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Supporting students' motivation in college online courses

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SUPPORTING STUDENTS' MOTIVATION IN COLLEGE ONLINE COURSES

by

Jae-eun Lee Russell

An Abstract

Of a thesis submitted in partial fulfillment of the requirements for the Doctor of Philosophy degree in Psychological and Quantitative Foundations (Educational Psychology) in the Graduate College of The University of Iowa

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Thesis Supervisor: Associate Professor Kathy L. Schuh

ABSTRACT

Students' motivation has been identified as a critical factor for meaningful engagement and positive academic achievement in various educational settings. In particular, self-regulation strategies have been identified as important skills in online learning environments. However, applying self-regulation strategies, such as goal setting, strategic planning, and reflect performance takes significant effort. Without motivation, students will not enact these types of strategies. Autonomous self-regulation has been investigated in traditional classroom settings and there is ample empirical evidence of a significant relationship between autonomous self-regulation and engagement and academic achievement. However, such research was limited in online learning environments.

The purpose of this study was to investigate the factors that affected students' autonomous or self-determined forms of regulation as defined in self-determination theory (SDT). The study examined the relations between students' self-regulated motivation and four other variables (students' interests in the course, students' perception of their instructor's interaction type, students' technology self-efficacy, and students' perception of the degree to which their online learning environment used constructivist-based pedagogy), and the interactions among these variables in college online courses. In addition, the study examined the relationship between students' autonomous forms of regulation and their engagement, learning achievement, interaction behaviors, and satisfaction in the online course. For students' interaction behaviors, the total number of authored and read messages, the total number of visits to the content page, the total number of visited topics in the content page, and total duration spent in the content page were examined.

One hundred forty students in 19 online courses participated in this study. The results of hierarchical linear modeling analyses revealed: (a) Both environmental factors, instructors' autonomy-supportive interaction and learning environments using constructivist-based pedagogy predicted students' autonomous self-regulated motivation (b) Students' autonomous self-regulated motivation predicted students' self-reported engagement, achievement, and satisfaction (c) Two personal factors, interest in the course and technology self-efficacy did not predict students' autonomous self-regulation (d) Students' autonomous self-regulated motivation did not predict any interaction behaviors.

The findings from this study are largely congruent with prior theory and research in the fields of academic motivation, self-determination, and online learning, which note that environmental factors, instructors' autonomy-supportive interaction and constructivist-based pedagogy significantly affect students' autonomous self-regulation in online learning environments.

Abstract Approved: ____
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CERTIFICATE OF APPROVAL

PH.D. THESIS

This is to certify that the Ph.D. thesis of

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has been approved by the Examining Committee for the thesis requirement for the Doctor of Philosophy degree in Psychological and Quantitative Foundations (Educational Psychology) at the May 2013 graduation.

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CHAPTER I

INTRODUCTION

The proliferation of online courses in higher education has been said to provide better access, convenience, and flexibility to support learners' educational opportunities (Conceicao, 2006). Because students have control of where and when learning takes place, online courses allow students great autonomy to individualize their learning speed and environment. However this flexibility and convenience can become a challenge for students' initial and persistent engagement.

In traditional courses, students are obligated to meet at the time and location of the class. However, once students enter the classroom, learning may be expected to occur without students' active participation. The class often begins with an instructor's lecture or instruction and students follow along. Having a teacher and peers in the same room may provide a sense of security to students who expect a teacher or peers to initiate and provide action needed to make learning happen. In contrast, in online courses, the location and time of the class become a student's choice. While this choice may provide autonomy that allows students to tailor their own learning process, it also takes away the common elements that a traditional classroom offers. The teacher and peers are invisible and natural interactions with them disappear. This may result in students' deprived and anxious feelings and these negative feelings might adversely influence learning.

By its very nature, online courses posit a reliance on learner initiative in an environment with less supervision than a traditional classroom setting (Tuckman, 2007) and this characteristic can lead to students' excessive procrastination. When students take a course at home or work, they could easily neglect course responsibilities when other tangible priorities interfere. Furthermore, students in online courses are physically away from the social supports that can help them better focus on course content. In a traditional classroom, when students come to class they enter the learning community that shares learning goals and knowledge domains. In class, as well as before and after class, students interact with a teacher, peers, and materials, and a social community begins to form. This social learning community encourages students' engagement and promotes their motivation. However, in online courses, students not only have to initiate such involvement but also those involvements are typically carried out in written form, requiring more time and effort than spoken communication. Furthermore, while the instructor's lecture tends to serve as the central event of a learning session in many traditional college classrooms, traditional lectures are not typically available in online environments. Instead lecture notes may be available in a resources area just like reading materials. This requires students to be active participants in the learning process rather than a passive recipient who is awaiting the teacher's lecture as may be typical in many traditional classrooms.

Therefore, despite the fact that online courses encourage autonomous learning environments (Artino, 2007) in which students have decision-making flexibility, students who have less motivation might encounter difficulties instead of the benefits offered by online courses. Without students' consistent involvement in course activities and communication, excessive procrastination might occur and consequently result in poor achievement in online learning environments or even course withdrawal. In order to produce initiation and persistent engagement and communication, students' motivation has been acknowledged as an important factor in online courses and students' self-regulated learning has emerged as an effective motivational strategy for successful learning in online courses (Antino, 2007; Hsu, 1997; Joo, Bong, & Choi, 2000).

The research on self-regulated learning that is grounded in social learning theory (Zimmerman, 2000) has been conducted in both classroom and online learning environments, and many studies identified self-regulated learning as a critical factor in successful learning, particularly in online courses (e.g., Antino, 2007; Joo, Bong, & Choi, 2000). Self-regulated learning from the social learning theory perspective has been defined as "an active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behavior" (Pintrich, 2000, p. 453). Learners who practice self-regulated learning efficiently control their own learning experiences in many different ways, including organizing information and using resources effectively (Schunk & Zimmerman 1994; 1998).

These studies focused on the acquisition of effective strategies and methods for keeping students on target with a goal or activity. Little research, however, focused on how the individual is psychologically affected by personal relationships and learning contexts to enact self-regulatory skills. In order to adopt and internalize those skills, students will need to develop autonomous motivation. Self-determination Theory (SDT) provides a fitting theoretical approach for autonomous motivation and the process of self-regulation.

SDT is a humanistic and dialectic approach to human motivation and personality, and is focused on social-contextual environments that foster or hinder the natural processes of self-regulation and healthy psychological development (Ryan & Deci, 2000). The research on autonomous and self-regulated motivation using the SDT framework has demonstrated significant findings on human motivation in various educational settings.

SDT considers human beings as "active, growth-oriented organisms that innately seek and engage challenges in their environments, attempting to actualize their potentialities, capacities and sensibilities" (Ryan & Deci, 2002, p. 8). In order to realize this innate tendency and thrive, three psychological needs should be satisfied: autonomy, competence, and relatedness. That is, when these innate psychological needs are met, intrinsic motivation and more autonomous forms of regulation can be developed that may lead to the positive consequences.

According to SDT, self-regulated motivation exists on a motivational continuum (Deci & Ryan, 2000). This continuum includes three types of motivation (amotivation, extrinsic motivation, and intrinsic motivation). While amotivation is the state of lacking the intention to act at all, extrinsic motivation refers to individuals' performing an activity in order to attain some separable outcomes (e.g., rewards). The last stage on the continuum is intrinsic motivation, which is the state of doing an activity out of interest and inherent satisfaction. Among these three types of motivation, self-regulated motivation is engaged by extrinsic motivation. As students recognize and accept the value of tasks or activity, and internalize and integrate it, the desired behaviors that were initiated by external sources, becomes regulated and these regulated behaviors may range from passive compliance to active personal commitment. That is, intentional behaviors may vary in the extent to which they are self-determined (experienced as being freely chosen and emanating from one's self) versus controlled (experienced as being pressured or controlled by some interpersonal force) (Deci & Ryan, 1994). SDT classifies these different degrees of regulation into four distinct types (external, introjected, identified, and integrated regulation). Identified and integrated regulations are more autonomous or self-determined forms (Deci & Ryan, 2000) than external or introjected regulations, and these distinct types of regulation produce specific consequences for learning, performance, personal experience, and well-being (Ryan & Deci, 2000).

SDT researchers have explored how students' motivation can be supported in various social contexts including many educational settings. Online learning environments, however, have been excluded in the research. Only one study (Chen & Jang, 2010) addressed SDT in online learning environments. Chen and Jang tested a model of SDT for online learner motivation and reported evidence for the mediating effect of need satisfaction between contextual support and self-determination.

If learning environments can be created to facilitate students' motivation in traditional classrooms how do different learning environments serve to foster students' motivation and consequently produce positive learning outcomes? Earlier research on online courses focused a great deal of effort on technology use and delivering content. More recently, online researchers and instructors have focused substantial effort on pedagogical soundness with integration of various technologies. Online course instructors try to provide learning environments that can compensate for the lack of core elements offered by traditional classrooms and furthermore, learning environments that take advantage of characteristics of online environments. This focus on learning environments is intended to support students' learning including students' motivation.

Statement of the Problem

The substantial dropout rates in online courses continue to be a pervasive issue (Levy, 2007; Parker, 1999; Xenos, Pierrakeas, & Pintelas, 2002) and the amount of empirical evidence of students' negative feelings toward online courses remains (Mansour & Mupinga, 2007). To address the issue, online instructors and course designers have engaged in a goal to promote quality interactions and communications. However, keeping students engaged in interactions and communications can be difficult and frustrating without fostering their autonomous motivation, particularly in learning contexts where physical interaction and natural communication are absent. It is imperative that educators understand students' motivation, and the impact of social contexts and interpersonal relationships on students' motivation. SDT provides a theoretical framework to understand students' experiences of autonomous motivation and enhance their learning satisfaction in online learning environments.

The Purpose of the Study

Students' motivation has been identified as a critical factor for meaningful engagement and positive academic achievement in various educational settings. In particular, self-regulation strategies have been identified as important skills in online learning environments. However, applying self-regulation strategies, such as goal setting, strategic planning, and reflect performance takes significant effort. Without motivation, students will not enact these types of strategies. Autonomous self-regulation has been investigated in traditional classroom settings and there is ample empirical evidence of a significant relationship between autonomous self-regulation and engagement and academic achievement. However, such research was limited in online learning environments.

The purpose of this study was to investigate how students' autonomous or self-determined forms of regulation, as defined in self-determination theory (SDT), were related to students' personal factors and environmental factors in online courses. The study examined the relations between students' self-regulated motivation and four other variables (students' interest in course content, students' perception of their instructor's interaction type, students' technology self-efficacy, and students' perception of the degree to which their online learning environment used constructivist-based pedagogy), and the interactions among these variables in college online courses. In addition, the study examined the relationship between students' autonomous forms of regulation and their engagement, achievement, interaction, and satisfaction. The relevance of these variables to self-regulated motivation is briefly presented below.

Instructor's Interaction Type

SDT research has focused on the interpersonal environment and the effects of that environment on autonomous and controlled motivation. Specifically, social contexts (e.g., classroom climate) are characterized in terms of the degree to which they are autonomy-supportive versus controlling, with research indicating that autonomy-supportive contexts enhance autonomous motivation, whereas controlling contexts diminish autonomous motivation (Vansteenkiste, Lens, & Deci, 2006). Many research studies indicate that the quality of a student's motivation depends, in part, on the quality of the student-teacher relationship. Students achieve highly, learn conceptually, and stay in school, in part because their teachers support their autonomy rather than control their behavior (Reeve, 2002). In autonomy-supportive contexts, instructors empathize with the learner's perspective, allow opportunities for self-initiation and choice, provide a meaningful rationale if choice is constrained, refrain from the use of pressure and contingencies to motivate behavior, and provide timely positive feedback (Deci, Eghrari, Patrick, & Leone, 1994).

In online learning environments, interactions between students and instructors are mainly through online tools such as email, chat, and message boards. Because of a lack of physical contact in online learning environments, students can easily feel isolated and anxious. Instructors' frequent interactions in any format may help students feel connected to the course and may foster their motivation. In particular, when instructors' interactions with students are conveyed in an autonomy-supportive way, the self-determined forms of regulation may be promoted as indicated by the SDT research studies in traditional educational settings.

Online Learning Environments Used Constructivist-based Pedagogy

In contemplation of developing well-designed methods for engaging the learner, establishing ownership of learning, and developing a commitment to solve the problem, many research studies (e.g., Duffy & Kirkley, 2004; Moallem, 2003; Taylor, 2007) have investigated innovative pedagogical approaches in online environments and showed robust evidence of the effectiveness of pedagogical methods that are theoretically grounded in the constructivist framework.

From the constructivist view, a learner is an active seeker who explores and makes sense of the world (Duffy & Orrill, 2001), and is considered the center of learning. Thus, a teacher becomes a facilitator who helps students construct knowledge rather than an authoritative figure who dispenses knowledge. Therefore, the constructivist approach to learning emphasizes learning environments that cultivate active engagement, which allows students to explore, discuss, and meaningfully construct concepts and relationships in contexts that involve real-world problems and projects that are relevant to the learners (Jonassen, 1999). In particular, a learning environment that involves real-world problems and projects that are relevant to the learners helps them understand the value of tasks and content knowledge during the learning process.

These constructivist perspectives of learners, teachers, and learning environments align well with those in SDT. Ryan and Deci (2002) indicate that "SDT conceives of humans as active, growth-oriented organisms that innately seek and engage challenges in their environments, attempting to actualize their potentialities, capacities and sensibilities" (p. 8). This statement is consistent with the constructivist view of learners in which a "human naturally engages in exploration in order to make sense of the new and strange environment" (Duffy & Orrill, 2001). Furthermore, Black and Deci (2000) state that one can see that being autonomy-supportive in an educational setting is essentially what is typically meant by being student-centered. The concept of student-centered in a learning process is consistent with the constructivist perspective, which highlights student's ownership of learning and the role of teachers as facilitators who help student's engagement and ownership (Duffy & Kirkley, 2004).

SDT also emphasizes the importance of providing optimal challenge, a meaningful rationale (Deci & Ryan, 2002), and timely informational feedback (Deci & Ryan, 1994) in order to foster students' autonomous or self-determined regulation. These perspectives align well with the learning environments that constructivists recommend. Jonassen (1999) recommends engaging learners in solving authentic problems that represent the same type of cognitive challenges as those in the real world. Helping students establish personal relevance to the problem, issue or goal, and providing constructive feedback in a timely manner are expected in the constructivist-based learning environment (Duffy & Kirkley, 2004).

Because both constructivism and SDT share these perspectives, pedagogical methods grounded in the constructivist framework may facilitate a student's autonomous or a self-determined form of motivation. That is, as students perceive learning environments as being more aligned with the constructivism, they may develop more autonomous or self-determined forms of motivation, resulting in persistent engagement, quality performance, and also emotional satisfaction.

Interest in the Course

In SDT research studies, interest has been central to both intrinsic motivation and autonomous forms of regulation (Deci, 1992). According to SDT, intrinsically motivated behaviors are defined as those that are performed out of interest and require no external consequences (Deci & Ryan, 1994). Interest experience is a psychological state that is characterized by an affective component of positive emotion and a cognitive component of concentration (Hidi & Renninger, 2006). When persons experience interest, their actions acquire an intrinsic quality; they are driven by enjoyment rather than external reasons. Therefore, students' higher interest in the course may result in autonomous or self-determined forms of regulation.

Technology Self-efficacy

As sophisticated technologies are employed to enhance communications and interactions among students and between instructors and students in online learning environments, competence in computer technology has emerged as an important factor in successful learning (Liaw, 2002). Many online courses adopt a course management system (CMS) as a main interface to present content and provide the tools for communication and collaborative learning. Mastering these features, however, is not simple for some individuals. In addition, developing searching skills for relevant electronic resources is often expected in the online learning environment. Therefore, a lack of confidence using computer technology might diminish students' motivation in this particular learning environment regardless of their academic competence.

Research Questions and Hypotheses

The following questions and hypotheses framed the development and implementations of this study. Statistical analyses were used in the analysis of the resulting data to discuss findings of the study related to the research questions which provided focus for the research.

