

Relationships among e-learning systems and e-learning outcomes: A path analysis model¹

Sean B. Eom*

Department of Accounting, Southeast Missouri State University, Cape Girardeau, MO, USA

Abstract. In this study, path analysis modeling is applied to examine the relationships among e-learning systems, self-efficacy, and students' perceived learning outcomes in the context of university online courses. Independent variables included in the study are e-learning system quality, information quality, computer self-efficacy, system-use, self-regulated learning behavior, and user satisfaction as potential determinants of online learning outcomes. A total of 674 valid unduplicated responses from students who have completed at least one online course at a university in the Midwest were used to fit the path analysis model. The results indicated that system quality, information quality, and computer self-efficacy all affected system use, user satisfaction, and self-managed learning behavior. The findings from the current study have significant implications for the distance educators, students, and administrators. First, university administrators must continuously invest to upgrade the systems so that e-learning systems exhibit faster response time, better systems accessibility, higher system reliability and flexibility, and ease of learning. Second, the instructor in e-learning courses should facilitate, stimulate, guide, and challenge his/her students via empowering them with freedom and responsibility. Third, In order for the e-learning system to be successful, it should provide e-learners with the information and knowledge they need.

Keywords: E-learning systems, system quality, information quality, user-satisfaction, and self-regulated learning behavior



Sean B. Eom is a Professor of Management Information Systems (MIS) at the Harrison College of Business of Southeast Missouri State University. He received his Ph.D. Degree in Management Science from the University of Nebraska - Lincoln in 1985. His other degrees are from the University of South Carolina at Columbia (M.S. in international business), Seoul National University (MBA in International Management), and Korea University (B.A.).

His research areas include decision support systems (DSS), expert systems, and global information systems management, and e-learning systems. He is the author/editor of nine books including *Student Satisfaction and Learning Outcomes in E-Learning: An Introduction to*

Empirical Research, The Development of Decision Support Systems Research: A Bibliometrical Approach, Author Cocitation Analysis: Quantitative Methods for Mapping the Intellectual Structure of an Academic Discipline, and Inter-Organizational Information Systems in the Internet Age. He published more than 55 refereed journal articles and 80 articles in encyclopedia, book chapters, and conference proceedings.

1. Introduction

An important goal of e-learning systems is to deliver instructions that can produce equal or better outcomes than face-to-face learning systems. To achieve that goal, an increasing number of empirical studies have been conducted over the past decades to address the issue of what antecedent variables affect students' satisfaction and learning outcomes and to examine potential predictors of e-learning outcomes [1, 2]. A primary theme of e-learning systems research has been empirical studies

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*Corresponding author: Sean B. Eom, Professor of MIS, Department of Accounting, Mail Stop 5815, Southeast Missouri State University, Cape Girardeau, MO 63701, USA. Tel.: +1 573 651 2615; Fax: +1 573 651 2992; E-mail: sbeom@semo.edu.

of the effects of information technology, instructional strategies, and psychological processes of students and instructors on the student satisfaction and e-learning outcomes in university online education. Many MIS scholars have focused on the development of conceptual and theoretical frameworks of online learning effectiveness. According to Arbaugh et al. [1], many conceptual frameworks developed by MIS scholars have not been tested other than the models of Holsapple and Lee-Post [3–5]. Consequently, such disconnects between conceptualizations and verified models create opportunities for future researchers.

The research model we developed is a blend of a management information systems (MIS) success model [6], a conceptual model of Piccoli, Ahmad and Ives [7], and an e-learning success model of Holsapple and Lee-Post [3]. Based on the review of 180 empirical studies, DeLone and McLean presented a more integrated view of the concept of information systems (IS) success and formulated a more comprehensive model of IS success. Their IS success model identified six constructs that are interrelated and interdependent – system quality, information quality, use, user satisfaction, individual impact, and organizational impact. DeLone and McLean's [8] model is further extended and adapted to e-learning settings by many e-learning systems research. The framework of Piccoli, Ahmad, and Ives [7] refers to human and design factors as antecedents of learning effectiveness. Human factors are concerned with students and instructors, while design factors characterize such variables as technology, learner control, course content, and interaction. Holsapple and Lee-Post [3] adapted the DeLone and McLean model to propose e-learning success model (Fig. 1). The proposed e-learning success model consists of three antecedents constructs (system quality, information quality, service quality) and two intervening constructs (system use and user satisfaction) and system outcome measuring academic success and systems efficiency and effectiveness (Fig. 2). The primary objective of this study is to investigate the determinants of students' perceived learning outcomes and satisfaction in university online education using e-learning systems. Using the extant literature, we begin by introducing and discussing a research model illustrating variables affecting e-learning systems outcomes and user satisfaction. We follow this with a description of the cross-sectional survey that was used to collect data and the results from a path analysis model. In the final section, we outline the implications of the results for higher educational institutions.

2. E-learning systems and systems outcomes

The e-learning systems literature has accumulated a considerable body of literature over the past decade [1, 2]. Nevertheless, little empirical research exists to understand the relationships among e-learning systems quality, the quality of information produced by e-learning systems and e-learning systems outcomes. E-learning systems comprised of a myriad of subsystems that interacts each other. They include human factors and design factors. Human factors include personality Characteristics [9], learning styles [10, 11], and instructor's attributes [12–14]. Design factors include a wide range of constructs that affect effectiveness of e-learning systems such as technology [3], learner control, learning model [15], course contents and structure [16], and interaction [17–19].

