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Measuring e-learning systems success in an organizational context: Scale development and validation

Yi-Shun Wang [a,*], Hsiu-Yuan Wang [b,c], Daniel Y. Shee [a]

[a] *Department of Information Management, National Changhua University of Education, 2, Shi-Da Road, Changhua 500, Taiwan*
[b] *Department of Business Education, National Changhua University of Education, Changhua 500, Taiwan*
[c] *Department of Computer Science and Information Engineering, ChungChou Institute of Technology, Yuanlin 510, Taiwan*

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Abstract

Electronic learning (e-learning) has been widely adopted as a promising solution by many companies to offer learning-on-demand opportunities to individual employees in order to reduce training time and cost. While information systems (IS) success models have received much attention among researchers, little research has been conducted to assess the success and/or effectiveness of e-learning systems in an organizational context. Whether traditional IS success models can be extended to investigate e-learning systems success has been scarcely addressed. Based on previous IS success literature, this study developed and validated a multi-dimensional model for assessing e-learning systems success (ELSS) from the perspective of the employee (e-learner). The procedures used in conceptualizing an ELSS construct, generating items, collecting data, and validating a multiple-item scale for measuring ELSS are described. This paper presents evidence of the scale's factor structure, reliability, content validity, criterion-related validity, convergent validity, and discriminant validity on the basis of analyzing data from a sample of 206 respondents. Theoretical and managerial implications of our results are discussed. This empirically validated instrument will be useful to researchers in developing and testing e-learning systems theories, as well as to organizations in implementing successful e-learning systems.

Keywords: Electronic learning (e-learning); Systems success; Measurement model; Scale development

* Corresponding author. Tel.: +886 4 723 2105x7331; fax: +886 4 721 1162.
E-mail address: yswang@cc.ncue.edu.tw (Y.-S. Wang).

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1. Introduction

The traditional context of learning is experiencing a radical change. Teaching and learning are no longer restricted to traditional classrooms (Marold, Larsen, & Moreno, 2000; McAllister & McAllister, 1996; Zhang & Nunamaker, 2003). Electronic learning (e-learning), referring to learning via the Internet, has become a major phenomenon in recent years. Schools and corporations are investing substantial amounts of time and money in developing online alternatives to traditional types of education and training systems. On the corporate side, to compete in today's lightning-fast business world, employees must be up-to-date with the latest knowledge and technologies. Many companies have adopted e-learning solutions for their corporate training, such as Dell Learning, CISCO E-Learning, and HP Virtual Classroom (Zhang, 2002; Zhang & Nunamaker, 2003). Through the e-learning systems, workers have access to various on-line databases and tools that help them find solutions for work-related problems.

Zhang and Nunamaker (2003) suggest that effective and efficient training methods are in great demand by companies to ensure that employees and channel partners are timely equipped with the latest information and the most advanced skills. Academics and practitioners alike consider e-learning systems to be a valuable knowledge sharing and transfer tool. However, researchers have not demonstrated a consistent relationship between IT/IS investment and organizational performance (Brynjolfsson, 1993; Farbey, Land, & Targett, 1999; Heo & Han, 2003; Hitt & Brynjolffson, 1996; Saunders & Jones, 1992). In order for e-learning applications to be used effectively in an organization, we need dependable ways to measure the success and/or effectiveness of the e-learning system. While a considerable amount of research has been conducted on IS success models (e.g., DeLone & McLean, 1992, 2003; Rai, Lang, & Welker, 2002; Seddon, 1997) and e-learning systems (e.g., Beam & Cameron, 1998; Carswell, 1997; Hiltz & Wellman, 1997; Kerrey & Isakson, 2000; Marold et al., 2000; McAllister & McAllister, 1996; McCloskey, Antonucci, & Schug, 1998; Zhang & Nunamaker, 2003), little research has been carried out to address the conceptualization and measurement of e-learning systems success within organizations. Whether or not traditional IS success models can be extended to assessing e-learning systems success is rarely addressed. Based on the DeLone and McLean's (2003) conceptual model of IS success, this study addresses the concern for a successful e-learning system implementation by means of the conceptualization and empirical measurement of an e-learning systems success (ELSS) construct.

However, the success of e-learning systems cannot be evaluated using a single proxy construct (e.g., user satisfaction) or a single-item scale (e.g., overall success). The measure of e-learning systems success must incorporate different aspects of the ELSS construct if it is to be a useful diagnostic instrument. To assess the extent and specific nature of e-learning systems success, different dimensions of ELSS construct must be defined both conceptually and operationally. An empirically validated instrument that identifies the dimensions of an ELSS construct can be of great value to both researchers and practitioners. It can enable researchers to identify various aspects of ELSS and investigate the causality between the success of e-learning systems and its drivers. Practitioners can employ it in the post-implementation phase as an evaluation mechanism to assess whether the anticipated outcomes and benefits of e-learning systems are realized. By using a well-validated instrument, e-learning managers will be able to better justify their activities, especially if they devote a significant portion of their organizational resources to these activities. In addition, until such an instrument is developed, the varying criteria of e-learning success among studies carried out will inhibit their generalizability and the accumulation of the research findings.

