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Sean Eom

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Learning Outcomes and Learner Satisfaction: The Mediating Roles of Self-regulated Learning and Dialogues

Sean Eom
(*Southeast Missouri State University*)

Nicholas Jeremy Ashill
(*Victoria University of Wellington*)

ABSTRACT

The interdependent learning process is regarded as a crucial part of e-learning success, but it has been largely ignored in e-learning empirical research. Grounded in constructivist and social constructivist theory, we present and test an e-learning success model consisting of eight e-learning critical success factors (CSF) derived from constructivist and social constructivist models. Three hundred seventy-two on-line students from a Midwestern university in the United States participated in the survey. The data collected from the survey was used to examine the partial least squares structural equation model. The results highlight the importance of self-regulated learning and dialogical processes to explain and predict perceived learning outcomes and student satisfaction.

Our research extends and fortifies a systems view of e-learning success (Eom & Ashill, 2018) to steer the direction of future e-learning empirical research to build strong e-learning theories. We provide a holistic and coherent framework around which a wide range of learning variables are organized, from which to conduct research on students' learning. In doing so, our research adds innovative insights and provides a new direction of future e-learning empirical research.

Keywords: E-Learning Success Model, Learning Outcomes, Student Satisfaction, Self-Regulated Learning, and Interdependent Learning Processes

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INTRODUCTION

Research on e-learning and distance learning originated more than 40 years ago (Hiltz & Turoff, 1978). Since then, the most common e-learning empirical research streams have focused on students' performance relative to face-to-face courses as well as the antecedents of course learning outcomes (Arbaugh et al., 2010; Arbaugh et al., 2009; Eom & Arbaugh, 2011; Eom & Ashill, 2018). However, a critical hurdle that hampers progress toward building a robust theoretical understanding of distance learning is the way variables are modeled when seeking to understand, explain, and predict the behavior of e-learning systems. Although a recent review of literature on the e-learning process and its impact on learning outcomes (Eom, 2021; Eom & Ashill, 2018) suggests that future e-learning research should examine a set of interconnected constructs with a system's view, most e-learning studies have examined a set of disconnected independent constructs.

This research aims to present and empirically test an e-learning success model that further extends and strengthens a systems view of e-learning success. Our work contributes to the existing literature on e-learning success in two critical ways. First, we present an integrated, holistic approach describing the systematic relationships of human and non-human inputs, inter-dependent learning processes, and two major distance-learning systems outputs (learning outcomes and learner satisfaction) from a systems view. Second, grounded in constructivist and social constructivist theory (Jonassen et al., 1995), our research identifies self-regulated learning (SRL) and active learning at its core that tightly integrate all learning variables. Panadero (2017) reviewed the most influential six models of SRL and defined that SRL as the voluntary management of multidimensional (motivational, emotional, behavioral, metacognitive, and cognitive) learning processes to achieve academic goals. Most importantly, SRL provides a remarkable umbrella that covers a significant number of constructs that influence e-learning processes and outcomes. Our SRL-centered e-learning conceptual model adds innovative insights and provides a new direction for future e-learning empirical research. The recent work of Yunusa and Umar (2021) provides an extensive overview of CSFs that affect the effectiveness of e-learning systems using student satisfaction and perceived learning outcomes as dependent variables and provided the taxonomy of predictive factors. But they fail to examine the interdependent process nature of learning success, which is crucial because learning process variables are indispensable elements of the learning systems and the glue that holds input variables
(student and instructor entity, as well as leaning management systems, information and communication technologies [ICT]), and outcome variables together.

The paper begins with theoretical foundations consisting of technology-mediated learning research framework and a systems view of the e-learning success model. The next section describes the research model which is derived from the theoretical

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foundation and hypotheses development. An overview of the research methodology and survey instrument development and measurement follows this. The following section discusses data analysis and results. The final section presents key findings and concludes with a discussion of theoretical contribution, study limitations, and future research directions.

THEORETICAL FOUNDATIONS

Technology-Mediated Learning Research Framework

More than two decades ago, Alavi and Leidner (2001) called for new research to include the psychological learning process as a mediating mechanism in technology-mediated learning (TML) research. They asserted that the majority of distance learning studies were based on "a static view" that examined the correlations between input (independent) variables and output (dependent) variables and, therefore, failed to consider the internal psychological process through which learning outcomes are produced. The internal psychological process in their suggested framework refers to a series of mental processes used by the learners, such as cognitive and information-processing activities.
The complexity of human psychological processes and the learner's cognitive structures make it difficult to apply widely to empirical e-learning research. Furthermore, their highly restricted and narrow definition of learning processes ignored the broader areas of learning processes utilized in distance learning, including self-regulated learning and interaction among many entities (students, the instructor, LMS, and communication and IT). Consequently, the TML research framework failed to be adopted widely in distance learning empirical studies.

A Systems View of the E-Learning Success Model

A systems view of the e-learning success emerged to overcome the shortcomings of the TML research framework and advance the understanding of the effective management of e-learning CSFs (Eom and Ashill 2018). The systems view is rooted in constructivist models, particularly constructivism and collaborativism.
Constructivism assumes that learners construct their knowledge and understanding. Further, individual learners do better when they uncover things themselves at their own time and pace. It implies that successful distance learners are self-regulated learners with self-determination and strong motivation.
Collaborativism, another element of the constructivist models, assumes that knowledge is socially and collaboratively constructed. It implies that involvement, engagement, dialogue, and feedback are critical elements of the knowledge construct.