In a study of Eom et al. [10], structural equation modeling is applied to examine the determinants of students' satisfaction and their perceived learning outcomes in the context of university online courses. Independent variables included in the study are course structure, instructor feedback, self-motivation, learning style, interaction, and instructor facilitation as potential determinants of online learning. A total of 397 valid unduplicated responses from students who have completed at least one online course at a university in the Midwest were used to examine the structural model. The results indicated that all of the antecedent variables significantly affect students' satisfaction. Of the six antecedent variables hypothesized to affect the perceived learning outcomes, only instructor feedback and learning style are significant. The structural model results also reveal that user satisfaction is a significant predictor of learning outcomes. The findings suggest online education can be a superior mode of instruction if it is targeted to learners with specific learning styles (visual and read/write learning styles), and with timely, meaningful instructor feedback of various types. Eom et al. found that all six factors—course structure, self-motivation, learning styles, instructor knowledge and facilitation, interaction, and instructor feedback—significantly influenced students' satisfaction. This is in accordance with the findings and conclusions discussed in the literature on student satisfaction.

Of the six factors hypothesized to affect perceived learning outcomes, only two (learning styles and instructor feedback) were supported. Contrary to previous research [20], Eom and others found no support for a positive relationship between interaction and

perceived learning outcomes. One possible explanation for this finding is that the study did not account for the quality or purpose of the interactions. Although a student's perception of interaction with instructors and other students is important in his/her level of satisfaction with the overall online learning experience, when the purpose of online interaction is to create a sense of personalization and customization of learning and help students overcome feelings of remoteness, it may have little effect on perceived learning outcomes. Furthermore, a well-designed online course delivery system is likely to reduce the need of interactions between instructors and students. The university under study has a very friendly online e-learning system and strong technical support system. Every class Web site follows the similar design structure which reduces the learning curve. Contrary to other research findings, no significant relationships were found between students' self-motivation and perceived learning outcomes. Theoretically, self-motivation can lead students to go beyond the scope and requirements of an educational course because they are seeking to learn about the subject, not just fulfill a limited set of requirements. Self-motivation should also encourage learning

even when there is little or no external reinforcement to learn and even in the face of obstacles and setbacks to learning.

This research further extends the study of Eom et al. [10] which did not include several constructs on which this study focuses. This research addresses the effects of system quality, information quality, self-regulated learning, and self-efficacy on the e-learning system use, user satisfaction, and e-learning outcomes. An e-learning system typically consists of learning management systems (LMS) and authoring systems. The LMS is a system for storing and delivering the course content, and tracks student access and progress. The authoring systems allow the instructors to develop the contents for e-learners.

3. Related research and hypothesis development

3.1. System quality and information quality

The IS success model [6, 8] and the e-learning success model [3] posit that the success of IS and e-learning