Thus, the purpose of this study is to develop a comprehensive, multidimensional instrument for measuring e-learning systems success in an organizational context. The rest of this paper is organized as follows. In Section 2, we establish the theoretical foundation and conceptualization for an e-learning systems success construct. This is followed by the description of the research methods used in scale item generation and data collection in Section 3. Next, we present the results of purifying the scale, identify the factor structure of the scale, and examine the evidence of reliability, content validity, criterion-related validity, convergent validity, and discriminant validity. Finally, the managerial implications and directions for future research are discussed.

2. Theoretical foundations

E-learning system is a special type of IS. Therefore, in this section we establish the theoretical foundation and conceptualization of an e-learning systems success construct based on prior IS success studies. The DeLone and McLean (1992) model is one of the most widely cited IS success models (Gable, Sedera, & Chan, 2003; Myers, Kappelman, & Prybutok, 1997; Heo & Han, 2003), suggesting that a systematic combination of individual measures from IS success categories can create a comprehensive measurement instrument. It consists of six IS success categories or dimensions, which are: (1) system quality, (2) information quality, (3) use, (4) user satisfaction, (5) individual impact and (6) organizational impact. As DeLone and McLean (1992) suggest, these six dimensions of success are interrelated rather than independent. System quality and information quality separately and jointly affect both use and user satisfaction. Additionally, the amount of use can affect the degree of user satisfaction – positively or negatively – and vice versa. Use and user satisfaction are direct antecedents of individual impact; and lastly, this impact on individual performance should eventually have some organizational impact.

The DeLone and McLean (henceforth, "D&M") model makes two important contributions to the understanding of IS success. First it provides a scheme for categorizing the multitude of IS success measures that have been used in the literature. Second, it suggests a model of temporal and causal interdependencies between the categories (McGill, Hobbs, & Klobas, 2003; Seddon, 1997). Since 1992, a number of studies have undertaken empirical investigations of the multidimensional relationships among the measures of IS success (e.g., Etezadi-Amoli & Farhoomand, 1996; Goodhue & Thompson, 1995; Guimaraes & Igbaria, 1997; Igbaria & Tan, 1997; Jurison, 1996; Li, 1997; Rai et al., 2002; Saarinen, 1996; Seddon & Kiew, 1994). Seddon and Kiew (1994) tested part of the model through a structural equation model (SEM). They replaced *Use* with *Usefulness* and added a new variable called *User Involvement*, and the results partially supported DeLone and McLean's (1992) model.

Seddon (1997) then presented and justified a re-specified and slightly extended version of DeLone and McLean's (1992) model. In this model, the process interpretation of DeLone and McLean's model has been eliminated, and the remainder of their model has been split into two distinct variance models. The first model is the partial behavioral model of *IS Use*, and the second is the IS success model. In Seddon's IS success model, user satisfaction is dependent upon six variables (i.e., System Quality, Information Quality, Perceived Usefulness, Net Benefits to Individuals, Net Benefits to Organizations, and Net Benefits to Society). Perceived Usefulness is hypothesized to depend upon the same six variables, excluding itself. Additionally, it is hypothesized that higher Perceived Usefulness will lead to higher User Satisfaction. Seddon (1997) also claims that IS Use is a behavior, not a success measure, and replaces DandM's (1992) IS Use with Perceived Usefulness, which serves as a general perceptual measure of net benefits of IS Use, in order to adapt his model to both volitional and non-volitional usage contexts. Rai et al. (2002) empirically and theoretically assessed DeLone and McLean's (1992) and Seddon's (1997) models of IS success in a quasi-voluntary IS use context, and found that both models exhibit reasonable fit with the collected data.

Recently, DeLone and McLean (2003) proposed an updated IS success model and evaluated its usefulness in light of the dramatic changes in IS practice, especially the emergence and consequent explosive growth of Internet-based applications. Based on prior studies, DeLone and McLean (2003) presented this updated IS success model by adding "service quality" measures as a new dimension of the IS success model and by grouping all the "impact" measures into a single impact or benefit category called "net benefit". Thus, this updated model consists of six dimensions: (1) information quality, (2) system quality, (3) service quality, (4) use/intention to use, (5) user satisfaction and (6) net benefits. Given that system usage continues to be used as a dependent variable in a number of empirical studies (Gelderman, 1998; Goodhue & Thompson, 1995; Guimaraes & Igbaria, 1997; Igbaria & Tan, 1997; Igbaria, Zinatelli, Gragg, & Cavaye, 1997; Rai et al., 2002; Taylor & Todd, 1995; Torkzadeh & Doll, 1999; Yuthas & Young, 1998) and takes on new importance in Internet applications success measurements where use is voluntary or quasi-voluntary, system usage or "intention to use" are still considered to be important measures of IS success in the updated D&M model.

