



Motivation in online learning: Testing a model of self-determination theory

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ABSTRACT

As high attrition rates becomes a pressing issue of online learning and a major concern of online educators, it is important to investigate online learner motivation, including its antecedents and outcomes. Drawing on Deci and Ryan's self-determination theory, this study proposed and tested a model for online learner motivation in two online certificate programs ($N = 262$). Results from structural equation modeling provided evidence for the mediating effect of need satisfaction between contextual support and motivation/self-determination; however, motivation/self-determination failed to predict learning outcomes. Additionally, this study supported SDT's main theorizing that intrinsic motivation, extrinsic motivation, and amotivation are distinctive constructs, and found that the direct effect and indirect effects of contextual support exerted opposite impacts on learning outcomes. Implications for online learner support were discussed.

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1. Introduction

In the field of education, motivation has been identified as a critical factor affecting learning (Lim, 2004). Past studies have shown that learner motivation associates with a variety of important learning consequences such as persistence (Vallerand & Bissonnette, 1992), retention (Lepper & Cordova, 1992), achievement (Eccles et al., 1993), and course satisfaction (Fujita-Starck & Thompson, 1994). Research evidence suggests that motivation should be taken seriously in the online learning environment. An online learning environment refers to any setting that “uses the Internet to deliver some form of instruction to learners separated by time, distance, or both” (Dempsey & Van Eck, 2002, p. 283). The Sloan Consortium (Allen & Seaman, 2006) further classified web-based learning environments by the proportion of content and activities delivered online: (1) *web facilitated* courses (1–29%); (2) *blended/hybrid* courses (30–79%), and (3) *online* courses (80+%). This study focuses on higher education courses with more than 80% of content and activities delivered online.

Despite its significance on learning consequences, motivation has not received commensurate attention in online learning (Jones & Issroff, 2005; Miltiadou & Savenye, 2003). One possible reason is that educators used to focus on the student cognition while ignoring affective, socio-emotional processes (Kreijns, Kirschner, & Jochems, 2003). As high attrition rates – a negative indicator of motivation – becomes a pressing issue of online learning and a major concern of online educators (Carr, 2000; Clark, 2003), it is

important to investigate online learner motivation, including its antecedents and outcomes. Miltiadou and Savenye, in a literature review article, examined six motivation constructs and discussed their implications for online learning. Miltiadou and Savenye concluded that, in order to reduce attrition rates and ensure student success, more empirical studies are needed to test motivation theories and constructs in the online learning environment.

In line with Miltiadou and Savenye's (2003) statement, Gabrielle (2003) applied Keller's (1983) ARCS (*attention, relevance, confidence, and satisfaction*) model to design technology-based instructional strategies for online students. Results showed that the ARCS-based learning support was effective in promoting students' motivation, achievement, and self-directed learning. Lee (2002) investigated constructs of *self-efficacy* (Bandura, 1982) and *task value* (Eccles, 1983) and found that the two constructs were significant predictors of online students' satisfaction and performance. Gabrielle's and Lee's theory-based studies have provided valuable insights for instructional design and facilitation. Therefore, evidence has emerged that warrants investigation into the ways a student determines the role of motivation for himself or herself in the online learning environment.

A motivation theory that deserves thorough investigation in online learning contexts is Deci and Ryan's (1985, 2002) *self-determination theory* (SDT), which was described by Pintrich and Schunk (2002) as “one of the most comprehensive and empirically supported theories of motivation available today” (p. 257). Self-determination theory has been successfully applied to a variety of settings, including physical education (Standage, Duda, & Ntoumanis, 2005), politics (Losier, Perreault, Koestner, & Vallerand, 2001), health care (Williams et al., 2006), religion (Neyrinck, Lens, & Vansteenkiste, 2005), and general education (Niemic et al.,

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2006). However, the tenability of self-determination theory has not been sufficiently established in online learning (Chen, 2007). With a few exceptions, such as Xie, Debacker, and Ferguson (2006) who applied SDT to examine online discussion, and Roca and Gagné (2008) who examined e-learning continuance intention in the workplace, studies that apply SDT in the online learning environment are barely found.

Mullen and Tallent-Runnels (2006), in their study of student perception, found that students in online classes and in face-to-face settings perceived classroom environments and instructors' support and demands differently. The differences in perception were related to students' motivation, course satisfaction, and learning. Mullen and Tallent-Runnels concluded that "instructors should be careful not to assume that teaching the same in both environments will create similar results" (p. 264). In the same vein, researchers may not assert that motivation theories established in traditional face-to-face classrooms and other settings can be directly transplanted to the online learning environment without substantiation, because the characteristics (e.g., flexibility, accessibility, and computer-mediated communications) of the learning environment and the dynamics of student motivation are different in online settings. Therefore, a thorough investigation of online learners' motivation, including testing self-determination theory in the online learning environment is necessary. The following section describes the central tenets of SDT, followed by a discussion of why SDT may serve as an appropriate framework for addressing learner motivation in online learning.

1.1. Self-determination theory

Self-determination theory (Deci & Ryan, 1985, 2002) is a general theory of motivation that purports to systematically explicate the dynamics of human needs, motivation, and well-being within the immediate social context. The term *self-determination*, as defined by Deci and Ryan (1985), is "a quality of human functioning that involves the experience of choice. [It is] the capacity to choose and have those choices . . . be the determinants of one's actions" (p. 38). Self-determination theory proffers that humans have three universal and basic needs: *autonomy* (a sense of control and agency), *competency* (feeling competent with tasks and activities), and *relatedness* (feeling included or affiliated with others). Individuals experience an elaborated sense of self and achieve a better psychological well-being through the satisfaction of the three basic needs. Conversely, the deprivation of the three basic needs produces highly fragmented, reactive, or alienated selves.

Another central tenet of SDT is that as opposed to other motivational theories (e.g., Bandura's social cognitive theory) that treat human motivation as a monolithic construct, SDT theorizes human

motivation into three main categories: *intrinsic motivation* (doing something because it is enjoyable, optimally challenging, or aesthetically pleasing), *extrinsic motivation* (doing something because it leads to a separable outcome) and *amotivation* (the state of lacking intention to act). Extrinsic motivation is further categorized into four stages/types: (1) *external regulation*, (2) *introjected regulation*, (3) *identified regulation*, and (4) *integrated regulation*. The above-mentioned types of motivation, as shown in Fig. 1 (adopted from Ryan & Deci, 2000, p. 72), are loaded on a continuum of self-determination. Amotivation represents the least self-determined type of motivation while intrinsic motivation signifies the most self-determined type of motivation. According to SDT, self-determined types of motivation (intrinsic motivation and identified regulation) may lead to positive outcomes while nonself-determined types of motivation (amotivation, external and introjected regulations) may result in negative outcomes (Deci & Ryan, 1991). Based on the self-determination continuum, Connell and Ryan (1985) developed a technique to calculate "the relative autonomy index, RAI," a single score weighed by different types of motivation to represent individuals' degree of self-determination.