Research Question 1

How are students' online learning experiences (perception of their instructor's autonomy-supportive interaction and perception of the degree to which their online learning environment used constructivist-based pedagogy) and individual factors (interest in the course and technology self-efficacy) related to their autonomous forms of self-regulation?

Hypothesis 1. Consistent with self-determination theory (Deci & Ryan, 2000) and studies of teacher's autonomy-supportive teaching styles in traditional classrooms (e.g., Black & Deci, 2000; Reeve, 2002), students' perception of their instructor's autonomy-supportive interaction type is hypothesized to predict students' autonomous self-regulation (Figure 1).

Hypothesis 2. Consistent with studies of constructivist pedagogical methods in online environments (e.g., Duffy & Kirkley, 2004; Felix, 2002; Herrington & Oliver, 2000; Huang, 2002; Moallem, 2003; Neo, 2005; Song, 2005; Taylor, 2006; Tsai, 2008; Wang, 2009), students' perception of the degree to which their online learning environments used constructivist-based pedagogy is hypothesized to predict students' autonomous self-regulation (Figure 1).

Hypothesis 3. Consistent with self-determination theory (Deci & Ryan, 2000) and interest theory (Hidi & Renninger, 2006; Krapp, 2007), students' interest in the course is hypothesized to predict students' autonomous self-regulation.

Hypothesis 4. Consistent with studies of technology efficacy in online learning environments (e.g., Compeau & Higgins, 1995; Liaw, 2002) students' technology efficacy is hypothesized to predict students' autonomous self-regulation (Fig. 1).

Research Question 2

How is students' self-regulated motivation related to their engagement, satisfaction, interaction, and achievement in the online course in which they are enrolled?

Hypothesis 5. Consistent with self-determination theory (Ryan & Deci, 2000) students' autonomous self-regulation is hypothesized to predict students' engagement (Figure 1).

Hypothesis 6. Consistent with self-determination theory (Ryan & Deci, 2000) students' autonomous self-regulation is hypothesized to predict students' achievement (Figure 1).

Hypothesis 7. Consistent with self-determination theory (Ryan & Deci, 2000) students' autonomous self-regulation is hypothesized to predict students' satisfaction (Figure 1).

Hypothesis 8. Consistent with self-determination theory (Ryan & Deci, 2000) students' autonomous self-regulation is hypothesized to predict students' interaction behaviors (Figure 1).

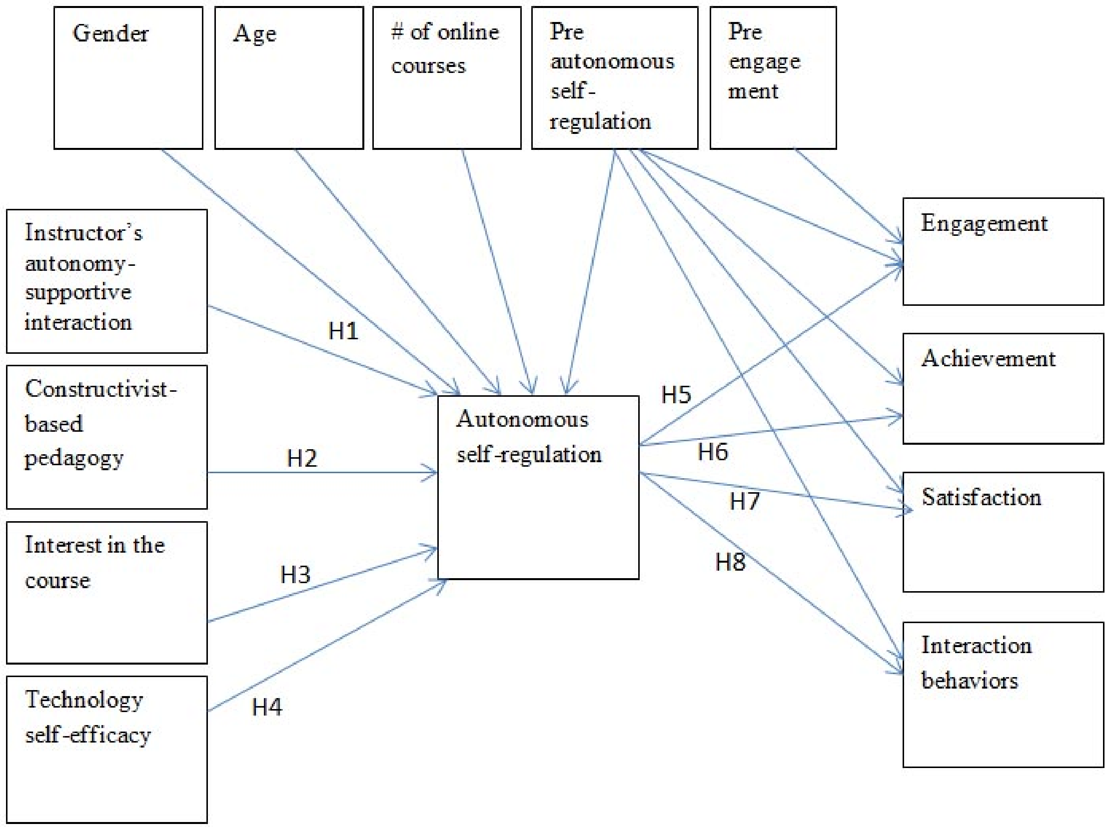

Figure 1. Illustration of Eight Hypotheses

Significance of the Study

The majority of research in online learning has paid attention to students' initial and persistent engagement driven by concern of substantial dropout rates and the quality of education in online courses. Many studies have explored various pedagogical methods and different types of computer technological tools to promote students' motivation. Many research studies on self-regulated learning have focused on students' acquisition of effective strategies and methods for keeping them on target with a goal. All these studies endeavored to support students' initial and persistent engagement. However, without an understanding of students' experience on the development of autonomous motivation, students' consistent engagement may be expected as behaviors that are contingent on external factors (Ryan & Deci, 2000). Students' motivation matters in their engagement. Students' persistent engagement leads to meaningful learning and high achievement. Different types of motivation result in different degrees of engagement. As students with intrinsic motivation or autonomous forms of regulation engage in course tasks and activities they will be less likely to drop the course, and show greater achievement and satisfaction.

The development of online courses in higher education will continue, and more students are expected to participate in online programs. Educators and course designers need to understand how students' motivation can be supported to increase their achievement in new environments. This study will identify which factors may be either positively or negatively related to students autonomous forms of regulation and bring important understanding of students' motivation and performance. The major findings in this study provide empirical evidence of how students' autonomous motivation is related to specific factors and this evidence adds to the body of motivation research on online courses.

CHAPTER II

REVIEW OF LITERATURE

The purpose of this study was to investigate how students' autonomous or self-determined forms of regulation, as defined in self-determination theory (SDT), was related to students' personal factors and environmental factors in online courses. The study examined the relationships between students' self-regulated motivation and four other variables (students' interest in course content, students' perception of their instructor's interaction type, students' technology self-efficacy, and students' perception of the degree to which their online learning environment used constructivist-based pedagogy), and the interactions among these variables in college online courses. In addition, the study examined the relationship between students' autonomous forms of regulation and their engagement, achievement, interaction, and satisfaction. A review of literature relevant to this study is presented in this chapter. The discussions in this chapter include:

- Motivation research guided by self-determination theory in traditional educational settings including interest as an individual factor and the impact of an instructor's interaction type on students' motivation.
- Research about students' motivation in online courses including pedagogical methods theoretically grounded in the constructivist framework, technology efficacy, and self-regulated learning from the social cognitive perspective.

Self-determination Theory

Self-determination theory (SDT) is a humanistic and organismic approach to motivation and personality development that embraces the assumption that humans are self-agents who inherently strive to develop their full potential and integrate experiences to the self. Ryan and Deci (2002) firmly stated, “SDT conceives of humans as active, growth-oriented organisms, that innately seek and engage challenges in their environments, attempting to actualize their potentialities, capacities and sensibilities” (p. 8).

Humans’ positive propensity, such as being full of energy and having an inquisitive nature, is observed in most babies and young children. They actively explore the environments they encounter. They typically seem to have a lot of interests and excitement about most social events, and even a small amount of encouragement appears to stimulate their positive tendencies. This tendency, however, is not always manifested as humans grow older. Some people are proactive and self-motivated to attend social activities and events, while others appear to be disinterested and lethargic in social events. Furthermore, the positive tendency is not consistently presented in the same person. That is, a person may show great excitement and persistence at certain social events, while the same person may appear to demonstrate a lack of interest in other social activities (Ryan & Deci, 2002). This may imply that different social contexts affect a person’s feeling and can trigger motivation. Hence social environments must take into account the different appearances of humans’ natural propensity (Ryan & Deci, 2000). SDT embraces a dialectical framework in which “people have a primary propensity to forge interconnections among aspects of their own psyches as well as with other individuals and groups in their social worlds" (Ryan & Deci, 2002, p. 5) for the study of personality growth and motivation. Maintaining a human's positive tendency and fulfilling one's potential cannot be accomplished without input from outside sources. An individual's endeavor to achieve one's full potential is carried out through consistent social interactions. As individuals interact with social environments, their innate desire may be stimulated and they may be encouraged to seek more challenges and adventures, or the desire can be dissuaded and wither.

The concept of basic psychological needs (Ryan & Deci, 2000) provides an elaborated description of this organismic and dialectic approach of SDT. According to SDT, for humans, three basic psychological needs must be satisfied in order to accomplish personal growth and integration. The need for autonomy, the need for competence, and the need for relatedness are fundamental factors that are essential in the process of integration and psychological growth (Ryan & Deci, 2000). That is to say, the more these basic needs are satisfied, intrinsic and more autonomous forms of self-motivations are prompted and a human's positive innate propensity blossoms. In this process, social environments may provide either the optimal conditions to satisfy these needs, or they may be flawed conditions in which these needs are ignored and suffer.

Autonomy as defined in SDT, refers to "being the perceived origin or source of one's own behavior" (Ryan & Deci, 2002, p. 8). People experience autonomy when decisions or attempts to act on certain activities are carried out from pure inner interests or inherent enjoyment those activities bring. When people experience autonomy, they produce self-determined motivation. Consequently people are responsible for their own behaviors and tend to put intensive effort into carrying out activity.

Competence refers to “feeling effective in one’s ongoing interactions with the social environment and experiencing opportunities to exercise and express one’s capacities” (Ryan & Deci, 2002, p. 7). When people experience competence, they tend to seek more challenges, strive to enhance their skills, and subsequently increase their capacities.

Relatedness is described as “feeling connected to others, to caring for and being cared for by those others” (Ryan & Deci, 2002, p. 7). Humans are social entities that cannot be completely excluded from social communities. Therefore, the desire to connect to others and belong to social communities is a natural human tendency. Satisfaction of relatedness offers psychological security and emotional comfort in a process of executing certain behaviors (Ryan & Deci, 2000). For example, when people work with someone they can trust and feel connected to, they feel more secure and comfortable than with someone they do not know or trust. Consequently, this emotional satisfaction may elicit or influence both frequency and quality of actions.

These basic needs are required for humans’ psychological growth, and provide people with natural motivation for learning, growing, and developing (Reeve, 2005). SDT research in education settings has provided strong evidence of positive relationships between basic needs satisfaction and outcomes of learning and performance (e.g., Filak & Sheldon, 2003). Filak and Sheldon (2003) presented psychological need satisfaction as a predictor of positive teacher and course evaluations in college-level education. In their correlation study, all three needs – autonomy, competence, and relatedness - were positively correlated with teacher and course evaluations. In particular, competence was indicated the strongest relationship with both teacher and course evaluations.

Intrinsic Motivation and Different Types of Self-regulation

Along with an organismic and dialectic approach, the basic psychological needs are fundamental factors that are related to intrinsic motivation and self-regulation of extrinsic motivation. Ryan and Deci (2000) introduced the self-determination continuum which presents different types of motivation with their regulatory styles in terms of the degree to which the motivations emanate from the self. The self-determination continuum includes three types of motivation (amotivation, extrinsic, and intrinsic motivation). While amotivation is the state of lacking the intention to act, extrinsic motivation refers to individuals' performing an activity in order to attain some separable outcomes (e.g., rewards). The last phase on the continuum is intrinsic motivation, which is the state of doing an activity out of interest and inherent satisfaction. Among these types of motivation, self-regulated motivation is engaged by extrinsic motivation. However, as a student accepts the value of the activity and incorporates the value into self, the desired behaviors are regulated. That is, although a student initially starts a certain behavior for an instrumental reason (e, g., not to get punished), as a student identifies with the value of an activity, those behaviors can be regulated and eventually become a part of the self. This is an internalization and integration process. During the internalization and integration process, the regulated behaviors may unfold varying from passive compliance to active personal commitment. That is, intentional behaviors may vary in the extent to which they are self-determined (experienced as being freely chosen and emanating from one's self) versus controlled (experienced as being pressured or controlled by some interpersonal force) (Deci & Ryan, 1994). SDT classifies these different degrees of regulation into four distinct types (external, introjected, identified, and integrated regulation). External regulation refers the behaviors that are performed because of external pressures or reward contingency. Introjected regulation refers to the behaviors related to feelings of guilty or anxiety. External or introjected regulations are controlled motivations, which are considered poorly internalized and integrated forms of motivation. Identified regulation refers the regulated behaviors through identification. As a person recognizes and understands value of a behavior, the action is performed because of acceptance of the value. Integrated regulation occurs when identified regulations are fully assimilated to the self and the value of a behavior becomes congruent with one's values. Identified and integrated regulations are more autonomous or self-determined forms, which involve the experience of volition and choice. These distinct types of regulation produce specific consequences for learning, performance, personal experience, and well-being (Ryan & Deci, 2000).

SDT researchers in education have inspected the relations between students' autonomous versus controlled motivation and relevant outcomes (e.g., Boiche, Sarrazin, Grouzet, Pelletier, & Chanal, 2008). In particular, Boiche et al. (2008) presented different motivation profiles and the links between those profiles and achievement outcomes in high school physical education. In their study, motivational profile was found to be significantly linked to students' final performance, final grade, and the effort they exerted. The more that students displayed a self-determined profile of motivation, the higher their performance; They provided more effort than did students with a non-self-determined profile. In contrast, a non-self-determined profile which was associated with high levels of external regulation and amotivation, was found to lead to poor effort, poor performance and poor grades.

Interest

In SDT research, interest has played a central role in both intrinsic motivation and self-determined forms of motivation (Deci, 1992). According to SDT, intrinsically motivated behaviors are defined as those that are performed out of interest and require no external consequences (Deci & Ryan, 1994). That is, when persons experience interest, their actions acquire an intrinsic quality; they are driven by enjoyment rather than external reasons.

Interest refers to a psychological state that is characterized by an affective component of positive emotion and a cognitive component of concentration (Hidi & Renninger, 2006). Typical characteristics of this state might include increased attention, greater concentration, pleasant feelings of applied effort, and increased willingness to learn (Krapp, Hidi, & Renninger, 1992). Interest always arises in the person-environment interaction, and has been acknowledged as two different components, personal or individual interest and situational interest (Krapp, Hidi, & Renninger, 1992). That is, in a form of person-environment interaction, interest experience is determined by individual characteristics (i.e., prior knowledge) that the student brings to the situation and also by how interesting the situation is, such as topics or activities. Individual interests are defined as relatively enduring dispositional characteristics or general orientations to action that develop over time. Thus, individual interests are considered to be relatively stable and not likely to be altered by situational characteristics (Krapp, Hidi, & Renninger, 1992). It is often observed that students express strong preference of a specific subject domain (e.g., language classes over science classes or vice versa) and naturally develop extensive knowledge and skills in that area. This preference tends to be consistent for a long period time and often leads to related academic careers and even vocational fields.

Situational interest is primarily generated by certain conditions and concrete objects in the environment and naturally assumed to be less stable and more easily manipulated than individual characteristics (Tsai, Kunter, Ludtke, Trautwein, & Ryan, 2008). Tsai et al. (2008) stated that whereas between-student variance indicates that interest experience differs from one student to another, within-student variance indicates that interest experience also differs within students from one lesson to another in the study. In addition, Tsai et al. (2008) noted that students were sensitive to the learning conditions afforded by the teacher. That is, although students' individual interest significantly contributes to generate interest experience, students' interest can also emerge from the characteristics of the learning environments that a teacher creates. This finding is encouraging for teachers but also brings teachers the additional task for creating an interesting and motivating learning environment.