Within the e-learning context, e-learners use the systems to conduct learning activities, making the e-learning system a communication and IS phenomenon that lends itself to the updated D&M IS success model. DeLone and McLean (2003) contend that the Internet applications process fits well into their updated IS success model and the six success dimensions, and encourage others to continue testing and challenging their model. DeLone and McLean's (2003) updated IS success model can be adapted to the measurement challenges of a new e-learning context. Accordingly, we adopted DeLone and McLean's (2003) IS success model as a theoretical framework to develop an instrument for assessing the success of e-learning systems in an organizational context.

Capturing the complete dimensions of the ELSS construct in the context of an organization is extremely difficult, since many combinations of individual, managerial and organizational measures can be adopted. In addition, different players or stakeholders may have different opinions as to what constitutes a benefit to them (DeLone & McLean, 2003; Seddon, Staples, Patnayakuni, & Bowtell, 1999). Researchers need to clearly and carefully define the stakeholders and the context in which IS success or Net Benefits are to be measured (DeLone & McLean, 2003). DeLone and McLean (2003) also suggest that "despite the multidimensional and contingent nature of IS success, an attempt should be made to reduce significantly the number of measures used to measure IS success, so that research results can be compared and findings validated" (p. 27). Thus, this study focuses mainly on the perspective of the employee (e-learner), and uses the six updated IS success dimensions – Information Quality, System Quality, Service Quality, System Use, User Satisfaction, and Net Benefit – to develop and validate a measurement model of e-learning systems success, rather than establishing new dimensions for the e-learning systems success construct.

3. Research methodology

3.1. Generation of scale items

There are various potential measuring items for the ELSS construct. A review of the literature on IS success, IS performance, web success, e-learner satisfaction, user information satisfaction, end-user computing satisfaction, web user satisfaction, system use, IS service quality, web quality, and organizational benefits (e.g., Aladwani & Palvia, 2002; Bailey & Pearson, 1983; Barnes & Vidgen, 2000; Chen, Soliman, Mao, & Frolick, 2000; DeLone & McLean, 2003; Doll & Torkzadeh, 1988, 1998; Downing, 1999; Etezadi-Amoli & Farhoomand, 1996; Gable et al., 2003; Heo & Han, 2003; Ives, Olson, & Baroudi, 1983; Kettinger & Lee, 1994; Liu & Arnett, 2000; McKinney, Yoon, & Zahedi, 2002; Mirani & Lederer, 1998; Muylle, Moenaert, & Despontin, 2004; Palvia, 1996; Rai et al., 2002; Saarinen, 1996; Segars & Grover, 1998; Wang, 2003; Wang & Tang, 2003; Wang, Tang, & Tang, 2001) obtained 46 items representing the six dimensions underlying the ELSS construct, and these were used to form the initial pool of items for the ELSS scale. To make sure that no important attributes or items were omitted, we conducted experience surveys and personal interviews on e-learning systems success with the assistance of four university professors, three professionals, and five IS managers. They were asked to review the initial item list of the ELSS scale, and they recommended eliminating 15 items because of redundancy, and adding three new items. After careful examination of the result of the experience surveys and interviews, the revised 34 items were further adjusted to make their wording as precise as possible, and could be considered to constitute a complete scale for the ELSS measurement.

An initial ELSS instrument involving 36 items (as shown in the Appendix), with the two global measures *perceived overall performance* and *perceived overall success of* the e-learning system as criteria, was developed using a seven point Likert-type scale, ranging from "strongly disagree" to "strongly agree". The global measures can be used to analyze the criterion-related validity of the instrument, and to measure the overall e-learning systems success prior to detailed analysis. In addition to the ELSS measuring items, the questionnaire contains demographic questions. For each question, respondents were asked to circle the response which best described their level of agreement.

3.2. Sample and procedure

To make the results generalizable, we gathered sample data from eight international or local organizations in Taiwan: Aerospace Industrial Development Corporation (AIDC), Data Systems Consulting Co., Ltd. (the leading commercial software company in Taiwan), Shihlin Electric & Engineering Corporation, Cheng Loong Corporation (one of the top 100 paper companies in the world), Chunghwa Post Co., Ltd., China Medical University Hospital (CHUH), Aegon Taiwan (a life insurance company with its headquarters in the Netherlands), and IBM Taiwan. All of these selected organizations have implemented enterprise e-learning systems.

A sample of 206 usable e-learner responses was obtained from a variety of respondents with different backgrounds. The respondents identified themselves as top-level managers (1.0%), middle level managers (6.6%), first level managers (18.3%), professional employees (35.0%), and general employees (39.1%). Of these respondents 65.2% were male, and the distribution of age was approximately normal: under 20 (0.0%), 21–30 (25.5%), 31–40 (46.1%), 41–50 (22.5%), 51–60 (5.9%), and over 61 (0.0%). The respondents had an average of 8.56 years of work experience (SD = 7.201) in their field, and most respondents (64.3%) had a college, university, or higher degree.