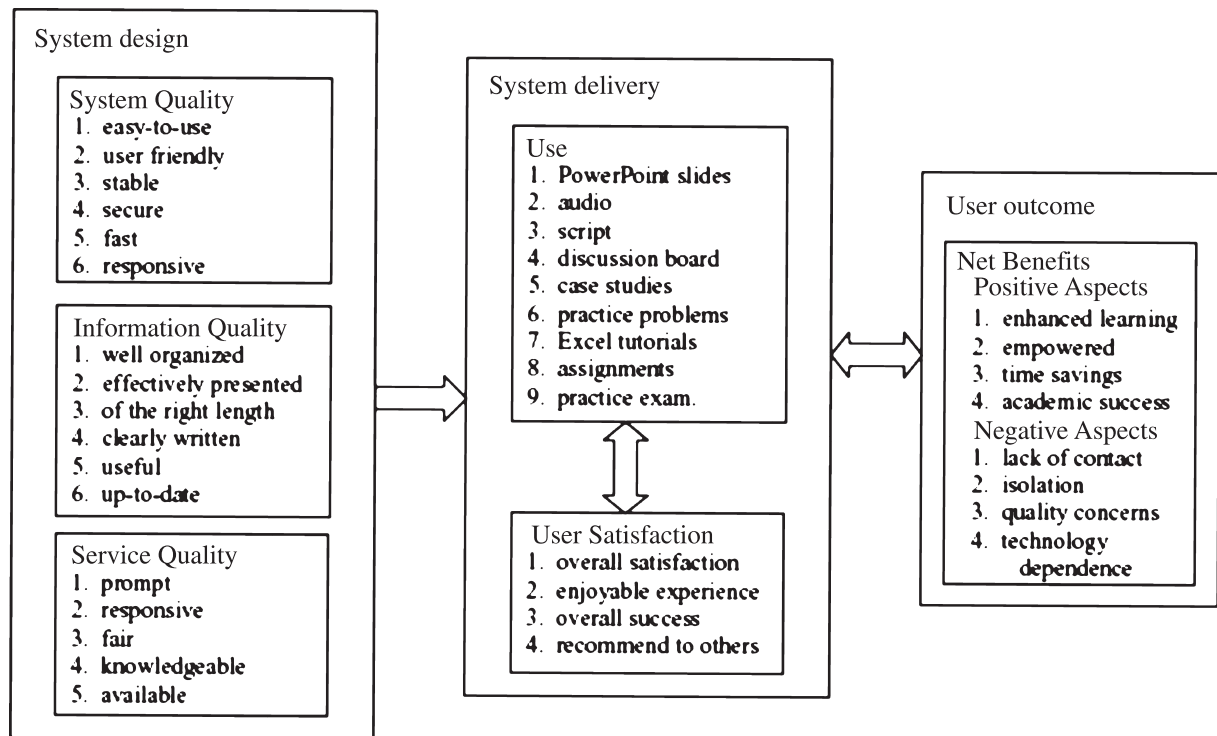


Fig. 1. E-learning success model and sample matrix Source: [3].

systems is dependent on the intervening variables (user satisfaction and system use), which are in turn dependent on the quality of information, system, and service. Technology acceptance model (TAM) developed in the IS area has emerged as a useful model for explaining e-learning system usage and satisfaction [21]. The TAM defines the relationships between systems use (dependent constructs) and perceived usefulness and perceived ease of use (two independent constructs). Therefore, the TAM theorizes that system use is determined by perceived usefulness and perceived ease of use. The TAM model has been extended by many other researchers. The unified theory of acceptance and use of technology (UTAUT) is an extension of the TAM model. The TAM postulates that perceived usefulness and ease of use determine an individual's intention to use a system, which in turn, determines actual system use. The theory posits that the four key constructs directly determine usage intention and behavior [22]. Moreover, gender, age, experience, and voluntariness of use are posited to mediate the impact of the four key constructs on usage intention and behavior [22–24]. Arbaugh [25] found that perceived usefulness and ease of use of Blackboard significantly predicted student satisfaction with the Internet as an educational delivery medium. Thus, we hypothesized:

H1a: e-learning system quality will lead to a higher level of system use.

H1b: e-learning system quality will lead to a higher level of user satisfaction.

H2a: Information quality will lead to a higher level of system use.

H2b: Information quality will lead to a higher level of user satisfaction.

3.2. Computer self-efficacy

A goal of e-learning empirical research includes the identification and effective management of factors that influence e-learning outcomes. One of such factors is computer self-efficacy of e-learners. Numerous e-learning empirical studies have been conducted to examine the relationships between e-learners' computer self-efficacy and other construct such as student satisfaction and e-learning outcomes. The concept of self-efficacy is defined by Bandura [26, P. 391] as:

People's judgments of their capabilities to organize and execute courses of action required to attain des-

ignated types of performances. It is concerned not with the skills one has but with the judgments of what one can do with whatever skills one possesses.

Self-efficacy is person's belief in his or her ability to accomplish a certain task and to produce designated levels of performance with the skills he or she has (Bandura, 1986; Bandura, 1991). Self-efficacy beliefs determine how people motivate themselves and behave [27]. The original concept of self-efficacy is defined broadly as an individual's belief/judgments/perceptions of his or her abilities to use skills/artifacts including computers and information technologies. Later MIS researchers introduced the term, computer self-efficacy as an important MIS research construct. Compeau and Higgins [28] defined it as "an individual's perception of his or her abilities to use computers in the accomplishments of a task." They also defined it as a judgment of one's capability to use a computer to accomplish broader tasks such as producing management information and monitoring production processes, etc.

3.3. Self-efficacy and e-learning system use

Significant positive relationships were found between self-efficacy and e-learning system use intention. Computer self-efficacy, attainment value, utility value, and intrinsic value were significant predictors of individuals' intentions to continue using Web-based learning [29].

Therefore, we hypothesize the following.

H3a: Computer self-efficacy will lead to a higher level of system use.

3.4. Self-efficacy and e-learner satisfaction

Johnson, Hornik and Salas [30] found that student self-efficacy and perceived usefulness of the system predicted perceived content value, satisfaction, and learning performance. Other system-related studies have examined attitudes and behaviors influencing course management system usage. Significant positive correlations were found among the three e-learning variables (Self-efficacy, e-learner satisfaction and perceived usefulness [31].

Thus, we hypothesized:

H3b: Computer self-efficacy will be positively related to e-learner satisfaction.

3.5. Self-efficacy and e-learning outcome

Computer self-efficacy was positively linked to learning outcomes measured by the average test scores in e-learning [32] and in the training literature [33–35].

Thus, we hypothesized:

H3c: Computer self-efficacy will be positively related to online learning outcomes.

3.6. System use

System use has been considered as a factor that influences the system success in the past decades and has been used by a number of researchers [3, 6, 8]. Consequently, we hypothesize that system use is a variable that will be positively related to e-learning systems success and e-learner satisfaction.

Thus, we hypothesized:

H4a: System use will lead to a higher level of user satisfaction.

H4b: System use will be positively related to online learning outcomes, which is equal to the quality of traditional classroom learning.

3.7. User satisfaction and e-learning outcomes

A study of Eom et al. [10] examined the determinants of students' satisfaction and their perceived learning outcomes in the context of university online courses. Their study found that all of the antecedent variables (course structure, instructor feedback, self-motivation, learning style, interaction, and instructor facilitation) significantly affect students' satisfaction. Their structural model results also reveal that user satisfaction is a significant predictor of learning outcomes.