Contextual support serves as a key concept in self-determination theory. Individuals absorb "nutrients" from social interactions that provide support for autonomy, competence, and relatedness, the three basic needs. With basic needs satisfied, individuals become more assured and self-determined, and in turn achieve enhanced psychological well-being.

1.2. Self-determination theory and motivation in online learning

A number of factors suggest that SDT is an appropriate framework for addressing motivation in the online learning environment. First, SDT may serve as a theoretical framework that integrates issues in online learning. Self-determination theory addresses autonomy, relatedness, and competency as determinants of motivation. The three constructs correspond to features of online learning such as flexible learning (Moore, 1993), computer-mediated communication and social interaction (Gunawardena, 1995), and challenges for learning technical skills (Howland & Moore, 2002). The notion of contextual support is especially valuable, as online learners need a variety of support from instructors, peers, administrators, and technical support personnel (Mills, 2003; Tait, 2000, 2003). Past experimental research indicates that self-determination theory predicts a variety of learning outcomes, including performance, persistence, and course satisfaction (Deci & Ryan, 1985, for a review). Self-determination theory has the potential to address learning problems such as student attrition in the online learning environment.

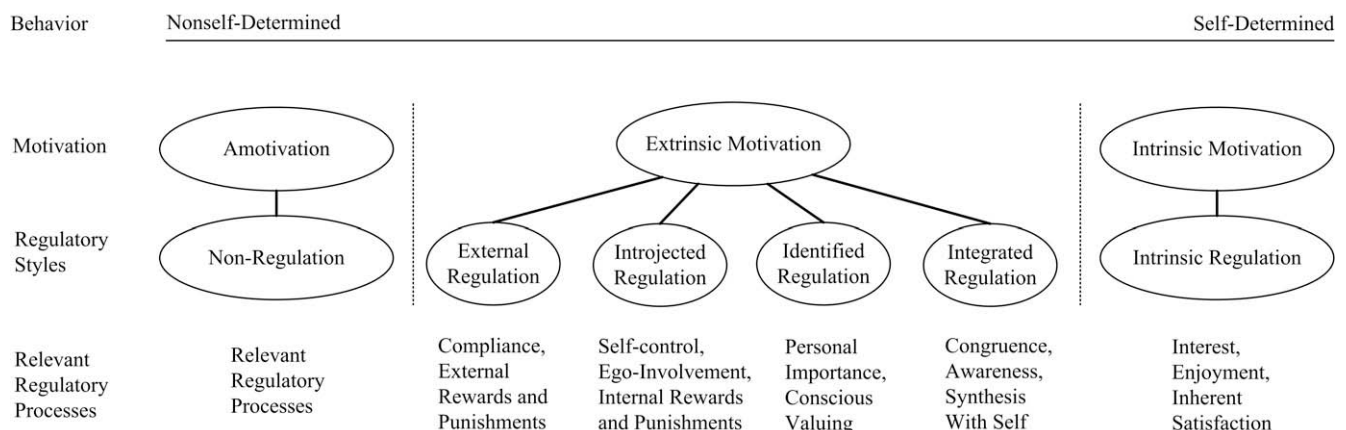


Fig. 1. The self-determination continuum.

Another advantage of SDT is that it generates prescriptions for motivational enhancement in addition to describing individuals' motivation process. Self-determination theory-based studies have identified strategies that foster individual self-determination and motivation. Reeve and Jang (2006), for example, validated eight types of teacher's autonomy-supportive behaviors, such as allowing choice, providing rationale, and offering informational feedback that enhanced students' perceived autonomy, engagement, and performance. The SDT-based strategies may be applicable to a variety of educational settings including the online learning environment.

Self-determination theory emphasizes the importance of the social context, which aligns with the emerging trend of a situated view of motivation. Jarvela (2001) said, "Motivation is no longer a separate variable or a distinct factor, which can be applied in explanation of an individual's readiness to act or learn – but it is a reflective of the social and cultural environment" (p. 4). Self-determination theory purports to explicate the dynamics of human need, motivation, and well-being within the immediate social context. The SDT framework enables researchers to examine the mechanism through which contextual factors, such as instructor behaviors or social interactions, enhance or dampen motivation of online learners. The SDT framework also helps instructors and instructional designers identify better strategies of online learner support.

1.3. Select study that applies self-determination theory in an online learning environment

Self-determination theory has been largely overlooked in online learning research; particularly, studies aiming to validate SDT in online learning contexts are barely found. One that can be retrieved is a recent study conducted by Xie et al. (2006). The authors applied SDT to examine student motivation in an online discussion board. Using a mixed-methods design, Xie et al. investigated students' *perceived interest* (intrinsic motivation), *value* (extrinsic motivation), *choice* (perceived autonomy), *course engagement* (as measured by the numbers of login and discussion board postings), and *attitudes* toward the class. Correlation analyses revealed that the three SDT-based indicators (perceived interest, value, and

choice) positively correlated with online students' course attitude and engagement. Additionally, results from interviews and open-ended questions indicated that instructor participation, guidance, and feedback were critical to online students' motivation. Having a clear rationale was also found to help online students perceive the value of discussion activities, supporting self-determination theory. However, the Xie et al. study revealed that perceived competency did not have significant correlations with engagement and course attitude, which was at odds with SDT.

The Xie et al. (2006) study represented preliminary success in applying SDT to the online learning environment. However, the interrelations among contextual support, need satisfaction, motivation, and learning outcomes remains unexplored in the Xie et al. study. Furthermore, while SDT addresses that perceived autonomy, relatedness, and competency are three determinants of motivation and well-being, the Xie et al. study did not assess the effects of perceived relatedness. Lastly, although the authors concluded that online learners' perceived competency failed to interpret learning outcomes, the "competency" defined in their study seems incomplete. The authors merely used computer/Internet skills as the competency measure; however, for online discussion, competency may also include other aspects such as communication and metacognitive skills. Excluding these dimensions are likely to yield skewed results. Given these limitations, the results of the Xie et al. study seems insufficient to draw conclusions about SDT's tenability. More studies are warranted to validate SDT in the online learning environment.

1.4. The research model

Drawing on SDT, we proposed a model for online learner motivation (see Fig. 2). In our proposed model, *contextual support* represents an exogenous latent variable measured by autonomy support and competency support. It is worth noting that relatedness support was not included in our model because autonomy and competency supports are more directly addressed by SDT (Ryan & Deci, 2002). In the literature, most SDT-based studies measured perceived relatedness rather than relatedness support.

