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Evaluating Complex Online Technology-enabled Course Delivery: A Contextualized View of a Decomposed IS Success Model

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Abstract:

In this paper, we focus on understanding the factors that influence whether online courses that involve complex technologies succeed. In particular, we conducted a study on SAP software as the complex technology that students learned online via several course-management platforms (e.g., Blackboard). We hypothesized the antecedent variables system quality, information quality, and service quality to influence students' perceived learning outcomes, satisfaction, and intention to continue using online learning. Grounded on the information systems (IS) success model, we decomposed core constructs into contextual factors. We surveyed business students from four mid-sized state universities in the United States that had membership in the SAP university alliances program, and the students had taken at least one online SAP-enabled course. We used structural equation modeling with partial least squares (PLS-SEM) to analyze data. The findings indicate that system quality, information quality, and service (instructor) quality were all significant antecedents of student satisfaction, system quality and information quality were significant antecedents of perceived learning outcomes, and only system quality was a significant antecedent of students' intention to continue using online learning.

Keywords: Online Learning, IS Success, Technology Adoption, Satisfaction, Learning Outcomes.

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1 Introduction

Instructors have always found teaching complex technologies a challenge. Students face a steep learning curve in learning such technologies, and they often struggle to master the materials throughout the term. They may find the learning even harder with online courses. While enjoying the benefits that distance learning provides, less tech-savvy students may experience stress and lack the ability to learn the new technology if they require adaptability. Thus, we need to evaluate the factors that help online courses that involve complex technologies succeed.

Many studies (e.g., Eom & Ashill, 2018; Alshare & Lane, 2011) have examined the factors that influence students' perceived learning outcomes and satisfaction with online courses. However, little research has evaluated the factors that help complex technology-enabled online courses succeed. Accordingly, in this paper, we expand the IS success model (DeLone & McLean, 1992, 2003) in the context of online learning that involves complex technologies, such as SAP. Specifically, we focus on 1) constructing a decomposed theoretical model to understand which main factors significantly influence students' perceived learning outcomes, satisfaction, and intention to continue using e-learning platforms; 2) testing and refining the IS success model based on contextual concepts by applying the PLS-SEM method; and 3) evaluating these factors' significance and their impact on the three outcomes. Our research question is:

> **RQ:** What success factors influence students' perceived learning outcomes from taking complex technology-enabled courses, their satisfaction with such courses, and their intention to continue using e-learning platforms to take such courses?

For this study in particular, we examined how students learned SAP software online using standard platforms (e.g., Blackboard). We did not evaluate course platform itself but how successfully instructors delivered SAP-enabled courses online through the platform's e-learning features (system quality), content design (information quality), and technical support (service quality). Rather than simply applying the IS success model, we decomposed its antecedents into contextual factors that we adapted from prior research and past teaching experiences.

The paper proceeds as follows: in Section 2, we discuss the research background and review the relevant literature. In Section 3, we develop the research model and hypotheses. We describe the research design in Section 4, report the results in Section 5, and discuss the findings and their implications in Section 6. In Section 7, we comment on the study's limitations and discuss some directions for future research. Finally, in Section 8, we conclude the paper.

2 Research Background

2.1 SAP Education

Many organizations across the world use complex information systems, such as enterprise resource planning (ERP) systems (Xu & Topi, 2017)—complex enterprise-wide information systems that integrate and streamline business processes across various functional areas (Topi, Lucas, & Babaian, 2005). Faced with rapid changing technologies, IS education brings students and various technologies together into systems to satisfy organizational and societal needs (Topi, 2019). SAP constitutes the world's largest provider of enterprise application software (SAP, 2019a). Today, more than 437,000 companies in over 180 countries run SAP applications (SAP, 2019a). SAP has had academic partnerships with tertiary institutions for decades in educating students with hands-on practices that intelligent enterprises desire. Over 3,200 institutions across 110 countries have joined the SAP university alliances program and can access the entire SAP license portfolio free of charge with full membership (SAP, 2019b). Many universities offer a SAP ERP certificate, which requires students to take at least three SAP-enabled courses. These SAP-enabled courses adopt a hands-on practical method in equipping students with skills in enterprise application software rather than providing only theoretical knowledge. By taking SAP-enabled courses, students develop knowledge and skills in enterprise architecture, such as ERP, supply chain management, customer relationship management, and business intelligence and analytics. SAP education helps students' employability since companies need such hands-on skills (Chang & Wills, 2015).

2.2 Evaluating E-learning

As an emerging technology, e-learning has seen wide use to improve access to education and training, and to reduce costs of education (Chang, 2016). Even though the majority (63.3%) of academic leaders believe that e-learning represents a crucial long-term strategy (Eom & Ashill, 2018), concerns about its effectiveness and acceptance exist (Eom & Ashill, 2016). For example, technical problems may constitute the main barriers to e-learning (Chang, 2016), and learners may have poor learning experiences (Eom & Ashill, 2016). While previous empirical studies in this field have focused on examining the factors that influence e-learning's effectiveness (i.e., student satisfaction and learning outcomes), we lack studies on which factors affect both e-learning's effectiveness *and* its acceptance. Thus, in this study, we examine whether the factors that influence e-learning's effectiveness also affect its acceptance.

3 A Review of the Literature

In understanding the factors that likely impact whether online courses that involve complex technologies succeed, we draw on four well-known and useful theories: 1) the information systems (IS) success model (DeLone & McLean, 1992, 2003), 2) social cognitive theory (SCT) (Bandura, 1982, 1986), 3) the technology acceptance model (TAM) (Davis, 1989), and 4) context-specific theorizing (Hong, Chan, Thong, Chasalow, & Dhillon, 2014).

DeLone and McLean (1992) introduced the IS success model to present an integrated view of what constitutes IS success via a comprehensive taxonomy. The model defined six distinct dimensions of IS success: system quality, information quality, information use, user satisfaction, individual impact, and organizational impact.

Based on the many studies on their original model (e.g., Goodhue & Thompson, 1995; Guimaraes & Igbaria, 1997; Weill & Vitale, 1999), DeLone and MacLean proposed an updated version of their IS success model in 2003. In the updated model, they added variable "service quality" to reflect the importance of service and support in successful information systems. Also, they added the variable "intention to use" to measure user attitude as an alternative measure of information use and collapsed the variables "individual impact" and "organizational impact" into a more parsimonious construct called "net benefits". The updated model, therefore, included six interrelated constructs. One could design an information system in terms of system quality, information quality, and service quality. These three constructs would affect the subsequent intention to use the system and user satisfaction. The net benefits that the system achieved would impact user satisfaction and intention to use the system in the future.