4. Scale purification

4.1. Item analysis and reliability estimates

The 34-item instrument (with the two global items excluded) was refined by analyzing the pooled data; that is, the data collected from e-learners across different organizations and e-learning systems were considered together. Because the primary purpose of this study was to develop a general instrument capable of reliably and accurately measuring ELSS in various contexts of enterprise e-learning systems, the pooling of the sample data was considered appropriate.

The first step in purifying the instrument was to calculate the coefficient alpha and the item-to-total correlations used to delete garbage items (Cronbach, 1951). To avoid spurious part-whole correlation, the criterion used in this study for determining whether to delete an item was the item's corrected item-to-total correlation. An iterative sequence of computing Cronbach's alpha coefficients and item-to-total correlations was executed for each ELSS dimension. The corrected item-to-total correlations were plotted in descending order, and items with item-to-total correlations below 0.4, or whose correlations produced a substantial or sudden drop in the plotted pattern were eliminated. Because each item's corrected item-to-total correlation was above 0.4 (see Table 1), no item was eliminated in this stage. The 34-item ELSS instrument has a reliability (Cronbach's alpha) of 0.9668.

4.2. Identifying the factor structure of the ELSS construct

An exploratory factor analysis was conducted to further examine the factor structure of the 34-item instrument. Before identifying the factor structure of the ELSS construct using factor analysis, a chi-square value of 5834.91 and significance level of .000 were obtained using Bartlett's sphericity test, which suggests that the intercorrelation matrix contains sufficient common variance to make factor analysis worthwhile. The sample data of 206 responses was examined using a principal components factor analysis as the extraction technique, and varimax as the orthogonal rotation method. To improve the unidimensionality/convergent validity and discriminant validity (Price & Mueller, 1986) of the instrument through exploratory factor analysis, four commonly employed decision rules (Hair, Anderson, Tatham, & Black, 1998; Straub, 1989) were applied to identify the factors underlying the ELSS construct: (1) using a minimum eigenvalue of 1 as a cut-off value for extraction; (2) deleting items with factor loadings less than 0.5 on all factors, or greater than 0.5 on two or more factors; (3) a simple factor structure; and (4) exclusion of single item factors from the standpoint of parsimony.

Table 1
Summary of results from the scale purification

Dimension/item		Reliability	Factor loading of items on dimension to which they belong	Corrected item-to-total correlation
System Quality		0.8956		
SQ1:	The e-learning system provides high availability		0.676	0.5377
SQ2:	The e-learning system is easy to use		0.741	0.7387
SQ3:	The e-learning system is user-friendly		0.765	0.7518
SQ4:	The e-learning system provides interactive features between users and system		0.643	0.7046
SQ5:	The e-learning system provides a personalized information presentation		0.648	0.6970
SQ6:	The e-learning system has attractive features to appeal to the users		0.643	0.7626
SQ7:	The e-learning system provides high-speed information access		0.617	0.6927
Information quality		0.9102		
IQ1:	The e-learning system provides information that is exactly what you need		0.735	0.7815
IQ2:	The e-learning system provides information you need at the right time		0.787	0.7681
IQ3:	The e-learning system provides information that is relevant to your job		0.591	0.7407
IQ4:	The e-learning system provides sufficient information		0.796	0.8166
IQ5:	The e-learning system provides information that is easy to understand		0.522	0.6422
IQ6:	The e-learning system provides up-to-date information		0.721	0.7577
Service quality		0.8807		
SV1:	The e-learning system provides a proper level of on-line assistance and explanation		0.519	0.5807
SV2:	The e-learning system developers interact extensively with users during the development of the e-learning system		0.734	0.7095
SV3:	The IS department staff provides high availability for consultation		0.785	0.7419
SV4:	The IS department responds in a cooperative manner to your suggestion for future enhancements of e-learning system		0.736	0.7364
SV5:	The IS department provides satisfactory support to users using the e-learning system		0.733	0.8127
System use		0.8561		
SU1:	The frequency of use with the e-learning system is high		0.816	0.7337
SU2:	The e-learning system usage is voluntary		0.800	0.7485
SU3:	You depend upon the e-learning system		0.757	0.7059
User satisfaction		0.9080		
US1:	Most of the users bring a positive attitude or evaluation towards the e-learning system function		0.551	0.8100

Table 1 (*continued*)

Dimension/item		Reliability	Factor loading of items on dimension to which they belong	Corrected item-to-total correlation
US2:	You think that the perceived utility about the e-learning system is high		0.637	0.8517
US3:	You are satisfied with the e-learning system		0.528	0.7911
Net benefits		0.9505		
NB1:	The e-learning system helps you improve your job performance		0.509	0.7574
NB2:	The e-learning system helps you think through problems		0.530	0.7704
NB3:	The e-learning system helps the organization enhance competitiveness or create strategic advantages		0.624	0.8291
NB4:	The e-learning system enables the organization to respond more quickly to change		0.633	0.7906
NB5:	The e-learning system helps the organization provide better products or services to customers		0.681	0.8558
NB6:	The e-learning system helps the organization provide new products or services to customers		0.729	0.8544
NB7:	The e-learning system helps the organization save cost		0.551	0.6211
NB8:	The e-learning system helps the organization to speed up transactions or shorten product cycles		0.806	0.8063
NB9:	The e-learning system helps the organization increase return on investment		0.804	0.8075
NB10:	The e-learning system helps the organization to achieve its goal		0.770	0.7955

Note. The loadings on dimensions to which they did not belong were all less than 0.5.