SDT proposes autonomy supportive learning environments for this task. Teachers' autonomy support during instruction can facilitate satisfaction of the three psychological needs (Reeve, 2002) and may elicit students' interest experience. Lessons in which students perceive the teacher taking their perspective and understanding what they want (i.e., an autonomy-supportive climate) are associated with higher interest experience. In contrast, lessons in which teachers disrupt students' natural learning rhythms and do not allow time for reflection (i.e., controlling instruction) are associated with lower interest experience (Tsai et al., 2008).

Creating Autonomy-supportive Learning Environments

Intrinsic and well-integrated forms of extrinsic motivation are autonomous motivations, which are the most optimal motivations. These types of motivation however, do not occur easily. The interpersonal and social environments greatly contribute to those different types of motivation and the effects of the environment on autonomous motivation have been the focus of many SDT studies (e.g., Vansteenkiste, Lens, & Deci, 2006). In particular, SDT research conducted in education has examined how teachers could influence the degree of satisfaction of students' basic needs and motivations. SDT proposed that social contexts are characterized in terms of the degree to which they are autonomy-supportive versus controlling. When people create autonomy-supportive or controlling environments for others, they adopt a particular motivation style (Reeve, 2002). The teachers who support autonomy are more likely to generate the internalization of the activity among students, nurture students' inner motivational resources by identifying their interests, preferences, and competences, and allow them to express those interests, preferences, and competences (Reeve, 2005). Furthermore in autonomy-supportive social environments, teachers acknowledge the students' feelings, and provide pertinent information and opportunities for choice, while minimizing the use of pressures and demands (Black & Deci, 2000). In contrast, teachers who are controlling use more directives, and put more pressure on students using rewards, threats, and deadlines (Reeve, 2005). Many studies provided empirical evidence showing that the degree to which teachers are autonomy supportive versus controlling is significantly linked with students' need satisfaction and types of motivation (Reeve, 2002).

Autonomy-supportive contexts enhance autonomous motivation and produce positive outcomes such as extensive efforts and high performance, while controlling contexts forestall autonomous motivation and develop poorly integrated forms of motivation (Black & Deci, 2000; Boiche, Sarrazin, Grouzet, Pelletier, & Chanal, 2008; Guay, Ratelle, & Chanal, 2008; Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004). Furthermore the goal orientation becomes more salient to people when it is provided in an autonomy-supportive (rather than a controlling) way, so that intrinsic goal content interacted with an autonomy-supportive context results in unusually high levels of deep processing, conceptual learning, and persistence (Vansteenkiste, Lens, Soenens, & Broeck, 2008).

Vansteenkiste et al. (2008) provided the significant findings that support these SDT hypotheses in an experimental study with high school and college students. Vansteenkiste et al. (2008) investigated the relations among intrinsic (vs. extrinsic) goals and autonomy-supportive (vs. controlling) learning climates, and students' learning. Their study presented the evidence that framing learning in terms of its instrumentality for intrinsic goals will lead to significantly better learning and performance than when the learning was framed in terms of its instrumentality for an extrinsic goal. Intrinsic goals tend to be associated with relationships, growth, and health, while extrinsic goals are more likely associated with wealth, image, and fame (Vansteenkiste et al., 2008). SDT proposes that intrinsic goal pursuits have positive effects on well-being because they promote satisfaction of the basic psychological needs for autonomy, competence, and relatedness (Deci & Ryan, 2000). In addition, their study suggested that intrinsic goals are even more fully engaged and accepted by an individual when they are encountered in an autonomy-supportive climate. Vansteenkiste et al. (2008) provided two sets of results, one for intrinsic-goal effects and one for autonomy-support effects that are positively related to high learning performance.

Autonomy-supportive contexts are also found to be beneficial in the identification process during uninteresting activities (Jang, 2008; Reeve, Jang, Hardre, & Omura, 2002). Both Jang (2008) and Reeve et al.'s (2002) experimental studies indicated that providing a meaningful rationale in an autonomy-supportive way can facilitate students' identification process when students engage in an uninteresting activity. That is, students consciously valued activities so that the activities were accepted or recognized as personally important (Ryan & Deci, 2000).

SDT proposes that extrinsically motivated behaviors can become self-determined through the process of identification (Ryan & Deci, 2000). In general when motivating students to perform relatively uninteresting tasks, teachers tend to use controlling motivation strategies, which are extrinsic contingences such as deadlines and tangible rewards. These studies provide robust evidence of the positive effect of autonomy-supportive contexts rather than controlling motivation strategies to generate better learning outcomes.

The effect of autonomy-supportive communication and contexts were also examined not only in laboratory settings but also in regular classrooms and presented similar results that were found in laboratory settings. Students' perception of their instructor's autonomy support predicted increases in autonomous self-regulation and also increases in course performance in a college-level course (Black & Deci, 2000).

SDT research has been conducted in various educational settings and provides significant guidelines for human motivation, optimal social environments, and motivational strategies that can be applied in practice. However, this research was conducted in either experimental studies or traditional classroom settings.

In online learning environments, an instructor's interaction becomes far more important than in traditional classrooms because the instructor's presence is invisible, meaning that all natural physical contacts and spoken language are also absent. In online learning environments, interactions between students and instructors are mainly through online tools such as email, chat and message boards. Because an instructor is not physically present and natural spoken communication is withdrawn, students can easily feel disconnected to the course and may become anxious (Hanuka & Jugdev, 2006). These negative feelings may lead to loss of motivation (Inoue, 2007) and eventually may negatively affect performance. An instructor's frequent interactions may partially compensate for these negative feelings and give students a feeling of belonging in the course.

However, only providing frequent interactions may not be enough to nurture students' autonomous motivations. Because interactions are conveyed in written forms through technological tools, natural body language such as facial expressions is omitted. Thus, how an instructor's interactions are conveyed may have more impact on students' motivation in online learning environments than in the traditional classrooms. If such interactions are conveyed in a coercive way, students may feel more pressure and intimidated than an instructor intends. Conversely, if students perceive an instructor's interactions in an autonomy-supportive way, students may feel less worried and be afforded more challenges in which students' self-determined forms of regulation may be promoted.

Recent research studies provide evidence that students prefer online learning environments that adopt more constructivist pedagogy (e.g., Tsai, 2008), and also present evidence of positive relationships between constructivist pedagogical approaches and students' engagement and satisfaction. If constructivist pedagogical approaches are significantly associated with students' engagement and satisfaction, constructivist pedagogical approaches may affect students' intrinsic motivation or the process of autonomous forms of regulation. Then, constructivist pedagogical approaches may share the core characteristics and assumptions that SDT posits. In the following, pedagogical approaches in online courses with particular emphasis on constructivist-based pedagogy are addressed.

Pedagogical Approaches in Online Courses

While many of the traditional courses are converted to online courses or new online courses are developed, educators have concerns about the educational quality of online courses. Many of them are aware that online courses require a new type of instruction that is customized to individual needs to help overcome the obvious limitations of the new learning environment (Johnson & Aragon, 2003). Educational quality of online courses certainly involves sensible use of media and computer technology potential but technology itself does not guarantee educational improvement. Use of technology requires sound pedagogical strategies that consider students' engagement, a vision of what students need, and deep understanding of the subject matter on the part of the teacher (Johnson & Aragon, 2003; Larreamendy-Joerns & Leinhardt, 2006). As online programs have drawn educators' attention, empirical evidence of various kinds about the quality of instruction has been accumulated from student surveys to experimental comparisons between online courses and traditional classroom learning, and from analyses of student attrition and success rates to studies of the relationships among various instructional strategies and performance (Larreamendy-Joerns & Leinhardt, 2006). Most studies on the quality of instruction of online courses have investigated the types of instruction related primarily to students' engagement, motivation, satisfaction, and positive performance.

Not long ago, the prevailing conception of online programs and teaching was that they were used to deliver content. These online courses tended to build on very traditional views of learning (Al-Bataineh, Brooks, & Bassoppo-Mayo, 2005). Often, the primary goal of an online course was to transfer information from the instructor to the student by providing students with access to information and expecting them to demonstrate their learning on an online exam (Johnson & Aragon, 2003; Larreamendy-Joerns & Leinhardt, 2006). Because of rapid changes and growing pressures to use Web technology in teaching, online instructors may simply convert their traditional courses into online courses by adapting a lecture-centered method. Instead of delivering lectures in a physical classroom, instructors prepare lecture-type materials in the form of presentation slides and post them to the Web using a course management system such as WebCT or Blackboard. As a result, online teaching becomes merely the electronic means of transmitting and presenting the written word. Lecture notes presented through the Web however, are generally not as compelling as lectures delivered in a classroom. Lack of eye contact, body language, and voice inflection in converted Web courses limit the effectiveness of lecture (Yu & Tsao, 2003). Furthermore, because of the absence of natural spoken language, most communications occur virtually and these virtual learning environments can dramatically impact teaching methods and students' engagement. Therefore, simply importing a lecture-centered traditional model of instruction may not work well in online learning environments.

Recently, many research studies that focus on instructional methods proposing to engage learners suggest that pedagogical methods that are theoretically grounded in the constructivist framework fit in online learning environments and provide empirical evidence of positive students' engagement and satisfaction (e.g., Duffy & Kirkley, 2004; Felix, 2002; Herrington & Oliver, 2000; Huang, 2002; Moallem, 2003; Neo, 2005; Song, 2005; Taylor, 2006; Wang, 2009). These studies also provide evidence that students prefer online learning environments that adopt more constructivist pedagogy (e.g., Tsai, 2008). Because these studies provided evidence of positive relationships between constructivist pedagogical approaches and students' engagement and satisfaction, constructivist pedagogical approaches may affect students' intrinsic motivation or the process of autonomous forms of regulation. Then constructivist pedagogical approaches may share the core characteristics and assumptions that SDT posits.

Constructivist Learning Environments

Constructivist learning environments emphasize learner-centered instruction that reflects constructivist conceptions of learning. In the constructivist view, learning is a process of making sense of the world (Duffy & Orrill, 2001). Learning is an active process in which learners construct new ideas or concepts through negotiations and interpretations from their experiences based upon their current and past knowledge. A learner selects and transforms information, tests and constructs hypotheses, and makes decisions. The constructivist view of a learner is as an active participant and self-motivated agent who actively constructs knowledge. Therefore a learner is considered to be the center of learning (Brown & Campione, 1996). Learners do not passively take whatever the environment presents to them. Instead, through the continuous constructing process, learners' mental function gradually becomes more sophisticated and can make sense of more complicated environments. This view of learning significantly contrasts with the traditional view in which learning is the passive transmission of information from one individual to another, a view in which reception is central.

The constructivist approach to learning emphasizes learning environments that encourage this learner's natural tendency. The optimal learning environment should cultivate students' active construction which allows them to explore, discuss, and meaningfully construct concepts and relationships in contexts that involve real-world problems and projects that are relevant to the learners. The model for designing constructivist learning environments was described by Jonassen (1999):

> The model for designing constructivist learning environments conceives of a problem, question or project as the focus of the environment, with various interpretative and intellectual support systems surrounding it. The goal of the learner is to interpret and solve the problem or complete the project. Related cases and information resources support understanding of the problem and suggest possible solutions, cognitive tools help learners to interpret and manipulate aspects of the problem; conversation/collaboration tools enable communities of learners to negotiate and co-construct meaning for the problem; and social/contextual support systems help to implement the constructivist learning environment. (p. 217)

Pedagogical approaches aligned with constructivism are learner-centered environments in which teachers help and facilitate students to construct knowledge rather than being the main person who delivers a series of knowledge and controls students' learning process. The constructivist teacher tends to provide tools such as problem-solving and inquiry-based learning activities with which students formulate and test their ideas, draw conclusions and inferences, and pool and convey their own knowledge.

Subsequently, this type of learning environment allows for arguments, discussions, debates among students, and a constant exchange of ideas between student and teacher is encouraged. In this type of learning environment, teachers no longer teach but rather they coach. The coach provides scaffolds for the learner rather than solutions developed by a teacher. The role of a teacher changes to a focus on aiding or facilitating (Duffy & Cunningham, 1996).

The constructivist perspective of the learning process, learners, and the teacher's role underlie specific pedagogical methods. Among various characteristics of constructivist pedagogy, authentic contexts, problem-based learning, project-based learning, reflective learning, and collaborative learning are frequently represented as the typical constructivist pedagogical methods (Duffy & Cunningham, 1996). These pedagogical methods have brought educators' attention to the effectiveness of instruction and how it facilitates students' motivation and the learning process, and generates positive outcomes in relation to students' engagement and performance in traditional classrooms. Online courses also have been included intensively practicing these pedagogical methods and provided positive findings (e.g., Moallerm, 2003; Neo, 2005; Tsai, 2008).

Providing authentic learning contexts is one of the most prominent characteristics of constructivist-based pedagogy and has been significantly promoted in relation to students' motivation and engagement. The most important feature of authentic learning is to provide learning experiences that are as realistic as possible (Grabinger, 1996).

Authentic learning contexts allow learners to explore, discuss, and meaningfully construct concepts and relationships in contexts that involve real-world problems and projects that are related to the learner. Because an authentic task or activity deals with the realistic problems that hold more relevance to learners' needs, learners can relate what they are learning to problems and goals that they see every day. Students are also able to realize that their achievements stretch beyond the course; therefore, a realistic context includes as much fidelity as possible to what students will encounter outside academic settings in terms of tools, complexity, and interactions with people (Payne et al., 2009).

Providing the learning context to reflect the complexity of the real world is critical in online learning environments. If learning is embedded in an authentic context, then students are encouraged to take ownership of their own learning (Honebein, Duffy, & Fishman, 1993) and are engaged in tasks that cultivate the opportunity for them to make direct connections between the new material that is being learned and their prior experiences. Authentic environments can lead students to become more actively involved and also promote their intrinsic motivation or autonomous forms of self-regulation in online courses.

Problem-based learning is often adopted to promote learner's motivation and create ownership of learning in which the learners are actively engaged in tasks and activities that are authentic to the environment in which they would be used (Savery & Duffy, 1996). When a problem is presented, students discuss the problem-generating hypotheses based on whatever experience or knowledge they have, identifying relevant facts in the case and identifying learning issues. Identifying learning issues allows students to engage in self-directed learning. In self-directed learning students have considerable responsibility for gathering and seeking information that is relevant to the content domain of the problem. In self-directed learning students may experience conflicts or dilemmas among various concepts. Subsequently students develop critical thinking skill in the process of exploring and investigating different ideas. After self-directed learning, students often collaborate with other students to investigate the problem with the new level of understanding. In this process different ideas are actively exchanged and arguments, discussion, and debates occur among students.

Because problem-based learning is organized around the investigation and resolution of complicated, real-world problems, it provides an authentic experience that fosters active learning, supports knowledge construction, and naturally integrates school learning and real life. Students are engaged in problem solving, identifying the root problem and the conditions needed for a good solution, pursuing meaning and understanding, and becoming self-directed learners.

Song (2005) investigated the effectiveness of problem-based learning in an online course. She provided an ill-structured problem solving activity to investigate students' intrinsic motivation and students' perceived learning-goal atmosphere. The results indicated that students perceived the problem-based learning environment as helpful in increasing their motivation.

Project-based learning, in contrast to problem-based learning, is a comprehensive perspective focused on teaching by engaging students in investigation. It requires a question or problem that serves to organize and drive activities that result in a series of artifacts or products that culminate in a final product that addresses that question or problem (Blumenfeld, Soloway, Marx, & Krajcik, 1991). Students can be responsible for the creation of both the question and the activities, as well as the nature of the artifacts. Therefore, project-based learning encourages originality of ideas of students. Artifacts are concrete and explicit representations of the students' problem solutions that reflect emergent states of knowledge. While students look for the solution to the question or problem, they acquire an understanding of key principles and concepts of subject matter. In addition this understanding is expended by seeking an effective presentation of the solution. Project-based learning also places students in realistic and contextualized problem-solving environments, and in so doing, projects can serve to build bridges between phenomena in an academic setting and real-life experiences (Blumenfeld, 1991). Hence, project-based learning promotes active engagement of students' effort over an extended period of time, and then it increases the persistence of engagement in online learning environments (Neo, 2005).