Research on IS success cites DeLone and McLean's (1992, 2003) IS success model more than any other model (Urbach & Mueller, 2011). Researchers have investigated the model's propositions in a broad spectrum of contexts, including e-learning. Wang, Wang, and Shee (2007) used the model to evaluate the success of a Web-based college course with an organizational approach. The authors modified the model to use it from the learners' (students') perspective. Lin (2007) used the model to study how system quality, information quality, and service quality influenced online course use via user satisfaction and intention to use. Wang (2008) suggested that future intention to use should more closely measure system success than initial or current system use. Eom, Ashill, Arbaugh, and Stapleton (2012) tested the model in a university e-learning context. They concluded that system quality and information quality affected how users used and their satisfaction with e-learning systems, which ultimately impacted the systems' success. Tajuddin, Baharuddin, and Hoon (2013) found a positive relationship between system quality and learning satisfaction. Kim, Trimi, Park, and Rhee (2012) found that, besides system quality and information quality, instructional quality also positively influenced user satisfaction. Wang and Chiu (2011) added communication quality to information quality and service quality and found that all three had significantly positive effects on user satisfaction and continued intention to use. Eom, Ashill, and Wen (2006) concluded that perceived instructor support—the degree to which students perceive instructors to be knowledgeable, facilitates teaching, and provides feedback—had a positive impact on students' perceived learning outcomes. More recently, Eom and Ashill (2016, 2018) developed e-learning success measures and relationships among a set of interdependent e-learning system factors using a system's view. In an e-learning context, instructor behavior would represent service quality. Jordan (2013) found that students' learning effectiveness mostly relied on how instructors designed and oriented the learning experience.

Social cognitive theory (SCT) (Bandura, 1982, 1986) also impacts our study. This framework suggests that learning occurs in a social context with an interaction between personal factors, behavior, and the environment. Besides the emphasis on social influences, Bandura (1982) introduced the term self-efficacy to describe one's belief in one's own ability to succeed in specific situations or to accomplish a task. One's sense of self-efficacy can play a major role in how one approaches goals, tasks, and challenges. Lee (2002) investigated the impact that self-efficacy has on online learning technologies and found that it significantly predicted students' satisfaction and performance.

One can also apply the technology acceptance model (TAM) (Davis, 1989)—a framework about how users come to accept and use a new technology—to e-learning technology. TAM has undergone several updates since it first appeared (Venkatesh & Davis, 2000; Venkatesh & Bala, 2008). Venkatesh, Morris, Davis, and Davis (2003) combined TAM with the theory of planned behavior (TPB) (Ajzen, 1991) to develop the unified theory of acceptance and use of technology (UTAUT). This model identifies four core determinants of the intention and usage of new technology: performance expectancy, effort expectancy, social influence, and facilitating conditions. Effort expectancy refers to the degree of ease associated with the system, and the construct captures the concept of ease of use (Venkatesh et al., 2003). Alshare and Lane (2011) applied UTAUT to examine the factors that influence student-perceived learning outcomes and satisfaction in ERP courses. They found that effort expectancy and performance expectancy directly impacted student attitude, and, in turn, student attitude had the largest direct impact on student-perceived learning outcomes and satisfaction (Alshare & Lane, 2011).

Many IS researchers (e.g., Benbasat & Zmud, 2003; Hong et al., 2014) have emphasized the central role that the interplay between the characteristics of technologies, users, and usage contexts has in theory development. No single way to conceptualize technology will likely work for all usage contexts (Orlikowski & Iacono, 2001). The given context or "setting" will determine the results that a particular technology provides (Hevner, March, & Park, 2004). Researchers need to study and apply technology needs in its social context (Gopal & Prasad, 2000). For example, researchers have contextualized the TAM to study online recommendation agents (Wang & Benbasat, 2005). Chang, Wang, and Wills (Forthcoming) contextualized the theory of planned behavior/reasoned action (Ajzen, 1991) to investigate behavioral intention to adopt hearing aids among old adults in smart cities. Researchers have also contextualized the IS success model (DeLone & McLean, 1992, 2003) to study e-commerce systems' success (DeLone & McLean, 2003).

Surveying the research on e-learning based on the theories that we summarize above, we can see that researchers have often combined factors drawn from different models to study their impact on online teaching methods. Primarily drawing from the TAM (Davis, 1989) and the IS success model (DeLone & McLean, 1992, 2003), Islam (2013) identified three constructs for e-learning system adoption outcomes: perceived learning assistance, perceived community-building assistance, and perceived academic performance. He found that perceived ease of use, perceived usefulness, and the way an e-learning system was used influenced students' perceived learning assistance and perceived community-building assistance. Subsequently, perceived learning assistance and perceived community-building assistance influenced students' perceived academic performance.

Eom (2011) researched the implications that e-learning systems and self-efficacy have on students' outcomes by integrating the TAM and the IS success model. He concluded that system quality, information quality, and computer self-efficacy impacted students' system use, user satisfaction, and self-managed learning behaviors. Mohammadi (2015) also investigated users' perspectives on e-learning by integrating TAM with the IS success model. He revealed that intention to use and user satisfaction both had positive effects on the actual e-learning use. He found system quality and information quality to be the most important drivers of the intention to use and user satisfaction. Li, Duan, Fu, and Alford (2012) identified that e-learning service quality, course quality, perceived usefulness, perceived ease of use, and self-efficacy directly affected system functionality. We propose our research model, which draws from the various theories described above, in Section 4.

4 Research Model and Hypotheses Development

Researchers have recognized the value of context and contextualization in theory development (Hong et al., 2014). Whetten, Felin, and King (2009) distinguished two ways of theory borrowing: vertical (cross level) and horizontal (cross context). We use the former in this study. The vertical contextualization decomposes a theory's core constructs into contextualized variables. It contributes to the theoretical generalizations across different contexts, enhances the borrowed theory (Whetten, 2009), helps one more deeply understand the "why" and "where" of theory building (Zahedi, Abbasi, & Chen, 2015), and ensures that the core constructs remain as the same phenomenon across contexts (Lee & Baskerville 2003).

We decompose the IS success model and contextualize antecedent constructs to understand the variables that influence whether online courses that teach complex technologies succeed. The model comprises factors that we draw from several research models (see Figure 1).

