivering rich user content whilst facilitating an 'architecture of participation" (p.1). Shang, Li, Wu, and Hou (2011) described Web 2.0 as "a network platform on which peers contribute to the development of tools, content and communities on the internet" (p. 178). Kitsantas and Dabbagh (2011) stated that "Web 2.0 is a collection of technologies and software application that allow people to interact, collaborate, create and share information with others" (p.101). According to Ballantyne and Quinn (2006), "Web 2.0 is place for networking, community building and sharing collective experience: leading some to describe this new phenomenon of massively distributed collective intelligence as the wisdom of crowds" (as cited in Mason & Rennie, 2007, p.197).

These definitions imply that Web 2.0 is an umbrella term for technologies (social media technologies in particular), that cause changes in economics, society, education, and learning. They provide opportunities to cater to people's desire to access and share information, connect and collaborate with other people, and build social networks. The key features of Web 2.0 proposed by researchers are consistent and focus on user participation, openness, personalization, social presence, user-generated content, wisdom of the crowds, social networking, and network effects (Chen, Yen, & Hwang, 2012; Shang et.al., 2011; Wang & Chiu, 2011).

The application of Web 2.0 technologies in education have led to the emergence of e-learning 2.0, which has the same 2.0 characterizing themes. In e-learning 2.0, learning is perceived as an interlinked, social process (Chen, 2009) in which Web 2.0 tools are used to "present learners with the opportunity to reflect on their ideas, organize resources, provide evaluative feedback to others, and build communities of knowledge" (Gundawardena, Hermans, Sanchez, Richmond, Bohley, & Tuttle, 2009, p.5).

The notion of self-regulation characterizes how individuals manage their personal learning process, especially how to plan, monitor, regulate, and evaluate their own learning (Zimmerman, 1989). "Self-regulated learning is an active, constructive process whereby learners set goals for their learning based on past experience and the contextual features of the current environment" (Pintrich, 2000, p.678). "Web 2.0 social software tools have significant potential to support student self-regulatory process" (Kitsantas & Dabbagh, 2011, p.102). There is also growing evidence suggesting that Web 2.0 technologies support self-regulated learning. Harrison (2011) examined blogging among college students and found that blogging helped students "direct their own learning, increased engagement in course material, and promoted the development of informal learning communities" (p.3). Dabbagh and Kitsantas (2012) also suggested that "social media have pedagogical affordances that can help support and promote student self-regulated learning" (p.5). Kitsantas and Dabbagh (2011) analyzed examples of three social software tools, looking at how instructors can use social software to support student self-regulation. They found that "Web 2.0 social software tools bring innovation in supporting student self-regulation" (Kitsantas & Dabbagh, 2011, p.105). Hilton (2009) believed that Web 2.0 technologies (social media in particular) were empowering students to take charge of their own learning. Furthermore, Schmidt (2007) proposed that Web 2.0 technologies facilitate three social cognitive processes: information management, identity management, and relationship management, which result in a change of self-regulation.

Self-regulated learning is viewed as "especially important during personally directed forms of learning, such as discovery learning, self-selected reading, or seeking information from electronic sources, [but is] also deemed important in social forms of learning" (Zimmerman, 2008, p. 167). Many studies have shown that self-regulation is a critical factor in affecting student attitudes toward e-learning (Kramarski & Gutman, 2006; Zimmerman & Schunk, 2001). In a web based learning environment, students must exercise a high degree of self-regulation to accomplish their learning goals (Dabbagh & Kitsantas, 2004). Cigognini, Pettenati, and Edirisingha (2011) also reported that effective pedagogical measures, including providing learning support and guidance, will help learners make the most of Web 2.0 technologies to achieve their goals.

The results of previous studies have fully indicated that Web 2.0 based e-learning environments and self-regulation have a high correlation. Web 2.0 technologies provide learners with powerful self-regulated learning tools to promote learning performance and get access to self-directed learning (Chen, 2009). This leads to a high degree of self-regulation, which in turn leads to greater engagement within e-learning systems, and makes students more likely to succeed (Liaw & Huang, 2013). Therefore, the most important task for educators and instructional designers is to develop effective e-learning environments and systems that support learners in becoming self-regulated learners. To this end, we must first answer the question of what kinds of factors may influence self-regulation in e-learning 2.0. To distinguish these factors from previous research, we will discuss the success of e-learning 2.0 systems.

What Factors Influence Self-Regulation in E-learning 2.0 Environments?

Highly self-regulated learners can efficiently control their own learning process including setting learning goals, selecting and organizing learning content, monitoring and regulating their learning processes, and holding positive motivation and self-efficiency (Artino & Stephens, 2009). Sharma, Dick, Chin, and Land (2007) proposed three key self-regulated abilities that learners should possess in e-learning environment: (1) motivation in terms of goal orientation and self-efficacy; (2) time and environment management; and (3) help seeking. Learner self-efficacy and motivation are positive individual characteristics. Both environment management and help seeking are related to the learning environment. A successful or powerful interactive learning environment could assist environment management for help seeking (Liaw & Huang, 2013). Previous e-learning studies have found that the interactive learning environment is a crucial factor for enhancing learners' positive attitudes, such as perceived satisfaction, usefulness, and self-regulation in e-learning environments (Liaw & Huang, 2007; Sharma et al., 2007). The findings of these studies suggest that successful learning environments may enhance learners' self-regulation (Vighnarajak, Wong, & Kamariah, 2009).