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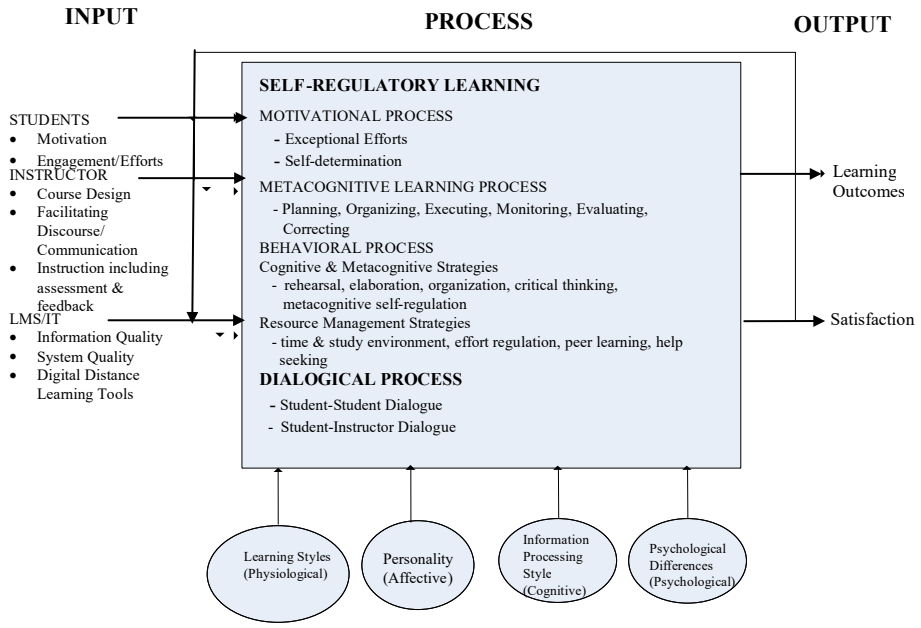

Figure 1. A Systems View of E-learning Success Model (Adapted from Eom and Ashill 2018)

Two types of intertwined learning processes

Figure 1 illustrates two types of intertwined learning processes involved in creating positive learning outcomes: self-regulated learning (SRL) and dialogical learning processes (student-student and instructor-student).

The SRL process: Many scholars in the educational psychology area agree with the notion that SRL is a robust theoretical framework to fasten critical e-learning success factors (Butler & Winne, 1995; Zimmerman, 1990). The constructivist paradigm is a pillar of distance learning theories.
It is essential for distance learners to become self-regulated learners.
There are several core attributes of self-regulated learners. Students who exhibit a high level of SRL behavior are "meta-cognitively, motivationally, and behaviorally active participants in their own learning process" (Zimmerman, 1986).

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Active self-participation in the metacognitive/cognitive learning processes refers to deliberately setting learning goals, planning, organizing, executing, reviewing, and assessing each one of the six sub-activities under the learning process by learners themself.
SRL behavior is the result of three indispensable processes working in tandem: motivational processes, management of meta-cognitive learning processes, and behavioral learning processes that select and apply cognitive, metacognitive, and resource management strategies to achieve learning goals and desired outcomes. Self-regulated learners who participate in the motivational learning process are self-starters who display exceptional efforts and determination to maintain motivation and to set individual learning goals. Active self-participation in the behavioral learning process is concerned with the four resource management strategies:
self-management of study time, self-instruct, self-reinforcement, and help-seeking.

The dialogical process: Another school of thought, collaborativism, assumes that knowledge is socially and collaboratively constructed through sharing.
Therefore, involvement, interaction, and dialogue between students (SSD) as well as between students and the instructor (SID) are viewed as being critical ingredients to the success of e-learning systems. One thing that sets e-learning apart from traditional face-to-face learning is the psychological and communication space (transactional distance) between the instructor and students (Moore, 1993).
The transactional distance in e-learning can be reduced by many types of interactions: learner-content, student-instructor, student-student, student-technology interaction (Hillman et al., 1994; Moore, 1989). Social construction theorists view learning as a social, dialogical process in which students and the instructors construct knowledge and build the meaning of phenomena (Jonassen et al., 1995).
The systems view assumes that three distance learning entities (students, instructors, and information technology/learning management systems) influence the intertwined mediating learning process, which in turn affects the perceived learning outcomes as well as the learners' affective reactions to e-learning (satisfaction). This study expands the scope of learning processes in addition to the psychological learning process to include the meta-cognitive learning process (Anthonysamy, 2021; Johnson et al., 2009) as well as learning strategy selection (self-regulated learning) (Hardy et al., 2019; Santhanam et al., 2008). In addition, the interaction/dialogue is an essential component of the collaborative learning process that affects the learning outcomes (Kim et al., 2014).
The social interdependence theory that is rooted in collaborative learning has been an important way of learning in education, as demonstrated by Johnson and Johnson (2009). Using more than 1,200 studies, they demonstrated that collaboration and cooperation, rather than competitive and individualistic efforts, foster higher

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achievement and greater productivity (Johnson & Johnson, 2009; Laal & Ghodsi, 2012).

RESEARCH MODEL AND HYPOTHESES

The research model guiding our study comprised three subsystems: inputs, processes, and outputs (see Figure 2). The left side and middle of the model included predictor, aka exogenous, latent variables. These predictor constructs were extracted based on the careful analysis of the constructivist model of learning (Jonassen et al., 1995) and extensions of the constructivist model such as collaborativism, socioculturism, and the cognitive information processing model (Leidner & Jarvenpaa, 1995).