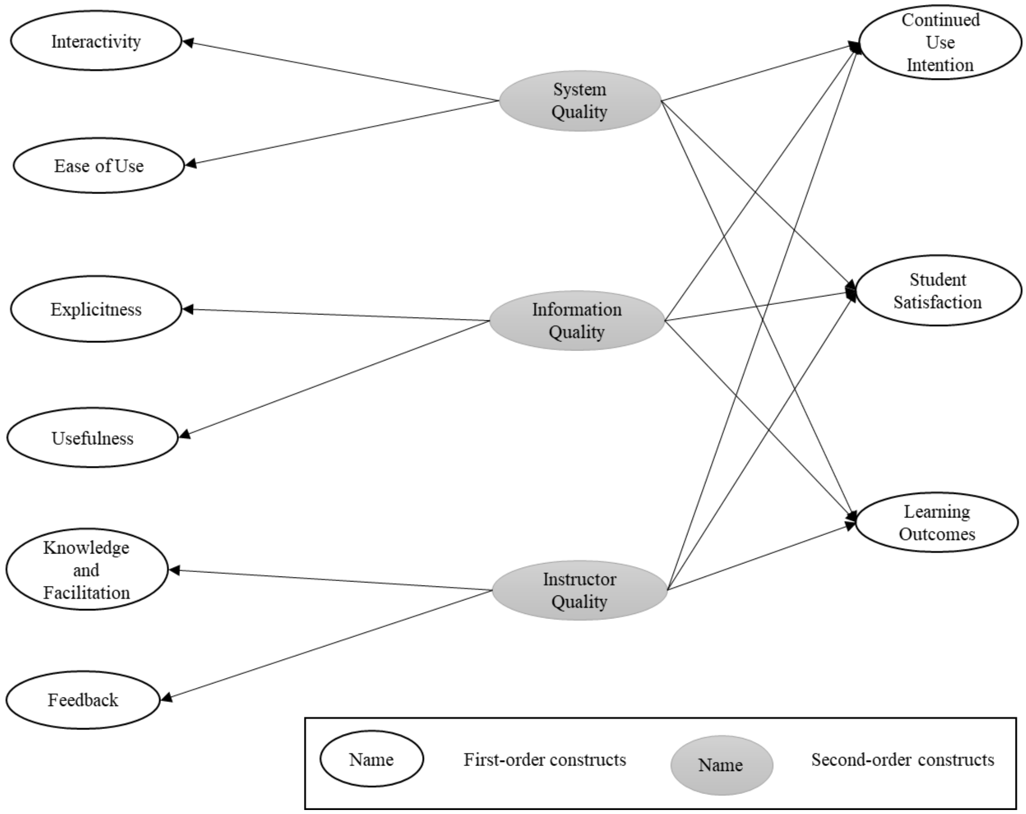

Figure 1. Research Model

4.1 System Quality: Interactions and Ease of Use

We define system quality as a desired characteristic in an information system (DeLone & McLean, 1992). Previous studies (e.g., Eom & Ashill, 2016; Mohammadi, 2015) have concluded that system quality positively influences students' satisfaction, learning outcomes, and their intention to use the learning system. The literature has highlighted the importance of system interactivity for online learning and established its positive relationships with continuous system usage, continued use intention, and learning outcomes (Panigrahi, Srivastava, & Sharma, 2018). Chang and Wills (2015) found that interactions among learners and instructors strengthened how easily they communicated and shared knowledge, which led to an improvement in learning efficiency. We define interactivity as an e-learning platform's purposeful, constructive, and meaningful interactive characteristics. Moreover, researchers have found ease of use, as a validated measure of system quality (Petter, DeLone, & McLean, 2008), to positively impact technology adoption (Kaba & Osei-Bryson, 2013), students' satisfaction (Lee, 2002), and online learning outcomes (Jia, Bhatti, & Nahavandi, 2014). In this study, ease of use refers to how easily one can use an e-learning platform. In our context, we posit that students will have better learning outcomes, increased satisfaction, and be more willing to continue using an e-learning platform to take complex technology-enabled online courses if they have positive and constructive interactions with the class using the e-learning platform's features and also if they find the platform easy to use. Thus, we hypothesize:

H1a: System quality is positively related to the intention to continue using e-learning platforms for students taking a complex technology-enabled course online.

H1b: System quality is positively related to satisfaction for students taking a complex technology-enabled course online.

H1c: System quality is positively related to perceived learning outcomes for students taking a complex technology-enabled course online.

4.2 Information Quality: Explicitness and Information Usefulness

Information quality is defined as the quality of the information produced in terms of accuracy, meaningfulness, and timeliness (DeLone & McLean, 1992). Prior research (e.g., Eom & Ashill, 2016; Lin, 2007) has suggested that information quality plays a significant role in influencing learning outcomes, satisfaction, and intent to use. In the online learning context, we categorize information quality into two measures—usefulness and explicitness—based on validated measures of information quality (Petter et al., 2008). Usefulness means that information is relevant, up to date, and complete and that it meets one's needs. Explicitness means that information is clear, accurate, understandable, and easy to follow. We expect that students' finding the information they receive through using online platforms useful and the content that complex technology-enabled online courses deliver via online platforms explicit to significantly affect their learning outcomes, satisfaction, and intent to continue using e-learning platforms to take complex technology-enabled online courses. Therefore, we hypothesize:

H2a: Information quality is positively related to the intention to continue using e-learning platforms for students taking a complex technology-enabled course online.

H2b: Information quality is positively related to satisfaction for students taking a complex technology-enabled course online.

H2c: Information quality is positively related to perceived learning outcomes for students taking a complex technology-enabled course online.

4.3 Service Quality: Instructor Knowledge, Facilitation, and Feedback

We define service quality as the quality of support that system users receive from service providers in terms of technical competence, empathy, and responsiveness (DeLone & McLean, 2003; Petter et al., 2008). In an online learning context, service providers act as instructors in that they deliver the online course, help students, and provide feedback on homework (Lee, 2010). Thus, we rephrase service quality to "instructor quality" in this study. Previous research (e.g., Eom & Ashill, 2016; Mohammadi, 2015) has shown that service (instructor) quality directly impacts learning outcomes and student satisfaction and students' intention to use the system. In the online learning area, research has classified service (instructor) quality as instructor knowledge and facilitation and instruction feedback (Eom & Ashill, 2006). Instructor knowledge and facilitation measures instructors' knowledge and the extent to which they participate in and stimulate student learning, while instructor feedback measures the extent to which instructors respond to student concerns, cares about student learning, and provides timely feedback (Eom & Ashill, 2006). In reviewing online learning, Chang (2019) found that any technology-based learning without instructor feedback and facilitation will have a lesser impact on the learning outcome. Thus, we contextualize service quality as instructor knowledge, facilitation, and feedback. We theorize that, with knowledgeable and involved instructors who stimulate student learning and provide timely feedback, students will have better learning outcomes and satisfaction and will have the intention to continue using e-learning platforms to take complex technology-enabled online courses. Thus, we hypothesize:

H3a: Service quality is positively related to the intention to continue using e-learning platforms for students taking a complex technology-enabled course online.

H3b: Service quality is positively related to satisfaction for students taking a complex technology-enabled course online.

H3c: Service quality is positively related to perceived learning outcomes for students taking a complex technology-enabled course online.

In Section 5, we describe the research design we used to empirically test our model.

5 Research Design

We used the survey method to empirically test our research model. To operationalize the constructs in Figure 1, we developed a survey instrument based on existing scales that we found from comprehensively reviewing the literature. Table 1 lists all measurement items and their original sources. We identified appropriate measures and modified them for our context (i.e., SAP-enabled online course delivery). We assessed all measures on a five-point Likert scale with strongly disagree (1) and strongly agree (5) as the anchors. We first conducted a pilot test by randomly selecting 50 respondents at one university. From the pilot study, we did not find any problems or confusion about the survey instrument and, thus, confirmed the instrument's suitability.