Online students' overall satisfaction of basic needs was presented by an endogenous latent variable: *need satisfaction*, with

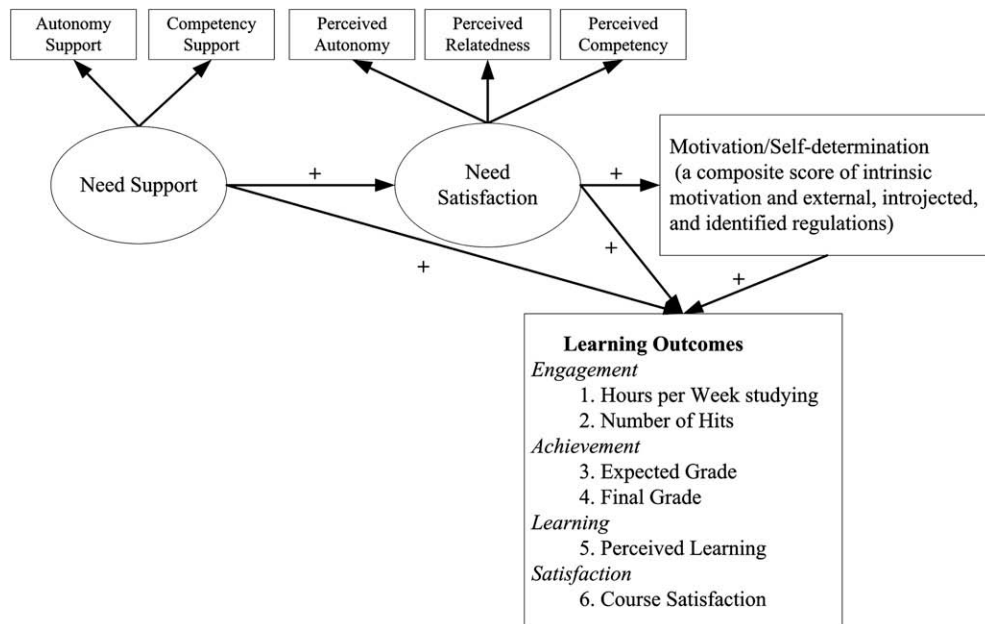


Fig. 2. The hypothesized SDT model for online learner motivation.

perceived autonomy, perceived competency and perceived relatedness as indicators. SDT posits that individuals' motivation/self-determination is mediated by their satisfactions of basic needs. The mediating effect has been supported by empirical studies, for example, [Standage et al. \(2005\)](#) found that students who perceived a need-supporting environment experienced greater levels of need satisfaction. Need satisfaction in turn predicted intrinsic motivation, a type of self-determined motivation. Therefore, we hypothesized that contextual support positively predicts need satisfaction; need satisfaction, in turn, positively predicts self-determination.

Self-determination theory proffers that autonomous/self-determined types of motivation lead to positive outcomes while non-self-determined types of motivation result in negative outcomes. Studies ([Grolnick & Ryan, 1987](#); [Grolnick & Ryan, 1989](#); [Grolnick, Ryan, & Deci, 1991](#)) have shown that higher self-determination/RAI positively predicted students' engagement, affect, conceptual learning, and effective coping strategies. Additionally, [Roca and Gagné \(2008\)](#) found a positive correlation between self-determination and work satisfaction, and [Vallerand and Bissonnette \(1992\)](#) found persistent students more self-determined than drop-out students. As such, we hypothesized that online learners' self-determination positively predicts learning outcomes.

Two predictions were explored in the model to better understand the dynamics and interrelationship among motivational antecedents and learning outcomes. In addition to the main causal chain "contextual support → need satisfaction → self-determination → learning outcome," paths from contextual support to learning outcome and from need satisfaction to learning outcome were drawn in the model to assess the direct impact of contextual support and need satisfaction on learning outcomes. In the SDT literature, [Black and Deci \(2000\)](#) found that instructors' autonomy support directly and positively predicted student performance for those with initially low self-determination. [Deci et al. \(2001\)](#) found that need satisfaction directly and positively predicted engagement, general self-esteem, and reduced anxiety. Hence, we hypothesized that contextual support and need satisfaction both positively predict learning outcomes.

In this study, we assessed six learning outcomes: hours per week studying, number of hits, expected grade, final grade, perceived learning, and course satisfaction. One learning outcome was evaluated at a time; therefore, there are six parallel models in this study.

2. Method

2.1. Context and participants

The context for this study are two online certificate programs designed for individuals who do not hold a renewable teaching certificate to become a Special Education General Curriculum Consultative P-12 teacher. Generally, it takes seven consecutive semesters to complete the programs. Students must attend the on-campus program advising and technology orientation, and finish required fully-online courses. The two online programs share similar course work. The online courses are hosted on the WebCT course management system at a large research university in the southeastern United States, and utilize a live chat system (Wimba) and a variety of software, such as Microsoft Office, Adobe Reader, and Real Player to facilitate teaching and learning.

Two hundred and sixty-seven (267) online students participated in this study. The majority of participants were female (78.1%). Participants' age ranged from 19 to 65, with the average of 37.80 (SD = 10.23) years old. The participants were recruited from the five courses offered in summer 2008; each course had several instructors teaching a specific section. In the online

courses, students read content modules, completed module-related quizzes, and participated in synchronous and asynchronous online discussions. Students were also required to submit assignments online, and to complete a final project such as individualized education program (IEP) at the end of the summer term. The instructors facilitated their online courses by posting important announcements, guiding assigned readings and asynchronous discussions, answering student questions, and leading synchronous chat sessions. Two teaching assistants were assigned in each course to help grading and course routines. The two online programs shared a technical support staff to lead technology orientations for new students and troubleshoot technical problems. When students needed technical help, they sent requests by filling out the online support request form. Students always got support responses within 24 h.

2.2. Procedures

Preceding the collection of data, consent to conduct the study was issued from the Human Subjects Office of the university where participants were recruited. The researcher also sought and obtained support from the administrators' and instructors to encourage student participation. Because students are geographically dispersed, a seven-point, Likert-type survey (see [Fig. 3](#) for a snapshot) along with the consent form were developed and distributed online. The survey, which takes approximately 15 min to complete, includes all the variables to the interest of this study (demographics, motivation, need support, need satisfaction, and learning outcomes, see the *measures* section for details). Data collection started during the next to last week of the summer term, and it lasted for 10 days. Concerning that students may have enrolled in more than one online courses in summer 2008, participants were asked to target one course and use it to answer the survey. Links to the surveys were provided on the WebCT course menu for students' easy access. Objective data, including students' final grades and the numbers of hits were gathered separately through the assistance of the program secretary.