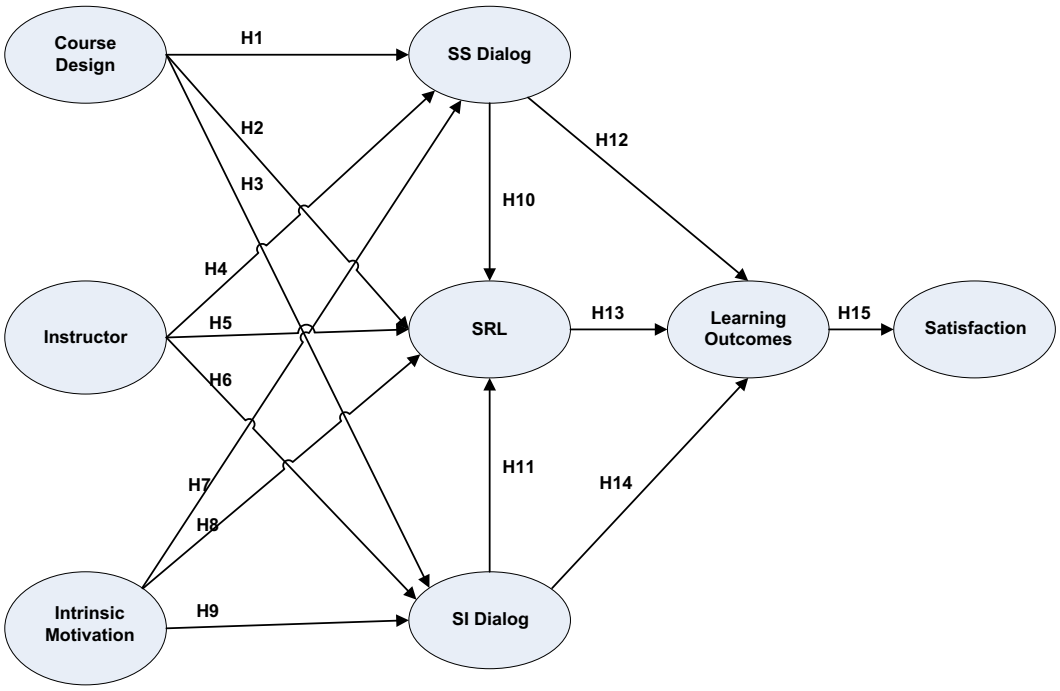

Figure 2. Research model

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Course Design Quality and Dialogues

Previous studies have largely examined the predictors of leaning outcomes such as course design, SS interaction, and SI interaction (Ekwunife-Orakwue & Teng, 2014; Kim & Kim, 2021; Swan et al., 2000). Some studies reported a positive relationship between course design and SI interaction (Benbunan-Fich & Hiltz, 2003; Peltier et al., 2007). This research used dialogue instead of interaction. According to Moore (1993), dialogue is the interaction that is purposefulness, constructive, and meaningful. The dialogue encourages students to actively participate in the learning process and enables them to develop higher-order knowledge through deep cognitive engagement (Moore, 1993; Muirhead & Juwah, 2004).

However, there is a lack of studies that show a positive correlation between SS dialogue and course design. Based on the examination of the prior literature on course design and interaction, we hypothesized that the student perceptions of course design quality and structure in online courses positively affect the level of student-student dialogue and student-instructor dialogue.

Thus, we hypothesized:

H1: *Student perceptions of course design in online courses are positively related to student-student dialogue.*

H3: *Student perceptions of course design in online courses are positively related to student-instructor dialogue.*

Course Design Quality and SRL

According to Zimmerman, self-regulated learners are those who actively participate in the metacognitive learning process: planning, organizing, executing, monitoring, evaluating, and correcting. It is mandatory to specify the learning objectives and the learning activities necessary to achieve them in course design. Therefore, course design helps distance learners be active participants in this learning process. Furthermore, a good course design provides distance learners with numerous tools to check their learning progress with timely instructor feedback.

Therefore, we hypothesized that course design quality positively affects self-regulated learning activities.

H2: *Student perceptions of online course design quality are positively related to student SRL activities.*

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Instructor's Involvement and Dialogues

A major responsibility of the instructor is facilitating two major types of interaction/dialogue: SI dialogue between students and the instructor and SS dialogue among students. The instructor facilitates SI dialogue to help students become active learners and self-regulated learners. In doing so, the instructor initiates group discussion on various subjects related to the metacognitive learning process as well as the behavioral process.
The metacognitive learning process is concerned with planning, organizing, executing, monitoring, and evaluating the process, while the behavioral process includes choosing one or more cognitive and metacognitive strategies. In the group discussion, the individual feedback provided by the instructor helps students become active and self-regulated learners. Therefore, we theorize that the level of instructor activities positively affects the level of student-student dialogue and student-instructor dialogue.

Therefore, we theorize that the perceptions of instructor activities positively affect student-student dialogue and student-instructor dialogue.

H4: *Instructor involvement is positively related to student-student dialogue.*
H6: *Instructor involvement is positively related to student-instructor dialogue.*

Instructor's Involvement and Self-Regulated Learning

The instructor plays the crucial role to set the initial course learning goals. Furthermore, the instructor provides a basic blueprint for planning goals on a weekly and monthly basis.

There are many SRL strategies that can be utilized to fulfil learning goals and to self-regulate the learning process. These strategies are classified into the following two broad categories: metacognitive and cognitive strategies. Metacognition characterizes thinking about meta learning processes i.e., how the learner plans, organizes, executes, monitors, evaluates and corrects activities associated with learning. Cognitive strategies characterize learning that draws upon repeated practice to learn (these strategies are often referred to as surface learning), and deep learning strategies such as elaboration, concept integration and critical thinking. The role of the instructor is to encourage students to use to use these different SRL strategies. Therefore, we posit that the level of instructor involvement will be positively associated with the level of using SRL strategies.

H5: *Instructor involvement is positively related to student SRL activities*

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Intrinsic Motivation and Dialogue

Ryan and Deci (2000) classified motivation into either intrinsic or extrinsic. Intrinsic motivation refers to doing something because it is inherently interesting or enjoyable, and extrinsic motivation refers to doing something because it leads to a separable outcome such as reward or recognition. Individuals can be motivated to achieve leaning goals intrinsically as well as extrinsically.
Existing evidence demonstrates that motivation effects the association between students interactions and perceived learning (Gomez, Wub, & Passerini, 2010; Xie, 2013). However, the results of a 2019 study indicated that only intrinsic motivation has a positive relationship with the use of self-regulated learning strategies as well as e-learners' learning outcomes (Eom, 2019).

Therefore, we focus on the effects of only intrinsic motivation on the use of self-regulated learning strategies as well as on SS dialogue and SI dialogue respectively. We posit that students' intrinsic motivation will be positively associated with dialog between students and between students and instructors.