Reflection is a characteristic of constructivist-based pedagogy, which emphasizes a learner as an autonomous organism. Reflective learning provides an opportunity for learners to engage in metacognitive processes such as examining and exploring the learning process with the expectation that the process will help them to learn better (Hernandez-Ramos, 2004). Reflective journals are commonly used for this type of learning in online courses. Such journals can be simply an accumulative description of knowledge gained, responses to more guided inquiries, or a combination of both. They offer an opportunity for students to connect with the content in an introspective manner. Content knowledge is often constructed even as the student reflects on new insights.

Murphy (2004) developed modules that focused on reflection based on principles and concepts related to social constructivism. Social constructivism views that knowledge is shaped by cultural influences and evolves through participation in contexts (Windschitl, 2002). From this perspective, developing knowledge and critical thinking skills should be fostered through "collaborative activities in which learners participate in tasks with the assistance of more knowledgeable others" (Windschitl, 2002, p. 141). In the modules, learners viewed 5 to 10 video segments about different perspectives on the given problem, and completed series of shared reflection activities using discussion forums. Discussions using electronic discussion boards were structured around questions that encouraged students to describe how the perspectives differed or resembled their own. Students also completed a self-assessment of how their thinking on the problem had or had not changed. Through this reflective learning process students monitor what they learned and deepen their critical thinking.

Besides electronic discussion boards, web logs (also known as "blogs") have been used to promote reflective learning in online courses. Even if these are relatively new phenomenon, the public nature of blogs can be motivating resources for students and their uses in education presented a positive effect in reflective learning (Hernandez-Ramos, 2004).

Collaborative learning has been a core characteristic of constructivist-based pedagogy that is typically adopted in classroom settings. Johnson and Johnson (2002) found that cooperative learning promoted higher individual achievement than did competitive or individualistic learning from the meta-analysis that included over 168 studies, Many research studies focused on online learning indicated learner-learner interactions as a key factor in high-quality online programs (e.g., Bernard, et al., 2009; Su, Bonk, Madjuka, Liu, & Lee, 2005). Bernard et al. (2009) conducted a meta-analysis of the experimental literature of distance education that compared different types of interaction treatments with other distance education instructional treatments. Three types of interaction were examined in the study: student-student, student-teacher, and student-content interactions. Among three types of interaction, student-student interaction was found to be highly associated with increasing achievement outcomes (Bernard et al., 2009).

In addition to practical reasons such as dividing up a large workload and teaching students to be effective group members, there are important advantages for adopting collaborative learning in online courses. Working in peer groups helps students refine their knowledge and build critical-thinking skills through argumentation, structured controversy, and reciprocal teaching (Grabinger, 1996). Students have an opportunity to test their ideas publicly. Through verbalizing their ideas to others, and engaging in debate, they can begin to internalize their understanding. Further, peers can provide assistance to each other in enriching and expanding ideas to reach comprehensive understanding.

In addition to refining and building critical thinking skills in a group setting, it is important to note that learners can have a community membership. One of characteristics in online courses is that students do not have the community membership associated with being on campus. It is not only the class “community” but the campus community and culture that the individual becomes a part of and that is central to growth during the college years (Duffy & Kirkley, 2004). Collaborative learning is more critical in the online environment, because it is a mechanism to provide a community for the student that may affect motivation to maintain initial engagement (Gallagher-Lepak, Reilly, & Killion, 2009; Rovai, 2001). Without the interaction, there may be uncertainty about how to proceed, how well the concepts are understood, what is required, and how much work is expected – understanding that students often develop informally in a traditional classroom setting. The community is important to help students prioritize academic requirements. This is just as it is with students on a campus who are engaged in their learning by seeing other students expending effort and meeting course requirements.

Collaborative learning is a way to build a learning community that may help students feel less isolated, and it can be a medium for students to test their understanding without overburdening the instructor. For learning to be successful, the instructor must work toward developing a sense of community (Duffy & Kirkley, 2004) among both the teacher and the student. This connection needs to occur from instructor to student, student to student, and student to content. Well-designed collaborative learning can successfully expend this connection.

Constructivist learning emphasizes personal meaning making and intentionally seeks to relate new ideas to experiences and prior learning. Constructivist-based pedagogy therefore, promotes conceptual and strategic thinking instead of learning that targets reproduction (Jonassen, 1999). The constructivist perspective on learners is well-aligned with the view of learners from a SDT perspective. Further, the characteristics of the constructivist-based learning environments and the pedagogies well support the basic psychological needs of learners as described by SDT.

SDT and Constructivist Learning Environments

SDT and Constructivism have similar views of learners, teachers, and learning environments. SDT notes humans as active and growth-oriented organism. People inherit the natural propensities for personal growth, social development, and well-being. The constructivist perspective views the learner as an active participant and self-motivated agent who actively constructs knowledge. Therefore, both SDT and constructivism view learners as active agents who are innate the natural potential to grow and are motivated to achieve personal well-being.

SDT and constructivism have similar views of teachers as well. According to SDT, a role of the teacher is to support the basic psychological needs of students (need for autonomy, competence, and relatedness) and provide an autonomy-supportive environment rather than controlling a student's behavior. In order for people to be self-motivated, people's innate three psychological needs have to be satisfied in the environment. The constructivist perspective views the teacher as a facilitator who considers students' interest and preference and provides scaffolds in their learning process rather than the main person who distributes knowledge and tests it. Therefore, both SDT and constructivism view the teacher as a facilitator who supports students' needs and provides the learning environment where students can be self-motivated and perform their best. From the both perspectives of learners and teachers, learner-centered is a common characteristic of both constructivist learning and autonomy-supportive environments.

The research guided by SDT has provided empirical evidence of autonomy-supportive learning environments as the optimal social condition that satisfies basic psychological needs, and consequences self-autonomous motivation. The need to feel efficacious with respect to tasks, the need to feel belongingness and connectedness with others, and the need to experience autonomy are critical psychological needs to nurture internalization and integration of extrinsic motivation. "Internalization is to people's "taking in" a value or regulation of the requested behavior, and integration refers to the further transformation of that regulation into their own to that, subsequently, it will emanate from their sense of self" (Ryan & Deci, 2000, p. 71). An autonomy-supportive teacher supports students' psychological needs by acknowledging their interests and needs, understanding their feeling, and providing choice of activity, challenge tasks, and positive feedback. An autonomy-supportive teacher use autonomy-supportive communication and minimize the use of pressure and demands on students using rewards, threats, and deadlines. An autonomy-supportive teacher also provides the meaningful rationale to help learners to understand and accept the value of behaviors when learners are involved in an uninteresting task (Jang, 2008; Reeve, Jang, Hardre, & Omura, 2002). This guideline of an autonomy-supportive teacher focuses on the trust relationship between teacher and students and autonomy-supported social contexts in which satisfy the students' needs of autonomy, relatedness, and competence and nurture the process of identification and integration of extrinsic motivation.

A teacher who employs the constructivist based pedagogy also acknowledges learners' interests and needs, and facilitates their learning process in the way learners maintain the ownership of learning. The main objectives of constructivist-based pedagogy is to provide tasks that are interesting, challengeable, and related to learners (Duffy & Cunningham, 1996) and facilitate self-directed learning (e.g., provide constructive feedback during the learning process) which supports learners' autonomy.

For example, one of the constructivist-based pedagogical methods, authentic learning tasks, provides learning experiences that are as realistic as possible and course activities and tasks that are challenge and related to learners (Grabinger, 1996). When students view the learning environments as realistic contexts, students may identify and accept the value of tasks easily because they feel the learning is related to them. In other words, providing authentic learning tasks nurture the process of identification and integration of extrinsic motivation in the similar way a teacher provides meaningful rationale to help learners to understand and accept the value of behaviors. Further, both problem-based and project-based learning are to provide challenge to students and also those challengeable tasks accompany constructive and positive feedback in the learning process, so that learners can build competent. Most of all, collaborative learning promotes meaningful interactions among peers so that learners feel belongingness and connectedness. In the collaborative learning contexts, students' need for relatedness can be satisfied not only through the relationship with their teacher but also the relationship with peers as they work together under common goals.

In summary, both constructivist-based pedagogy and SDT share similar views of learners and teachers as self-motivated agents and facilitators who support learners' needs. Both promote the learning environments in which share similar characteristics to satisfy the basic psychological needs of learner and nurture the process of identification and integration. Therefore, just as autonomy-supportive teaching has been showed to support intrinsic motivation and autonomous forms of regulation from a SDT perspective, the learning environments used constructivist-based pedagogy may also satisfy the basic psychological needs to promote intrinsic motivation and autonomous forms of regulation in online courses.

In addition to pedagogical methods, technology skills and confidence have been considered as one of the main factors related to positive learning outcomes in online courses. In the following, the role of technology self-efficacy in online courses is addressed.

Technology Self-efficacy

According to Bandura (1997) self-efficacy is defined as "people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives" (p.7). Self-efficacy beliefs have been found to influence how people feel, think, motivate themselves and behave (Bandura, 1997). If people believe that their actions can produce the outcomes that they desire, they are more apt to act or persist even in the face of difficulties.

Strong efficacy beliefs also enhance human accomplishment and personal well-being in many ways. People with strong self-efficacy in their capabilities approach difficult tasks as challenges to be mastered rather than as threats to be avoided. They will set challenging goals and strive to accomplish the goals. In contrast, people with weak self-efficacy, tend to avoid difficult tasks and see them as personal threats. When they are faced with difficult tasks, they tend to stay in their deficiencies instead of becoming engaged in how to perform successfully (Bandura, 1997).

Drawing from Bandura's self-efficacy theory, technology self-efficacy may become a critical variable for successful learning outcomes in online learning environments where technology mediates learning (Compeau & Higgins, 1995). Technology self-efficacy can be viewed as an individual's belief of his or her capabilities regarding specific technological knowledge and skills (Liaw, 2002). Perceived technology self-efficacy reflects an individual's confidence in his or her ability to perform the behavior required to produce specific outcomes related to technology. It directly impacts the choice to engage in a task as well as the effort and the persistence that will be exhibited (Liaw, 2002).

Technology self-efficacy was examined as an important factor related to the acquisition of computing skills (Zhang & Espinoza, 1998). Positive technology self-efficacy may encourage learning new technological skills, whereas negative technology self-efficacy may create resistance in capabilities.

Several studies have examined the relationship between technology self-efficacy and other attributes. Attitude toward computers is found to be a significant predictor of self-efficacy in computer technologies (Levine & Donitsa-Schmidt, 1998) and computer comfort/anxiety is indicated as another significant predictor of technology self-efficacy in general (Zhang & Espinoza, 1998). In addition, the desirability of learning computing skills was associated with two predictive attributes – attitude toward computers and computer self-efficacy in the same study.

Most online courses provide a main learning platform to facilitate various interactions (e.g., WebCT, Blackboard, or Desire to Learn). These are also called as course management system (CMS). Most CMS requires specific technological knowledge and skills to operate and navigate features for the given tasks. Viewing and downloading information that is presented in various formats (e.g. texts, graphics, animation, audio and videos), communicating with instructors and peers, submitting completed assignments, and searching resources effectively on the Web are considered basic tasks to pursue the content learning of the course. Furthermore, as the literature on online courses has paid substantial attention to the quality of interactions and the importance of collaboration to produce high quality learning experiences, online instructors tend to adopt more sophisticated technological tools to provide real-time communication and interactive experiences. Those technological tools allow collaboration with options for full duplex audio, sharing power point presentations, instant messaging, application sharing, breakout rooms, recording sessions for later playback and many more. However, these tools demand substantial technological knowledge and skills to operate the given features appropriately. Therefore, learners who perceive themselves as having low competency in technology use might feel an extra burden to learn necessary technology skills. This will have an impact on their motivation and cognitive capacity, which can considerably reduce performance. This is in contrast to learners with high competency in technology use who can easily adapt to the new learning environments. Many research studies have reported learners' negative experiences with technological problems in online courses (e.g., Packham, Jones, Miller, & Thomas, 2004) and technology problems have been identified as one of the prime causes of withdrawal from online courses (e.g., Packham, Jones, Miller, & Thomas, 2004).

Past research indicates that technology self-efficacy affects the perceived ease of use (Pan, Sivo, Gunter, & Cornell, 2005). Teo (2009) found that technology self-efficacy had a direct effect on learners' technology acceptance. Technology self-efficacy was also found to be negatively correlated with technology anxiety which can impede learning in online learning environments (Vuorela & Nummenmaa, 2003).

However, recent researchers found that high technological skills or experiences do not predict learner's activity level in the online learning environments. Neither deep approaches to learning nor anxiety predict actual performance level in the online learning environments (e.g., Vuorela & Nummenmaa, 2003). It is promising that people may take advantage of such environments regardless of their experiences with computers.

Unlike autonomous self-regulation from the SDT perspective, self-regulated learning from the social cognitive perspective has been widely conducted and provided empirical evidence of positive outcomes of self-regulated learning in particular, in online learning environments. In the following self-regulated learning from the social cognitive perspective is addressed, with particular emphasis on the meaningful rationale of investigation of self-regulation from the SDT perspective in online learning environments.

Self-regulated Learning from the Social Cognitive Perspective

Interest in academic self-regulated learning has increased significantly as investigators and practitioners attempt to understand how students become masters of their own learning process (Artino, 2007). Many research studies on self-regulated learning present evidence of the consequences of personal self-regulation in various educational settings and some of these studies specifically address self-regulated learning in online learning environments (e.g., Antino, 2007; Dabbagh & Kitsantas, 2004; Hsu, 1997; Narciss, Proske, & Koerndle, 2007; Whipp & Chiarelli, 2004). These studies found that a number of SRL strategies fit in the online learning environments and also present specific SRL strategies that are uniquely adapted for an online course.

Self-regulation refers to 'self-generated thought, feelings, and actions that are planned and cyclically adopted to the attainment of personal goals' (Zimmerman, 1999, p. 14). Zimmerman (1999) proposed three cyclical phases of self-regulatory systems, forethought phase, performance phase, and self-reflection phase. The forethought phase involves goal setting and strategic planning, and the performance phase follows in which the actual process of self-instruction and self-observation is carried out. The self-reflection phase occurs after performance efforts in which the individual evaluates one's own performance. Goal setting and strategy planning in the forethought phase control and lead the actual effort process. The self-reflection phase impacts the subsequent forethought phase. Goals may be changed and strategies planning may be revised depending on the self-evaluation of one's own performance.

Self-regulated learning is therefore, the mental act in which one deliberately extends on-going effort in monitoring and evaluating to attain the goal (Reeve, 2005). Learners who practice self-regulated learning efficiently control their own learning experiences in many different ways, including organizing information and using resources effectively (Schunk & Zimmerman 1994; 1998). Narciss et al. (2007) indicated that online learning demands self-regulated learning in that online learning requires not only task or content-related cognitive learning strategies, but also specific and general meta-cognitive strategies that enable the learner to monitor and regulate the learning process. Therefore, the most important task of instructional designers and teachers is to "develop strategies which encourage, prime and guide learners" (p. 1128) in order for students to practice self-regulated learning appropriately to better cope with demands imposed by a different learning environment. Research on SRL learning has provided various strategies to improve self-regulated learning. Time management skills and effective use of study aids (Whipp & Chiarelli, 2004) were found to be compelling strategies in relation to students' academic performance. Help seeking and structuring the learning environment strategies were also identified as important SRL strategies in online courses (Whipp & Chiarelli, 2004).