An iterative sequence of factor analysis was executed. Fortunately, none of the items were deleted in this phase. At the end of the factor analysis procedure, we obtained a 6-factor, 34-item instrument. The six factors were exactly interpreted as System Quality, Information Quality, Service Quality, System Use, User Satisfaction, and Net Benefit, explaining 72.56% of the variance in the dataset. Table 1 summarizes the factor loadings for the 34-item instrument. The significant loading of all the items on the single factor indicates unidimensionality, while the fact that no cross-loadings items were found supports the discriminant validity of the instrument.

5. Reliability and validity assessment

5.1. Reliability

Reliability was evaluated by assessing the internal consistency of the items representing each factor using Cronbach's alpha. The 34-item instrument had a very high reliability of 0.9668, far exceeding the minimum standard of 0.80 suggested for basic research. The reliability of each factor was as follows: system quality = 0.8956; information quality = 0.9102; service quality = 0.8807; system use = 0.8561; user satisfaction = 0.9080; and net benefit = 0.9505.

5.2. Content validity

The ELSS instrument met the requirements of reliability and had a consistent factor structure. However, while high reliability and internal consistency are necessary conditions for a scale's construct validity (the extent to which a scale fully and unambiguously captures the underlying, unobservable construct it is intended to measure), they are not sufficient (Nunnally, 1978). The basic qualitative criterion concerning construct validity is content validity. Content validity implies that the instrument considers all aspects of the construct being measured. Churchill (1979) contends that "*specifying the domain of the construct, generating items that exhaust the domain, and subsequently purifying the resulting scale should produce a measure which is content or face valid and reliable.*" Therefore, the rigorous procedures used in conceptualizing the ELSS construct and its dimensions, generating items representing the six dimensions underlying the ELSS construct, and purifying the ELSS measures suggest that the ELSS instrument has strong content validity.

5.3. Criterion-related validity

Criterion-related validity was assessed by the correlation between the total scores on the instrument (sum for 34 items) and the measures of valid criterion (sum for two global items). Criterion-related validity refers to concurrent validity in this study where the total scores on the ELSS instrument and scores on the valid criterion are measured at the same time. A positive relationship is expected between the total score and the valid criterion if the instrument is capable of measuring the ELSS construct. The 34-item instrument has a criterion-related validity of 0.828 and a significant level of 0.000, representing an acceptable criterion-related validity.

5.4. Discriminant and convergent validity

While the previous factor analysis has preliminarily demonstrated the discriminant and convergent validity, we further used the correlation matrix approach to evaluate these two validities of the ELSS instrument. Convergent validity tests whether the correlations between measures of the same factor are different from zero and large enough to warrant further investigation of discriminant validity. Table 2 presents the measure correlation matrix. The smallest within-factor correlations are: system quality = 0.37; information quality = 0.49; service quality = 0.42; system use = 0.64; user satisfaction = 0.73; net benefits = 0.46. These correlations are significantly higher than zero and large enough to proceed with discriminant validity analysis.

Discriminant validity for each item is tested by counting the number of times that the item correlates higher with items of other factors than with items of its own theoretical factor. For discriminant validity, Campbell and Fiske (1959) suggest that the count should be less than one-half the potential comparisons. However, examining the correlation matrix in Table 2 reveals 176 violations of the discriminant validity condition from 928 comparisons. This number of violations does not exceed the benchmark suggested by Campbell and Fiske, supporting the discriminant validity.