H7: *Student intrinsic motivation in online courses is positively related to student-student dialogue.*
H9: *Student intrinsic motivation in online courses is positively related to student-instructor dialogue.*

Intrinsic Motivation and SRL Strategies

Motivation and SRL are inseparably related to each other. Education psychologists such as Pintrich, et al. (1991a) argue that motivation and SRL strategies cannot be separated. As noted by Zimmerman (2008), student motivation activates SRL processes when students seek to plan, organize, monitor, evaluate, and control their learning activities. Self-regulated learners are active contributors to their own learning process. Such learners display exceptional self-determination to achieve learning goals (Zimmerman, 1990). The word motivation is said to derive from a Latin word movere meaning 'to move,' and it is related to the direction and magnitude of human behavior (Dörnyei & Ushioda, 2013).
The ground-breaking study of Eom, Ashill, and Wen (2006) found no significant relationship between student motivation and perceived learning outcomes.
A later study by Eom (2019) explored the effects of both forms of motivation (intrinsic and extrinsic) on SRL activities and learning outcomes. Study findings demonstrated a non-significant association between student intrinsic motivation and both self-regulated learning activities and learning outcomes. In contrast, a

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direct and significant positive association between student intrinsic motivation and learning outcomes was established by Castillo-Merino and Serradell-López (2014). These studies suggest that instructors teaching online classes should integrate intellectually challenging assignment material that activates the SRL process. In light of these arguments, we hypothesized:

H8: *Student intrinsic motivation is positively related to student SRL activities.*

SS Dialog and SRL Strategies

Student-student dialogue/interactions may affect the choice and implementation of support seeking resource management and peer learning strategies. Butler and Winne (1995) contend that receiving feedback is a key antecedent of student SRL effectiveness, and they argue that research on student feedback and SRL should be tied. Feedback is essential to fostering learning goal attainment and is an outcome of monitoring. Other studies also confirm that learning is more effective when learners respond to feedback provided by peers, as well as the instructor (Bangert-Drowns et al., 1991; Butler & Winne, 1995). This external and visible feedback takes place using various interaction/dialogue mechanisms, including multimedia conferencing, e-mails, text messaging, and bulletin board systems.
Michailidis and others (2018) demonstrated that SRL is an important antecedent of students' self-awareness, which enhances student motivation and engagement through interaction analysis (IA). They studied the use of IA in asynchronous learning by studying Computer-Supported Collaborative Learning (CSCL) activities. Their findings showed that when student groups utilized blogs as a communication and information management tool, they improved collaborative learning. Thus:

H10: *Student-student dialogue in online courses is positively related to student SRL activities.*

SI Dialog and SRL Strategies

Unlike student-student dialogue/interactions that affect peer learning and help seeking SRL resource management strategies, SI dialogue/interactions may affect motivational processes as well as cognitive and metacognitive strategies. Empirical evidence suggests that self-regulation scaffolding increases levels of online learners' self-regulated learning skills, course participation, and learning performance (Song & Kim, 2020). Self-regulation scaffolding can be provided through the instructor or an intelligent conversational agent. Perry et al. (2002)

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observed that the instructor provides instrumental support to students through SI interactions in the form of questioning, clarifying, correcting, elaborating.
That SI interactions foster self-regulated learning activities and create opportunities for students to collaborate, share ideas, and brainstorm problem-solving strategies. Furthermore, they found that the instructor created intrinsically motivating learning contexts and it made students accountable for their learning and encourage them to focus on personal progress and view errors as opportunities to learn.
Therefore, we hypothesized:

H11: *Student - instructor dialogue in online courses is positively related to student SRL activities.*

Dialog and Learning Outcomes

The empirical study of the association between dialogue and student satisfaction and learning outcomes has fascinated scholars for many years (Eom, 2009; Grandzol & Grandzol, 2010; Kent, Laslo, & Rafaeli, 2016; Eom & Laouar, 2017). All of these studies can be broadly classified into two groups: the direct effects of student-instructor (SI) dialogue and student-student (SS) dialogue on learning outcomes and the role played by SI and SS dialogue as mediating variables (Eom, 2021). Previous literature (Moore, 1993; Vrasidas & McIsaac, 1999; Hirumi, 2002; Woo & Reeves, 2007) suggests a positive relationship between both forms of dialogue and student learning outcomes. Therefore:

H12: *Student – student dialogue in online courses is positively related to perceived learning outcomes.*
H14: *Student – instructor dialogue in online courses is positively related to perceived learning outcomes.*

SRL and Learning Outcomes

Zimmerman (1989) further argued that students' use of SRL strategies is positively correlated with greater academic functioning, and therefore, it is an important antecedent of learning outcomes. Zimmerman (1990) argues that self-regulated students (1) choose and implement SRL activities to attain positive learning outcomes, (2) systematically seek out feedback about their learning, and (3) initiate motivational procedures that are interdependent in nature.
Richardson, Abraham, & Bond (2012) showed that students' use of metacognition, time management, and effort regulation in a traditional non-online learning environment has a positive effect on student learning outcomes. In e-learning

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research, Pellas (2014) found that students' metacognitive self-regulation is positively associated with cognitive and emotional engagement. Thus:

H13: *Student SRL activities in online courses are positively related to perceived learning outcomes.*

Perceived Learning Outcomes and Satisfaction

The constructs of perceived student satisfaction and learning outcomes are widely discussed by Eom & Ashill (2018). Readers are recommended to visit the work of Bloom et al. (1956) for the origin of these two constructs. E-learners' learning outcomes (the perceived quality of the e-learning experience and the academic quality of the online class) and satisfaction (the disposition to take another online class and recommend the class instructor to other students) are identified as core dependent constructs in e-learning research (Zhao, Bandyopadhyay, & Bandyopadhyay, 2020; Eom, 2021; Yunusa & Umar, 2021). Thus, consistent with existing research, we hypothesized:

H15: *Student perceptions of learning outcomes in online courses are positively related to student satisfaction.*

METHODOLOGY

Survey Instrument Development and Measurement

The survey questionnaire consists of 41 items covering eight constructs. Appendix A presents each of the eight constructs and indicators (scale items) used to reflect each construct. All of the multi-item constructs were measured using five-point Likert scales and were measured with reflective indicators. Various control variables were also examined to provide a rigorous test of the hypothesized theoretical associations including age, gender, and study year.