Although there is significant evidence of the effectiveness of self-regulated learning related to performance outcomes, it would not be worthwhile when a person is not motivated to adopt it in one's learning process, and self-regulatory strategies are of little value if a person cannot motivate themselves to use them (Zimmerman, 1999). Self-regulated learning is exercised and self-regulatory strategies are adopted with the intention of achieving goals. Without interest in the task, activity, or course content, and a lack of autonomous motivation, a person is unlikely to set a goal that will drive oneself to the certain direction and put great efforts on monitoring or evaluating one's own performance. In order to expect self-regulated learning, personal motivation should be considered in advance. Therefore, while self-regulated learning from the social cognitive perspective provides robust evidence for the high achievement in online learning environments, it is necessary to consider motivation, particularly, different types of motivation and the process of internalization and integration of extrinsic motivation as outlined in SDT. Instructors cannot expect learners to apply self-regulated learning and strategies by simply providing the information about them. Instead instructions should consider the learning contexts in which learners can "take in" a value of regulation and further, transform that regulation into their own.

SDT research provided substantial evidence of the positive influence of autonomy-supportive teaching on students' intrinsic motivation and autonomous forms of regulation. Many research studies on online courses have suggested pedagogical methods that are theoretically grounded in a constructivist framework are effective in online learning environments and provided empirical evidence of positive students' motivation, engagement and satisfaction. SDT noted that individual interest is a critical factor to produce intrinsic motivation or autonomous forms of regulation. In addition, particularly, in online learning environment, technological self-efficacy was identified as a core factor that might affect students' motivation and engagement.

This study extends and deepens the understanding the relationships among these factors that are related to students' motivation in college online courses. In the next chapter, the methods and research design that guide this study are described.

CHAPTER III

METHOD

The purpose of this study was to investigate the factors that affected students' autonomous or self-determined forms of regulation as defined in self-determination theory (SDT). The study examined the relations between students' self-regulated motivation and four other variables (students' interest in the course, students' perception of their instructor's interaction type, students' technology self-efficacy, and students' perception of the degree to which their online learning environment used constructivist-based pedagogy), and the interactions among these variables in college online courses. In addition, the study examined the relationship between students' autonomous forms of regulation and their engagement, learning achievement, interaction behaviors, and satisfaction in the online course. In this chapter, the methods and procedures in this study are presented. Specifically, the research design, participants, procedure for participants' recruitment, data collection procedure, survey instruments, and data analysis methods are described.

Research Design

This study employed a pre- and post-test, causal-comparative design. Causal-comparative research is a type of non-experimental design in which independent variables are not manipulated in order to observe its effect on the dependent variable. Rather than variable manipulation, causal-comparative design relies on "observation of relationships between naturally occurring variations in the presumed independent and dependent variables" (Gall, Gall, & Borg, 2003). Causal-comparative research is conducted when researchers seek to identify cause-and-effect relationships by forming groups of individuals in whom the independent variable is present or absent – or present at several levels and then determining whether the groups differ on the dependent variable (Gall, Gall, & Borg, 2003). Causal-comparative research fits this study because students' interest in the course and their technology efficacy pre-exist at different degrees and those variables cannot be experimentally manipulated and students self-selected the course. The researcher acknowledges that this design does not allow strong conclusions about cause-and-effect. However, investigation of the relationship among students' personal factors and learning environmental factors could be useful to understand students' autonomous forms of self-regulation.

Participants

The recruited online courses were 19 graduate level online courses that were offered in fall 2010 and spring 2011 by a large University located in the Midwest. Among the 19 online courses, 14 courses were recruited in fall 2010 and 5 courses were recruited in spring 2011. The recruited online courses were from 4 different academic units: 1 course was in the School of the Social Work, 1 course in the Department of Radiology, 1 course in the department of Rehabilitation and Counselor Education, and 16 courses were in the College of Nursing. The average course size was 23 students with the course size ranging from 8 students to 59 students. Two courses had less than 10 students, 3 courses had between 11 and 19 students, 2 courses had more than 30 students, the remaining 12 courses had between 20 and 30 students. The instructors of these courses indicated that their course required students' active participation and also required moderate technology skills. However, none of the instructors assessed the level of students' technology skills prior to enrollment.

The recruited online courses used Iowa Courses Online, powered by Desire2learn software (ICON) as a main learning interface. ICON included the course homepage, content, discussion, and grade pages as a default setting and it also offered various communication tools such as emails and chats. Of the 19 courses, 3 courses did not require discussion participation; that is, there were no assigned points that students could earn by posting messages in the discussion page. Sixteen courses assigned specific points for posting messages in the discussion page. The average discussion participation was worth 21% of the course grade, ranging from 4% to 40% of the course grade. Of the 16 courses, 9 courses specified a required number of postings.

The recruited online courses were all graduate level courses. However, seniors and juniors could enroll in those courses with instructors' special permission. The sample of this study included 76 graduate students (54.3%) and 64 undergraduate students (45.7%) enrolled in the recruited 19 online courses. Of the 64 undergraduate students, 29 students were seniors, 23 were juniors, and 10 students were in the program of Registered Nursing-Bachelor of Science (RN-BSN) in the College of Nursing. RN-BSN is an associate degree which is designed for the diploma-prepared registered nurses who seek a Bachelor of Science in Nursing. Two students were postdoctoral fellows. Eighty-nine students were recruited in fall 2010 and 51 students in spring 2011. One-hundred-three students (73.6%) indicated that they were taking the course because it was required for their programs.

Most students expressed some level of previous experience of online courses. The average number of online courses that had been previously taken was 5.49. Only 6 students (4.3%) answered that they had not taken any online courses before, while over half of participants (n = 75, 53.6%) answered they had taken more than 4 online courses, 18 students (12.9%) more than 10 online courses, and 27 students (19.3%) had taken one to four online courses previously.

Participant Recruitment

To recruit participants, the researcher searched online courses through the course information system website in the University. The recruitment criteria for online courses for the study were: it should be a semester long schedule, and be a part of a graduate program on campus, and a relatively small or mid size course. The course size was considered because of the limited capability for instructors to provide feedback on a large quantity of students' work. Majority of online courses had less than 50 enrollments but a couple of courses had over 100 enrollments. The courses with over 100 enrollments were excluded from the recruitment. Thirty-one online courses offered in fall 2010 and spring 2011were selected based on the criteria. The researcher then contacted the instructors of the 31 online courses via an introductory email that included a brief introduction to the study and the procedure for the study. Of the 31 instructors, 19 instructors replied with permission to recruit their students for the study.

On the first day of the semester, the researcher sent an introductory email to all students in the recruited courses. This introductory email included a brief introduction to the study, the procedure of the study, and the link to the consent form. Participants were informed that participation was voluntary, had no bearing on their grade in the course, and that they would be asked to complete two sets of questionnaires, one at the beginning of the semester (pre-survey) and one at the end of the semester (post-survey). Students were also informed that five types of their interaction behaviors in their course websites (the total number of visits to the content page, the number of visited items in the content page, the total time spent in the content page, and the number of authored and read messages in discussion board), and their total course points would be collected at the end of the semester. Students were also informed that their responses were held completely confidential and the course instructors would not have access to them. The online survey link was listed at the bottom of the consent form. Therefore, after students read the consent form and decided to participate in the study, they could go to the online survey site and complete the pre-survey. The participants who completed only the pre-survey received a $5 store gift certificate and the participants who completed both pre and post surveys received a $15 store gift certificate. A total 558 students were invited to participate in the study. Of the 558, 161 students participated in the first survey, which yielded 29% of response rate. Of the 161 students who participated in the first survey, 141 students returned to complete the second survey.

Data Collection Procedure

Online survey forms were designed for all measures. Participants completed the pre-survey at the first week of the semester. The pre-survey contained five measures: demographic information, engagement (pre), self-regulation (pre), interest in the course, and technology self-efficacy. At the last week of the semester, the post-survey was administrated. The post-survey included six measures: The Learning Environment Climate Questionnaire (LECQ) (Williams & Deci, 1996), Teacher Controllingness Scale (TCS) (Jang, Reeve, Ryan, & Kim, 2008), the Constructivist Learning Environment Questionnaire (CLEQ) (Tenenbaum et al., 2001), self-regulation (post), engagement (post), and the satisfaction questionnaire. After the sixteenth week of the semester, participants' interaction behaviors that were captured in ICON and the total course points were collected. The total course points were collected rather than letter grades for the learning outcomes, because there was a wide range of students in the same letter grade. The course points indicated different levels of students' performance more accurately than letter grades.

ICON was the main learning interface for these online courses. If students enrolled in multiple online courses, they viewed all course websites and clicked the specific course title and number that they participated in for this study. When students clicked their course link they first viewed the homepage of the course. Each course website consisted of the content, discussion, grade, and other pages depending on how the instructor designed for their course. Students could view or download learning materials and interact with their instructors and peers with the available communication tools such as a built-in email system, chat room, discussion boards, and virtual office.

Two main pages in the course website were examined to collect students' interaction behaviors: discussion and content pages. The content page contained all course materials including readings, videos, and audio files. Three types of interaction behaviors were obtained in the content page: the total number of visits, the total hours spent, and the total number of visited topics in the content page. Initially, the total number of visits to the course was to be collected rather than the total visits to the content page. The total number of visits to the course could include not only the visits to the content page but also the visits to the other pages of the course (e.g. resource, grade, discussion page). However, ICON does not provide these particular data. The ICON system could provide either the total number of visits to the content page of the particular course or the total number of logins to ICON system, but not for the particular course. This means if a student was taking multiple online courses, his or her logins to other online courses had been counted as well. Therefore, the total number of visits to the content page was collected for this study.

The discussion page was the main communication page on which students and the instructor shared their opinions and knowledge. The discussion page was organized by topics, and students posted their messages and read the messages that were posted by other students and their instructor. Two types of interaction behaviors were obtained in the discussion page, the total number of messages that students authored and read. These five types of interaction behaviors, the total number of visits, the total hours spent, the total number of visited topics in the content page, and the total number of messages that students authored and read were obtained after the semester was over.

Instruments

The primary instrument type used in this study was a self-report survey. The questionnaires that were administered in this study were selected to measure a variety of online course experiences, individual variables of students, a predictor variable, and outcome variables of students' learning. The course-related experience variables were students' perception of their instructor's interaction type and perception of the degree to which their online learning environment used constructivist-based pedagogy. The individual variables were students' interest in the course and technological self-efficacy. The predictor variable was a type of self-regulated motivation specifically, autonomous self-regulation. Finally, the outcome variables were students' self-reported engagement and satisfaction with the course. In addition, students' total course scores and five types of interaction behaviors were also set as students' learning outcomes.

Self-regulation Questionnaire**.** Self-regulation was measured by sixteen items of a self-regulation questionnaire that was adapted from the original Academic Self-regulation Questionnaire (SRQ-A). Self-regulation questionnaire asked the reasons why students do their course work. The words "homework and classwork" in the original SRQ-A were replaced with "coursework" in this study. In the SRQ for this study, participants rated how true each of 16 reasons was for why they were studying the online courses in which they were enrolled using a 7-point Likert scale with 7 indicating Very much true and 1 as Not at all true. Participants endorsed various statements reflecting the different styles of self-regulation and the extent that they explained the reasons for their own behavior with regard to their online course. Sixteen of these reasons were external, introjected, identified, and intrinsic regulation. External referred to taking behaviors because of external demand or possible reward (e.g., “So that I can make a good grade in the course”; items 8, 11, and 13 in Appendix A). Introjection indicated enacting behaviors because of feeling of guilty or pressure (e.g., “Because, if I didn’t I’d feel guilty”; items4, 6, and 16 in Appendix A). Identification referred to accepting the value of the behaviors as personally important (e.g., “Because I know I’ll find valuable, useful things by doing the work in this course”; items 10, 12, and 15 in Appendix A). Finally, integration referred to enacting behaviors because of personal enjoyment and interest (e.g., “Because I enjoy it”; items 4, 8, and 13 in Appendix A). External and introjected were considered controlled self-regulation, whereas identified and integrated were considered autonomous self-regulation. The autonomous self-regulation score was the average of identified and integrated subscales and the controlled self-regulation score was the average of external and introjected subscales.

Ryan and Connell (1989) reported internal consistency for each reason category ranging from .62 to .82. Internal consistencies of .75 for autonomous self-regulation and .67 for controlled self-regulation were reported by Black and Deci (2000) indicating moderate to high levels of internal consistency. Both studies were conducted in traditional face-to-face classrooms. Chen and Jang (2010) reported satisfactory internal consistency across subscales, ranging from .77 to .96 from college students in online course. The subscale alphas for this study were .90 for the autonomous self-regulation and .66 for the controlled self-regulation.

Perceived Instructors' Interaction Type**.** To assess students' perception of instructor's interaction type, two measures were used: The Learning Environment Climate Questionnaire (LECQ) and Teacher Controllingness Scale (TCS). LECQ is a 15-item scale designed to assess perceived autonomy as evidenced by feeling supported in the learning environment. LECQ was adapted from Black and Deci (2000). Black and Deci used LECQ to assess the degree to which students' workshop leader supports their autonomy in the college classrooms. The word "my group leader" was replaced with "my instructor" in this study. The LECQ offers response options on a 7-point Likert-type scale ranging from "strongly disagree" to "strongly agree" (e.g., "My instructor encouraged me to ask questions"; items 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, and 31 in Appendix A). Higher scores indicated higher levels of perceived autonomy. The LECQ were found to be internally consistent, with Cronbach alpha of .93 from college students (Black & Deci, 2000), and .96 from high school students (Hardre & Reeve, 2003) in the face-to-face classrooms. Cronbach alpha was .96 in this study.

Teacher Control Questionnaire is a 4-item measure with a 7-point Likert-type response ranging from 1 (strongly disagree) to 7 (strongly agree). TCQ was used from Jang et al.'s study (2009). The TCQ was designed to assess perceived external control in the learning environment (e.g., "My instructor tries to control everything I do"; items 33, 34, and 35 in Appendix A). The obtained Cronbach alpha was .87 from college students in the face-to-face classroom in Jang et al. (2009). The Cronbach alpha in this study was .88. The scores of LECQ and TCS were calculated separately in this study as indicators of perceived autonomy-support or external control.

Constructivist Learning Environment Questionnaire (CLEQ). The students' perception of the degree to which their online learning environment used constructivist-based pedagogy was measured with a 30-item scale that consisted of seven components of constructivist teaching and learning. Tenenbaum et al. (2001) empirically defined and examined key features of constructivist learning environments and their incorporation into two different learning environments (on-campus and online courses).

In the first phase of the study, a 6-week discussion through an electronic mailing list was carried out to explore the concept of constructivism, the process underlying constructivist learning and its facilitation. In the second phase of the study, they elaborated further on the key features of constructivism in the learning environment and developed a questionnaire to ascertain the presence of constructivist principles in formal higher-education instructional activities. The subsidiary aim of this second, quantitative phase was the development of a questionnaire that could be used by other researchers in different educational settings to investigate the presence and/or absence of constructivist practices. The study resulted in a survey containing 30 5-point Likert scale questions: 5 indicated as Very much and 1 as Not at all.

Seven key factors of constructivist learning environments underlie this questionnaire: (1) arguments, discussions, debates (e.g., "This course allows for arguments, discussions, and debates"; items 47, 48, 49, and 50 in Appendix A), (2) conceptual conflicts and dilemmas (e.g., "The course poses some dilemmas for me.";

items 52, and 53 in Appendix A), (3) sharing ideas with others (e.g., "The course allows social interaction."; items 55, 56, and 57 in Appendix A), (4) materials and measures targeted toward solutions (e.g., "The course teaches me how to arrive at appropriate answers."; items 59, and 60 in Appendix A), (5) reflections and concept investigation (e.g., "The course motivates me to think reflectively."; items 62, 63, 64, 65 and 66 in Appendix A), (6) meeting students' needs (e.g., "The course take into consideration my needs and concerns."; items 68, 69, 70, and 71 in Appendix A), and (7) making meaning, real-life examples (e.g., "The learning environment encourages me to think."; items 73, 74, and 75 in Appendix A).

Confirmatory Factor Analysis (CFA) was used to verify whether the original factor structure could be validated (Gijbels, Watering, Dochy, & Bossche, 2006). In Gijbels et al. (2006), the value for the Root Mean Square Error of Approximation (RMSEA = .07) in the current study indicated that the data set fit the 7-factor model fairly well (sufficient fit values are smaller than 0.08, Guay et al., 2003). The average score of 30 items was used as an indicator of the students' perception of the degree to which their online learning environment used constructivist-based pedagogy in this study. The Cronbach alpha of CLEQ in this study was .95.