Thus, we hypothesized:

H5a: User satisfaction will lead to higher levels of student agreement that the learning outcomes of online course are equal to or better than in face-to-face courses.

3.8. Self-regulated learning behavior and learner satisfaction

E-learning systems placed more responsibilities on learners than traditional face-to-face learning systems. A different learning strategy, self-regulated learning, is

necessary for e-learning systems to be effective. Self-regulation refers to self-managing behavior, motivation, and cognition [36]. The strength of the learner's self-motivation is influenced by self-regulatory attributes and self-regulatory processes. The self-regulatory attributes are the learner's personal learning characteristics including self-efficacy, which is situation-specific self-confidence in one's abilities [37], self-awareness, and resourcefulness. The self-regulatory attributes affect the completion rates in the e-learning courses. Eom et al. [10] found that student motivation, an important element of self-regulated learning behavior, was positively related to perceived student satisfaction with the e-learning course. Therefore, we hypothesize:

H6a: Self-regulated learning behavior of e-learners will lead to a higher level of user satisfaction

3.9. Self-regulated learning behavior and learning outcomes

Past research suggests that students who can self-regulate manage the entire learning process is more successful and learn the most in e-learning courses than those who cannot with less motivation [38]. Self-regulatory learning behavior and strategy have positive effects on learning outcomes [39]. Sathanam et al. found that when the instructional strategy included such interventions that taught learners to self-regulate, learners applied more self-regulatory learning strategies, leading to enhanced learning outcomes.

Thus, we hypothesized:

H6b: Self-regulated learning behavior of e-learners will be positively related to online learning outcomes, which is equal to the quality of traditional classroom learning.

4. Survey instrument

The survey questionnaire is in part adapted or selected from the survey originally developed by Wang et al. [40] for the business e-learning environment. Wang et al. developed a comprehensive, multidimensional instrument for measuring e-learning systems success in an organizational context. They established the theoretical foundation and conceptualization for an e-learning systems success construct. Moreover, they purified the scale, examined the evidence of reliability,

content validity, criterion-related validity, convergent validity, and discriminant validity. This instrument has been successfully used in many studies [41, 42].

The survey instrument consisted of 35 questions addressed using a seven point Likert scale ranging from “strongly disagree” to “strongly agree”. In addition, students were asked six demographic-type questions. The survey was administered online in the fall semester of 2007 at a state university in Missouri. A total of 2,156 online students were invited to reply to the survey. Of those students invited, 809 students responded with 674 surveys being complete and usable for a response rate of 31.3%. Appendix A summarizes the characteristics of the student sample. To conduct a path analysis, we only used the following 7 questions to represent our variables.

- System Quality: The system is user-friendly.
- Information Quality: The system provides information that is exactly what you need.
- System Use: Items I frequently use the system.
- User Satisfaction: Overall, I am satisfied with the system.
- Learning Outcome: I feel that online learning is equal to the quality of traditional classroom learning.
- Self-managed learning Behavior: In my studies, I am self-disciplined and find it easy to set aside reading and homework time.
- E-learning System Self-efficacy: I feel confident using a web browser.

5. Research model and data

The research model (Fig. 2) was tested using path analysis. LISREL 8.70 was used to do path analysis. It is a technique to assess the causal contribution of directly an observable variable to other directly observable variables. Unlike structural equation modeling that is concerned with latent variables, path analysis examine the causal contribution of directly observable variables. The model consists of three independent variables (system quality, information quality, and self-efficacy) and 4 dependent variables (system use, user satisfaction, self-regulated learning behavior, and e-learning Outcomes). A total of 674 valid unduplicated responses from students who have completed at least one online course at a university in the Midwest were used to fit the path analysis model.

6. Data analysis

6.1. Model identification

After the specification of path model, the identifiability of a path model can be determined by comparing the number of the parameters to be estimated (unknowns) and the number of distinct values in the covariance matrix (knowns). If the number of the parameters to be estimated is less than the number of distinct values, the model is over identified and satisfies a necessary condition.

The number of distinct values are $(7*8)/2 = 28$.

The number of unknowns is 23.

the number of paths – 13

the number of disturbance terms (error variances) – 4

the number of variances of exogenous variables – 3

the number of covariances/correlations of exogenous variables – 3

The degrees of freedom in this model are 5 (28–23).

6.2. Model testing and evaluation of goodness of fit statistics

Model testing is to test the fit of the correlation matrix of sample data against the theoretical causal model built by researchers based on the extant literature. Goodness of fit statistics includes an extensive array of fit indices that can be categorized into six different subgroups of statistics that may be used to determine model fit. For a very good overview of LISREL goodness-of-fit statistics, readers are referred to [43, 44]. There seems to be an agreement among SEM researchers that it is not necessary to report every goodness of fit statistics from path analysis output. Although there are no golden rules that can be agreed upon, Table 1 includes a set of indices that have been frequently reported and suggested to be reported in the literature [44–50]. Table 1 includes our model fit statistics of various fit indices and corresponding acceptable threshold levels of each corresponding fit index. Considering all indices together, the specified model (Fig. 2) seems to be supported by the sample data. Since our model is tested bas on sample size of 674, Chi-Square statistic is not a good measure of goodness of fit, since Chi-Square statistic nearly always rejects the model when large samples are used [51]. The RMSEA is the second fit statistic reported in the LISREL program. A cut-off value close to 0.069 indicates a close