Table 2
Correlation matrix of measures

	SQ1	SQ2	SQ3	SQ4	SQ5	SQ6	SQ7	IQ1	IQ2	IQ3	IQ4	IQ5	IQ6	SV1	SV2	SV3	SV4	SV5	SU1	SU2	SU3	US1	US2	US3	NB1	NB2	NB3	NB4	NB5	NB6	NB7	NB8	NB9	NB10
SQ1	**1.00**
SQ2	**0.57**	**1.00**
SQ3	**0.47**	**0.78**	**1.00**
SQ4	**0.37**	**0.64**	**0.64**	**1.00**
SQ5	**0.41**	**0.45**	**0.50**	**0.55**	**1.00**
SQ6	**0.38**	**0.56**	**0.59**	**0.62**	**0.72**	**1.00**
SQ7	**0.44**	**0.47**	**0.53**	**0.50**	**0.66**	**0.68**	**1.00**
IQ1	0.34	0.32	0.37	0.41	0.47	0.47	0.55	**1.00**
IQ2	0.24	0.28	0.31	0.38	0.42	0.37	0.51	**0.70**	**1.00**
IQ3	0.40	0.45	0.45	0.45	0.49	0.52	0.54	**0.69**	**0.56**	**1.00**
IQ4	0.29	0.36	0.35	0.44	0.36	0.46	0.55	**0.69**	**0.73**	**0.65**	**1.00**
IQ5	0.32	0.45	0.45	0.52	0.38	0.51	0.40	**0.55**	**0.49**	**0.61**	**0.55**	**1.00**
IQ6	0.26	0.34	0.35	0.44	0.39	0.40	0.55	**0.60**	**0.71**	**0.57**	**0.73**	**0.53**	**1.00**
SV1	0.18	0.39	0.39	0.46	0.27	0.42	0.41	0.41	0.35	0.41	0.55	0.53	0.53	**1.00**
SV2	0.16	0.43	0.37	0.52	0.41	0.48	0.42	0.29	0.45	0.38	0.45	0.41	0.54	**0.53**	**1.00**
SV3	0.21	0.42	0.41	0.44	0.41	0.48	0.27	0.31	0.32	0.38	0.32	0.41	0.33	**0.42**	**0.64**	**1.00**
SV4	0.23	0.35	0.40	0.38	0.36	0.45	0.33	0.35	0.30	0.34	0.35	0.42	0.28	**0.48**	**0.52**	**0.69**	**1.00**
SV5	0.27	0.46	0.44	0.48	0.41	0.52	0.42	0.39	0.42	0.49	0.47	0.52	0.44	**0.57**	**0.66**	**0.70**	**0.72**	**1.00**
SU1	0.23	0.33	0.31	0.24	0.36	0.40	0.31	0.28	0.25	0.40	0.34	0.32	0.31	0.27	0.31	0.35	0.24	0.42	**1.00**
SU2	0.25	0.36	0.33	0.27	0.34	0.39	0.24	0.33	0.29	0.43	0.31	0.36	0.30	0.27	0.28	0.45	0.28	0.43	**0.70**	**1.00**
SU3	0.23	0.32	0.31	0.23	0.35	0.36	0.32	0.38	0.40	0.46	0.42	0.37	0.43	0.29	0.30	0.29	0.23	0.37	**0.64**	**0.66**	**1.00**
US1	0.32	0.48	0.42	0.50	0.43	0.57	0.38	0.43	0.33	0.50	0.39	0.50	0.41	0.43	0.51	0.51	0.43	0.52	0.35	0.44	0.38	**1.00**
US2	0.31	0.45	0.42	0.47	0.41	0.56	0.36	0.47	0.35	0.53	0.41	0.50	0.41	0.44	0.43	0.53	0.45	0.58	0.40	0.46	0.42	**0.81**	**1.00**
US3	0.28	0.51	0.46	0.48	0.45	0.59	0.42	0.46	0.37	0.58	0.45	0.49	0.46	0.49	0.49	0.53	0.47	0.62	0.48	0.44	0.48	**0.73**	**0.78**	**1.00**
NB1	0.32	0.46	0.41	0.47	0.50	0.51	0.45	0.51	0.38	0.58	0.47	0.50	0.50	0.38	0.40	0.42	0.38	0.53	0.52	0.46	0.48	0.63	0.68	0.75	**1.00**
NB2	0.32	0.46	0.43	0.39	0.44	0.53	0.36	0.48	0.34	0.53	0.45	0.50	0.43	0.40	0.42	0.43	0.48	0.56	0.51	0.47	0.54	0.61	0.67	0.65	**0.75**	**1.00**
NB3	0.33	0.45	0.40	0.40	0.43	0.49	0.44	0.52	0.44	0.54	0.54	0.50	0.52	0.44	0.45	0.40	0.43	0.50	0.51	0.48	0.61	0.54	0.62	0.65	**0.71**	**0.76**	**1.00**
NB4	0.41	0.43	0.40	0.40	0.44	0.47	0.46	0.50	0.47	0.53	0.53	0.43	0.51	0.43	0.44	0.39	0.37	0.46	0.43	0.41	0.53	0.59	0.60	0.61	**0.63**	**0.66**	**0.76**	**1.00**
NB5	0.38	0.50	0.43	0.46	0.49	0.53	0.49	0.53	0.47	0.57	0.52	0.51	0.52	0.43	0.50	0.47	0.43	0.57	0.45	0.41	0.45	0.65	0.65	0.67	**0.72**	**0.69**	**0.75**	**0.77**	**1.00**
NB6	0.35	0.49	0.46	0.48	0.47	0.51	0.51	0.52	0.49	0.55	0.53	0.48	0.61	0.45	0.49	0.47	0.40	0.54	0.36	0.36	0.42	0.62	0.58	0.63	**0.68**	**0.65**	**0.72**	**0.72**	**0.81**	**1.00**
NB7	0.28	0.39	0.43	0.37	0.30	0.40	0.45	0.51	0.37	0.40	0.46	0.44	0.46	0.46	0.27	0.25	0.35	0.35	0.24	0.25	0.30	0.40	0.37	0.39	**0.49**	**0.49**	**0.54**	**0.46**	**0.52**	**0.61**	**1.00**
NB8	0.31	0.45	0.37	0.41	0.44	0.49	0.44	0.44	0.43	0.48	0.46	0.41	0.54	0.40	0.53	0.38	0.32	0.47	0.35	0.35	0.42	0.56	0.52	0.57	**0.59**	**0.61**	**0.62**	**0.64**	**0.69**	**0.74**	**0.62**	**1.00**
NB9	0.25	0.40	0.33	0.37	0.41	0.48	0.42	0.49	0.50	0.42	0.51	0.40	0.59	0.41	0.51	0.38	0.33	0.53	0.41	0.35	0.45	0.51	0.51	0.57	**0.59**	**0.61**	**0.65**	**0.60**	**0.70**	**0.72**	**0.58**	**0.78**	**1.00**
NB10	0.28	0.42	0.34	0.36	0.44	0.50	0.45	0.47	0.45	0.47	0.49	0.42	0.51	0.33	0.50	0.47	0.38	0.51	0.41	0.40	0.43	0.55	0.57	0.60	**0.57**	**0.60**	**0.69**	**0.67**	**0.72**	**0.71**	**0.48**	**0.76**	**0.79**	**1.00**