<u>Technology self-efficacy.</u> Students' technology self-efficacy questionnaire contained five items to measure students' perception of their competence to use technological tools appropriately in the course. This measure was adapted from the original Patterns of Adaptive Learning Scales (PALS) (Midgley et al., 2000). The PALS had been developed and refined over time using goal orientation theory to examine the relation between the

learning environment and students' motivation, affect, and behavior. The PALS contains student and teacher scales. Among the 94 items of student scale, 5 items assess students' academic efficacy. For this study, those 5 academic efficacy items were modified to assess students' technology efficacy. For example "class work" was changed to "technological skills". Internal consistency of the original academic efficacy subscale scale was consistently satisfactory. Cronbach's alpha of this measure was .78 (Midgley et al., 2000) and .74 (Kaplan & Midgley, 1997). Items are responded to on a 5-point Likert scale with 1 representing "not at all true of me" and 5 representing 'very true of me." (e.g., "I'm certain I can master technological skills that need in this course"; items 42, 43, 44, and 45 in Appendix A). Technology self-efficacy score was the average of these 5 items. The Cronbach alpha was .91 in this study.

<u>Interest in the Course</u>. Students' interest in the course was measured by five items that were adapted from Tsai et al. (2008) assessing the emotion component and value component of the course. Responses were given on a 7-point scale that ranged from 1 (strongly disagree) to 7 (strongly agree). The items assessing the emotion component included: "The content of this course is interesting to me" and "I like the course content." The items assessing the value component included: "The course content was meaningful to me", "I saw what the teacher taught can be useful in real life", and "It is important to me that I thoroughly understand my course work." Cronbach's alpha of this measure as an index for internal consistency was calculated in Tsai et al. (2008). In their study, Cronbach's alpha was measured separately for each lesson-specific measurement: mathematics, German and the second foreign language. The Cronbach's alpha of these

lesson-specific measurements showed .90, .90 and .91, respectively (Tsai et al., 2008). Interest score was the average of the 5 items. The Cronbach alpha was .94 in this study.

Engagement. The engagement measure contained three separate subscales: Behavioral engagement, Cognitive engagement, and Voice engagement. This measure consisted of 28 items with a 7 response scale rating from 1 (strongly disagree) to 7 (strongly agree).

Behavioral engagement questions were adapted from the questionnaire in Miserandino's study (1996). This measure consisted with two subscales, one for involvement (e.g., "I read all materials carefully"; items 77, 78, 79, 80, 81, and 82 in Appendix A) and a second for persistent (e.g., "If a problem is really hard, I keep working at it"; items 84, 85, 86, 87, 88, and 89 in Appendix A). This measure showed adequate internal consistency, .76 and .77 for the involvement and the persistence (Miserandino, 1996).

Cognitive engagement questions were adapted from the metacognitive strategies questionnaire in Wolters' study (2004). Wolters used this measure for the high school students in a math class. The word "math" in the original measure was deleted for this study. This measure included nine items and reflected students' use of planning (e.g., "Before starting an assignment, I try to figure out the best way to do it."; items, 91, and 92 in Appendix A), monitoring (e.g., "For the assignments, I double check my work to make sure I am doing it right"; items, 94, and 95 in Appendix A), and regulatory strategies (e.g., "I try to change the way I study for this course to fit the type of material I'm trying to learn."; items, 97, and 98). Cronbach's alpha of this measure was .78 in Wolter's (2004) study.

The five items from Reeve and Tseng's (In press) Voice Engagement questionnaire were used to assess voice engagement. This measure was initially developed from classroom observation notes on the various ways that middle and high school students' attempted to contribute constructively to the flow of instruction they received. The five frequent ways that students attempted to voice themselves constructively during instruction were identified from the review and reflected general categories of behavior. Cronbach's alpha of this measure was .82 (Reeve & Tseng, in press). Sample items include: "I ask questions", "I let my teacher know what I'm interested in." (items 99, 100, 101, 102, and 103 in Appendix A). The engagement score for this study calculated the average of the three scales: Behavioral engagement, Cognitive engagement, and Voice engagement. Cronbach alpha was .93 in this study.

Satisfaction. Artino's (2008) satisfaction scale was used to assess students' overall satisfaction with the online course. This measure includes 3 Likert-scale items with a response scale ranging from 1 (completely disagree) to 7 (completely agree). This instrument yielded satisfaction scores with good internal reliability estimates (alpha = .92) from college students (Artino, 2008). The items are: "Overall I was satisfied with my online learning experience.", "This online course met my needs as a learner." and "I would recommend this online course to a friend who needed to learn the material." Cronbach alpha was .97 in this study.

Student demographics and background information. Distance education researchers such as Moore and Kearsley (1996) identified the need for investigating learner's characteristics in a group of students. This questionnaire consisted of 6 items and included questions regarding personal and background information of students. Items include student's age, gender, academic status, reasons for taking the online course, and the number of online course they have taken (Demographic information items 1, 2, 3, 4, 5, and 6 in Appendix A).

Data Analysis Methods

To answer the two research questions and test the eight hypotheses, correlations and hierarchical linear modeling (HLM) were conducted. The correlation coefficient *r* was measured to investigate the linear relationship among the independent variables: students' perception of their instructor's interaction type (autonomy-supportive interaction and controlling interaction), students' perception of the degree to which their online learning environment used constructivist-based pedagogy, students' interest in the course, and students' technology efficacy, and the dependent variable, students' self-regulated motivation. Correlation was employed to examine the preliminary relationships between self-regulated motivation and outcome variables (students' engagement, satisfaction, and interaction behaviors, and learning outcome).

HLM was used to test hypotheses to correctly account for course effects because students were nested within intact courses in this study. HLM analysis allows researchers to examine data from two levels – students (level-1) and the school or course (level-2). Misestimated standard errors occur with multilevel data when the dependence among individual responses within the same course is not taken into account. This dependence may arise because of shared experiences within the course or because of the ways in which individuals were initially drawn into the course. HLM resolves this problem by incorporating into the statistical model a unique random effect for each course unit. The variability in these random effects is taken into account in estimating standard errors (Raudenbush & Bryk, 2002).

In the test of each hypothesis, the pre-test autonomous self-regulation score was set as a covariate and post-test autonomous self-regulation scores as the dependent variable. Each of the four independent variables: students' interest in the course, student' technology self-efficacy, students' perception of the degree to which their online learning environments used constructivist-based pedagogy, and students' perception of instructor's autonomy support, was separately evaluated to determine if it explained post-autonomous self-regulation. Independent variables that were significant were tested simultaneously to determine the best predictor, or predictors. Hypotheses and related variables are presented below.

Table1. Research Questions / Hypotheses and Related Variables / Instruments

Research questions / Hypotheses	Variables/Instruments
Research question 1: How are students' online learning experiences (perception of their instructor's autonomy-supportive interaction and perception of the degree of online learning environments using constructivist-based pedagogy) and individual factors (interest in the course and technology self-efficacy) related to their autonomous self-regulation?	
Hypothesis 1. Students' perception of their instructor's autonomy-supportive interaction type is hypothesized to predict students' autonomous self-regulation.	LECQ, Self-regulation questionnaire (pre & post)

Table 1 - continued

Research questions / Hypotheses	Variables/Instruments
Hypothesis 2. Students' perception of the degree to which their online learning environments used constructivist-based pedagogy is hypothesized to predict students' autonomous self-regulation.	CLEQ, Self-regulation questionnaire (pre & post)
Hypothesis 3. Students' interest in the course is hypothesized to predict students' autonomous self-regulation.	Interest in the course, Self-regulation questionnaire (pre & post)
Hypothesis 4. Students' technology self-efficacy is hypothesized to predict students' autonomous self-regulation.	Technology Self-efficacy, Self-regulation questionnaire (pre- & post)
Research question 2: How is students' self-regulated motivation related to their engagement, satisfaction, interaction behaviors, and achievement in the online course in which they are enrolled?	
Hypothesis 5. Students' autonomous self-regulation is hypothesized to predict students' self-reported engagement.	Self-regulation questionnaire (pre & post), Engagement (pre & post)
Hypothesis 6. Students' autonomous self-regulation is hypothesized to predict students' achievement.	Self-regulation questionnaire (pre & post), course points
Hypothesis 7. Students' autonomous self-regulation is hypothesized to predict students' satisfaction.	Self-regulation questionnaire (pre & post), Satisfaction
Hypothesis 8. Students' autonomous self-regulation is hypothesized to predict students' interaction behaviors.	Self-regulation questionnaire (pre & post), 5 types of interaction behaviors data from ICON

CHAPTER IV

RESULTS

The purpose of this study was to investigate the factors that affected students' autonomous or self-determined forms of regulation as defined in self-determination theory (SDT). The study examined the relations between students' self-regulated motivation and four other variables (students' interest in course content, students' perception of their instructor's interaction type, students' technology self-efficacy, and students' perception of the degree to which their online learning environment used constructivist-based pedagogy), and the interactions among these variables in college online courses. In addition, the study examined the relationship between students' autonomous forms of regulation and their engagement and learning outcomes. In this chapter, the results of the statistical analyses aimed at answering two research questions are presented. The results are divided into four main sections; preliminary analyses, hypotheses testing, mediation analysis, and the summary of results.

First, preliminary analyses were conducted to determine if there was any significant difference between two groups (students who completed both surveys and students who did not complete the post survey) on the measures in the pre survey, and examined the missing data and the psychometric properties of each measurement instrument to confirm their consistency with the normal distribution and the reliability of the measures. Second, intercorrelation of the self-regulated motivation measure was explored to verify two composite variables, autonomous and controlled forms of self-regulation. Third, descriptive statistics and correlation analyses were conducted to explore the relationship among the proposed variables. Last, t-test and ANOVA were conducted to determine if scores on the dependent measures unexpectedly varied by demographic background such as gender, age, experiences of online courses, reasons to take the course, and academic statues.

Next, a series of hierarchical linear modeling analyses (HLM) were conducted to test proposed hypotheses and evaluate the adequacy of the proposed models. In hypotheses testing the unconditional model was explored first to determine if the multilevel analysis was appropriate for the current data. Subsequently, conditional models were presented by examining the proposed predictors. Mediation analysis was also conducted to investigate the mediating role of autonomous self-regulation, based on the relationship between personal and environmental factors and outcomes. Last, a summary of the results is presented.

Preliminary Analyses

Prior to analysis, data were examined through various SPSS 19.0 programs for accuracy of data entry, significant tests on the pre-survey items between two groups (students who completed and who did not complete the post survey), and missing values. Of the 161 students who completed the pre-survey, 141 students also completed the post-survey. In order to test any differences on pre-survey items between the two groups, t tests were conducted. Measures of interest in the course, technology self-efficacy, self-regulated motivation, and engagement questionnaire were obtained in the pre-survey. Table 2 contains mean scores, standard deviations, and p values of two groups for four pre-survey measures. The self-regulated motivation measure consisted of four subscales:

intrinsic, identified, introjected, and external motivation. Each subscale was tested separately. As can be seen in the Table 3, no significant differences were found between responses by the students who completed the both surveys and students who did not complete the post-survey. Therefore, the students who withdrew their participation from this study were not different from the students who remained.

Table 2. T-test Results of the Measures in the Pre-survey comparing Two Groups

Measures		Completed Post-survey	Incomplete Post-survey	Sig.
Interest in the course	M (SD)	5.64 1.19	5.34 1.16	.29
Technology self-efficacy	M (SD)	4.37 .64	4.29 .54	.60
Intrinsic Motivation	M (SD)	4.18 1.34	4.59 1.29	.20
Identified Motivation	M (SD)	4.99 1.24	5.11 1.35	.70
Introjected Motivation	M (SD)	4.64 1.26	4.93 1.49	.36
External Motivation	M (SD)	5.22 .98	5.58 .93	.13
Engagement	M (SD)	5.40 .72	5.34 .72	.73

Note. Total N = 161, N (Completed S) = 141, N (Incomplete S) = 20

Of the 141 students who completed the post-survey, one student's data was removed from the final analysis because the student did not complete over 60% of post-survey questions. Therefore, 140 cases were used in the analysis.

Next, the 140 cases were examined through SPSS 19.0 program for missing values. Excluding the demographic questions, the suite of surveys included 150 survey items. Of the 140 cases, there were 8 cases (5.7%) with missing values on individual survey items. Of the 8 cases, 3 cases had 2 missing entries, 3 cases had 3, 1 case had 4, and 1 case had 6 missing entries. Therefore, there were 25 missing values out of 21,000 entries in total, accounting for less than 1% of the total. The missing values were substituted using multiple imputation in SPSS 19.0. In multiple imputation, missing values for any variable are predicted using existing values from other variables. Multiple imputation has been shown to produce unbiased parameter estimates which reflect the uncertainly associated with estimating missing data (Wayman, 2003).

Reliability Analyses

Preliminary analyses were also calculated to explore the properties of the instruments and the distribution of scores on the instruments. The responses were treated as continuous variables. Table 3 illustrates the number of participants, the number of items, alpha coefficient, skewness, and kurtosis values for each of the instruments. Cronbach's alpha coefficients were calculated to estimate reliability. Alphas of nine instruments of the 11 were above .88 and alphas of two instruments were .69 and .63. For the purpose of this study, these alphas were considered acceptable.

How well each variable conformed to the normal distribution is illustrated by its skewness and kurtosis score in the same table. All 11 variables had acceptable scores on skewness and kurtosis in which the scores were between -2 and 2.

Table 3. Reliability of Measures

Instruments	N	Number of Items	Alpha	Skewness	Kurtosis
Interest in the course	161	5	.94	-1.39	1.80
Technology self-efficacy	161	5	.91	-.96	1.14
Self-Regulation (pre)					
Intrinsic	161	4	.90	-.46	-.28
Identified	161	4	.89	-.79	.37
Introjected	161	4	.69	-.82	.26
External	161	4	.63	-.43	-.05
Engagement (pre)	161	28	.93	.19	.38
LECQ	140	15	.96	-.97	.20
TCS	140	4	.88	-.41	-.21
CLEQ	140	30	.95	-.40	-.61
Satisfaction	140	3	.97	-.99	-.13

Note. LECQ = students' perception of their instructor's autonomy supportive interaction, TCS = students' perception of instructor's controlling interaction, CLEQ = students' perception of the degree to which their online learning environment used constructivist-based pedagogy.

Intercorrelation of Self-regulated motivation measure

Before creating the composite measures for autonomous and controlled forms of regulation, the intercorrelation among the set of scales that underlie these composite concepts was explored. Table 3 illustrates the intercorrelations matrix of the four subscales: intrinsic, identified, introjected, and external motivation. As shown in Table 4, the intercorrelation of intrinsic and identified motivation was significant (r = .86) at the p

< .01 level and intercorrelation of introjected and external motivation was also significant (r = .48) at the p < .01 level.

Table 4. Properties of Autonomous Motivation Composite Variable

Self-Regulation	M	SD	Possible Range	1	2	3	4
1. Intrinsic	4.19	1.43	1-7	-			
2. Identified	4.98	1.44	1-7	.86**	-		
3. Introjected	4.45	1.38	1-7	-.08	.03	-	
4. External	5.01	1.13	1-7	-.01	.06	.48**	-

Note. **p < .01

Given these significant correlations, a composite variable of autonomous self-regulated motivation was created by combining measures of intrinsic and identified, and a composite variable of controlled regulation was created by combining measures of introjected and external.

Descriptive Statistics of the Measured Variables

Descriptive statistics for the measured variables are provided in Table 5. As indicated, ten of the 12 variables were measured on a 7-point Likert-type scale: Interest, Technology self-efficacy, Autonomous self-regulation (pre and post), Controlled self-regulation (pre and post), Engagement (pre and post), LECQ, CLEQ, and satisfaction. All of variables had means above the midpoint of the response scale except TCS. Two variables (Technology self-efficacy and CLEQ) were measured on a 5-point Likert-type scale also had means above the midpoint of the response scale. Standard deviations for these 12 variables ranged from .64 to 1.70.