The success of learning systems has been widely investigated (DeLone & McLean, 1992, 2003; Seddon, 1997; Wang, 2008). Research on e-learning environment success consistently indicates that "learner satisfaction is one of the most important factors in assessing the success of e-learning environment" (Sun, Tsai, Finger, Chen, & Yeh, 2008, p.1184). User satisfaction refers to the collection of users' feelings or attitudes toward learning system. (Liaw & Huang, 2013). It can also be defined as the comfort or contentment one feels when they are involved in the e-learning environment (Shee & Wang, 2008). This means that a greater degree of satisfaction with the e-learning environment will create a stronger willingness to use it. Some researchers have

concluded that user satisfaction and self-regulation are highly correlated in e-learning environments (Kramarski & Gutman, 2006).

Many researchers have identified factors that affect learners' satisfaction in an e-learning environment (Arbaugh, 2000; Hong, 2002; Kanuka & Nocente, 2003; Sun et al., 2008; Wang, Wang & Shee, 2007). These factors can be classified to different categories including student, instructor, course, technology, design, and environment dimension (Sun et al., 2008). A large number of studies have been conducted to identify the influencing factors of information system success. Among these studies, the DeLone and McLean (D & M) model, which was proposed in 1992 and updated in 2003, is one of the most widely cited models. The D & M model is a theoretical framework used to assess the e-learning environment success. DeLone and McLean first proposed a six-factor information systems (IS) success model to be used as a taxonomy and framework for measuring the complex dependent variables of information system. Since then, research has been conducted that has led to the model being assessed, validated, and revised. In the most recent D & M model (2003), environment success depends on six variables: (1) information quality, (2) system quality, (3) service quality, (4) use/intention to use, (5) user satisfaction, and (6) net benefits. Many researchers have proposed other models based on the D & M model, including Wang's e-commerce success model (i.e., system quality, information quality, service quality, perceived value, user satisfaction, intension to reuse) (Wang, 2008) and the Seddon model (i.e., system quality, information quality, perceived usefulness, net benefits to individuals, net benefits to organization) (Seddon, 1997).

In previous studies, researchers focused on the question of what is the best measurement of IS. Most of this research was conducted within the context of e-commerce systems. E-learning systems are not the same as e-commerce systems. In e-learning systems, the educational effects (i.e., learners' performance) are what educators are concerned about. This means that learners' performance (i.e., self-regulation) should be employed as one of the dimensions of e-learning system success. Moreover, with the development of new technologies – especially social applications – the dimensions and interpretations of the dependent variables for IS success should be changed as well. Therefore, some items within the model need to be reworded, and some associations have to be considered within e-learning environments.

How do we measure e-learning 2.0 system success? Wang and Chiu (2011) proposed a new learning system success model (Figure 1) within the context of e-learning 2.0. This model adopts the theoretical framework called the "quality-satisfaction-loyalty" chain (Wang & Chiu, 2011, p.1793) to reframe the original D & M model. In the Wang and Chiu model, communication quality was added in order to assess whether users can benefit from interactive communications, which are considered to affect system success in many research studies (Chen & Yen, 2004; Davison, 1997; Hrastinski, 2008). Loyalty intention also replaced intension to reuse as a net benefit.
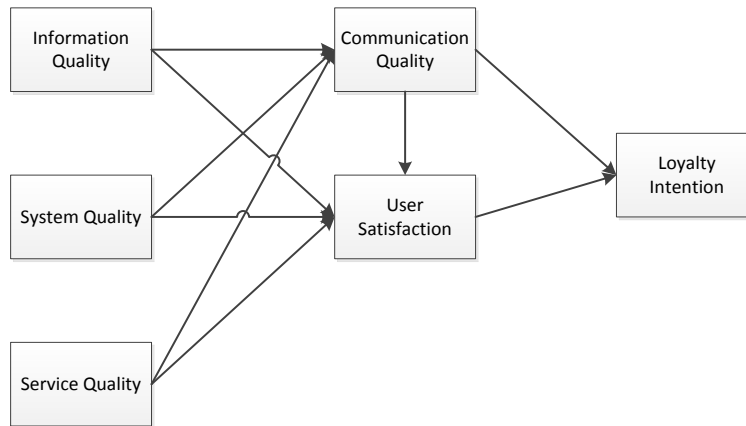
Figure 1. Wang and Chiu's (2011) model.

Wang and Chiu's (2011) research provided a conceptual model to investigate learner satisfaction toward e-learning 2.0. The model suggested that learners' satisfaction is influenced by system quality, information quality, service quality, and communication quality.

The Wang and Chiu (2011) model is a successful attempt to apply the D & M model within the context of e-learning 2.0. The result suggested that information quality, system quality, service quality, and communication quality significantly influenced user satisfaction and user loyalty in e-learning 2.0 system. But the Wang and Chiu model is also concerned with how to retain users within the e-learning 2.0 system, not just the benefit or development of learners in the e-learning 2.0 system. In the updated D & M model, DeLone and McLean put forward an important new factor, "net benefit," and suggested that its definition should be different in different contexts. They suggest that the definition of net benefit be decided by asking the question "benefit for whom?" (DeLone & McLean, 2003, p.22). In e-learning systems, the foremost service objects are students. E-learning 2.0 systems are designed for learners to learn; therefore, students' benefits should be taken into account as net benefit when measuring IS success. And yet, few studies that seek to measure IS success bring students' benefits into account. The main purpose of this study is to develop a new research model that measures system success from a student benefit perspective.