6. Implications for practice

Through the above analysis, a 6-factor, 34-item instrument with good psychometric properties for measuring e-learning systems success was developed, and the factor structure presented in the DeLone and McLean's (2003) was also validated in the context of enterprise e-learning systems.

This research provided several implications for e-learning effectiveness management. This empirical result emphasized the importance of assuming a multidimensional analytical approach. It is imperative for managers to put emphasis on various system success levels. Information Quality, System Quality, and Service Quality belong to the system developing level; System Use, User Satisfaction, and Net Benefit belong to the effectiveness-influence level (DeLone & McLean, 2003). Establishing strategies to improve only one success variable is therefore an incomplete strategy if the effects of the others are not considered. The results of this study encourage e-learning managers to include the measures of Information Quality, System Quality, Service Quality, System Use, User Satisfaction, and Net Benefit into their present evaluation techniques of e-learning systems success.

This study presented an empirically validated model for measuring e-learning systems success. The 34-item ELSS instrument that emerged was demonstrated to produce acceptable reliability estimates, and the empirical evidence supported its content validity, criterion-related (concurrent) validity, discriminant validity, and convergent validity. The ELSS instrument can be utilized to assess the success of organizational e-learning systems from learner/employee perspectives. This evaluation will provide a fast and early feedback to the firm. As the ELSS instrument with good reliability and validity is periodically administered to a representative set of learners, e-learning managers can use this ELSS instrument to enhance their understanding of the level of e-learning systems success and take corrective actions if necessary for improvement.

Besides making an overall assessment, this ELSS instrument can be used to compare effectiveness for different e-learning systems with specific factors (i.e., information quality, system quality, service quality, system use, user satisfaction, and net benefit). If a company finds itself lacking in any of these dimensions, then it may do a more detailed analysis and take the necessary corrective actions. This ELSS instrument was designed to be applicable across a broad spectrum of e-learning systems, and to provide a common framework for comparative analysis. The framework, when necessary, can be adapted or supplemented to fit the specific practical needs of a particular e-learning environment.

7. Implications for research

User satisfaction has traditionally been employed as a surrogate of IS success, and therefore has been frequently measured in past studies. Several instruments have been developed to measure user satisfaction with traditional data processing systems (Bailey & Pearson, 1983; Ives et al., 1983), end-user computing (Doll & Torkzadeh, 1988), wire-based Internet applications (McKinney et al., 2002; Muylle et al., 2004; Wang et al., 2001), asynchronous e-learning systems (Wang, 2003), or mobile commerce systems (Wang & Liao, in press). However, according to previous IS success literature, information systems success/effectiveness is a multidimensional construct, which cannot be measured only through user satisfaction or system use. In this study, we conceptualized the construct of e-learning systems success, provided empirical validation of the construct and its underlying dimensionality, and developed a standardized instrument with desirable psychometric properties for measuring e-learning systems success. The validated 34-item ELSS instrument consists of six factors: System Quality, Information Quality, Service Quality, System Use, User Satisfaction, and Net Benefit.

Using the proposed ELSS instrument, future research efforts can develop and test research hypotheses and theories relating to e-learning systems success/effectiveness. While we developed and validated an instrument for measuring e-learning systems success using DeLone and McLean's (2003) updated IS success model, we did not investigate the causal relationships between the six factors of e-learning systems success. However, DeLone and McLean (2003) emphasize that IS success is a multidimensional and interdependent construct, and it is therefore necessary to study the interrelationships among those dimensions. Hence, based on the updated IS success model proposed by DeLone and McLean (2003), future research efforts should explore and test the causal relationships among information quality, system quality, service quality, user satisfaction, system use, and other objective net benefit constructs (e.g., organizational profitability, earning per share, market share, and customer loyalty) within the boundary of e-learning. The findings can provide more insights into how to implement successful e-learning systems within the organizations. The multiple-item ELSS instrument with good reliability and validity can also provide researchers with a tool for measuring the e-learning systems success dimensions, and a basis for explaining, justifying, and comparing differences among the results.