The survey URL and instructions were emailed to 3,285 students taking online courses with no face-to-face meetings. delivered through the online program of a university in the Midwestern United States. We collected 382 valid, unduplicated responses from the survey (11.63% response rate). Of these responses, 10 incomplete responses with missing values were deleted. Appendix B summarizes the characteristics of the student sample of 372.

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Analytical Techniques

Partial Least Squares (PLS) was used to test the conceptual model. PLS is well-suited to operationalizing conceptual models in an applied setting (Edvardsson et al., 2000). The test of the measurement model included an assessment of internal consistency, as well as convergent and discriminant validity (Hair et al., 2013). In order to evaluate the structural model, the R^2 values for the endogenous constructs and the size, *t* statistics, and significance level of the structural path coefficients were computed using the bootstrap re-sampling procedure (5000 bootstrap samples) (Hair et al., 2017).

We also calculated the f^2 effect size, and the Stone–Geisser *Q*-square test for predictive relevance (Geisser, 1975; Stone, 1974). Cohen's (1988) measure of effect size for regression provides information on the practical significance of an effect. f^2 of 0.02, 0.15, and 0.35, similar to Cohen (1988) operational definitions for multiple regression, can be viewed as a gauge for whether a predictor variable has a small, medium, or large effect at the structural level.

As with all self-reported data, there is a potential for common method biases (CMB). However, CMB is unlikely to be a concern in our data for several reasons. First, Harman's one factor test (Harman, 1976) resulted in a 6-factor solution with the largest factor accounting for 36.43% of variance. Second, following the recommendations of Kock and Lynn (2012), we also conducted a full collinearity test. Results showed that variance inflation factor (VIF) scores were lower than 3.3 (Kock & Lynn, 2012) suggesting that our model is unlikely to be contaminated by common method bias. Finally, we acknowledge the findings of Fuller et al. (2016) who found that lower to moderate levels of common method variance do not inflate correlations.

RESULTS

Measurement Model Estimation

Table 1 summarizes the measurement model results. With one exception, all item loadings for the model constructs were near or above the 0.70 threshold (Chin, 1998) and were significant using bootstrapping. The one item measuring intrinsic motivation exhibited a loading of 0.57 and was dropped from further analysis (Hair et al., 2013).

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Table 1. Measurement Model Evaluation

Construct Items	Loading	t-value[a]	AVE	Internal Consistency[b]
Course Design			0.67	0.91
Design1	0.78	23.61		
Design2	0.81	28.31		
Design3	0.82	35.43		
Design4	0.83	42.85		
Design5	0.83	37.01		
Instructor Activities			0.75	0.94
Ins1	0.90	73.77		
Ins2	0.84	44.13		
Ins3	0.79	28.11		
Ins4	0.91	95.44		
Ins5	0.88	61.39		
Student-Student Dialogue			0.87	0.97
Diastu1	0.91	86.69		
Diastu2	0.96	196.74		
Diastu3	0.95	158.24		
Diastu4	0.91	68.89		
Instructor-Student Dialogue			0.80	0.94
Diaist1	0.89	69.22		
Diaist2	0.91	90.06		
Diaist3	0.86	55.64		
Diaist4	0.91	81.85		
Intrinsic Motivation			0.56	0.74
Intm1	0.66	9.00		
Intm2	0.86	22.86		
Self-regulated Learning Strategies			0.57	0.84
Sreg1	0.73	22.40		
Sreg2	0.79	28.63		
Sreg3	0.79	25.25		
Sreg4	0.71	16.53		
Learning Outcomes			0.77	0.93

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Out1	0.89	85.10		
Out2	0.90	83.26		
Out3	0.84	36.53		
Out4	0.87	58.36		
User Satisfaction			0.75	0.92
Sat1	0.85	45.21		
Sat2	0.92	79.54		
Sat3	0.74	25.52		
Sat4	0.94	129.95		

Notes.
[a] Bootstrapping results (N=5000)
[b] PLS uses an alternative measure to Cronbach's Alpha as a measure of internal consistency
IC: Internal consistency; **AVE**: average variance extracted, # All significant p <.01.

The composite reliability measure of internal consistency and average variance extracted (AVE) were used to assess construct reliability. Adequate internal consistency was demonstrated. All reliability measures met the 0.70 threshold (Gefen, Straub, and Boudreau, 2000)**.** AVE scores ranged from 0.56 to 0.87 and were thus above the minimum threshold of 0.5 (Fornell & Larcker, 1981). Discriminant validity was also demonstrated (see Table 4).

Table 2. Descriptive Statistics and Correlation among Construct Scores (square root of AVE in the diagonal).

Construct	1	2	3	4	5	6	7	8
1. Course design	**0.81**							
	0.74	**0.87**						
2. Instructor activities	0.69	0.76	**0.93**					
	0.50	0.51	0.57	**0.90**				
3. Student-student dialogue	0.25	0.21	0.26	0.24	**0.77**			
	0.20	0.09	0.11	0.24	0.53	**0.76**		
4. Instructor-student dialogue	0.69	0.70	0.71	0.62	0.31	0.22	**0.88**	
	0.75	0.77	0.76	0.54	0.25	0.16	0.80	**0.87**
	3.84	3.61	3.01	3.33	3.25	4.15	3.00	3.71

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5. Intrinsic motivation	0.86	1.04	1.01	1.09	0.79	0.57	1.09	1.10
6. Self-regulated learning strategies								
7. Learning Outcomes								
8. User Satisfaction								
Mean								
SD								

Notes. SD = Standard Deviation. The bold numbers on the diagonal are the square root of the Average Variance Extracted. Off-diagonal elements are correlations among constructs. All correlations are significant at the .05 level.

Measurement model estimation also used the heterotrait-monotrait ratio of correlations (HTMT) (Henseler et al., 2015; Voorhees et al., 2016). We calculated the HTMT criteria for each construct pair using the item correlations.
The calculations generated values between .06 and were below the criterion of 0.85 (Kline, 2011), thus providing further support for discriminant validity.
Structural Model Results

The structural model results using 5000 bootstrapping samples are summarized in Table 5. The structural model explained 74% of the variance in student-student dialogue, 31% of the variance in self-regulated learning activities, 31% of the variance in student-instructor dialogue, 58% of the variance in learning outcomes and 65% of the variance in student satisfaction.