2.3. Measures

This study collected four categories of variables aside from demographic data: (1) Contextual support, (2) Need satisfaction, (3) Motivation, and (4) Learning outcome. Details of the instruments are described below:

2.3.1. Contextual support

To measure instructors' autonomy support, we used [Williams & Deci's \(1996\)](#) Learning Climate Questionnaire (LCQ). The original LCQ scale has 15 items. For the sake of brevity, we selected nine items that are more tied to the autonomy construct (e.g., "I feel that my instructor provides me choices and options"), or those that include concrete actions of instructors (e.g., "My instructor tries to understand how I see things before suggesting a new way to do things"). A reliability test (based on the data of this study) on the nine-item Autonomy Support Scale revealed a satisfactory internal consistency ($\alpha = .95$).

Regarding competency support, in view of the lack of questionnaires available for online learning contexts, we created a Competency Support Scale that was meant to be context-specific and quality ensured. The scale creation process started with two open-ended questions asking students' opinions about online learning competencies as well as the types of support that they needed. Responses from online students were coded and then developed into 15 items. Item analysis eliminated one question that failed to differentiate low and high scores. The final Competency Support Scale contains 15 items, of which a sample

The following sections contain items about your learning experiences in a [redacted] or [redacted] course. This survey is confidential. Please be honest and candid. Read the items carefully and choose the option that is closest to your CURRENT feelings. Please use the following scale as a guide:

1	2	3	4	5	6	7
not at all true		somewhat true			very true	

SECTION 2: Reasons for Enrollment

I enrolled in "this" online course...

13. Because with my current degree I would not find a high-paying job later on.

1 not at all true 2 3 4 5 6 7 very true

14. Because I experience pleasure and satisfaction while learning new things.

1 not at all true 2 3 4 5 6 7 very true

15. Because I think that this online course will help me better prepare for the career I have chosen.

1 not at all true 2 3 4 5 6 7 very true

16. For the positive feeling I experience when I am communicating my own ideas to others.

1 not at all true 2 3 4 5 6 7 very true

17. Honestly, I don't know; I really feel that I am wasting my time in this class.

1 not at all true 2 3 4 5 6 7 very true

Fig. 3. A snapshot of the online survey.

is: "I usually receive clear directions about how to finish my class activities and projects." Based on the data of this study, the scale yielded a satisfactory internal consistency ($\alpha = .93$).

2.3.2. Need satisfaction

Three previously validated questionnaires were used to assess online students' perceived autonomy, relatedness, and competence. The six-item Perceived Autonomy Scale was adapted from the Standage et al.'s (2005) study. The original scale has a stem "In this PE class..." and items such as "I feel a certain freedom of action." In this study, the stem "in this online course" has been merged into each item. A sample item is "I feel a certain freedom of action in this online course." A reliability test on the Perceived Autonomy Scale revealed an acceptable internal consistency ($\alpha = .69$) based on the data of this study.

To assess participants' perceived relatedness, South's (2006) Sense of Community Instrument was adopted. The instrument was designed for an online continuing education program, similar to the context of this study. A total of nine items were extracted from the trust, interactivity, and shared values subscales, of which a sample item is "I feel that my classmates care about each other." Based on the data of this study, the nine-item Perceived Relatedness Scale revealed a satisfactory internal consistency ($\alpha = .86$).

Perceived competency was measured by the Perceived Competence subscale of the Intrinsic Motivation Inventory (IMI, McAuley, Duncan, & Tammen, 1989). The Perceived Competence subscale contains six items. The items have been slightly modified to fit the research context, for instance, the original item "I am satisfied with my performance *at this task*" has been changed to "I am satisfied with my performance *in this online course*." A reliability test revealed a satisfactory internal consistency ($\alpha = .86$).

2.3.3. Motivation

Vallerand et al.'s (1992) Academic Motivation Scale (AMS) was applied to measure student motivation. Developed based on self-determination theory, the AMS is made up of seven subscales each contains 4 items, for which intrinsic motivation has been further categorized into intrinsic motivation to know, to accomplish, and to experience stimulation, totaling three subscales with twelve items. For the purpose of this study, all of the twelve items were treated as presenting a single construct: intrinsic motivation. Amotivation and three types of extrinsic motivation – external, introjected, and identified regulations – were also measured by the Academic Motivation Scale. The items have been slightly modified to fit the research context, for instance, the original item "Because I think that *a college education* will help me better prepare for the career I have chosen"

has been changed to “Because I think that *this online class* will help me better prepare for the career I have chosen.” More sample items are available in Fig. 3. A reliability test indicated that AMS has satisfactory internal consistency across subscales, ranging from .77 to .96.

Distinct from the other scales in this study that only measure a single construct (e.g., autonomy support, perceived competency, and course satisfaction), the AMS measures five types of motivation. Therefore, in order to ensure rigor, we further examined the construct (factorial) validity of the Academic Motivation Scale. We performed an exploratory factor analysis (using the principal component method with varimax rotation) on the 28 items. Five factors (eigenvalue >1) appeared as a result. As shown in Table 1, the item grouping of the five factors appeared exactly the same as the original AMS scale. Moreover, the factor loadings for all 28 items exceeded .40. This result not only provides evidence for AMS' construct/factorial validity, but also support SDT's main postulate that intrinsic motivation (IM), extrinsic motivation (EM, including external, introjected, and identified regulations), and amotivation (AM) are distinct constructs.

Upon obtaining each participant's motivation profile, the Relative Autonomy Index was calculated to represent online students' degree of self-determination. The RAI formula (Grolnick & Ryan, 1987) is presented by:

$$\text{External} * (-2) + \text{Introjected} * (-1) + \text{Identified} * (1) + \text{Intrinsic} * (2).$$

2.3.4. Learning outcomes

This study assessed six learning outcomes in four categories: (1) engagement, (2) achievement, (3) perceived learning, and (4) course satisfaction. Student engagement was assessed using both

Table 1
Factor loadings of the Academic Motivation Scale Items.