Table 1. Measurement Items and Resource of Literature

Construct	Measurement items
System quality	
Interactivity (Eom & Ashill, 2018)	Interactivity1: there are features in the online learning platform that I can have positive and constructive interactions with others. Interactivity2: in this SAP-enabled online class, the level of positive and constructive interactions was high. Interactivity3: the positive and constructive interactions in this SAP-enabled online class helped me improve the quality of the learning outcomes. Interactivity4: positive and constructive interactions in this SAP-enabled online class was an important learning component.
Ease of use (Alshare & Lane, 2011)	Ease1: learning to use the online learning platform was easy for me. Ease2: I find online learning platform easy to use. Ease3: my interaction with online learning platform has been clear and understandable.
Information quality	
Explicitness (Eom & Ashill, 2018; Lin, 2007)	Explicitness1: the course objectives and procedures of this online class were clearly communicated. Explicitness2: the structure of the modules of this online class was well organized into logical and understandable components. Explicitness3: the information provided by the online learning platform is accurate.
Usefulness (Lin, 2007)	Usefulness1: the online learning platform provides relevant information for learning. Usefulness2: the information from the online learning platform is up-to-date enough for my purpose. Usefulness3: the information content in the online learning platform meets my needs. Usefulness4: the online learning platform provides me with a complete set of information.
Instructor quality	
Knowledge and facilitation (Eom et al. 2006)	Facilitation1: the instructor was very knowledgeable about the SAP-enabled course. Facilitation2: the instructor was actively involved in facilitating (teaching) the SAP-enabled course. Facilitation3: the instructor stimulated students to exert intellectual effort.
Feedback (Eom et al. 2006)	Feedback1: the instructor was responsive to student concerns. Feedback2: the instructor provided timely helpful feedback on assignments, exams, or projects. Feedback3: the instructor cared about my individual learning in this class.
Continued use intention (Venkatesh et al., 2003; Chen, Keys, & Gaber, 2015)	Use1: I intend to use online learning platform to take SAP-enabled course in the future. Use2: I expect to use online learning platform to take SAP-enabled course in the future. Use3: I want to use online learning platform to take SAP-enabled course in the future.
Student satisfaction (Alshare & Lane, 2011)	Satis1: I would recommend this course to other students to learn about SAP. Satis2: I am satisfied with the quality of the learning experience of this course. Satis3: I enjoyed this course.
Learning Outcomes (Alshare & Lane, 2011; Chen et al., 2015)	Outcomes1: I expect an excellent grade in this course. Outcomes2: I performed well in this course. Outcomes3: I expect an excellent grade on my SAP assignments. Outcomes4: I feel I have gained a hands-on understanding of the concepts of underlying SAP systems. Outcomes5: I feel I have developed technical SAP skills.

The target respondents for this study represented the national online student population and had enrolled in at least one online SAP-enabled course. We collected data through an online survey from four mid-sized state universities in the United States. The universities had membership in the SAP university alliances program. We contacted faculty members who taught SAP-enabled online courses in these universities and sent them the survey link. The faculty members then posted the invitations in their online SAP-enabled courses close to the end of the semester. We assured respondents that they could withdraw participation at any time and that we would anonymously record the collected survey data.

The online survey contained the items that operationalized the variables in the model. We received 293 completed responses from our online survey. All respondents had taken at least one SAP-enabled online course. We examined response patterns and checked for straight lining (i.e., when a respondent marks the same answer for a high number of the questions). Among the 293 returned questionnaires, we found 32 suspicious questionnaires in this regard and discarded them. As a result, we used the remaining 261 valid responses for the data analysis. The largest number of independent variables estimated for a dependent variable was four. Thus, according to the often-cited "10 times rule" (Barclay, Higgins, & Thompson, 1995), we had a more than adequate sample size for data analysis. We present the respondents' demographic information in Table 2.

Table 2. Demographic Characteristics of Survey Respondents

Respondents	Category	Frequency	Percentage (%)
Gender	Male	121	46.4%
	Female	140	53.6%
Age	18-24	116	44.4%
	25-34	76	29.1%
	35-44	36	13.8%
	45-54	28	10.7%
	Above 54	4	1.5%
	Not answered	1	0.4%
Educational Program	Undergraduate	186	71.3%
	MBA	51	19.5%
	Master	24	9.2%

6 Results

We used structural equation modeling with partial least squares (PLS-SEM) to analyze the data. Prior research (e.g., Chen et al., 2015; Liang et al., 2017) suggests that PLS-SEM has lower constraints regarding the distributional properties (multivariate normality), identification, measurement level, and factor indeterminacy than covariance-based structural equation modeling does (CB-SEM), and PLS-SEM constitutes a powerful method to analyze complex models using smaller samples (Hair, Ringle, & Sarstedt, 2011). While CB-SEM relies on the common factor model, PLS-SEM relies on the composite model (Rigdon, Sarstedt, & Ringle, 2017). Using the composites as input, PLS-SEM applies a series of regressions to maximize the variance that the endogenous variables explain (Rigdon et al., 2017). A causal modeling approach, PLS-SEM focuses on prediction (Hair et al., 2011). In contrast, CB-SEM focuses on reproducing the theoretical covariance matrix to minimize the difference between the theoretical covariance matrix and the estimated covariance matrix (Richter, Sinkovics, Ringle, & Schlaegel, 2016).

We chose PLS-SEM over CB-SEM because the former has better flexibility and better suits exploratory and predictive work (Mital, Chang, Choudhary, Papa, & Pani, 2018). Because we conducted an exploratory study to investigate and predict structural relationships, PLS-SEM represented the more appropriate choice. We used the SmartPLS 2.0 software to evaluate the measurement properties and to test the model. We measured all latent variables in the research model with reflective constructs. We estimated the measurement models and the structural model. The measurement models measured the relationships between the indicators and the constructs, while the structural model measured the relationships between the constructs (Hair, Hult, Ringle, & Sarstedt, 2014).