Table 3. Tests of the Research Model and Hypotheses[a]

Hypothesized Relationships[a]	Standardised Coefficient	*t*-value[b]	Test Result
H1. CD→ SS Dialog	.12**	2.84	Supported
H2. CD→ SRL	.15*	2.22	Supported
H3. CD→ SI Dialog	.23***	3.49	Supported
H4. IA → SS Dialog	.76***	19.63	Supported
H5. IA→ SRL	-.18*	2.07	Not Supported
H6. IA → SI Dialog	.32***	5.32	Supported
H7. IM → SS Dialog	.04[ns]	1.24	Not Supported
H8. IM→ SRL	.49***	9.64	Supported
H9. IM → SI Dialog	.13**	3.07	Supported
H10. SS Dialog → SRL	-.02[ns]	0.25	Not Supported

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H11. SI Dialog → SRL	.15***	13.37	Supported
H12. SS Dialog → Out	.54***	13.60	Supported
H13. SRL → Out	.09*	2.51	Supported
H14. SI Dialogue → Out	.29***	6.70	Supported
H15. Out → Sat	.81***	48.89	Supported

Main Effects Model Evaluation Statistics:
R^2 for: SS Dialog = .74, SI Dialog = .31, SRL = .31, Out = .58 and Sat = .65
Communality *Q*-square values all above zero
With the exception of the IA-SRL-LO relationship, all indirect effects examining the impact of course design, instructor and intrinsic motivation on learning outcomes are significant at the .05 level. The indirect effect of student-student dialog on learning outcomes through self-regulatory learning is also non-significant at the .05 level

Notes.
[a] CD = Course Design, IA = Instructor Activities, IM = Intrinsic Motivation, SS Dialog = Student-Student Dialogue, SI Dialog = Student-Instructor Dialogue, SRL = Self-regulatory Learning Strategies, Out = Learning Outcomes and Sat = User Satisfaction.
[b] *t*-values corresponding to 2-tail tests at: t >1.96, p < .05; t > 2.58, p < .01; t > 3.29, p < .001. Significance levels: ***p < .001, **p < .01, *p < .05, ns not significant

Results of the Stone-Geisser test of predictive relevance in Table 6 (Geisser, 1975; Stone, 1974) and show that the research model has satisfactory predictive ability.

Table 4. Blindfolding Results

Construct	R^2	Omission distance = 10 Communality Q-square	Omission distance = 25 Communality Q-square
Course design	n/a	0.49	0.49
Instructor activities	n/a	0.61	0.61
Intrinsic motivation	n/a	0.05	0.05
Student-student dialogue	0.74	0.76	0.75
Student-instructor dialogue	0.31	0.65	0.64
Self-regulated learning strategies	0.31	0.28	0.29
Learning outcomes	0.58	0.59	0.59
User satisfaction	0.65	0.58	0.58

Note. n/a is not applicable

Thirteen of the fifteen hypothesized relationships were found to be statistically significant. Specifically, course design demonstrated a positive and significant effect on student-student dialogue (β = .12, p < .01) (f^2 effect size = .03), self-regulated learning (β = .15, p < .05) (f^2 effect size = .02) and student-instructor dialogue (β = .23, p < .001) (f^2 effect size = .02), thus supporting H1, H2 and H3. The relationship between instructor activities and student-student dialogue (β = .76, p < .001) (f^2 effect size = .90), self-regulated learning (β = -.18, p < .05) (f^2 effect size = .02) and student-instructor dialogue (β = .32, p < .001) (f^2 effect size = .07) were also significant. H4 and H6 were thus supported. H5 was rejected because the relationship was in the opposite direction to that hypothesized. H7 was also rejected. The relationship between intrinsic motivation and student-student dialogue was not significant (β = .04, p > .05). The relationship between intrinsic motivation and both self-regulated learning (β = .49, p < .001) (f^2 effect size = .31) and student-instructor dialogue (β = .13, p < .01) (f^2 effect size = .02) were significant, thus supporting H8 and H9. Student-student dialogue demonstrated a non-significant relationship with self-regulated learning (β = -.02, p > .05).
Thus, H10 was rejected. In contrast, the relationship between student-instructor dialogue and self-regulated learning was significant (β = .15, p < .001) (f^2 effect size = .02), thus supporting H11. All three direct antecedents of learning outcomes were also significant. Specifically, student-student dialogue (β = .54, p < .001) (f^2 effect size = .47), self-regulated learning (β = .09, p < .05) (f^2 effect size = .02) and student-instructor dialogue (β = .29, p < .001) (f^2 effect size = .13) demonstrated a positive and significant impact on learning outcomes. H12, H13 and H14 were thus supported. Lastly, learning outcomes showed a positive and significant effect on student satisfaction (β = .81, p < .001) (f^2 effect size = .67), thus supporting H15. We also tested the research model with and without the control variables.
Study findings showed that the direction and magnitude of the hypothesized relationships did not change.

DISCUSSION

The holistic e-learning success model presented in this study incorporates the interdependent (not independent) process nature of e-learning success. A recent bibliometric analysis of the adoption and use of e-learning in higher education (Ortega Azurduy, 2021) reported that Eom, Wen, & Ashill's study (2006) of the predictors of student perceived learning outcomes and satisfaction in university online education environments has spawned a plethora of studies identifying predictors of e-learning success. E-learning CSF research is now recognized as a mainstream distance learning research stream (Alqahtani & Rajkhan, 2020;

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Bhuasiri et al., 2012; Eom & Ashill, 2016; Selim, 2007; Yunusa & Umar, 2021). However, despite the increasing volume of e-learning empirical research on CSFs, the overwhelming majority of studies examine direct relationships between CSF variables and learning outcomes (Eom & Ashill, 2016; Eom et al., 2006; Sun et al., 2008; Yunusa & Umar, 2021). We argue that this research represents "a static view" of the interdependent learning process and "an outdated stimulus-response perspective"

Our holistic e-learning research model in Figure 3 asserts that examination of a single part cannot provide complete explanation of the whole without considering the process of how each part interacts and coordinates in a system of organized entity (Bertalanffy, 1972). Learning outcomes are the result of a series of on-going interaction and coordination among three input entities and three mediating entities (sub-activities of SS dialogue, SI dialogue, and SRL). Consequently, all results of direct modeling in prevailing empirical studies (Yunusa & Umar, 2021) lack theoretical robustness and limited practical application.