Item	Varimax rotated factor loadings				
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
IM 4	<u>.83</u>	.15	.20	.00	.13
IM 3	<u>.82</u>	.31	-.04	.03	.00
IM 2	<u>.78</u>	.11	.25	-.13	.15
IM 6	<u>.78</u>	.30	.16	-.15	.22
IM 5	<u>.77</u>	.09	.19	-.28	.25
IM 1	<u>.76</u>	-.04	.25	-.17	.20
IM 11	<u>.75</u>	.27	.22	-.12	.12
IM 7	<u>.73</u>	.24	.12	.02	.32
IM 12	<u>.72</u>	.28	.20	-.13	.32
IM 8	<u>.72</u>	.26	.16	.00	.10
IM 9	<u>.68</u>	.36	.16	-.28	.25
IM 10	<u>.67</u>	.26	-.03	.13	.41
INTRO 3	.35	<u>.78</u>	.22	.02	.18
INTRO 2	.38	<u>.71</u>	.25	.16	.5
INTRO 1	.46	<u>.67</u>	.12	-.09	.12
INTRO 4	.46	<u>.60</u>	.28	-.22	.26
EXT 4	.05	.34	<u>.73</u>	.07	.20
EXT 1	.18	-.05	<u>.71</u>	-.05	.02
EXT 2	.29	.26	<u>.69</u>	.06	.16
EXT 3	.26	.38	<u>.68</u>	.07	.13
AM 4	-.08	-.01	.04	<u>.86</u>	.02
AM 3	-.06	.09	-.16	<u>.86</u>	-.16
AM 2	.00	-.08	.04	<u>.75</u>	-.17
AM 1	-.19	.00	.10	<u>.68</u>	-.04
IDEN 4	.35	.18	.00	-.12	<u>.77</u>
IDEN 1	.33	.05	.13	-.16	<u>.67</u>
IDEN 3	.17	.24	.34	-.15	<u>.63</u>
IDEN 2	.24	-.02	.49	-.10	<u>.56</u>

Note: IM, intrinsic motivation; INTRO, introjected regulation; EXT, external regulation; AM, amotivation; IDEN, identified regulation.

self-report and objective measures. The self-report measure refers to a questionnaire item asking “How many hours per week did you devote to this course?” The objective measure includes online students' number of hits, referring to the number of times that students accessed WebCT content pages. The number of hits data was gathered through the “track student” function of WebCT.

Student achievement was assessed using both self-report and objective measures. The self-report measure is presented by students' expected grade, gathered from a questionnaire item asking “What grade do you expect to get for this course?” Possible responses for the expected grade item include A, B, C, D, F, and incomplete. The objective measure includes online students' final grade, which was loaded on a 0–100 scale.

Participants' perceived learning was measured using Alavi's (1994) six-item Perceived Learning Scale, of which a sample item is “I learned to inter-relate the important issues in the course material.” The Perceived Learning Scale has been adopted by many studies to measure students' self-perception of knowledge and skills gained from a course, either in face-to-face or online contexts. The Perceived Learning Scale has yielded a high internal consistency ($\alpha = .95$) based on the data of this study.

Hao's (2004) Online Course Satisfaction Survey was adopted in this study to evaluate “the general course satisfaction of the online students” (Hao, 2004, p. 47). The survey has ten items, of which a sample is: “Overall, I am satisfied with this course.” The items have been modified to fit the research context. A reliability test on the Course Satisfaction Survey revealed a satisfactory internal consistency ($\alpha = .93$).

2.4. Data analysis

Before conducting formal analyses, datasets were screened and modified for missing values, outliers, and normality. The screening process indicated that no systematic missing pattern was detected, and the maximum missing rate across variables was 2.6%. The expectation maximization (EM) algorithm was used in this study to impute missing values, for it provides unbiased estimates when the data are missing at random (Schafer & Graham, 2002).

Outliers were screened by examining standardized scores of each variable. Because the sample size was larger than 200, this study applied the criteria that any case with a z score greater than |3.5| be deemed an outlier. Five cases were identified as outliers. A preliminary data analysis indicated that the results did not change significantly after deleting outliers; therefore, the outliers were removed from the dataset to avoid possible interference with the results.

Normality was screened by examining the skewness and the kurtosis of each variable. Results from a descriptive analysis showed that amotivation had both the highest skewness (2.86) and kurtosis (8.33), even after outliers were removed. Following Kline's (2005) suggestion to keep values less than |3.0| for skewness and |8.0| for kurtosis, the amotivation data have been transformed using the log 10 algorithm.

Structural equation modeling (SEM) was performed to evaluate the six parallel models. A partial correlation matrix (see Table 2) was firstly generated to partial out possible confounding of demographic variables. The partial correlation matrix was then coded into the AMOS 7.0 program to calculate path coefficients and the overall model fit. Maximum likelihood (ML) estimation was adopted, as it produces estimates that are unbiased, consistent and efficient, plus it is scale-free and scale-invariant (Kaplan, 2000).

To present the extent to which the hypothesized SDT model fit empirical data, the χ^2 statistics were used along with four fit indices recommended by Hu and Bentler (1998). The fit indices include: standardized root mean square residual (SRMR), comparative

Table 2
The partial correlation (controlling for demographic variables) matrix for structural equation modeling.

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. AS	–											
2. CS	.79**	–										
3. PA	.42**	.37**	–									
4. PC	.34**	.34**	.33**	–								
5. RE	.63**	.66**	.44**	.36**	–							
6. RAI	.14*	.07	.08	.10	.13	–						
7. HR	.07	.09	.11	.13	.15*	.06	–					
8. HIT	.09	.02	.25**	.12	.23**	.14	.24**	–				
9. EG	.02	.03	.11	.43**	.07	.05	.22**	.17	–			
10. FG	–.20*	–.11	–.12	.14	–.18*	–.04	.09	.21*	.29**	–		
11. LN	.58**	.59**	.43**	.54**	.48**	.17*	.21**	.01	.13	–.24*	–	
12. SA	.80**	.86**	.43**	.43**	.68**	.11	.10	.12	.05	–.10	.60**	–

Note: AS, autonomy support; CS, competency support; PA, perceived autonomy; PC, perceived competency; RE, perceived relatedness; RAI, self-determination; HR, hours per week studying; HIT, number of hits; EG, expected grade; FG, final grade; LN, perceived learning; SA, course satisfaction.

* Coefficient is significant at the 0.05 level (2-tailed).
** Coefficient is significant at the 0.01 level (2-tailed).

tit index (CFI), non-normed fit index (NNFI), and root mean square error of approximation (RMSEA). A good fit would be evidenced by nonsignificant chi-square test results, values less than .05 for SRMR, greater than .90 for CFI and NNFI, and a value less than .08 for RMSEA.

3. Results

3.1. Model 1. Hours per week studying

Fig. 4 illustrates standardized path coefficients and fit indices of the Hours per Week Studying model. The fit indices suggested a good fit of data, $\chi^2 (11, N = 262) = 13.18$, n.s.; SRMR = .02, CFI = .99, NNFI = .99, RMSEA = .03. Regarding the structural paths, contextual support positively predicted need satisfaction ($\beta = .86$), and in turn need satisfaction positively predicted self-determination ($\beta = .15$). Hours per week studying, the outcome variable, was directly predicted by need satisfaction ($\beta = .44$). However, contextual support and self-determination did not yield a significant direct effect on the outcome variable.