Research Model and Hypotheses

Researchers have suggested that the selection of IS success variables should be consistent with the context of the empirical investigation (DeLone & McLean, 2003; Seddon, 1997). Therefore, this study will select the success dimensions based on the context of e-learning 2.0.

In dynamic and interactive e-learning 2.0 environments, students can access nonlinearly to large amounts of multimedia resources including text, graphics, animations, audios and videos, and meanwhile do self-directed learning in the process. (Kramarski & Gutman, 2006; Vighnarajah, Wong, & Kamariah, 2009). Thus, in e-learning system, learners are expected to have high self-regulation as a result of the separation of time and space (Al-Harthi, 2010). Previous research has shown that self-regulation is the predictor that best explains both student achievement and persistence in e-learning environments (Zimmerman & Bandura, 1994).

Therefore, this study will examine learner self-regulation as the "net benefit" in measuring e-learning 2.0 system success.

The updated D & M model provides us with a taxonomy for measuring system success that has also been validated in e-learning 2.0 environments. According to the D & M model, quality has three major dimensions: "information quality," "systems quality," and "service quality"(DeLon, & McLean, 2003, p.24). In e-learning 2.0 systems, the users or customers are students who use the system for their learning development. User-friendly tools, strategies, and services are provided for users so that they can easily collaborate or interact with other learners, and create and share information. In e-learning 2.0 systems, system quality measures the desired characteristics of an e-learning 2.0 system: usability, availability, reliability, flexibility, and adaptability. Information quality focuses on learning content. Learning content provided by e-learning 2.0 systems should be personalized, relevant, sufficient, easy to understand, and up-to-date. Service quality refers to the learning support given by instructors or tutors. Consistent with the updated D & M model, service quality is also an important dimension in measuring e-learning 2.0 system success. Chen, Yen, and Hwang (2012) proposed that Web 2.0 is characterized by service rather than software. Services are a key to maintaining learners' participation and persistence.

User satisfaction is defined as learners' attitudes toward the e-learning 2.0 system, which influences their acceptance of the system. According to DeLone and McLean (2003), user satisfaction covers the entire user experience including software, content, and service. User satisfaction is also significantly influenced by system quality, information quality, and service quality (Chen & Yen, 2004; Liaw & Huang, 2013; Sun et al., 2008; Wang, Wang, & Shee, 2007; Wang & Chiu, 2011). User satisfaction is also closely related to self-regulation in e-learning environments (Kramarski & Gutman, 2006; Liaw & Huang, 2013; Roca & Gagne, 2008). User satisfaction is therefore a key factor that affects learners' self-regulation in e-learning environments (Liaw & Huang, 2013).

In the Wang and Chiu (2011) model, communication quality was added as an important dimension of e-learning 2.0 system success, which is consistent with the characteristics of e-learning 2.0. E-learning 2.0 systems supported by Web 2.0 technologies are interactive and cooperative environments. For learners, interactive, or cooperative communication positively enhanced learning (Wang & Chiu, 2011).In the Wang and Chiu model, "communication quality" refers to the extent to which the user can benefit from interactive communications, such as sharing, feedback, and discussion.

Based on the above analysis, I developed a research model (Figure 2), which includes six variables: information quality, system quality, service quality, communication quality, user satisfaction, and self-regulation. DeLone and McLean (2003) argued that the variables in IS success are interrelated and, therefore, measuring the possible interactions among them is important. Because of this, this study also attempts to hypothesize and test the relationships among the variables. Arrows were used to demonstrate the proposed associations among the six variables in the research model. As Figure 2 shows, information quality, system quality, and service quality influence communication quality and user satisfaction, which in turn, influence self-regulation. The directions of the arrows show the relationship, rather than the positive or negative impacts.
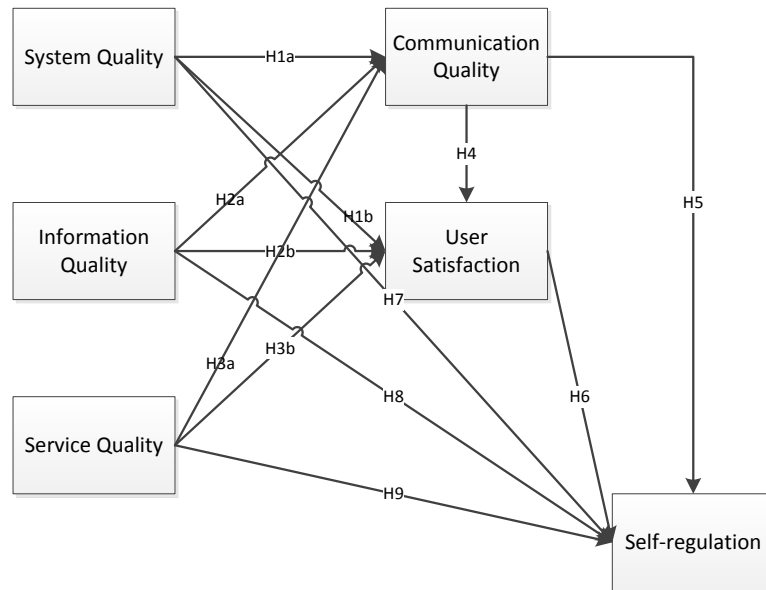
Figure 2. Research model.