Table 5. Descriptive Statistics of the Measured Variables

Instruments	N	Mean	SD	Possible Range
Interest in the course	140	5.64	1.19	1 - 7
Technology self-efficacy	140	4.36	0.64	1 - 5
Autonomous self-regulation (pre)	140	4.60	1.22	1 - 7
Controlled self-regulation (pre)	140	4.94	1.01	1 - 7
Engagement (pre)	140	5.40	0.73	1 - 7
Autonomous self-regulation (post)	140	4.59	1.38	1 - 7
Controlled self-regulation (post)	140	4.74	1.09	1 – 7
LECQ	140	5.56	1.27	1 – 7
TCS	140	1.99	1.28	1 – 7
CLEQ	140	3.71	0.72	1 – 5
Engagement (post)	140	5.41	0.78	1 – 7
Satisfaction	140	5.43	1.70	1 - 7

Note. LECQ = students' perception of their instructor's autonomy supportive interaction, TCS = students' perception of instructor's controlling interaction, CLEQ = students' perception of the degree to which their online learning environment used constructivist-based pedagogy

Therefore, the students who participated in this study indicated that they had high interest in their course content and technology self-efficacy, autonomous and controlled self-regulation and engagement. They also perceived their instructors' interaction in an autonomy-supportive way rather than controlling way and also perceived their learning environments as using constructivist-based pedagogy.

Table 6 presents the descriptive statistics of five types of interaction behaviors that were collected from ICON. The class averages of the authored and read messages were 52 and 511. The averages of the number of visits to the content page, percentage of visited topics, and hours spent in the content page were 130, 77, and 22, respectively. The ranges of these interactions were considerably broad due to different course requirements and structure. Of the 19 courses, 3 courses did not require discussion participation that is, there were no assigned points that students could earn by posting messages in the discussion page. Sixteen courses assigned specific points by posting messages in the discussion page. The average discussion participation was worth 21% of the course grade with ranging from 4% to 40% of the course grade. Of the 16 courses, 9 courses specified the required quantity of the message. These types of interaction behaviors were converted to z-scores within each course for further analyses.

Table 6. Descriptive Statistics of Five Types of Interaction Behaviors

	Number of authored messages	Number of read messages	Number of visits to the content page	% of visited topics	Hours spent in the content page
Mean	52.39	511.21	129.74	77.25	21.73
Std. Deviation	46.52	304.68	88.99	23.19	19.90
Range	0 - 251	0 - 1483	8 - 649	16 - 100	0.2 - 89

Pearson Correlations

Table 7 presents the results of the correlation of five variables that were obtained at the pre-survey: Interest, Technology self-efficacy, Autonomous self-regulation, Controlled self-regulation, and Engagement. Pearson correlation indicated that personal factors, interest and technology self-efficacy were significantly and positively correlated with autonomous self-regulation ($r = .68$, $p < .01$, $r = .18$, $p < .05$), while these two variables were not related to controlled self-regulation. Autonomous self-regulation was significantly and positively correlated with engagement ($r = 65$, $p < .01$). However, Controlled self-regulation did not show any significant relationship with engagement ($r = .04$).

Table 7. Correlation Matrix for the Pre-Measures

Measures	1	2	3	4	5
1 Interest in the course	-				
2 Technology self-efficacy	.25**	-			
3 Autonomous self-regulation (pre)	.68**	.18*	-		
4 Controlled self-regulation (pre)	-.07	.09	.02	-	
5 Engagement (pre)	.48**	.36**	.65**	.04	-

Note. N=140, * $p < .05$, ** $p < .01$

Table 8 displays the correlation matrix for 7 variables that were obtained at the post-survey: Autonomous self-regulation, Controlled self-regulation, Learning Environment Climate Questionnaire (LECQ), Teacher Controllingness scale (TCS), Constructivist Learning Environment Questionnaire (CLEQ), engagement, and satisfaction. LECQ was to assess students' perception of their instructors' autonomy-supportive interaction and TCS was for students' perception of their instructors' controlling interaction style. CLEQ indicated students' perception of the degree to which their learning environments used constructivist-based pedagogy.

Table 8. Correlation Matrix for the Post-Measures

Measures	1	2	3	4	5	6	7
1 Autonomous self-regulation (post)	-						
2 Controlled self-regulation (post)	.00	-					
3 LECQ	.49**	.06	-				
4 TCS	-.31**	.04	-.55**	-			
5 CLEQ	.67**	-.09	.73**	-.36**	-		
6 Engagement (post)	.56**	-.17	.38**	-.06	.51**	-	
7 Satisfaction	.68**	.01	.71**	-.43**	.75**	.47**	-

Note. LECQ = Learning Environment Climate Questionnaire, TCS = Teacher Controllingness Scale, CLEQ = Constructivist Learning Environment Questionnaire, N=140, * p < .05, ** p < .01

Two environmental factors, LECQ and CLEQ were significantly correlated with each other (r = .73, p < .01). These two variables showed a significant relationship with autonomous self-regulation (r = .49, 67, p < .01), while these variables were not significantly correlated with controlled self-regulation (r = .06, -09). LECQ and TCS were negatively and significantly correlated (r = -.55, p < .01) and TCS also showed a negative relationship with autonomous self-regulation. These negative relationships between LECQ and TCS, and TCS and autonomous self-regulation are consistent with the previous findings (e.g., Reeve, 2002).

As same as the pre-survey, autonomous self-regulation was significantly correlated with engagement ($r = .56$, $p < .01$) in the post-survey. Autonomous self-regulation was also significantly correlated with satisfaction ($r = .68$, $p < .01$). Controlled self-regulation did not show any relationship with either engagement or satisfaction.

Table 9 presents the correlation matrix for five variables and post-autonomous and controlled self-regulation. Both interest and technology self-efficacy showed a significant relationship with pre-autonomous self-regulation (see Table 6). Interest continue to show a significant relationship with post-autonomous self-regulation ($r = .44$, $p < .01$) as it had with the pre-autonomous self-regulation. Technology self-efficacy was not significantly correlated with post-autonomous self-regulation as it had been in the pre-survey. All five variables in post-survey did not show any significant relationship with controlled self-regulation.

Table 9. Correlation Matrix for the Five Variables and Post-Self-regulation

Measures	1	2	3	4	5	6	7
1 Interest in the course	-						
2 Technology self-efficacy	.25**	-					
3 LECQ	.12	.16	-				
4 TCS	-.01	.05	-.55**	-			
5 CLEQ	.24**	.11	.73**	-.36**	-		
6 Autonomous self-regulation (post)	.44**	.03	.49**	-.31**	.67**	-	
7 Controlled self-regulation (post)	-.05	.03	.06	.04	-.09	.00	-

Note. LECQ = Learning Environment Climate Questionnaire, TCS = Teacher Controllingness Scale, CLEQ = Constructivist Learning Environment Questionnaire, N=140, * $p < .05$, ** $p < .01$

Next, Table 10 presents the results of the correlation of students' achievement (course points) and the five types of interaction behaviors that were obtained from the course websites, and the post-measures of autonomous and controlled self-regulation, engagement, and satisfaction. The course points, the total number of authored messages that were posted, the total number of read messages, the total number of visits to the content page, the number of topics that were viewed in the content page, and the total time spent in the content page were converted to z-scores within each course.

The total course points was used for students' achievement rather than letter grades in this study because each letter grade was assigned based on the course points and there was a wide range of students with a same letter grade. The obtained course points were converted to z-scores within each course to indicate students' achievement across courses accurately. Converting total course points to z-scores has the effect of the transforming the original distribution to one in which the mean becomes zero and the standard deviation becomes 1. A z-score quantifies the original score in terms of the number of standard deviations that the score is from the mean of the distribution. Because each course had its own grade scheme and different distribution, comparing the students' raw scores in one course to another was not appropriate.

The total number of authored messages and read messages, the number of visits to the content page, the number of topics that were viewed in the content page, and the total time that students spent in the content page were also converted to z-scores within each course in the analysis because these raw numbers varied depending on the course structure and requirements. For example, the course with a designated textbook had far less posted materials in the content page than the course that had all reading and activity materials posted in the content page. The students who took the course that had little materials in the content page would likely have less visits than the students who took the course that had many materials posted in the content page. In the same sense, students posted messages more when it was required than the students who did not have that requirement. For example, 20 times of posting messages can be considered a high number when the course average is 10, but 20 becomes a low number when the course average is 50. Therefore, converting raw scores to z-scores within a course addressed this problem by setting the course average to '0' and the standard deviation to '1" in all the courses.

As shown in Table 10, the course points were significantly correlated with only three interaction behaviors: the total number of authored and read messages, and the total number of visited topics in the content page (r = .18, .20, .21, $p < .05$). The total number of visits to the content page and the total time spent in the content page did not show any significant relationship with the course points. Students' autonomous self-regulation was significantly related to the course points ($r = .46$, $p < .01$) and also significantly correlated with the number of authored messages ($r = .26$, $p < .01$) and the number of visited topics in the content page ($r = .22$, $p < .01$). The course points was also significantly correlated with students' self-reported engagement ($r = .38$, $p < .01$) and satisfaction ($r = .44$, $p < .01$). However, controlled self-regulation did not show any significant relationship with the course points, engagement, satisfaction, and any other interaction data types.

Table 10. Correlation Matrix for Self-regulation, Interaction behaviors, Engagement, and Satisfaction

Measures	1	2	3	4	5	6	7	8	9	10
1 Course points										
2 MA#	.18*									
3 MR#	.20*	.54**								
4 CV#	.13	.22**	.21*							
5 TV#	.21*	.33**	.51**	.54**						
6 CT	.07	.01	-.11	.06	-.10					
7 ASR (post)	.46**	.26**	.15	.15	.22**	-.03				
8 Engagement (post)	.38**	.41**	.30**	.28**	.28**	.01	.56**			
9 Satisfaction (post)	.44**	.19*	.20*	.13	.30**	-.01	.68**	.47**		
10 CSR (post)	-.03	-.14	.07	.04	-.01	.15	.00	-.17	-.01	

Note. MA# = Number of messages authored, MR# = Number of messages read, CV#= Number of visits to the content page, TV# = Number of visited topics in the content page, CT = Total time spent in the content page, ASR = Autonomous self-regulation, CSR = Controlled self-regulation, * $p < .05$, ** $p < .01$

Differences in Responses Depending on Students' Demographic Background

Preliminary analyses were also conducted to investigate any significant differences in responses between participants who had different demographic backgrounds. Gender (male, female), age, previous online course experience (the number of online courses that students had taken), academic status (e.g., junior, senior, graduate), and the reason to take the online course (required vs. other reasons) were investigated.

Table B1 (Appendix B) includes mean scores, standard deviation, and the results of one-way ANOVA for the variables as a function of academic status. As can be seen in the table, no significant differences were found among response patterns in students in different academic status at the $p < .05$ level. Table B2 (Appendix B) includes mean scores, standard deviations, and t-tests for the measures as a function of reasons to take the course. The results indicated no significant differences were found among students who took the course for the different reasons (required vs. other reasons) at the $p < .05$ level.

Table B3 (Appendix B) contains mean scores, standard deviations, and t-tests for all 12 measures as a function of gender. The results indicate that interest and pre- and post-autonomous self-regulation were significantly different for male and female respondents. Female students scored higher than male students on interest and pre-and post-autonomous self-regulation. Female students were overrepresented in this sample. Of 140 participants 126 were female students and male students were 14.

In order to investigate any significant difference in responses between the students who were of different ages, a correlation was conducted between age and measured variables. Mean age of participants was 31.49 years old with the youngest being 19 and the oldest 56 years old. As shown in Table B4, age was significantly related to interest ($r = .20$, $p < .05$), pre-autonomous self-regulation ($r = .25$, $p < .01$), and post-autonomous self-regulation ($r = .22$, $p < .01$), post-controlled self-regulation ($r = -.21$, p

< .05), pre-engagement ($r = .26$, $p < .01$), and post-engagement ($r = .27$, $p < .01$). This implies that older students had more interest in the content and autonomous self-regulation, and engaged in the course better than younger student, but indicated less controlled self-regulation than the younger students.

A one-way ANOVA was also conducted to determine if different online course experiences influenced any of the variables. The online course experience was divided into four categories: less than 3 courses, 3 -5 courses, 6 – 8 courses, and more than 8 courses. Six measures showed significant differences among these categories: pre-controlled self-regulation, post-autonomous forms of self-regulation, LECQ, CLEQ, post-engagement and satisfaction (see Table B5 in Appendix B).

As can be seen in the ANOVA test results, three demographic variables showed significant differences in the students' responses: gender, age, and previous online experience. Therefore, these three variables were controlled in hypothesis testing.

Hypothesis Testing

Eight hypotheses were tested. The first four hypotheses were related to the first research question. Hypothesis 1 and 2 proposed that learning environmental factors would predict autonomous self-regulation and Hypothesis 3 and 4 proposed that students' personal factors would predict students' autonomous self-regulation.

Research question 1. How are students' online learning experiences and individual factors related to their autonomous forms of self-regulation?

Hypothesis 1. Students' perception of their instructor's autonomy-support interaction type is hypothesized to predict students' autonomous forms of self-regulation.

Hypothesis 2. Students' perception of the degree to which online learning environments used constructivist-based pedagogy is hypothesized to predict students' autonomous forms of self-regulation.

Hypothesis 3. Students' interest in the course is hypothesized to predict students' autonomous forms of self-regulation.

Hypothesis 4. Students' technology efficacy is hypothesized to predict students' autonomous forms of self-regulation.

The second four hypotheses were related to the second research question. Hypothesis 5 - 8 proposed that students' autonomous self-regulation would predict their engagement, achievement, satisfaction, and interaction behaviors.

Research question 2. How is students' self-regulated motivation related to their engagement, satisfaction, academic achievement, and interaction behaviors in the online course in which they are enrolled?

Hypothesis 5. Students' autonomous self-regulation is hypothesized to predict their self-reported engagement.

Hypothesis 6. Students' autonomous self-regulation is hypothesized to predict their achievement.

Hypothesis 7. Students' autonomous self-regulation is hypothesized to predict their satisfaction.

Hypothesis 8. Students' autonomous self-regulation is hypothesized to predict their interaction behaviors.

The PROC MIXED procedure in SAS was used to fit two-level course effects models in this study. The behavior of level-1 outcomes as a function of both level-1 and level -2 predictors were investigated.

The data in this study consists of the responses of 140 students from 19 different courses. In hypothesis testing from 1 to 4, the student level (level-1) outcome was post-autonomous forms of self-regulation. The covariates at the student level were pre-autonomous forms of self-regulation, interest in the course, technology self-efficacy, students' perception of autonomy support instructor's interaction, and students' perception of the degree to which their online learning environment used constructivist-based pedagogy.

First, by fitting an unconditional means model, variation in post-autonomous forms of self-regulation was examined across courses in which any predictors were not included, and then it was sequentially examined the effects of student level (level-1) predictors.

Unconditional Mean Model

Prior to fitting models that test substantive hypotheses, this unconditional mean model assessed certain "baseline" characteristics on the data. This is a model with a single population-average intercept and single random-effect for the intercept.

The level-1 equation is expressed as:

$\gamma ij = \beta oj + rij$

where γij is the outcome measure for individual *i* in course j. βoj is the sum of an intercept for student's online course and *rij* is a random error associated with the *ith* student in the *jth* course.

The level-2 equation is expressed as:

$\beta oj = \gamma oo + \mu oj$

where the course level intercepts is the sum of an overall mean (γoo) and a series of random deviation from that mean (μoj). Table 10 presents the results of fitting this model.