3.2. Model 2. Number of Hits

Fig. 5 illustrates standardized path coefficients and fit indices of the Number of Hits model. The fit indices suggested a good fit of

data, $\chi^2 (11, N = 262) = 18.14$, n.s.; SRMR = .03, CFI = .99, NNFI = .98, RMSEA = .05. Regarding the structural paths, contextual support positively predicted need satisfaction ($\beta = .86$), and in turn need satisfaction positively predicted self-determination ($\beta = .15$). Number of hits, the outcome variable, was directly predicted by contextual support ($\beta = -.79$) and need satisfaction ($\beta = .97$). However, self-determination did not yield a significant direct effect on the outcome variable.

3.3. Model 3. Expected Grade

Fig. 6 illustrates standardized path coefficients and fit indices of the Expected Grade model. An examination of fit indices suggest a poor fit of data, $\chi^2 (11, N = 262) = 61.02$, $p < .001$; SRMR = .07 (>.05), CFI = .92, NNFI = .84 (<.90), RMSEA = .13 (>.08). Therefore, the SDT-based Expected Grade model was not supported by empirical data gathered in this study.

3.4. Model 4. Final Grade

Fig. 7 illustrates standardized path coefficients and fit indices of the Final Grade model. The fit indices suggested a marginally acceptable fit of data, $\chi^2 (11, N = 262) = 37.43$, $p < .001$; SRMR = .05, CFI = .95, NNFI = .91, RMSEA = .10 (>.08). Regarding the structural paths, contextual support positively predicted need satisfaction

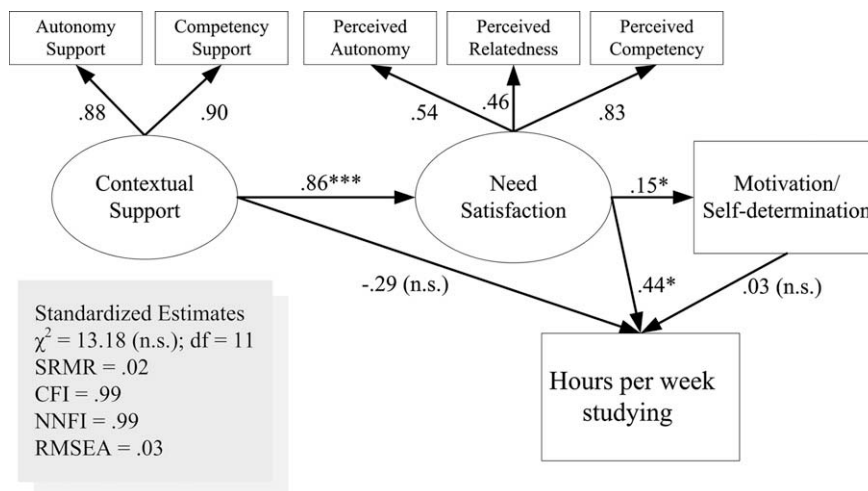


Fig. 4. Standardized path coefficients and fit indices of the Hours per Week Studying Model.

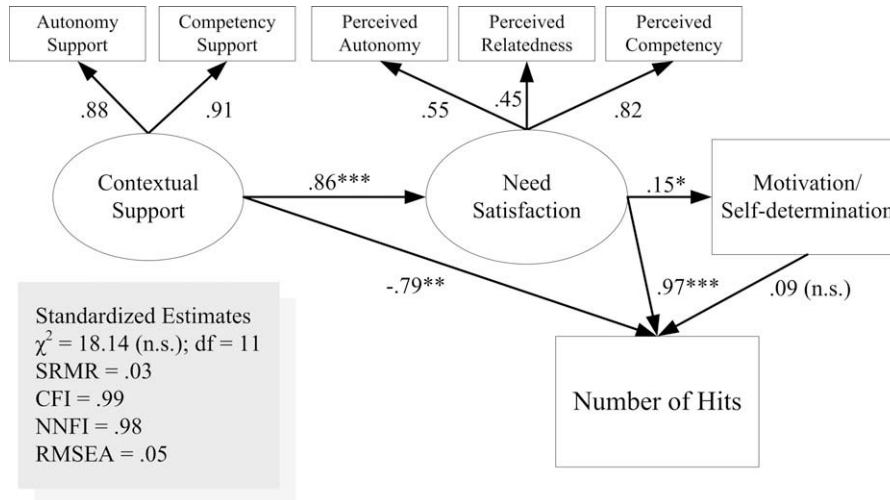


Fig. 5. Standardized path coefficients and fit indices of the Number of Hits Model.

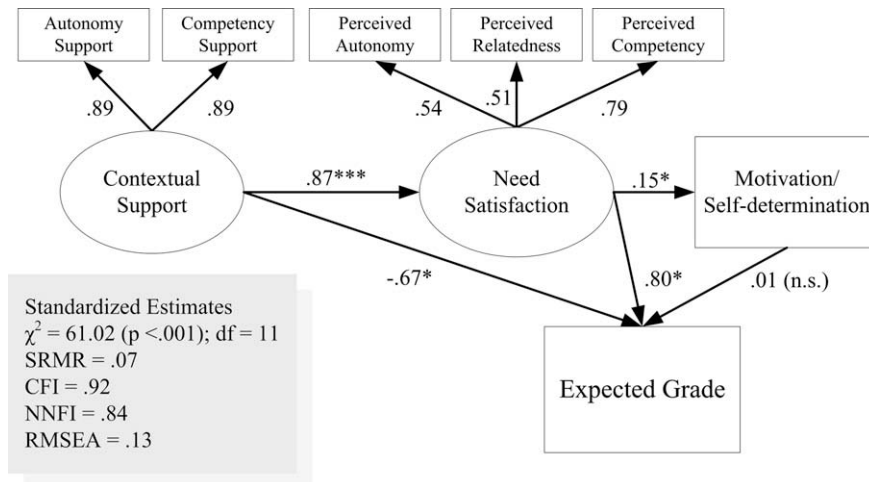


Fig. 6. Standardized path coefficients and fit indices of the Expected Grade Model.

($\beta = .85$), and in turn need satisfaction positively predicted self-determination ($\beta = .15$). Unexpectedly, none of the predictive variables (contextual support, need satisfaction, and self-determination) directly predicted participants' final grade.