Based on previous studies (DeLone & McLean, 2003; Seddon, 1997; Wang, 2008; Wang & Chiu, 2011), user satisfaction can be affected by system quality, information quality, and service quality. Wang and Chiu also pointed out that communication quality plays an important role in an e-learning 2.0 environment because high communication quality can increase user satisfaction with the e-learning environment. An e-learning environment should enhance the interaction, communication and collaboration among users (Barwise & Farley, 2005). One of the most important indicators for environment quality improvement is to enhance interaction and communication. Therefore, I propose the following hypotheses:

H1a. System quality impacts communication quality in the e-learning 2.0 environment.
H1b. System quality impacts user satisfaction in the e-learning 2.0 environment.
H2a. Information quality impacts communication quality in the e-learning 2.0 environment.
H2b. Information quality impacts user satisfaction in the e-learning 2.0 environment.
H3a. Service quality impacts communication quality in the e-learning 2.0 environment.
H3b. Service quality impacts user satisfaction in the e-learning 2.0 environment.
H4. Communication quality impacts user satisfaction in the e-learning 2.0 environment.

Web 2.0 has grown rapidly because of increased collaboration and knowledge sharing. Researchers have indicated that Web 2.0 is most often used as interactive tools, especially for collaborative social interaction (Augustsson, 2010). Web 2.0 based interactive learning environments help learners communicate with peers actively and reflectively and in the meantime interact with learning resources. (Dabbagh & Kitsantas, 2004). According to the Liaw and Huang (2013) study, an effective self-regulative e-learning environment should be a friendly, interactive environment. Previous studies noted that increased satisfaction can increase learners' self-regulation in e-learning environment (Liaw & Huang, 2013). Therefore, the following hypotheses are proposed:

H5. Communication quality impacts self-regulation in e-learning 2.0 environment.
H6. User satisfaction positively impacts self-regulation in e-learning 2.0 environment.

Some research has suggested that Web 2.0 environments can facilitate learner self-regulated learning processes, such as establishing learning goals, promoting the development of effective time planning and management skills, and supporting self-reflection, in particular (Augustsson, 2010; Kitsantas & Dabbagh, 2010). Researchers have also discussed how Web 2.0 social software could be used to support the processes of self-regulation (e.g., Dabbagh & Kitsantas, 2004; Kitsantas & Dabbagh, 2011). Other studies have suggested that self-regulation can be affected by an interactive learning environment (Liaw & Huang, 2013). Therefore, I propose the following hypotheses:

H7. Information quality impacts self-regulation in e-learning 2.0 environment.
H8. System quality impacts self-regulation in e-learning 2.0 environment.
H9. Service quality impacts self-regulation in e-learning 2.0 environment.

Methodology

Measurement

For this research, a questionnaire was developed to collect the information concerning the six factors mentioned in the proposed model (Figure 2).To ensure the content validity, the questionnaire items were adopted by modifying them from relevant prior research. The factors of system quality, information quality, service quality, communication quality, and user satisfaction were revised from the research of Wang, Wang, and Shee (2007), Sun et al. (2008), Wang and Chui (2011), and Liaw and Huang (2013). The questionnaire items for self-regulation were revised from the research of Dilireba, Zhao, and An (2010). The six-factor questionnaire covered 32 items using a 5-point Likert scale ranging from 5 (strongly agree) to 1 (strongly disagree). The questionnaire was composed of two parts. The first part was designed to collect learners' demographic information including gender, age, work, and online learning experience. The second part contained the measurement items of the research framework. PASW AMOS (SPSS China, Shanghai) 20.0 was employed to examine the hypotheses above using a structural equation modeling (SEM) technique.

Participants

The study concentrated on distance learners from the Network Education School of Beijing Language & Culture University and the Open University of Hong Kong. These participants took an online course in the online learning platform. The online learning platform for both institutions employed Web 2.0 technologies, such as wikis, blogs, BBS (Bulletin Board System), YouTube, RSS (Rich Site Summary), and Facebook. Of the total administered 290 questionnaires, 257 valid ones were received back with an effective response rate of 88.6%. In the final sample, 71.6% of the participants were females and 28.4% were males. The majority of participants (91.8%) were between 20 to 40 years old. The majority of the sample was made up of first to third year students (73.4%).

Results

The data analysis was conducted using a two-step approach for SEM analysis, and included a measurement model and a structural model (Anderson & Gerbing, 1988).

Analysis of the Measurement Model

In this section, two tests were carried out: convergent validity and discriminant validity. Convergent validity measures the correlation of a construct's multiple indicators. According to the Hair proposal (Hair, Anderson, Tatham, & Black, 2006), we used three indices to test the convergent validity. First, the reliability of the six constructs of the proposed research model were examined using Cronbach's alpha (as shown in Table 1). The Cronbach's alpha coefficient for the six constructs all exceed 0.8 and the factor loading of all questionnaire items is above 0.65, which indicates high reliability and internal consistency. Second, Average Variances Extracted (AVE) and Composite Reliability (CR) were performed. As shown in Table 1, all constructs have an AVE and CR that are higher than 0.6, which suggest good convergent validity.