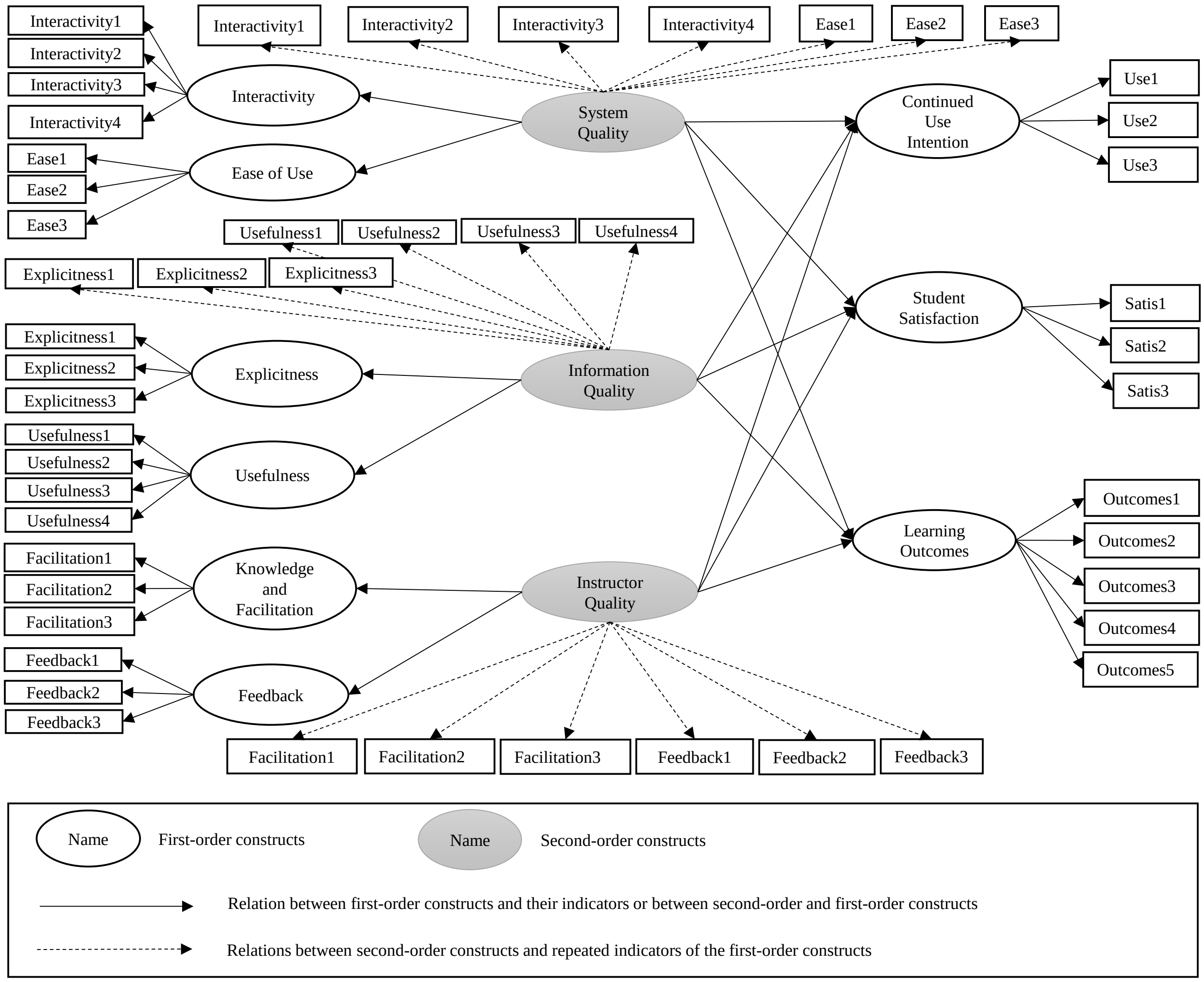

Figure 2. Hierarchical Component Models

Hierarchical component models, or higher-order constructs, are multidimensional constructs that exist at a higher level of abstraction and can be created by repeatedly using manifest variables (Hair et al., 2014). Our model is hierarchical: it has six exogenous first-order constructs, each of which represents a dimension of a second-order construct (two for system quality, two for information quality, and two for service quality), and three second-order constructs (system quality, information quality, and service quality). It also includes three endogenous first-order constructs (continued use intention, perceived learning outcomes, and student satisfaction). By using the repeated indicators approach (Wetzels, Odekerken-Schröder, & Van Oppen, 2009), we constructed hierarchical component models with second-order latent variables in the following steps (see also Figure 2):

1) We constructed the first-order latent variables (system interactivity, system ease of use, information explicitness, information usefulness, instructor knowledge and facilitation, instructor feedback, continued use intention, perceived learning outcomes, and student satisfaction) by relating them reflectively with their indicators (see Table 3 for the indicators and properties of the first-order constructs).
2) We constructed the second-order latent variables (system quality, information quality, and service quality) by setting up an outer model that included blocks of manifest variables of the first-order latent variables. Thus, for system quality, the blocks of indicators corresponded to interactivity and ease of use. For information quality, the blocks of indicators corresponded to explicitness and information usefulness. For instructor quality, the blocks of indicators corresponded to knowledge and facilitation, and feedback. The inner model between the second-order latent variables and their corresponding first-order latent variables represent the second-order loadings.

3) Following the research model, we related the second-order latent variables to the structural model with the endogenous first-order constructs (continued use intention, learning outcomes, and student satisfaction).

4) We used PLS path modeling to estimate the hierarchical model. We got estimates for the first-order loadings, second-order loadings, and the structural parameters. Then, we ran the bootstrapping method using 5,000 samples and 261 cases to obtain empirical t values.

Table 3. Indicators and Properties of the First-order Constructs

Construct	Item	Loading	CR	Cronbach's alpha	AVE
Continued use intention	Use1	0.98	0.98	0.97	0.95
	Use2	0.98			
	Use3	0.96			
Ease of use	Ease1	0.95	0.97	0.95	0.91
	Ease2	0.95			
	Ease3	0.95			
Explicitness	Explicitness1	0.94	0.96	0.93	0.88
	Explicitness2	0.94			
	Explicitness3	0.93			
Information usefulness	Usefulness1	0.95	0.97	0.96	0.89
	Usefulness2	0.94			
	Usefulness3	0.96			
	Usefulness4	0.93			
Instructor feedback	Feedback1	0.94	0.96	0.94	0.89
	Feedback2	0.95			
	Feedback3	0.94			
Instructor knowledge and facilitation	Facilitation1	0.92	0.95	0.92	0.86
	Facilitation2	0.93			
	Facilitation3	0.92			
Interactivity	Interactivity1	0.88	0.96	0.95	0.86
	Interactivity2	0.95			
	Interactivity3	0.95			
	Interactivity4	0.94			
Learning outcomes	Outcomes1	0.90	0.95	0.94	0.80
	Outcomes2	0.91			
	Outcomes3	0.90			
	Outcomes4	0.91			
	Outcomes5	0.86			
Student satisfaction	Satis1	0.94	0.96	0.93	0.88
	Satis2	0.95			
	Satis3	0.93			

6.1 The Measurement Models

We assessed the reflective measurement models through indicator reliability, internal consistency (composite reliability and Cronbach's alpha), convergent validity (average variance extracted; AVE), and discriminant validity. First, the indicator's outer loadings should be higher than 0.708. Second, according to the rule for evaluating reflective measurement models, composite reliability should be higher than 0.708, and the AVE should be higher than 0.5 (Hair et al., 2014). Third, regarding discriminant validity, the generally accepted Fornell-Larcker criterion indicates that the square root of construct's AVE needs to be higher than its highest correlation with any other construct (Fornell & Larcker, 1981). Additionally, to support discriminant validity, each indicator's outer loadings on a construct should be higher than all its cross-loadings with other constructs (Gefen, Straub, & Boudreau, 2000; Hair et al., 2014).