3.5. Model 5. Perceived Learning

Fig. 8 illustrates standardized path coefficients and fit indices of the Perceived Learning model. An examination of fit indices suggested a poor fit of data, χ^2 (11, $N = 262$) = 52.29, $p < .001$; SRMR = .05, CFI = .94, NNFI = .89 ($< .90$), RMSEA = .12 ($> .08$). Therefore, the SDT-based Perceived Learning model was not supported by empirical data gathered in this study.

3.6. Model 6. Course Satisfaction

Fig. 9 illustrates standardized path coefficients and fit indices of the Course Satisfaction model. The fit indices suggested a good fit of data, χ^2 (11, $N = 262$) = 20.19, $p < .05$; SRMR = .03, CFI = .99, NNFI = .98, RMSEA = .06. Regarding the structural paths, contextual support positively predicted need satisfaction ($\beta = .86$), and in turn need satisfaction positively predicted self-determination ($\beta = .14$).

Course satisfaction, the outcome variable, was directly predicted by contextual support. However, need satisfaction and self-determination did not yield a significant direct effect on the outcome variable.

Four patterns were discovered when we examined across the four fitted models. First, the path "contextual support \rightarrow need satisfaction \rightarrow self-determination" was significant, supporting SDT. Second, for the category of engagement (including Hours per Week Studying and Number of Hits), need satisfaction was the strongest and positive predictor of learning outcomes. However, for the Course Satisfaction model, contextual support was the strongest predictor. Third, as shown in Table 3, the direct effect of contextual support on learning outcome was generally negative, whereas the indirect effect (through the mediation of need satisfaction) was generally positive. Lastly, self-determination failed to directly predict any of the learning outcomes in this study, which contradicted SDT.

4. Discussion

The purpose of this study was to test self-determination theory in an online learning environment. A SDT-based model depicting

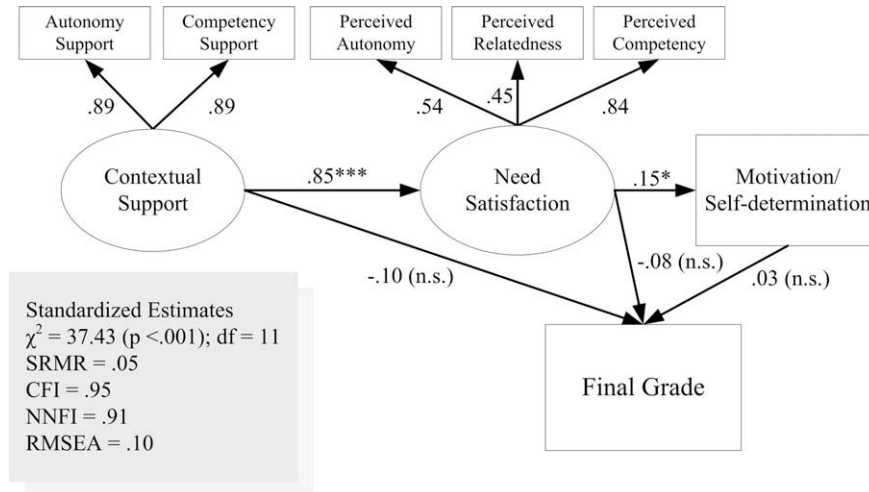


Fig. 7. Standardized path coefficients and fit indices of the Final Grade Model.

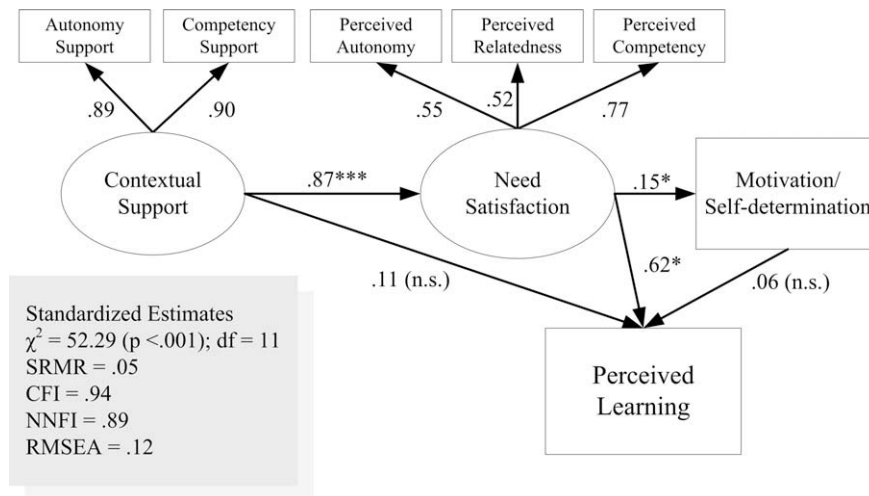


Fig. 8. Standardized path coefficients and fit indices of the Perceived Learning Model.

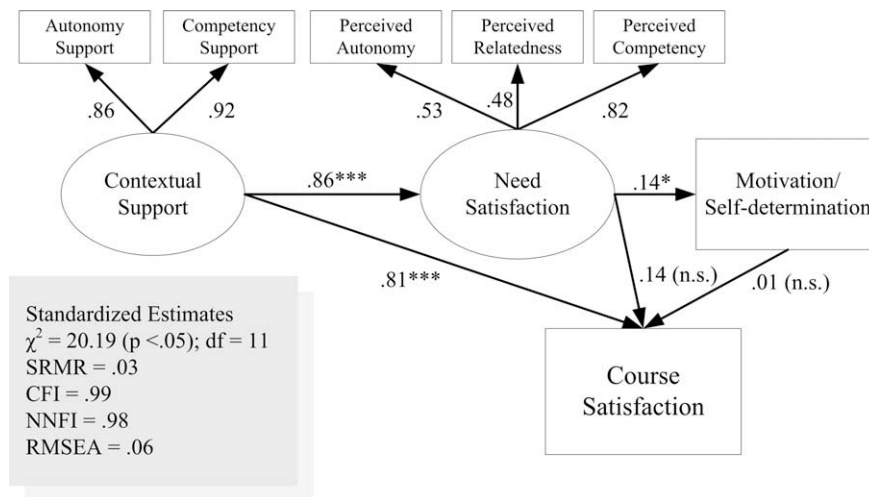


Fig. 9. Standardized path coefficients and fit indices of the Course Satisfaction Model.

interrelationships among contextual support, need satisfaction, motivation/self-determination, and learning outcome was proposed and empirically tested. In line with SDT, and consistent with

Standage et al's (2005) and Vallerand and Reid's (1984) studies, this study found a mediating effect of need satisfaction between contextual support and motivation/self-determination. In other

words, supports of autonomy and competency positively affected online students' perceived autonomy, relatedness, and competency, the satisfaction of the three basic needs. Students' need satisfaction, in turn, positively affected online students' self-determination.