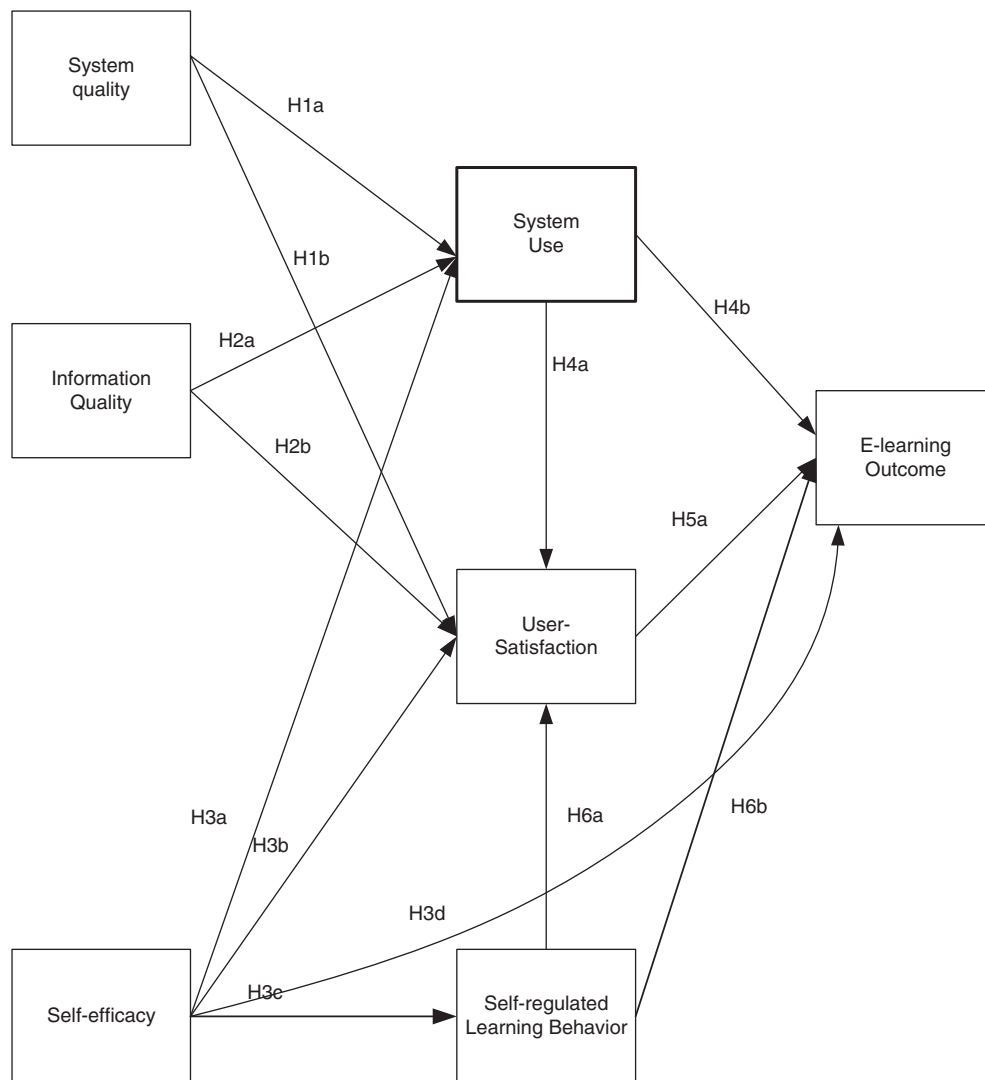


Fig. 2. Research model.

fit and the values up to 0.08 are considered to represent reasonable error of approximation [52].

6.3. LISREL estimates using maximum likelihood

The path analysis output shows two different outputs from structural equations and reduced form equations. Path analysis using LISREL estimates the coefficients of a set of linear structural equations. The structural equations comprised of independent (cause) variables and dependent (effect) variables. A single regression equation model and bivariate regression model can be analyzed by path analysis of LISREL. Outputs from these single regression and

bivariate regression analysis include only structural equations and the estimated relationships between the effect variables and cause variables. However, our model outputs list two equations (structural form equations and reduced form equations) and the two estimated relationships of each equation, because the path model includes the structural form equations that define the relationships among the cause variables. In the model, system use, user satisfaction, and self-regulated learning behavior are endogenous, but they are also intervening variables. If covariance among measurement errors of three intervening variables equals to zero, we can apply ordinary least square (OLS). However, structural equation models assume

Table 1
The results of the model

Fit index	Our model fit statistics	Acceptable threshold levels
<i>Absolute indices</i>		
Chi-square (χ^2)	<i>p</i> values are all less than 0.05	Low χ^2 relative to degrees of freedom with an insignificant <i>p</i> value (<i>p</i> less than 0.05)
RMSEA	0.060	Less than 0.07
Goodness-of-fit index (GFI)	0.99	Greater than 0.95
Adjusted GFI (AGFI)	0.96	Greater than 0.95
Standardized RMR (SRMR)	0.032	Less than 0.08
<i>Incremental indices</i>		
Normed-fit-index (NFI)	0.99	Greater than 0.95
Non-normed-fit-index (NNFI)	0.98	Greater than 0.95
Comparative fit index (CFI)	1.00	Greater than 0.95

there exists covariance among measurement errors of three intervening variables. LISREL estimates all structural coefficients simultaneously, not separately. The LISREL output sections provide us with two different sections: structural equations and reduced form equations. The structural equations consist of all the equations including mediating variables. The reduced form equations show only effects of exogenous (independent) variables on endogenous variables.