Each of the distance learning input constructs in our research affects, jointly or individually, self-regulated learning processes as well as dialogue/interaction processes, which in turn affect the output of distance learning systems (learning outcomes and student satisfaction. Study findings in part support a model of SRL that views SS dialogue and instructor feedback delivered through SI dialog as prime determinants of the SRL process (Butler & Winne, 1995). Butler and Winne proposed an elaborated model of SRL and two streams of research on SRL and feedback should be tightly linked together. In our research model, we directly linked SRL and feedback and argued that the SRL construct is pivotal to fostering more positive student learning outcomes. However, the results of our study indicate that both SS dialogue and SI dialogue are more important predictors of student learning outcomes than SRL (see Figure 4). Moreover, SS dialogue and SI dialogue represent important mediators in relationships between system inputs (course design, instructor activities and intrinsic motivation) and learning outcomes.

Study findings also enrich our understanding of how other constructs such as course design, intrinsic motivation, and student-instruct dialogue, despite the absence of the positive impact of both instructor involvement and student-student dialogue, jointly affect the self-regulated learning process, and its impact on student learning outcomes and satisfaction. SS dialogue is an important predictor of learning outcomes but has no significant impact on facilitating or promoting self-regulated learning activities, while SI dialogue is a significant predictor of both earning outcomes and self-regulated learning activities.

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Finally, our study provides additional empirical evidence that supports an earlier finding of Eom and Ashill (2018), which reported that learning outcomes have a direct association with the level of student satisfaction, which, in turn, is a significant predictor of the retention and dropout rates (Roberts & Styron, 2010; Schreiner, 2009).

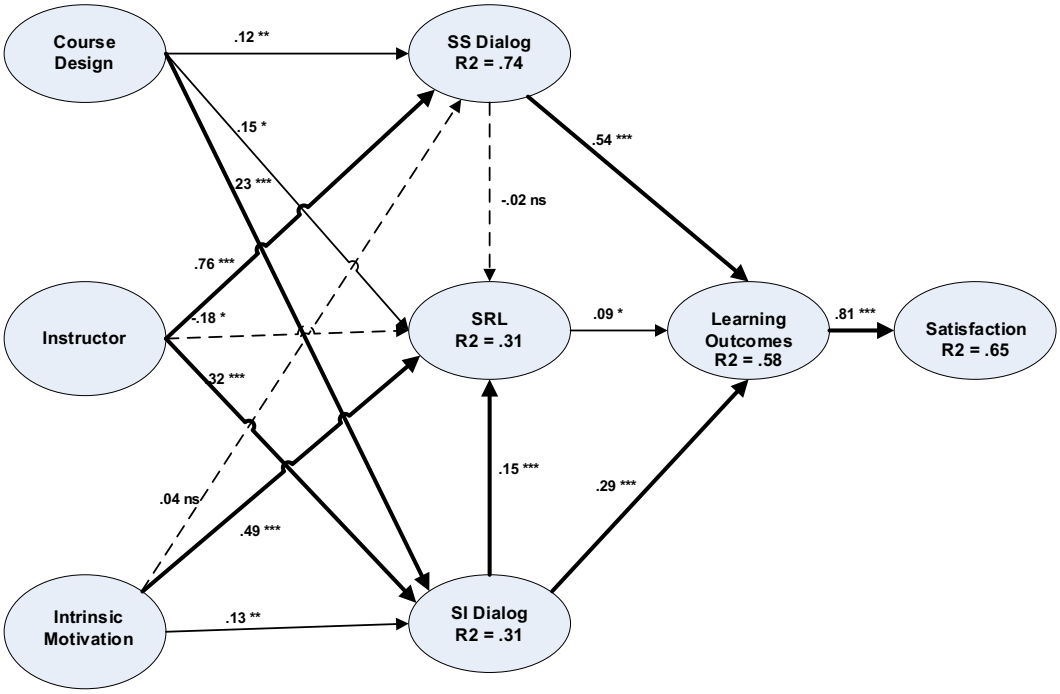

Figure 4: Structural model results

Notes.
Significance levels. ***p<.001, **p<.01, *p<.05, ns not significant
Dotted arrows indicate not supported test results

THEORETICAL AND PRACTICAL IMPLICATIONS

Previous studies examining e-learning success have ignored important learning process variables. This is a startling observation. Building a holistic e-learning success model should be a major goal of e-learning researchers. Our research addresses this void by examining the interdependent nature of the e-learning process in a model of inputs, processes and outputs. Specifically, our work adds to existing literature by studying how e-learning inputs and outputs interact with e-

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learning process variables (SRL, student-student interactions and student-instructor interactions). In addition, where learning process variables have been examined, studies have largely focused on examining direct relationships with output variables and have ignored antecedents. For example, Broadbent and Poon (2015) investigated the effect of each type of SRL strategy on learning outcomes (grade). Santhanam et al. (2008) also conducted a similar line of research on the examination of the direct impact of SRL strategies on learning outcomes.

On the other hand, Butler and Winne (1995) built an elevated model of SRL that involved a limited set of constructs, including SRL, feedback, cognitive engagement, etc. The current study represents a broadly framed holistic research model in which SRL is a part of the dynamic systems. Positive student learning outcomes are the outcome of a dynamic, holistic and systemic model of e-learning success. The heart of the empirically tested, holistic distance learning success model consists of the self-regulatory learning process component and the dialogical process component. These two components perform pivotal functions to facilitate and generate more positive student learning outcomes and user satisfaction.