Judging for the above result, it could be argued that effective support strategies are those that address online learners' needs of autonomy, relatedness, and competency. In the online learning literature, there are many instructional strategies proposed to support online learners. For instance, instructors can provide flexible learning options, including assessment (Willems, 2005), design collaborative learning activities to foster peer interactions (Kreijns et al., 2003), and assist students with self-regulation and learning strategies (Motteram & Forrester, 2005). Furthermore, expert technical help should be in place to provide troubleshooting, hardware and software advice, and assistance with class routines (Beffa-Negrini, Cohen, & Miller, 2002; Kuboni & Martin, 2004). In terms of SDT-based support strategies, Reeve (2002) summarized three points to promote students' self-determination:

1. Providing students with a meaningful rationale as to why the task, lesson, or way of behaving is important or relevant to the child's well-being;
2. Establishing an interpersonal relationship that emphasizes choice and flexibility rather than control and pressure;
3. Acknowledging and accepting the negative feelings associated with engaging arduous activities (p. 196).

In order for online instructors to better understand their students' needs, and adopt appropriate strategies to support their students, we suggest that online instructors create an open, interactive, and learner-centered atmosphere for students to freely express their feelings, thoughts, and concerns.

This study yielded another thought-provoking result: except for the Course Satisfaction model, the direct effect of contextual support on learning outcome was negative, whereas the indirect effect (through the mediation of need satisfaction) was positive (or less negative for the Final Grade model). This finding suggests that haphazard and aimless supports without addressing students' needs are likely to lead to adverse – even worse than “no effects” – outcomes. It is through the enhancement of students' perceptions of autonomy, relatedness, and competency that makes contextual support effective and meaningful to online students. This study also echoes several studies on social support (Kaul & Lakey, 2003; Lakey & Lutz, 1996; Reinhardt, Boerner, & Horowitz, 2006) that revealed “perceived support” to be positively associated with well-being variables whereas “received support” had no or negative effects. Again, it is of critical importance that instructors and other online learning practitioners understand their students, and provide support pertinent to students' needs.

The SEM results showed that the path from self-determination/RAI to learning outcome was insignificant across all fitted models, contradicting SDT's theorizing, as well as Vallerand, Fortier, and Guay's (1997) and Standage, Duda, and Ntoumanis' (2006) findings

that students' self-determination directly predicted learning outcomes. While it is possible that the insignificant path was caused by the survey and objective data that were not as valid as we have hoped (e.g., $\alpha = .69$ for the Perceived Autonomy Scale; $CV = 5.57\%$ for student grades), an examination of the overall SEM structural paths provided an alternative explanation. Learning outcomes were in fact directly explained by contextual support and need satisfaction categories, as opposed to self-determination/RAI. Therefore, it appears that in the studied online learning context, contextual support and need satisfaction have more salient influence on students' learning consequences.

This study has shown the intricate dynamics among contextual support, need satisfaction, motivation/self-determination, and learning outcomes through SDT full model tests. The opposite results of the direct and indirect effects of contextual support on learning outcomes, for instance, would not have been detected through this macro, integrated view. Furthermore, comparisons across fitted models indicated the strong association between student engagement and need satisfaction, and the direct and salient link from contextual support to course satisfaction – these results present the specific dynamics of individual learning outcomes, and reflect that exploring the antecedents, correlates, and outcomes in an integrative approach serves as a pathway to enrich our understanding of online learner motivation.

As an additional finding, this study revealed that intrinsic motivation, external, introjected, and identified regulations, and amotivation were distinct constructs (through the examination of the factor structure of the Academic Motivation Scale). Therefore, this study supported SDT's main theorizing that human motivation is a complicated, multidimensional inner process, as opposed to a singular, monolithic construct.

An implication for online education is that instructors should be aware not to simply dichotomize students into “motivated” and “unmotivated” groups, because two students with seemingly the same motivation level may have totally different reasons to participate in class. In online education, students have different reasons to participate in class. They may embrace internal reasons such as interest, joy, or the pursuit of self-fulfillment. Students may also have external reasons to participate in class, such as fear of being outdated, coerced by authorities, in pursuit of a better salary, or pressured by examinations (Jang, 2009). Evidenced by Otis, Grouzet, and Pelletier's (2005) longitudinal study, students' differentiated reasons of enrollment may have ongoing impact on their attitudes and behaviors in class, and eventually influence their long-term school adjustment. Online instructors should spend time understanding their students' intentions for study, and provide customized facilitation that help individual students reduce uncertainty and anxiety, become more assured and self-determined, and begin to enjoy their learning online.

5. Limitations and recommendations

Despite efforts to increase rigor, this study has its limitations. First, this study was conducted in two special education online programs at a large research university in the southeastern USA, which may to some extent limit its level of generalizability. Future studies may extend this research by surveying across programs, regions, subject matters, or even culture.

This study employed a correlational research design due to practical concerns. Although four SDT models that contained directional paths had been validated through structural equation modeling, the evidence was still insufficient to draw causal conclusions. Future studies may employ experimental design to individually test the tenets of self-determination theory in the online learning environment.

Table 3
Direct and indirect (through need satisfaction) effects of contextual support on learning outcomes.

Model	Direct effect (contextual support → learning outcome)	Indirect effect (contextual support → need satisfaction → learning outcome)
Hours	-.29	.38
Hits	-.79	.83
Final grade	-.10	-.07
Course satisfaction	.81	.12

In this study, final grade was not predicted by any of the predictive variables, including contextual support, need satisfaction, and self-determination. Perhaps it is due to the general high and homogeneous ($M = 92.58$, $CV = 5.57\%$) student grades. Therefore, online instructors' policies of grading may have confounded the results of this study. Interpretations and generalizations of the results pertaining to students' final grade should proceed with caution.

Lastly, two out of six SDT models, namely the Expected Grade and the Perceived Learning models did not yield proper fit. While testing alternative model structures is beyond the scope of this study, future efforts could be devoted to exploring alternative ways that contextual support, need satisfaction, self-determination, and the two learning outcomes interact in online learning contexts.

Aside from the aforementioned limitations, this study serves as one of the earliest studies that test a model of self-determination theory in online learning context. Knowledge gained in this study has provided implications for online learner support. This study also expands the knowledge base concerning the complex nature of online learner motivation and its dynamic relationships among various antecedents and derivatives. It is hoped that this study inspires more SDT-based studies to address learner needs, motivation, and contextual support, on the basis of which vibrant, motivating online learning environments may flourish.

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