6.4. Structural equations

The term, structural equations, refers to the simultaneous equations in a model. It is also known as multiequations. It refers to the equation that contains mediating variables. The mediating variable functions as the dependent (response) variable in one equation.

At the same time, it functions as the independent variable (predictor) in another equation.

Structural equation outputs show direct effects and indirect effects of all exogenous variables and mediating variables. Structural equations illustrate the effects of endogenous variables on each other. In SEM including path analysis modeling, the *t* value that is typically used is $t > 1.96$. The system use is positively influenced by information quality and self-efficacy. But it is not affected by system quality contrary to our hypothesis, due to the low *t*-value (1.79). User satisfaction is positively influenced by all antecedents we hypothesized except self-efficacy. The perceived learning outcomes are positively influenced by user satisfaction, self-managed learning behavior and self-efficacy. But the model failed to support the effect of system use on the e-learning outcomes.

$$\begin{aligned}
 \text{su} &= 0.067*\text{sq} + 0.18*\text{iq} + 0.37*\text{eff}, \text{ Errorvar.} = 0.67, R^2 = 0.35 \\
 &\quad (0.038) \quad (0.037) \quad (0.033) \quad (0.036) \\
 &\quad 1.79 \quad 4.81 \quad 11.24 \quad 18.30 \\
 \\
 \text{us} &= 0.12*\text{su} + 0.066*\text{sml} + 0.39*\text{sq} + 0.43*\text{iq} - 0.024*\text{eff}, \text{ Errorvar.} = 0.50, R^2 = 0.66 \\
 &\quad (0.034) \quad (0.022) \quad (0.033) \quad (0.032) \quad (0.033) \quad (0.027) \\
 &\quad 3.60 \quad 2.98 \quad 11.76 \quad 13.36 \quad -0.73 \quad 18.30 \\
 \\
 \text{outcome} &= -0.016*\text{su} + 0.39*\text{us} + 0.34*\text{sml} + 0.27*\text{eff}, \text{ Errorvar.} = 2.67, R^2 = 0.25 \\
 &\quad (0.078) \quad (0.061) \quad (0.051) \quad (0.074) \quad (0.15) \\
 &\quad -0.20 \quad 6.46 \quad 6.77 \quad 3.68 \quad 18.30 \\
 \\
 \text{sml} &= 0.53*\text{eff}, \text{ Errorvar.} = 1.55, R^2 = 0.18 \\
 &\quad (0.043) \quad (0.085) \\
 &\quad 12.22 \quad 18.30
 \end{aligned}$$

The results indicated that system quality, system uses, information quality, and self-managed learning behavior significantly affect students' satisfaction. Of the four antecedent variables hypothesized to affect the perceived learning outcomes, only three (user satisfaction, self-managed learning behavior, and computer self-efficacy) are significant. The findings suggest that computer self-efficacy, self-regulated learning behavior, and user-satisfaction are primary determinants of e-learning outcomes. The user satisfaction is, in turn, derived from information quality, system quality, system use, and self-regulated learning behavior.

6.5. Reduced form equations

Reduced form equations simply refer to the equations expressed without using the mediating variable. By eliminating the mediating variables in the equations, reduced form equations provide us with the equations of the endogenous variables in terms of direct and indirect effects of exogenous variables. In other words, e-learning outcomes are expressed by the exogenous variables with their regression coefficients which combine the direct and indirect effects of the exogenous variables. Some equations such as first equation (system use) are listed identical under both structural equation and reduced form equation outputs, because system use has no indirect path as shown in Fig. 2. But except the first equation, three remaining equations are clearly different between reduced form equation and structural equation in terms of the different path coefficients and the number of variables. The reduced form equations do not include mediating variables in the equations.

Reduced form equations are shown below

$$\begin{aligned} su &= 0.067*sq + 0.18*iq + 0.37*eff, \text{ Errorvar.} = 0.67, R^2 = 0.35 \\ &\quad (0.038) \quad (0.037) \quad (0.033) \\ &\quad 1.79 \quad 4.81 \quad 11.24 \end{aligned}$$

$$\begin{aligned} us &= 0.39*sq + 0.45*iq + 0.055*eff, \text{ Errorvar.} = 0.52, R^2 = 0.65 \\ &\quad (0.033) \quad (0.032) \quad (0.029) \\ &\quad 11.93 \quad 14.12 \quad 1.91 \end{aligned}$$

$$\begin{aligned} outcome &= 0.15*sq + 0.17*iq + 0.47*eff, \text{ Errorvar.} = 2.96, R^2 = 0.17 \\ &\quad (0.026) \quad (0.030) \quad (0.065) \\ &\quad 5.84 \quad 5.91 \quad 7.26 \end{aligned}$$

$$\begin{aligned} sml &= 0.0*sq + 0.0*iq + 0.53*eff, \text{ Errorvar.} = 1.55, R^2 = 0.18 \\ &\quad (0.043) \\ &\quad 12.22 \end{aligned}$$

For example, the coefficients of information quality exogenous variable in the second reduced form equation (us) is 0.45. The coefficients in the reduced form equations are combination of direct and indirect effects of information quality on user satisfaction.