Table 1

Reliability Analysis and Convergent Validity

Construct / Indicator	Questionnaire Items	Factor Loading	CR	AVE	Cronbach's Alpha
System Quality	SYSQ01	0.731	0.922	0.664	0.898
	SYSQ02	0.851			
	SYSQ03	0.848			
	SYSQ04	0.752			
	SYSQ05	0.843			
	SYSQ06	0.855			
Information Quality	INFQ01	0.762	0.914	0.640	0.883
	INFQ02	0.782			
	INFQ03	0.789			
	INFQ04	0.833			
	INFQ05	0.837			
	INFQ06	0.795			
Service Quality	SERQ01	0.763	0.870	0.626	0.897
	SERQ02	0.816			
	SERQ03	0.823			
	SERQ04	0.760			
Communication Quality	CQ01	0.819	0.913	0.677	0.878
	CQ02	0.852			
	CQ03	0.873			
	CQ04	0.761			
	CQ05	0.805			
User	UQ01	0.877	0.938	0.790	0.911

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	SYSQ04	0.752			
	SYSQ05	0.843			
	SYSQ06	0.855			
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	INFQ02	0.782			
	INFQ03	0.789			
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	INFQ05	0.837			
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	SERQ03	0.823			
	SERQ04	0.760			
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	CQ02	0.852			
	CQ03	0.873			
	CQ04	0.761			
	CQ05	0.805			
Satisfaction	UQ02	0.886			
	UQ03	0.904			
	UQ04	0.888			
Self-Regulation	SR01	0.677	0.934	0.671	0.915
	SR02	0.872			
	SR03	0.881			
	SR04	0.875			
	SR05	0.849			
	SR06	0.801			
	SR07	0.756			

Note. CR: Composite Reliability; AVE: Average variance extracted.

Discriminant validity can assess the extent to which a construct is distinct from other constructs. Fornell and Larcker (1981) proposed that the discriminant validity is acceptable when the square root of every AVE for each construct is larger than any correlation among any pair of the constructs. Table 2 shows that each value of the square root of AVE exceeds the correlation coefficient between this construct and any other constructs.

Table 2

Correlation Matrix and Discriminant Validity

Constructs	1	2	3	4	5	6
1. System Quality	**0.815**					
2. Information Quality	.751	**0.800**				
3. Service Quality	.766	.750	**0.791**			
4. Communication Quality	.803	.788	.776	**0.822**		
5.User Satisfaction	.794	.763	.785	.801	**0.889**	
6. Self-Regulation	.775	.760	.755	.741	.774	**0.819**

Note. The bold values are the square root of AVE.

Analysis of Structural Model

Goodness-of-fit indices were used to examine the structural model, including x^2/df, CFI, NFI, RFI, RMSEA. These results, listed in Table 3, indicate that the model fit well.
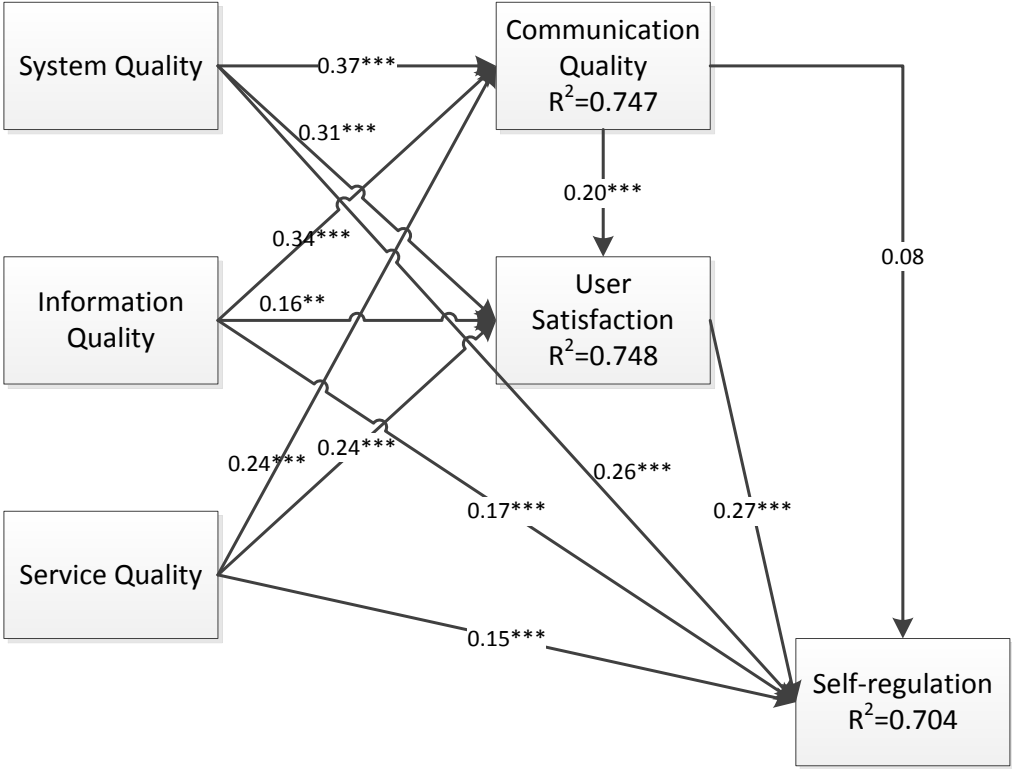
Table 3

Fit Indices of the Structural Model

Fit Indices	Structural Model	Recommended Value
x^2/df	1.01	<3
CFI	0.998	>0.9
NFI	1.000	>0.9
RFI	0.990	>0.9
RMSEA	0.008	<0.05

Hypothesis Examination and Discussion

After confirming the research model, the research hypotheses were tested by SEM. The path significance of each hypothesized association in the research model, and the R^2 value for each path were examined. Figure 3 and Table 3 each respectively show the standardized path coefficient and path significances. In this research, ten hypothesized associations had strong significance at $p<0.001$(H1a, H1b, H2a, H3a, H3b, H4, H6, H7, H8, H9), one hypothesized association was significant at $p<0.01$ (H2b), and Hypothesis 5 was not significant. The R^2 value indicates the percentage of variance that are explained by the independent variables, including 74.7% for communication quality, 74.8% for user satisfaction and 70.4% for self-regulation.