We analyzed the first-order latent variables. Table 3 shows the outer loadings of each measured item and each first-order construct's composite reliability (CR), Cronbach's alpha, and average variance extracted (AVE). Table 3 indicates that all items loadings were above the threshold 0.708, and Table 4 shows that every indicator's outer loading on its intended construct was higher than its cross-loadings with any other constructs. For all first-order constructs, the lowest composite reliability for a construct was 0.95, the lowest Cronbach's alpha for a construct was 0.92, and the lowest AVE was 0.80—well above the threshold values. Table 5 presents the intercorrelations among the first-order constructs. The square root of each construct's AVE was higher than its highest correction with any other construct. Thus, the reflective construct measures met all reliability and validity measures.

Table 4. Item Loadings and Cross Loadings

Construct	Indicator	1	2	3	4	5	6	7	8	9
1. Continued use intention	Use1	**0.98**	0.55	0.50	0.55	0.39	0.44	0.54	0.45	0.59
	Use2	**0.98**	0.57	0.51	0.58	0.39	0.44	0.54	0.43	0.59
	Use3	**0.96**	0.57	0.50	0.54	0.41	0.47	0.58	0.49	0.61
2. System ease of use	Ease1	0.53	**0.96**	0.67	0.68	0.38	0.42	0.60	0.59	0.64
	Ease2	0.57	**0.95**	0.66	0.69	0.38	0.43	0.61	0.57	0.60
	Ease3	0.55	**0.95**	0.72	0.74	0.46	0.50	0.65	0.61	0.60
3. Information explicitness	Explicitness1	0.49	0.66	**0.94**	0.82	0.54	0.59	0.65	0.59	0.64
	Explicitness2	0.51	0.69	**0.95**	0.78	0.57	0.57	0.64	0.62	0.64
	Explicitness3	0.45	0.68	**0.93**	0.83	0.50	0.54	0.64	0.64	0.60
4. Information usefulness	Usefulness1	0.58	0.73	0.82	**0.95**	0.53	0.59	0.71	0.65	0.71
	Usefulness2	0.48	0.64	0.79	**0.94**	0.50	0.54	0.64	0.58	0.65
	Usefulness3	0.59	0.72	0.81	**0.96**	0.54	0.60	0.69	0.61	0.68
	Usefulness4	0.50	0.68	0.84	**0.92**	0.47	0.53	0.63	0.60	0.61
5. instructor Feedback	Feedback1	0.40	0.43	0.57	0.55	**0.95**	0.87	0.51	0.43	0.54
	Feedback2	0.39	0.40	0.54	0.49	**0.96**	0.83	0.52	0.41	0.55
	Feedback3	0.35	0.37	0.51	0.48	**0.93**	0.86	0.47	0.35	0.48
6. Instructor knowledge and facilitation	Facilitation1	0.41	0.41	0.55	0.53	0.81	**0.91**	0.48	0.38	0.48
	Facilitation2	0.45	0.44	0.55	0.57	0.81	**0.94**	0.56	0.42	0.56
	Facilitation3	0.42	0.46	0.57	0.55	0.87	**0.92**	0.54	0.45	0.56
7. System interactivity	Interactivity1	0.56	0.64	0.64	0.70	0.49	0.51	**0.88**	0.59	0.68
	Interactivity2	0.50	0.61	0.64	0.66	0.48	0.54	**0.95**	0.60	0.68
	Interactivity3	0.54	0.59	0.62	0.63	0.50	0.52	**0.95**	0.60	0.68
	Interactivity4	0.51	0.58	0.65	0.64	0.50	0.54	**0.94**	0.64	0.69
8. Learning outcomes	Outcomes1	0.35	0.52	0.57	0.54	0.35	0.38	0.56	**0.90**	0.57
	Outcomes2	0.35	0.54	0.55	0.54	0.32	0.32	0.53	**0.91**	0.59
	Outcomes3	0.38	0.53	0.54	0.56	0.35	0.38	0.56	**0.90**	0.58
	Outcomes4	0.47	0.61	0.63	0.61	0.40	0.43	0.61	**0.91**	0.67
	Outcomes5	0.55	0.56	0.64	0.65	0.45	0.48	0.65	**0.86**	0.72
9. Student satisfaction	Satis1	0.58	0.58	0.61	0.64	0.48	0.51	0.69	0.67	**0.94**
	Satis2	0.56	0.62	0.68	0.71	0.57	0.61	0.71	0.66	**0.95**
	Satis3	0.59	0.61	0.60	0.63	0.51	0.51	0.67	0.64	**0.93**
Note: bold numbers indicate that all items load more highly on the construct that it should have measured than on any other construct.										

Table 5. Intercorrelations among the First-order Constructs

Construct	1	2	3	4	5	6	7	8	9
1. Continued use intention	**0.97**								
2. System ease of use	0.58	**0.95**							
3. Information explicitness	0.52	0.72	**0.94**						
4. Information usefulness	0.57	0.74	0.86	**0.94**					
5. Instructor feedback	0.41	0.42	0.57	0.54	**0.94**				
6. Instructor knowledge and facilitation	0.46	0.47	0.60	0.60	0.90	**0.93**			
7. System interactivity	0.57	0.65	0.69	0.71	0.53	0.57	**0.93**		
8. Learning outcomes	0.47	0.62	0.66	0.65	0.42	0.45	0.65	**0.90**	
9. Student satisfaction	0.61	0.65	0.67	0.70	0.56	0.58	0.73	0.70	**0.94**
Note: we display the square roots of the AVEs on the diagonal.									

We also estimated the second-order constructs' CR and AVE (see Table 6). It indicates that CRs were above 0.708 and AVEs were above 0.5 with the lowest composite reliability for a construct being 0.95, the lowest Cronbach's alpha for a construct being 0.94, and the lowest AVE being 0.731. The loading of all the first-order latent variables in their corresponding second-order constructs exceeded 0.88. Thus, the measures were reliable.