- Direct effects of information quality on user satisfaction: 0.43 (taken from the second structural equations)
- Indirect effects of information quality on user satisfaction—the indirect effects come from only one path paths in the research model (Fig. 2)
 - Information quality quality → system use → user satisfaction: $(0.18 * 0.12 = -0.0216)$
- Adding all effects from structural equation form outputs produces the coefficients of information quality variables in reduced form equation output (0.45)

Figure 3 shows the summary of path analysis. The bold lines indicate 10 supported hypotheses and the other lines indicated 5 hypotheses that were not supported.

7. Conclusion

Abundant e-learning empirical research points out that superior e-learning outcomes are one of the critical objectives of e-learning research. Our path analytical model suggests that of these six variables we hypothesized, all of them are useful predictor of e-learning outcomes, except the following three unsupported hypotheses. The paths from system quality and information quality to user satisfaction, system use to user satisfaction, and user satisfaction to

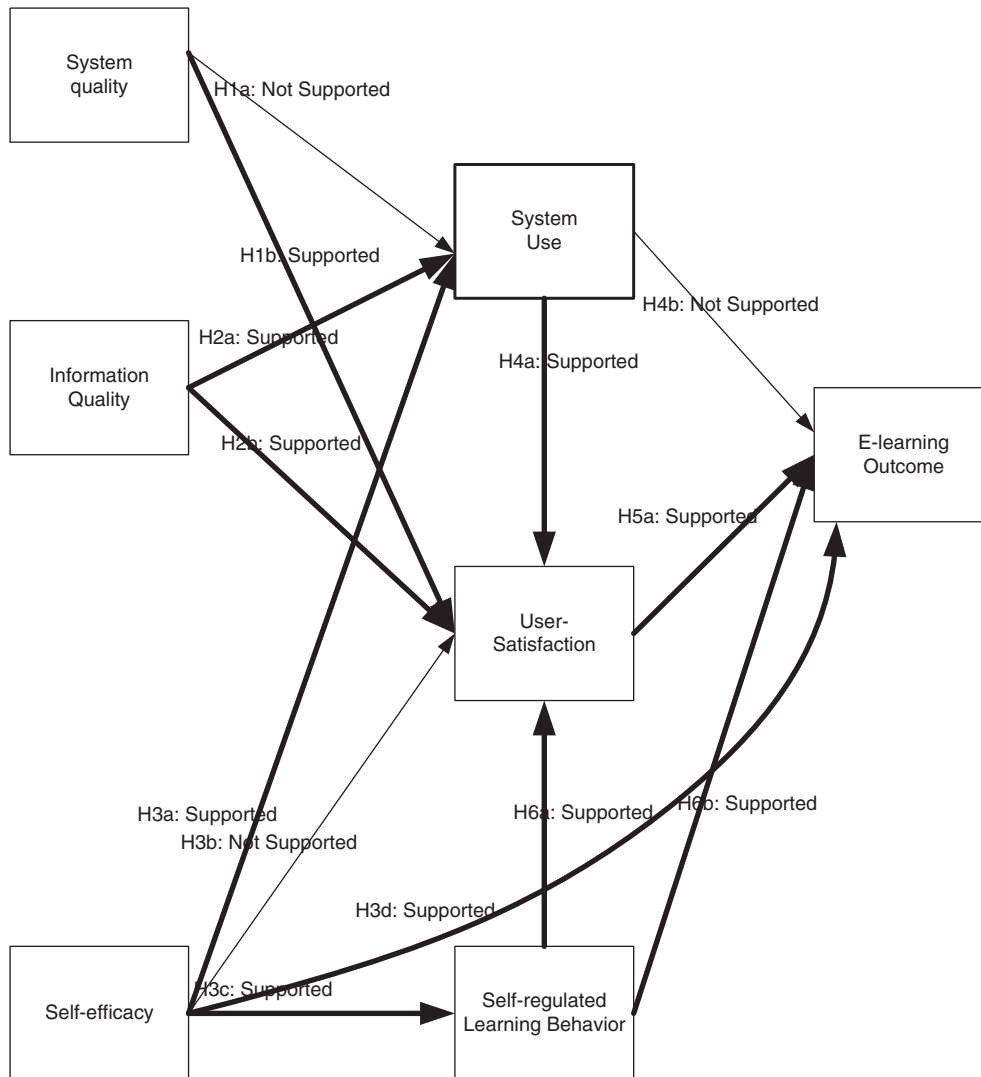


Fig. 3. Summary of the path analysis.

e-learning outcomes were significant as hypothesized by the DeLone-McLean model. On the other hand, the paths from system quality to system use, system use to e-learning outcome, and self-efficacy to user satisfaction were not significant. This negative finding may be explained by the mandatory nature of the e-learning system.