8. Limitations

Even though the rigorous validation procedure allowed us to develop a general instrument for measuring e-learning systems success, this work has some limitations that could be addressed in future studies.

First, while the valid instrument was developed using the sample data gathered in Taiwan, a confirmatory analysis and cross-cultural validation using another large sample gathered elsewhere is required for further generalization of the instrument. While exploratory factor analysis may be a satisfactory technique during the early stages of research on a construct, the subsequent use of confirmatory factor analysis (CFA) seems to be necessary in later stages. The advantages of applying CFA as compared to classical approaches to determine convergent and discriminant validity are widely recognized (Anderson & Gerbing, 1988). Additionally, the sampling method has potential bias, since a sample of willing respondents may not be generalizable. Consequently, other samples from different areas or nations should be gathered to confirm and refine, the factor structure of the ELSS instrument, and to assess its reliability and validity.

Second, the nomological validity should be validated using structural equation modeling (SEM) in the future. An instrument has nomological validity if it "behaves as expected with respect to some other constructs to which it is theoretically related" (Churchill, 1995, p. 538). Thus, the nomological validity of the ELSS instrument should be validated through investigating the causality between the ELSS construct and its theoretically related antecedents or consequents.

Finally, the test–retest reliability of the instrument should be evaluated. Measures of reliability include internal consistency, generally evaluated by coefficient alpha, and stability, while test–retest reliability examines the stability of an instrument over time. Galletta and

Lederer (1989) also contend that test–retest is necessary for establishing the reliability of an instrument. Therefore, the stability of the ELSS instrument, including short- and long-range stability, should be further investigated using the test–retest correlation method.

9. Conclusion

A primary contribution of our work was to have started a stream of work to develop and validate a generic instrument for measuring e-learning systems success. While information systems success/effectiveness models have received much attention among researchers, little research has been conducted to assess the success of e-learning systems in the context of an organization. Whether traditional information systems success models can be extended to investigate e-learning systems success has rarely been addressed. Based on the previous research on IS success, this study has conceptually defined the domain of the ELSS construct, operationally designed the initial ELSS item list, and empirically validated the general ELSS instrument. The final instrument indicates adequate reliability and validity across a variety of enterprise e-learning systems. The generality of this proposed instrument provides a common framework for the comparative analysis of results from various research. We recommend that practitioners and researchers use this instrument in various contexts of enterprise e-learning systems. The instrument provides not only an overall assessment but also has the capability to investigate the aspects of e-learning systems that are most problematic.

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Appendix. The initial measurement of e-learning systems success

System quality: Items 1–7

1. The e-learning system provides high availability.
2. The e-learning system is easy to use.
3. The e-learning system is user-friendly.
4. The e-learning system provides interactive features between users and system.
5. The e-learning system provides a personalized information presentation.
6. The e-learning system has attractive features to appeal to the users.
7. The e-learning system provides high-speed information access.

Information quality: Items 8–13

8. The e-learning system provides information that is exactly what you need.
9. The e-learning system provides information you need at the right time.
10. The e-learning system provides information that is relevant to your job.
11. The e-learning system provides sufficient information.
12. The e-learning system provides information that is easy to understand.
13. The e-learning system provides up-to-date information.

Service quality: Items 14–18
14. The e-learning system provides a proper level of on-line assistance and explanation.
15. The e-learning system developers interact extensively with users during the development of the e-learning system.
16. The IS department staff provides high availability for consultation.
17. The IS department responds in a cooperative manner to your suggestion for future enhancements of e-learning system.
18. The IS department provides satisfactory support to users using the e-learning system.

System use: Items 19–21
19. The frequency of use with the e-learning system is high.
20. The e-learning system usage is voluntary.
21. You depend upon the e-learning system.

User satisfaction: Items 22–24
22. Most of the users bring a positive attitude or evaluation towards the e-learning system function.
23. You think that the perceived utility about the e-learning system is high.
24. You are satisfied with the e-learning system.

Net benefits: Items 25–34
25. The e-learning system helps you improve your job performance.
26. The e-learning system helps you think through problems.
27. The e-learning system helps the organization enhance competitiveness or create strategic advantages.
28. The e-learning system enables the organization to respond more quickly to change.
29. The e-learning system helps the organization provide better products or services to customers.
30. The e-learning system helps the organization provide new products or services to customers.
31. The e-learning system helps the organization save cost.
32. The e-learning system helps the organization to speed up transactions or shorten product cycles.
33. The e-learning system helps the organization increase return on investment.
34. The e-learning system helps the organization to achieve its goal.

Criterion: Items 35–36
35. As a whole, the performance of the e-learning system is good.
36. As a whole, the e-learning system is successful.

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