***p<0.001; **p<0.01

Figure 3. The results of hypotheses.

Table 4

Summary of Hypotheses Tests

	Hypothesis	β	p	Support
H1a	System quality → Communication quality	0.37	<0.001	Yes
H1b	System quality → User satisfaction	0.31	<0.001	Yes
H2a	Information quality → Communication quality	0.34	<0.001	Yes
H2b	Information quality → User satisfaction	0.16	0.004	Yes
H3a	Service quality → Communication quality	0.24	<0.001	Yes
H3b	Service quality → User satisfaction	0.24	<0.001	Yes
H4	Communication quality → User satisfaction	0.24	<0.001	Yes
H5	Communication quality → Self-regulation	0.08	0.195	No
H6	User satisfaction → Self-regulation	0.27	<0.001	Yes
H7	System quality → Self-regulation	0.26	<0.001	Yes
H8	Information quality → Self-regulation	0.17	<0.001	Yes
H9	Service quality → Self-regulation	0.15	<0.001	Yes

The influence of system quality, information quality, and service quality on communication quality. The empirical results show that the three paths from system quality, information quality, and service quality to communication quality are significant. This implies that a high quality e-learning environment can enhance online communication and interaction. This result provides positive support for previous studies (Sicilia, Ruiz, & Munuera, 2005; Wang & Chiu, 2011). A high quality e-learning environment should provide various opportunities and support for interactive communication. Walther (1992) pointed out that online learning system are not just an interactive platform. The quality of communication depends not only on the system itself, but also on whether the learners are motivated to interact. Therefore, high system quality, sufficient information, and personalized service are significant factors in improving learners' communication quality.

The influence of system quality, information quality, and service quality on user satisfaction. The results from the statistical analysis indicate that the three connections from system quality, information quality, and service quality to user satisfaction are significant. These findings are consistent with previous research that indicates that system quality, information quality, and service quality are all critical factors in enhancing user satisfaction in e-learning 2.0 systems (Kim & Ong, 2005). This suggests that better design functions, information quality, and high service quality can satisfy users in e-learning 2.0 environments.

Additionally, according to Wang and Chiu (2011), information overload will cause dissatisfaction for users in e-learning environments. In e-learning environment, learners are sensitive to information quality. They appeal to teachers to provide support for guidance and help about learning content (Lee & Lee, 2008). Therefore, it is important for instructors to

provide learners with information that is highly relevant to the learning purpose and need, in order to improve satisfaction in e-learning environments.

The influence of communication quality on user satisfaction. The empirical results show that the connection from communication quality to user satisfaction is significant, indicating that the more effective the interactivity and communication, the more satisfaction students will feel towards the e-learning 2.0 environment. The positive association between CQ and US is consistent with previous studies (Bench-Capon & Leng, 2000; So & Brush, 2008; Wang & Chiu, 2011). Roca and Gagne (2008) proposed that users would enjoy e-learning more when they felt connected to and supported by other users. Therefore, communication quality is a key factor to enhance learners' satisfaction towards e-learning 2.0 systems and promote their using willingness.

The influence of system quality, information quality, service quality, communication quality, and user satisfaction on self-regulation. The results indicate that system quality, information quality, service quality, and user satisfaction all predict self-regulation in e-learning 2.0 environments. The results support previous research that self-regulation can be influenced by interactive e-learning environments and user satisfaction (Kramarski & Gutman, 2006; Liaw & Huang, 2013). Chen (2009) stated that Web 2.0 functionalities, such as sharing, content editing, co-creation, and regeneration, allow e-learning to be a powerful self-regulation tool. Thus, for pedagogical practice, promoting self-regulation should create effective e-learning environments and further enhance learners' satisfaction.

Communication quality is insignificant in promoting self-regulation. This insignificance may be due to fact that online teacher-student interactions in the sample groups are quite limited. Wang and Chiu (2011) suggested that effective interactive learning processes exist in the communication between instructors and learners, not between information systems and users. In both the Network Education School of Beijing Language & Culture University and the Open University of Hong Kong, communication between instructors and learners is mainly in the form of face-to-face interpersonal interactive activity, rather than online interaction. Therefore, the teachers' tutorials and support are very important for self-regulation, which can help learners set goals, share strategies, conduct self-reflection, and self-assessment. Teachers' support can also further increase service quality, and enhance user satisfaction.

However, the insignificant connection from communication quality to self-regulation does not mean that communication quality has no effect on self-regulation. The relationship between communication quality and user satisfaction is significant, and user satisfaction is an important factor influencing self-regulation, which has been tested in this study as well as previous research. Therefore, communication has an indirect influence on self-regulation and communication quality via user satisfaction can impact self-regulation. High communication quality can increase user satisfaction, and therefore promote self-regulation, which also indicates that user satisfaction is a key factor for promoting self-regulation in e-learning 2.0 environments.