This is in accordance with the findings of the study of Livari [53], which tested the DM model in a mandatory city government information system context. System use is the pivot of the DM model. System use, either actual or perceived, is one of the most frequently reported and the most objective measure of MIS success

or the MIS success measure of choice in MIS empirical research [6] in a voluntary IS use context. The DM model has been empirically tested using structural equation modeling in a quasi-voluntary IS use context [54] and in a mandatory information system context [53]. Nevertheless, the usage of information and systems, as repeatedly pointed out by DeLone and McLean (1992), is only relevant when such use is voluntary. Needless to say, e-learning systems are mandatory systems. Regardless of the quality of the e-learning management system, e-learners must use the system. We suggest that future e-learning empirical studies exclude “system use” construct in the model.

8. Practical implications

According to the latest industry statistics, “the e-learning market in the United States is growing approximately 30 percent a year and is expected to reach well beyond \$20 billion within the next several years” [55]. Higher educational institutions have invested heavily to constantly update their e-learning management systems. The findings from the current study have significant implications for the distance educators, students, and administrators. We have focused on the effect of e-learning management systems on user satisfaction, and the relationship between user satisfaction and e-learning outcome. E-learner satisfaction is an important predictor of e-learning outcome. On the other hand, system quality, information quality, and self-regulated learning behavior have significant direct impacts on the perceived satisfaction of e-learners. Self-efficacy does not show a direct effect on user satisfaction, but it shows indirect effect on user-satisfaction via self-regulated learning behavior. It is conceivable that, through this type of research, online learning will be enhanced when there is a better understanding of critical success factors for e-learning management systems.

Learning is a complex process of acquiring knowledge or skills involving a learner’s biological characteristics/senses (physiological dimension); personality characteristics such as attention, emotion, motivation, and curiosity (affective dimension); information processing styles such as logical analysis or gut feelings (cognitive dimension); and psychological/individual differences (psychological dimension) [56]. Moreover, e-learning outcomes are the results of dynamic interactions among e-learners, instructors, and e-learning systems. This study may be useful as a pedagogical tool for all entities involved in the dynamic learning process. First, university administrators must continuously invest to upgrade the systems so that e-learning systems exhibit faster response time, better systems accessibility, higher system reliability and flexibility, and ease of learning. By doing so, e-learning systems can provide e-learners with the information that are accurate, precise, current, reliable, dependable, and useful. This study provided a basis for justifying technological expenditures at the administrative level.

Second, e-learners must be able to self-manage the entire learning process including self-regulation of behavior, motivation, and cognition, proactively and deliberately. The core of self-regulated learning is self-

Appendix A
Student characteristics

	Number	Proportion (%)
Age		
>20	53	7.86
20–24	307	45.55
25–34	160	23.74
35–44	99	14.69
45–54	43	6.38
<54	12	1.78
Total	674	100.00
Gender		
Male	177	26.26
Female	497	73.74
Total	674	100.00
Year in school		
Freshman	24	3.56
Sophomore	71	10.53
Junior	164	24.33
Senior	297	44.07
Graduate	118	17.51
Total	674	100.00
Area of study by colleges		
Education	183	27.15
Business	127	18.84
Health & Human services	57	8.46
Science & Math	82	12.17
Speech communications	33	4.90
University studies	42	6.23
Polytechnic studies	78	11.57
Others	72	10.68
Total	674	100.00

motivation (Smith, 2001). Students’ motivation is a major factor that affects the completion rates in the Web-based course and a lack of motivation is also linked to high dropout rates [38, 57]. The instructor in e-learning courses should facilitate, stimulate, guide, and challenge his/her students via empowering them with freedom and responsibility. Instructor feedback to students can improve learner affective responses, increase cognitive skills and knowledge, and activate meta-cognition, which refers to the awareness and control of cognition through planning, monitoring, and regulating cognitive activities [14].

Third, In order for the e-learning system to be successful, it should provide e-learners with the information and knowledge they need. As this study indicates, Information quality has positive effects on

user satisfaction. Information quality has also positive effects on system use, which in turn positively contributes user satisfaction. However, the information quality in e-learning is not dependent on only e-learning management systems' software and hardware. It is the instructor who creates the contents of e-learning material that are useful and essential for gaining necessary knowledge for the future success of students. In information systems, the roles of instructors as a contents creator are even more critical when assembling daily/weekly reading assignments for each semester by selecting chapters, topics within a chapter, project assignments, and creating power point files and supplementary files, due to the fact that the nature of information systems are constantly changing with a fast speed. Information systems educators are continuously witnessing the emergence of a host of disruptive technologies such as virtualization and cloud computing. According to the ranking of technologies Chief Information Officers (CIOs) selected as their top priorities in 2010, virtualization and cloud computing were the number one and number two priorities. Cloud computing was not on the radar in 2007 and 2008. It was a distant 14 in 2009. Cloud can help firms do more with less. Moreover, the technologies that CIOs are prioritizing in 2010 are technologies that can be implemented quickly and without significant upfront expense [58]. However, some introductory information systems textbooks paid scant attention to these topics of cloud computing and virtualization. For this reason, the instructor must play a pivotal role to create and enhance the quality of information for e-learners.

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