Table 6. Indicators and Properties of the Second-order Constructs

	System quality	Information quality	Instructor quality
CR	0.95	0.97	0.97
Cronbach's alpha	0.94	0.97	0.96
AVE	0.73	0.83	0.83
System interactivity	0.93**		
System ease of use	0.88**		
Information explicitness		0.95**	
Information usefulness		0.98**	
Instructor knowledge and facilitation			0.97**
Instructor feedback			0.98**
**p < .01			

6.2 The Structural Model

To evaluate the structural model, we measured coefficients of determination (R^2), the size and significance of path coefficients, and f^2 effect sizes. We estimated path coefficients and R^2 by running the PLS algorithm. The value of R^2 is the amount of explained variance of an endogenous latent variable in the structural model. In our study, the endogenous latent variables were student satisfaction, learning outcomes, and continued use intention. The estimated path coefficients have standardized values between -1 and +1. If these values near 0, the hypothesized relationships most likely lack significance (Hair et al., 2014). To determine the statistical significance of the path coefficients, we ran the bootstrapping method using 5,000 samples and 261 cases, which generated empirical t values. Moreover, we employed the widely used f^2 to measure the effect size following Cohen's (1992) guidelines. To calculate each exogenous construct's effect size, we ran the PLS path model twice. The change in the R^2 value when one omits a specific exogenous construct from the model constitutes the effect size (f^2) of the omitted construct on the endogenous constructs (Hair et al., 2014). The values 0.02, 0.15, and 0.35 represent small, medium, and large effects of the exogenous latent variable, respectively Figure 3 shows the estimated relationships in the structural model. Table 7 shows the estimated parameters in the structural model.

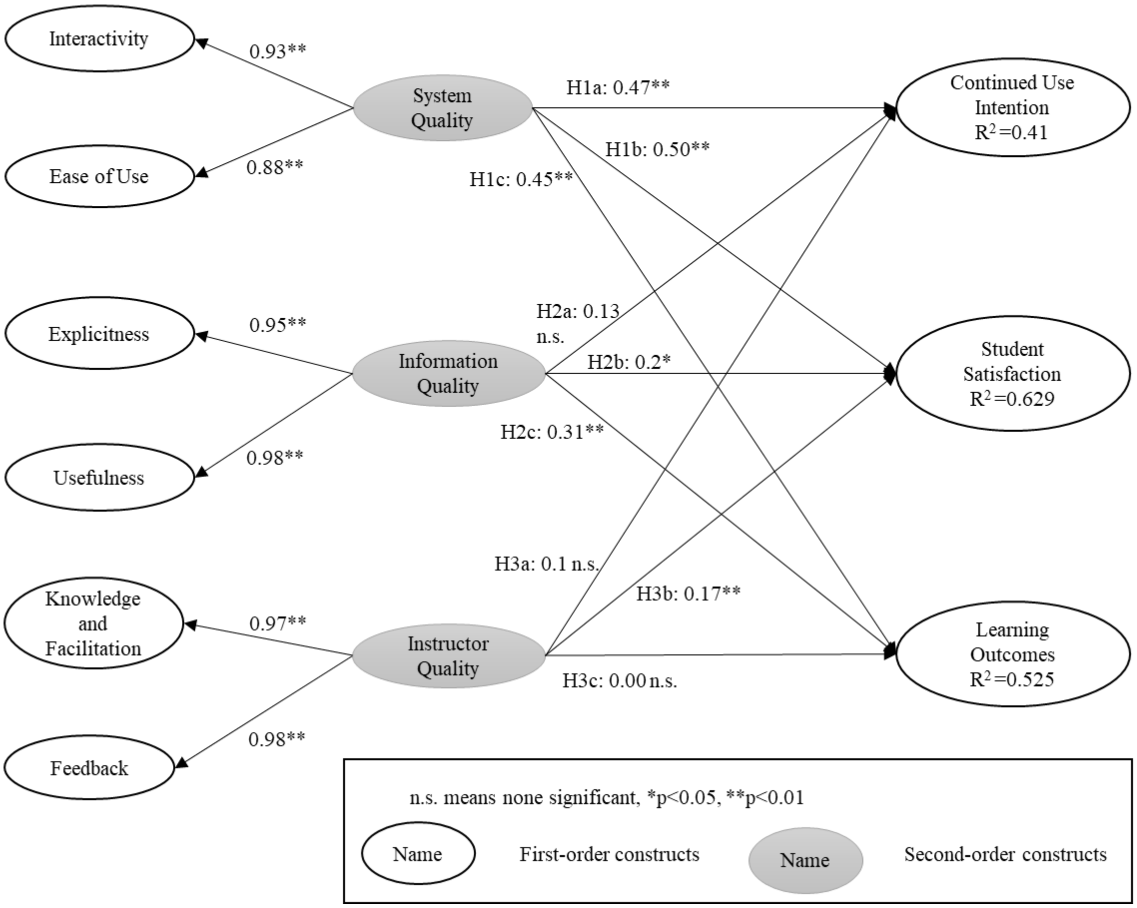

Figure 3. Estimated Relationships in the Structural Model

Table 7. Structural Parameter Estimates ($p < 0.01$)

Hypothesized path	Path coefficients	T- statistic	Sig.	Effect size
H1a: System quality → continued use intention	0.467	5.07	Yes	0.12 (medium)
H1b: System quality → student satisfaction	0.503	7.24	Yes	0.23 (medium)
H1c: System quality → learning outcomes	0.446	5.09	Yes	0.14 (medium)
H2a: Information quality → continued use intention	0.129	1.42	No	0.01 (not sig.)
H2b: Information quality → student satisfaction	0.201	2.42	Yes	0.03 (small)
H2c: Information quality → learning outcomes	0.315	3.19	Yes	0.07 (small)
H3a: Instructor quality → continued use intention	0.099	1.15	No	0.01 (not sig.)
H3b: Instructor quality → student satisfaction	0.173	2.61	Yes	0.05 (Small)
H3c: Instructor quality →learning outcomes	0.000	0.00	No	0 (not sig.)

From Figure 3, one can that the model explained 52.5 percent of the variance of learning outcomes ($R^2 = 0.525$), 62.9 percent of the variance of student satisfaction ($R^2 = 0.629$), and 41 percent of the variance of continued use intention ($R^2 = 0.41$). The empirical test results supported two-thirds of all the hypotheses, and almost all the supported relationships of our research model were significant at the 0.01 level.

The results demonstrate that system quality, information quality, and instructor quality significantly predicted student satisfaction, while only system quality significantly predicted students' intention to continue using online SAP-enabled course learning. Both system quality and information quality significantly predicted students' perceived learning outcomes. Among these three predictors, online learning system quality had the most significant impact on all three endogenous constructs. Information quality had a small effect on perceived learning outcomes and satisfaction. Instructor quality had a small impact on student satisfaction, but it did not have a significant impact on students' continued use intention or on their perceived learning outcomes. We discuss these findings in detail in Section 7.

7 Discussion of Research Findings

In our study, we focus on the factors that lead to better learning outcomes, satisfaction, and intention to continue using e-learning platforms for students taking online courses that involve complex technologies such as SAP. We incorporated factors from four different theories to build our comprehensive model to evaluate the success factors associated with using complex technologies in an online learning environment. We found that our comprehensive research model adequately described the relationships among the three predictors and the three endogenous constructs. We summarize the findings in Table 8.