Our findings show that e-learning systems should consider a dynamic collection of interdependent sub-entities that interact together (Eom and Ashill 2018). A key finding to emerge from our review of the extant literature on online critical success factors revealed that only 15% of the studies identified by Yunusa and Umar (2021) include learning process variables. Eighty five percent of e-learning empirical studies have failed to examine the interrelations/interactions of between e-learning inputs and learning process variables. Considering this finding, we argue that the majority of e-learning studies report sub-optimal results. Therefore, we suggest that future studies must include the process variables to produce more meaningful results, theoretically as well as practically.

LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

Although our research advances understanding of the interdependent learning process in e-learning systems, we acknowledge several limitations. First, our sample consisted of online students of one institution in one geographical area in the United States which limits generalization. Future research should test the model using samples from other online programs at other universities. Second, the research design is cross-sectional which means study cannot make claims about causality. Adopting a longitudinal research design would overcome this limitation. Future research could investigate the role of mobile technology in relationships between dialogues, SRL activities, student learning outcomes, and satisfaction. Specifically, the role of digital technologies and mobile technology in facilitating

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dialogue among students and between students and instructors and how these dialogues impact self-regulatory learning processes (motivational, metacognitive and behavioral), and enhance e-learning outcomes and student satisfaction. A recent literature review by Pinto and Leite (2020) identified ten most frequently used digital technologies by students in higher education: learning management systems (LMS), publish and share tools, collaborative systems, social networking tools, interpersonal communication tools, content aggregation tools, 3D virtual world, assessment and feedback tools, mobile tools, and ICTs. Mobile technologies will continue to create opportunities for the delivery of e-learning (Eom & Laouar, 2020) and provide new tools to increase student learning outcomes and enhance the e-learning experience (Basak et al., 2018; Grand-Clement et al., 2017).

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APPENDIX A: SURVEY QUESTIONS

1. What is your age?
2. What is your gender?
3. What is your year in school?
4. What is your area of study?
5. Are/were you enrolled in an online course at this University? If so, please give feedback of just ONE online class you are/were enrolled. Write course number and title of that course.

Student Motivation

6. In an online class like this, I prefer class material that really challenges me so I can learn new things [Intm1, adapted from MSLQ (Pintrich et al., 1991)]
7. When I have the opportunity in this online class to choose class assignments, I

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choose the assignments that I can learn from even if they don't guarantee a good grade
[Intm2, adapted from MSLQ (Pintrich et al., 1991)]
8. I do all that I can do to make my assignments turn out perfectly [Intm3, adapted from AIM (Shia, 1998)]
9. I work hard to get a good grade even when I don't like a class [Extm1, adapted from MSLQ (Pintrich et al., 1991))]
10. I want to do well in this online class because it is important to show my ability to my family, parents, or others [Extm2, adapted from MSLQ (Pintrich et al., 1991)]
11. I like to be one of the most recognized students in a class [Extm3, (Shia, 1998)]

Instructor activities [Adopted from (Eom et al., 2006)]
12. The instructor was actively involved in facilitating (teaching) this online class (Ins1).
13. The instructor in this online class provided timely helpful feedback on assignments, exams,
or projects (Ins2).
14. The instructor in this online class stimulated students to intellectual effort beyond that required by face-to-face classes (Ins3).
15. The instructor cared about my individual learning in this class (Ins4).
16. The instructor in this online class was responsive to student concerns (Ins5).

Dialogue with students [Adopted from (Eom & Ashill, 2016)]
17. I had positive and constructive interactions with other students frequently in this
online class (Diastu1).
18. In this online class, the level of positive and constructive interactions between students was high (Diastu2).
19. In this online class, I learned more from my fellow students than in other classes at this university (Diastu3).
20. The positive and constructive interactions between students in this online class helped me
improve the quality of the learning outcomes (Diastu4).

Dialogue with the Instructors [Adopted from (Eom & Ashill, 2016)]

21. I had positive and constructive interactions with the instructor frequently in this
online class (Diaist1).

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22. The level of positive and constructive interactions between the instructor and students was high in this online class . (Diaist2).
23. The positive and constructive interactions between the instructor and students in this online class helped me improve the quality of the learning outcomes (Diaist3).
24. Positive and constructive interactions between students and the instructor was an important learning component (Diaist4).

Course design quality /Structure [Self developed based on categories 1-4 of the QM standards]

25. The course objectives and procedures of this online class were clearly Communicated (Design1) .
26. The structure of the modules of this online class was well organized into logical and understandable components (Design2) .
27. The course materials of this online class were interesting and stimulated my desire to learn (Design3) .
28. The course materials of this online class supplied me with an effective range of challenges (Design4).
29. Student grading components such as assignments, projects, and exams were related to learning objectives of the class (Design5) .

Self-regulated learning

30. In the beginning, I set my goals and plan accordingly according to what I need to do to make desired learning outcomes [Sreg1, adapted from MSLQ (Pintrich et al., 1991)]
31. Even when study materials are dull and uninteresting, I keep working until I finish [Sreg2, adapted from MSLQ (Pintrich et al., 1991)]
32. I keep up with my grades in each course, and if one seems to be sliding I'll stress that class more in my studying [Sreg3, adapted from the College Student Inventory (Stratil, 1988)]
33. When I study for a test, I try to put together the information from class notes and from the book [Sreg4, adapted from MSLQ (Pintrich et al., 1991)]

Learning Outcomes [Adopted from (Eom et al., 2006)]

34. The academic quality of this online class is on par with face-to-face classes I've taken (Out1).
35. I have learned as much from this online class as I might have from a face-to-face version of the course (Out2).
36. I learn more in online classes than in face-to-face classes (Out3).
37. The quality of the learning experience in online classes is better than in face-to-face classes (Out4).

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User Satisfaction [Adopted from (Eom et al., 2006)]
38. I would recommend this instructor to other students (Sat1).
39. I would recommend this online class to other students (Sat2).
40. I would take an online class at this university again in the future (Sat3).
41. I was very satisfied with this online class (Sat4).

Note
Each question includes item names used in table 3.

Data Availability Statements

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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