Conclusion

Various studies have suggested the importance of self-regulation in e-learning (Chen, 2009; Liaw & Huang, 2013; Zimmerman & Schunk, 2001). Learners with a higher degree of

self-regulation are more inclined to succeed. Therefore, developing learners' self-regulated learning abilities become important for instructors. Kitayama (2002) stated that self-regulated learning processes are directed and organized by environmental events. For students, how to learn and what to learn are largely predetermined by the learning environment provided by distance institutions (Al-Harthi, 2010). However, how to orchestrate self-regulation into e-learning environments is seldom discussed (Dabbagh & Kitsantas, 2004). This research examined the relationship between e-learning 2.0 environments and self-regulation, to explore what environmental factors influence self-regulation. The findings provide more insight for distance institutions on how to construct successful e-learning environment to support self-regulation. Based on the research results, our empirical findings indicate that the improvement of system quality, information quality, service quality, and user satisfaction is very useful for promoting self-regulation in e-learning 2.0 environments. That is to say, building self-regulated e-learning environments should create effective interactive learning environments in which the above five factors should be especially considered.

Meanwhile, this study presents evidence that user satisfaction plays an important role for self-regulation. These findings correspond to the argument that enhanced user satisfaction can promote learners' self-regulation towards e-learning (Liaw & Huang, 2013). There are many factors should be taken into account in future research. Sun et al. (2008) proposed that course quality has the strongest association with satisfaction in e-learning systems. Course scheduling, discussion arrangement and types, course materials and technical assistance are all related to user satisfaction. Therefore, these course characteristics should be considered in future research.

References

AI-Harthi, A. S. (2010). Learner self-regulation in distance education: A cross-culture study. *The American Journal of Distance Education*, *24*, 135–150.

Anderson, J.C., & Gerbing, D.W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin*, *103*(3), 411-423.

Arbaugh, J.B. (2000).Virtual classroom characteristics and student satisfaction with internet–based MBA courses. *Journal of Management Education*, *24*(1), 32–54.

Artino, A.R., & Stephens, J.M. (2009). Academic motivation and self-regulation: A comparative analysis of undergraduate and graduate students learning online. *Internet and Higher Education*, *12*, 146-151.

Augustsson, G. (2010). Web 2.0, pedagogical support for reflexive and emotional social interaction among Swedish students. *Internet and Higher Education*, *13*, 197–205.

Ballantyne, N., & Quinn, K. (2006). *Informal learning and the social web*. Retrieved from http://informallearning.pbwiki.com/

Barwise, P., & Farley, J.U. (2005). The state of interactive marketing in seven countries: interactive marketing comes of age. *Journal of Interactive Marketing*, *19*(3), 67–80.

Bench-Capon, T.J.M., & Leng, P.H. (2000). Computer-mediated collaborative learning of legal argumentation. *Information & Communications Technology Law*, *9*(2), 129-138.

Chen, C.M. (2009). Personalized E-learning system with self-regulated learning assisted mechanisms for promoting learning performance. *Expert System with Applications*, *36*, 8816–8829.

Chen, K., & Yen, D.C. (2004). Improving the quality of online presence through interactivity. *Information & Management*, *42*, 217–226.

Chen, S.C., Yen, D.C., & Hwang, M.I. (2012). Factors influencing the continuance intention to the usage of Web 2.0: An empirical study. *Computers in Human Behavior, 28*, 933–941.

Cigognini, M.E., Pettenati, M.C., & Edirisingha, P. (2011). Personal knowledge management skills in Web 2.0-based learning. In M. J. W. Lee, & C. McLoughlin (Eds.), *Web 2.0-based E-learning: Applying Social Informatics for Tertiary Teaching* (pp.109-127), Hershey, PA: IGI Global.

Dabbagh, N., & Kitsantas, A. (2004). Supporting self-regulation in student-centered web-based learning environments. *International Journal on E-Learning*, *3*(1), 40–47.

Dabbagh, N., & Kitsantas, A. (2012). Personal learning environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning. *Internet and Higher Education, 15*, 3-8.

Davison, R. (1997). An instrument for measuring meeting success. *Information & Management*, *32*, 163–176.

DeLon, W.H., & McLean, E.R. (1992). Information systems success: The quest for the dependent Variable. *Information System Research, 3*(1), 60–95.

DeLon, W.H., & McLean, E.R. (2003). The DeLon and McLean model of information systems success: A ten-year update. *Journal of Management Information System, 19*(4), 9–30.

Dilireba, K., Zhao, H., & An, Z.H. (2010). The structure and compilation of the self-evaluation Scale of adult distance learners' autonomous learning ability. *Modern Distance Education Research*, *3*, 43-47.

Fornell, C., & Larcker, D.F. (1981). Structural equation models with unobservable variables and measurement errors. *Journal of Marketing Research*, *18*(1), 39–50.

Gunawardena, C.N., Hermans, M.B., Sanchez, D., Richmond, C., Bohley, M., & Tuttle, R. (2009). Theoretical framework for building online communities of practice with social networking tools. *Educational Media International*, *46*(1), 3–16.

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (2006). *Multivariate data analysis.* Upper Saddle River, NJ: Prentice Hall.

Harrison, D. (2011). *Can blogging make a difference?* Retrieved from http://campustechnology.com/articles/2011/01/12/can-blogging-make-a-difference.aspx

Hilton, J. (2009, July/August). Essential versus strategic IT investments. *EDUCAUSE Review*, *44*(4), 8-9.

Hong, K.S. (2002). Relationships between students' and instructional variables with satisfaction and learning from a Web-based course. *Internet and Higher Education, 5*, 267–281.

Hrastinski, S. (2008). The potential of synchronous communication to enhance participation in online discussions: A case study of two e-learning courses. *Information & Management*, *45*(7), 499–506.

Kanuka, H., & Nocente, N. (2003). Exploring the effects of personality type on perceived satisfaction with web-based learning in continuing professional development. *Decision Education*, *24*(2), 227–245.