Table 8. Summary of Research Findings

Exogenous construct	Endogenous construct	Finding
System quality	Continued use intention	Supported
	Satisfaction	Supported
	Students' perceived learning outcomes	Supported
Information quality	Continued use intention	Not supported
	Satisfaction	Supported
	Students' perceived learning outcomes	Supported
Service quality	Continued use intention	Not supported
	Satisfaction	Supported
	Students' perceived learning outcomes	Not supported

System quality, which measured the interactivity and the ease of use of an online platform's features, had the maximum influence on continued use intention, satisfaction, and perceived learning outcomes in an online SAP-enabled course. This finding agrees the results from prior research on e-learning success. In our context, the significant positive relationships between system quality and the endogenous constructs clearly indicate the importance of having easy-to-use features in an online learning platform that enable class members to interact positively and constructively.

We found information quality to have a small direct effect on satisfaction and perceived learning outcomes no effect on continued use intention. Our results confirm that the clarity of a course's design and the quality of the information that an online learning platform provides do not affect whether students intend to continue using the online learning system outside class.

We found that service quality influenced only satisfaction. We did not expect the nonsignificant relationships that we found between service quality and continued use intention and between service quality and learning outcomes. Knowledgeable instructors actively involved in facilitating teaching activities and providing timely feedback will influence students' satisfaction. They, however, will not have any impact on whether students intend to continue using learning platform on their perceived learning outcomes.

In an effort to determine how one can successfully deliver complex technologies (e.g., SAP-enabled courses) online to students, we conducted a study in which we found that an e-learning platform's features (system quality), content design (information quality), and technical support (service quality) have explanatory power concerning students' intention to continue to use the e-learning system, their satisfaction, and their perceived learning outcomes. Additionally, the results indicate that, even though instructors play a significant impact on students' satisfaction, they have no impact on students' intention to continue using the online platform in the future and on learning outcomes. Information quality also had no impact on students' intention to continue using the e-learning system. The e-learning platform's system quality influenced the success of deliver complex technologies the most.

7.1 Implications

This research makes several contributions to the literature on the effectiveness and acceptance of e-learning systems. First, we address the issue of teaching complex technologies online through e-learning systems. Many studies have measured what factors contribute to whether e-learning succeeds in general, but no specific study has examined the factors that contribute to whether online courses that teach complex technologies succeed. Instructors have always found it challenging to teach complex technologies online—particularly when students must install the technologies on their own computers and learn it on their own. However, due to the IS discipline's unique characteristics, students must successfully learn complex technologies. Even though ERP systems have proliferated, few studies have empirically examined the success factors that help students learn complex technologies online. In our study, we investigate the factors that influence whether teaching complex technologies through e-learning systems succeed. By advancing our knowledge on teaching and learning complex technologies in the distance education area, we fill a void in the IS literature.

Second, based on the social cognitive theory and the technology acceptance model, we decompose the IS success model's core constructs into contextualized variables. Our study contributes to the theoretical generalization by making the IS success model more context sensitive. This refinement results in a more robust conception of the IS success model that accounts for the factors that help learning complex technologies through distance education succeed. Online education has entered the mainstream in the United States, and the demand for online courses in specialized disciplines continues to grow. Therefore, we need to understand what may help complex technology-enabled courses to succeed and what impacts students' intention to take more complex technology-enabled courses. We surveyed business students who had taken at least one SAP-enabled online course across four mid-sized state universities in the United States. We found that whether online SAP-enabled education succeeds depends most on system interactivity and how easily one can use online learning platforms. Thus, higher education administrators and e-learning platform providers should cooperate to evaluate and ensure that users can easily use their existing e-learning platforms and that such platforms provide adequate interactivity features. Instructors should recognize the importance of interactivity and enable more interactivity features in online course design. Even though instructor knowledge, facilitation, and feedback did not influence students' perceived learning outcomes and the intention to continue using online learning platform to take SAP-enabled courses in the future, they had a considerable impact on their satisfaction. Perhaps, for complex technologies, knowledgeable instructors can stimulate student satisfaction but cannot guarantee learning and continued use. That may also depend on students' commitment to learning and taking knowledge forward with them. Educators will benefit from knowing that presenting a clearly designed course and accurate, relevant, and complete information to students through an e-learning platform will contribute to the latter's learning and satisfaction.

Third, in this study, we investigate influences that success factors have on both e-learning acceptance and effectiveness (i.e., student satisfaction and learning outcomes). IS researchers have largely examined only the influence that factors have on e-learning effectiveness (e.g., Eom & Ashill, 2018). As higher education focuses on not only learning effectiveness but also retention rates, this paper fills the gap in the literature by delineating the key factors that influence both e-learning effectiveness and acceptance in the context of complex online technology-enabled courses. We found that only system quality influenced both e-learning effectiveness and acceptance. Hence, to help online students effectively learn complex technology-enabled courses and accept the e-learning method, e-learning systems should enhance design features related to system interactivity and ease of use.

7.2 Limitations and Future Research

This study has several limitations. First, we collected data from the same respondents on all variables at a single point in time. A longitudinal study might provide useful information since respondents may give different answers as they gain more experience with ERP systems with time. Also, since we used data from four mid-sized public universities in the United States that solely used SAP as their ERP system, the results may not generalize to all universities, particularly those that use complex technologies other than SAP. Further, although we decomposed the core constructs in the IS success model into contextualized variables, the list of variables might not be exhaustive. Future research may continue to explore a greater range of contextualized variables associated with quality assessment. In addition, future research should consider a mixed methodology that combines qualitative and quantitative approaches to increase the results' robustness. A qualitative investigation with e-learning system stakeholders may help researchers in exploring broader quality-assessment aspects (Farid, Ahmad, Alam, Akbar, & Chang, 2018), which they could further test in a quantitative approach. Moreover, future research may evaluate and compare the relative importance of three outputs: continued use intention, student satisfaction, and learning outcomes. Doing so would enrich our understanding about which outputs may better contribute to e-learning's success.

Statista (2019) has predicted that the e-learning market worldwide will exceed US$243 billion by 2022. Faculty and students worldwide have shown considerable support in favor of online education. Appsruntheworld (2019) has predicted that the ERP applications market will reach US$86 billion by 2022, compared to $82.6 billion in 2017, at a compound annual growth rate of 0.8 percent. SAP has led all ERP vendors with the most market share for the last several years. In the future, researchers could investigate the factors that influence the learning outcomes, satisfaction, and intent to take SAP-enabled online courses in students in other countries and compare the results to our own. In doing so, researchers could test our comprehensive research model across cultures. Given the global interest in online education and in using complex software such as SAP, it would be interesting to note if the contextualized view of decomposing the IS success model has the same predictive power across cultures.

8 Conclusion

This work provides important findings to educators that teach complex technologies online. Based on the social cognitive theory and the technology acceptance model, we decompose the IS success model and contextualize the antecedent constructs. We provide empirical evidence on the impact that factors such as system quality, information quality, and service quality have on students' learning outcomes, satisfaction, and intention to continue using an e-learning platform to take complex technology-enabled online courses. Our study augments earlier research in understanding the determinants of e-learning's success factors by extending it to include online SAP-enabled courses.

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