Kim. G.M., & Ong, S.M. (2005). An exploratory study of factors influencing m-learning. *Journal of Computer Information Systems*, *46*(1), 92-98.

Kitsantas, A., & Dabbagh, N. (2010). *Learning to learn with integrative learning technologies (ILT): A practical guide for academic success.* Charlotte, N.C.: Information Age Publishing.

Kitsantas, A., & Dabbagh, N. (2011). The role of Web 2.0 technologies in self-regulated learning. *New Directions for Teaching and Learning*, *126*, 99–106.

Kitayama, S. (2002). Culture and basic psychological processes-Toward a system view of culture: Comment on Oyserman et al. (2002). *Psychological Bulletin*, *128*(1), 89-96.

Kramarski, B., & Gutman, M. (2006). How can self-regulated learning be supported in mathematical E-learning environment? *Journal of Computer Assisted Learning*, *22*, 24–33.

Lee, J.K., & Lee, W.K. (2008). The relationship of e-learner's self-regulatory efficacy and perception of e-learning environment quality. *Computers in Human Behavior*, *24*(1), 32-47.

Liaw, S. S., & Huang, H.M. (2007). Developing a collaborative e-learning system based on users' perceptions. *Lecture Notes in Computer Science*, *4402*, 751–759.

Liaw, S. S., & Huang, H.M. (2013). Perceived satisfaction, perceived usefulness and interactive learning environments as predictors to self-regulation in e-learning environments. *Computer & Education*, *60*, 14–24.

Maloney, E.J. (2007). What Web 2.0 can teach us about learning. *Chronicle of Higher Education*, *53*(18), B26–B27.

Mason, R., & Rennie, F. (2007). Using web 2.0 for learning in the community. *Internet and Higher Education*, *10*, 196–203.

O'Reilly, T. (2005). *Web 2.0: Compact definition.* Retrieved from http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.htm

Pintrich, P. R. (2000). A motivational science perspective on the role of student motivation in learning and teaching contexts. *Journal of Educational Psychology*, *95*, 667–686.

Roca, J.C., & Gagne, M. (2008). Understanding e-learning continuance intention in the workplace: A self-determination theory perspective. *Computers in Human Behavior, 24,* 1585-1604.

Schmidt, J. (2007). Social software: Facilitating information-, identity- and relationship management. In T.N. Burg, & J. Schmidt (Eds.), *Blog talks reloaded: social software research & cases* (pp.31-49). Norderstedt, Germany: Books on Demand.

Seddon, P. B. (1997). A respecification and extension of the DeLone and McLean model of IS success. *Information System Research*, *8*(3), 240–253.

Shang, S.S.C., Li, E.Y., Wu, Y.L., & Hou, O.C.L. (2011). Understanding Web 2.0 service models: A knowledge-creating perspective. *Information & Management, 48*,178–184.

Sharma, S., Dick, G., Chin, W. W., & Land, L. (2007). Self-regulation and e-learning. In H. Osterle, J. Schelp, R. Winter (Eds.), *proceedings of the fifteenth european conference on information system(ECIS 2007)*. Switzerland: University of St. Gallen, 383–394.

Shee, D., & Wang, Y.H. (2008).Multi-criteria evaluation of the web-based e-learning system: a methodology based on learner satisfaction and its applications. *Computers & Education*, *50*, 894–905.

Sicilia, M., Ruiz, S., & Munuera, J.L. (2005). Effects of interactivity in a web site. *Journal of Advertising*, *34*(3), 31-46.

So, H. J., & Brush, T. A. (2008). Student perceptions of collaborative learning, social presence and satisfaction in a blended learning environment: relationships and critical factors. *Computer & Education*, *51*(1), 318-336.

Sun, P. C., Tsai, R.J., Finger, G., Chen, Y.Y., &Yeh, D. (2008). What drives a successful e-learning? An empirical investigation of the critical factors influencing learner satisfaction. *Computers & Education, 50*, 1183-1202.

Vighnarajah, Wong, S.L., & Kamariah, A.B. (2009). Qualitative findings of students' perception on practice of self-regulated strategies in online community discussion. *Computers & Education*, *53*, 94–103.

Walther, J.B. (1992). Interpersonal effects in computer-mediated interaction: A relational perspective. *Communication Research*, *19*(1), 52-90.

Wang, Y.S. (2008). Assessing e-commerce systems success: a respecification and validation of the DeLone and McLean model of IS success. *Information Systems Journal, 18*(5), 529-557.

Wang, H.C., & Chiu, Y. F. (2011). Assessing e-learning 2.0 system success. *Computer & Education, 57*, 1790–1800.

Wang, Y.S., Wang, H.Y., & Shee, D.Y. (2007). Measuring e-learning systems success in an organizational context: Scale development and validation. *Computers in Human Behavior, 23*, 1792–1808.

Zimmerman, B.J. (1989). A social cognitive view of self-regulated academic learning. *Journal of Educational Psychology*, *81*(3), 329–339.

Zimmerman, B.J. (2008). Investigating self-regulation and motivation: Historical background, methodological developments, and future prospects. *American Educational Research Journal*, *45*(1), 166–183.

Zimmerman, B.J. & Bandura, A. (1994). Impact of self-regulatory influences on writing course attainment. *American Educational Research Journal*, *29*, 663-676.

Zimmerman, B.J. & Schunk, D.H. (2001). *Self-regulated Learning and Academic Achievement: Theoretical perspectives*. Mahwah, N.J.: Lawrence Erlbaum.

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