In Table 11, the level-1 (student level) variance is estimated at 1.48 and the level-2 (course level) intercept variance is estimated at 0.42. These indicate that both variance components are significantly different from 0. These estimates suggest that courses do differ in their average of post-autonomous self-regulation scores and that there is even more variation among students within courses. The variance component within courses is nearly four times the size of the variance component between courses. This variation in autonomous forms of self-regulation was estimated by the interclass correlation as well.

$$\gamma oo / (\gamma oo + \alpha 2) = 0.4161 / (0.4161 + 1.4784) = 0.22$$

Table 11. The HLM results of unconditional Mean Model

Covariance Parameter Estimates (Level-2)					
Cov Parm	Subject	Estimate	SE	Z Value	P
Intercept	Course	0.42	0.21	1.98	0.02
Residual		1.48	0.19	7.84	< .0001
Fixed Effects (level-1)					
Effect	Estimate	SE	DF	t Value	P
Intercept	4.64	0.19	18	24.89	< .0001

In HLM, an intraclass correlation coefficient (ICC) score is used to test the appropriateness of the multi-level model. ICC scores range from 0 for complete independence of observations to 1 for complete dependence (Hope & Shannon, 2005). The ICC of 0.22 indicated that 22% of the variability in the model occurred at the course level (level-2). Therefore, this suggests that one level regression analysis of these data would likely yield misleading results because it excludes the course level variability.

Conditional Model – Including Effects of Student Level (level-1) Predictors

The unconditional model provided a baseline in which none of the predictors was included. In the conditional model, both effects of course-level and student-level predictors were investigated. In the current study, there were only student level predictors but no course level predictor. Therefore, only the effects of student level predictors were examined.

In Hypotheses testing 1 through 4, the post-autonomous self-regulation score was set as the dependent variable and the pre-autonomous self-regulation scores as a covariate along with four other independent variables. Each of four independent variables: students' perception of instructor's autonomy supportive interaction, students' perception of the degree to which their learning environments used constructivist-based pedagogy, students' interest in the course, and students' technology self-efficacy, was separately evaluated to determine if each explained post-autonomous self-regulation. Independent variables that were significant in the individual testing were tested simultaneously to determine the best predictor, or predictors. Three demographic variables, gender, age, and previous experience in online courses (the number of online courses that were taken previously) were controlled in each hypothesis testing.

Hypothesis 1 proposed that the instructor's interaction style would predict post students' autonomous self-regulation. Specifically, it proposed that students' perception of their instructor's autonomy-supportive interaction type would predict higher students' autonomous self-regulation. This model is expressed as;

$$\gamma ij = \beta oj + \beta ij\ Gij + \beta ij\ Agij + \beta ij\ Eij + \beta ij\ Pij + \beta ij\ AUij + rij$$

where γij is the outcome measure (post autonomous forms of self-regulation) for individual *i* in course j. G is gender, Ag is age, E is the number of online courses taken, P is pre-autonomous forms of self-regulation, AU is students' perception of their instructor's autonomy-supportive interaction type, and *rij* is a random error associated with the *ith* student in the *jth* course.

Table 12 shows the results of HLM analysis testing the effect of students' perception of their instructor's autonomy-supportive interaction type on their autonomous self-regulation. Pre-autonomous self-regulation, gender, age, and the number of online courses taken were set as covariates with autonomy-supportive interaction in this test.

The first part of the table indicates the level-2 (course-level) results in which no variable shows significance except residual (parameter estimate = 0.89, $p < .0001$). That is, most variance occurred at the student level but not course level. The second part of the table presents the results of level-1, student level. The results showed that students' perception of their instructors' autonomy-supportive interaction predicted post-autonomous self-regulation (t (116) = 5.36, $p < .0001$). The parameter estimate of students' perception of their instructors' autonomy-supportive interaction was 0.39 (SE = 0.07). That is, a one-point increase in students' autonomous self-regulation was associated with a 0.39 point increase on students' perception of their instructors' autonomy-supportive interaction type. Therefore, Hypothesis 1 was supported.

Table 12. Results of HLM Analysis of Students' Perception of their Instructor's Autonomy-Supportive Interaction on their Autonomous Self-regulation

Covariance Parameter Estimates					
Cov Parm	Subject	Estimates	SE	Z Value	P
Intercept	Course	0.05	0.23	0.24	0.41
Gender	Course	0	-	-	-
Age	Course	0.00	0.00	0.11	0.46
Number of online course	Course	0.00	0.001	0.16	0.44
Autonomous self-regulation (pre)	Course	0	-	-	-
Autonomy-supportive interaction	Course	0.00	0.006	0.02	0.49
Residual		0.89	0.12	7.56	< .0001
Fixed Effects					
Parameter	Estimate	SE	DF	t Value	P
Intercept	-.092	0.57	18	-1.61	0.12
Gender	0.74	0.29	116	2.55	0.01
Age	0.02	0.01	116	1.84	0.07
Number of online course	0.01	0.02	116	0.58	0.57
Autonomous self-regulation (pre)	0.45	0.08	116	5.88	< .0001
Autonomy-supportive interaction	0.39	0.07	116	5.36	< .0001

Hypothesis 2 proposed that students' perception of the degree to which their online learning environments used constructivist-based pedagogy was hypothesized to predict students' autonomous forms of self-regulation. This model is expressed as:

$$\gamma ij = \beta oj + \beta ij\ Gij + \beta ij\ Aij + \beta ij\ Eij + \beta ij\ Pij + \beta ij\ Cij + rij$$

where γij is the outcome measure (post-autonomous forms of self-regulation) for individual *i* in course j. G is gender, A is age, E is the number of online courses taken, P is pre-autonomous forms of self-regulation, C is students' perception of the degree of online learning environments using constructivist-based pedagogy, and *rij* is a random error associated with the *ith* student in the *jth* course.

Table 13 shows the results of HLM analysis testing the effect of students' perception of the degree of their online learning environments used constructivist-based pedagogy on their autonomous motivation. Similar to the results of students' perception of their instructors' autonomy-supportive interaction, the level-2 (course level) results showed no variable was significant except residual (parameter estimates = 0.70, $p < .0001$). At the student level, the results of fixed effect indicated students' perception of the degree to which their learning environment used constructivist-based pedagogy predicted the autonomous forms of self-regulation (t (116) = 9.47, $p < .0001$). The parameter estimate of students' perception of the degree to which their learning environment used constructivist-based pedagogy was 1.02 (SE = 0.11). That is, a one-point increase in students' autonomous self-regulation was associated with a 1.02 point increase on students' perception of the degree to which their online learning environment used constructivist-based pedagogy. Therefore, Hypothesis 2 was supported.

Table 13. Results of HLM Analysis of Students' Perception of Their Online Learning Environments Used Constructivist-based Pedagogy on Their Autonomous Self-regulation

Covariance Parameter Estimates					
Cov Parm	Subject	Estimates	SE	Z Value	P
Intercept	Course	0.01	0.04	0.28	0.39
Gender	Course	0	-	-	-
Age	Course	0	-	-	-
Number of online course	Course	0	-	-	-
Autonomous self-regulation (pre)	Course	0	-	-	-
Constructive-based pedagogy	Course	0	-	-	-
Residual	Course	0.70	0.09	7.71	<.0001
Fixed Effect					
Parameter	Estimate	SE	DF	t Value	P
Intercept	-2.0	0.48	18	-4.14	0.01
Gender	0.61	0.25	116	2.46	0.02
Age	0.01	0.01	116	0.95	0.35
Number of online course	0.01	0.02	116	0.46	0.64
Autonomous self-regulation (pre)	0.43	0.07	116	6.41	< .0001
Constructive-based pedagogy	1.02	0.11	116	9.47	< .0001

Hypothesis 3 proposed that students' interest in the course was hypothesized to predict students' autonomous forms of self-regulation. This model is expressed as:

$$\gamma ij = \beta oj + \beta ij\ Gij + \beta ij\ Aij + \beta ij\ Eij + \beta ij\ Pij + \beta ij\ INTEREST\ ij + rij$$

where γij is the outcome measure (post-autonomous self-regulation) for individual *i* in course j. G is gender, A is age, E is the number of online courses taken, P is pre-autonomous self-regulation, INTEREST is students' interest in the course, and *rij* is a random error associated with the *ith* student in the *jth* course.

Table 14 presents the results of HLM Analysis of students' interest in the course on their autonomous forms of self-regulation. The results indicated that students' interest in the course did not predict their autonomous self-regulation (t (116) = .46, p = .65). Therefore, Hypothesis 3 was not supported.

Hypothesis 4 proposed that students' technology self-efficacy was hypothesized to predict students' autonomous forms of self-regulation and this model is expressed as:

$$\gamma ij = \beta oj + \beta ij\ Gij + \beta ij\ Aij + \beta ij\ Eij + \beta ij\ Pij + \beta ij\ TECHNOLOGYij + rij$$

where γij is the outcome measure (post-autonomous self-regulation) for individual *i* in course j. G is gender, A is age, E is the number of online courses taken, P is pre-autonomous forms of self-regulation, TECHNOLOGY is students' technology self-efficacy, and *rij* is a random error associated with the *ith* student in the *jth* course.

Table 15 presents the results of HLM Analysis of students' technology self-efficacy on their autonomous forms of self-regulation. The results showed that students' technology self-efficacy did not predict their autonomous forms of self-regulation 4 (t (116) = -.83, p = .41). Hypothesis 4 was not supported.

Table 14. Results of HLM Analysis of Students' Interest in the Course on Their Autonomous Self-regulation

Covariance Parameter Estimates					
Cov Parm	Subject	Estimates	SE	Z Value	P
Intercept	Course	0.08	0.24	0.35	0.36
Gender	Course	0.09	0.19	0.48	0.32
Age	Course	0	-	-	-
Number of online course	Course	0	-	-	-
Autonomous self-regulation (pre)	Course	0.002	0.01	0.16	0.44
Interest in the course	Course	0	-	-	-
Residual	Course	1.02	0.14	7.52	<.0001
Fixed Effect					
Parameter	Estimate	SE	DF	t Value	P
Intercept	0.98	0.55	18	1.80	0.09
Gender	0.48	0.31	116	1.54	0.13
Age	0.01	0.01	116	1.12	0.26
Number of online course	0.04	0.02	116	1.55	
Autonomous self-regulation (pre)	0.52	0.11	116	4.94	< .0001
Interest in the course	0.05	0.10	116	0.46	0.65

Table 15. Results of HLM Analysis of Students' Technology Self-efficacy on Their Autonomous Self-regulation

Covariance Parameter Estimates					
Cov Parm	Subject	Estimates	SE	Z Value	P
Intercept	Course	0	-	-	-
Gender	Course	0.07	0.18	0.36	0.37
Age	Course	0	-	-	-
Number of online course	Course	0	-	-	-
Autonomous self-regulation (pre)	Course	0.001	0.02	0.03	0.49
Technology self-efficacy	Course	0.007	0.02	0.40	0.34
Residual	Course	1.006	0.13	7.49	<.0001
Fixed Effect					
Parameter	Estimate	SE	DF	t Value	P
Intercept	1.58	0.74	18	2.14	0.05
Gender	0.48	0.31	116	1.55	0.12
Age	0.01	0.01	116	1.21	0.23
Number of online course	0.04	0.02	116	1.48	0.14
Autonomous self-regulation (pre)	0.55	0.08	116	6.76	< .0001
Technology self-efficacy	-0.12	0.15	116	-0.83	0.41

Hypothesis testing for fixed effects revealed significant t statistics for students' perception of instructor's autonomy-supportive interaction and students' perception of the degree to which their learning environments used constructivist-based pedagogy. Therefore, the more instructors were rated by students as providing autonomy-supportive interaction and the more learning environments were rated by students as using constructivist-based pedagogy, the greater autonomous self-regulation the students reported.

Next, two independent variables that were significant, students' perception of instructor's autonomy-supportive interaction and their learning environments used constructivist-based pedagogy, were tested simultaneously to determine the best predictor. Three control variables, gender, age, and the number of online courses taken were not included in this simultaneous testing because both independent variables were significant in the previous analyses when these control variables were set as covariates. However, pre-autonomous forms of self-regulation remained as a covariate.

This model is expressed as:

$$\gamma ij = \beta oj + \beta ij\ AUij + \beta ij\ Cij + rij$$

where γij is the outcome measure (post-autonomous self-regulation) for individual *i* in course j. AU is students' perception of their instructor's autonomy-supportive interaction, C is students' perception of the learning environments using constructivist-based pedagogy, and *rij* is a random error associated with the *ith* student in the *jth* course.

Table 16 shows the results of HLM analysis. When students' perception of instructor's autonomy supportive interaction and learning environments used constructivist-based pedagogy were tested simultaneously, only students' perception of the degree to which their learning environments used constructivist-based pedagogy was a significant predictor (t (118) = 7.19, $p < .0001$). That is, among four variables: students' perception of instructors' autonomy-supportive interaction, students' perception of the degree to which their learning environments used constructivist-based pedagogy, students' interest in the course, and technology self-efficacy, students' perception of the degree to which their learning environments used constructivist-based pedagogy was the most significant predictor of students' autonomous self-regulation.

Table 16. Results of HLM Analysis of Students' Perception of Their Instructors' Autonomy-Supportive Interaction and Learning Environment used Constructivist-based Pedagogy on Their Autonomous Self-regulation

Covariance Parameter Estimates					
Cov Parm	Subject	Estimates	SE	Z Value	P
Intercept	Course	0	-	-	-
Autonomous self-regulation (pre)	Course	0	-	-	-
Autonomous-supportive interaction	Course	0	-	-	-
Constructive-based pedagogy	Course	0	-	-	-
Residual	Course	0.73	0.09	8.25	<.0001
Fixed Effect					
Parameter	Estimate	SE	DF	t Value	P
Intercept	-1.43	0.42	18	-3.43	0.003
Autonomous self-regulation (pre)	0.49	0.06	116	7.85	< .0001
Autonomous-supportive interaction	-0.05	0.08	116	-0.56	0.58
Constructive-based pedagogy	1.08	0.15	116	7.19	< .0001

The next four hypotheses were related to the second research question seeking how students' autonomous self-regulation is related to their engagement, satisfaction, academic achievement, and interaction behaviors in the online course. Three demographic variables, gender, age, and the number of online courses that were taken, were also controlled in each testing.

Hypothesis 5 proposed that students' autonomous self-regulation was hypothesized to predict students' engagement. Students' pre-engagement and pre autonomous self-regulation scores were used as a covariate in this testing. Table 17 indicated no variable showed significant except residual (Estimates = 0.24, $p < .0001$) at the course level. At the student level, autonomous forms of self-regulation predicted post-engagement (t (115) = 6.23, $p < .0001$). The parameter estimate of autonomous forms of self-regulation was 0.25 (SE = 0.04). That is, a one-point increase in students' engagement was associated with a 0.25 point increase on students' autonomous self-regulation. Therefore, Hypothesis 5 was supported.

Hypothesis 6 proposed that students' autonomous self-regulation was hypothesized to predict students' academic achievement. Table 18 showed that no variable showed significant except residual (Estimates = 0.48, $p < .0001$) at the course level, which indicated most variation occurred at the student level. At the student level, autonomous forms of self-regulation predicted academic achievement (t (116) = 5.00, $p < .0001$). The parameter estimate of autonomous forms of self-regulation was 0.28 (SE = 0.06). That is, a one-point increase in students' achievement was associated with a 0.28 point increase on students' autonomous self-regulation. Therefore, Hypothesis 6 was supported.

Table 17. Results of HLM Analysis of Students' Autonomous Self-regulation on Their Self-reported Engagement

Covariance Parameter Estimates					
Cov Parm	Subject	Estimates	SE	Z Value	P
Intercept	Course	0	-	-	-
Gender	Course	0	-	-	-
Age	Course	0	-	0.87	0.19
Number of online course	Course	0	-	0.48	0.31
Engagement (pre)		0	-	-	-
Autonomous self-regulation (pre)	Course	0	-	-	-
Autonomous self-regulation (post)	Course	0	-	-	-
Residual	Course	0.24	0.03	7.35	<.0001
Fixed Effect					
Parameter	Estimate	SE	DF	t Value	P
Intercept	1.20	0.35	18	3.45	< .0001
Gender	- 0.18	0.15	115	- 1.20	0.23
Age	0	0	115	0.5	0.62
Number of online course	0.02	0.01	115	1.44	0.15
Engagement (pre)	0.66	0.08	115	8.59	< .0001
Autonomous self-regulation (pre)	-0.12	0.05	115	-2.21	0.03
Autonomous self-regulation (post)	0.25	0.04	115	6.23	< .0001

Table 18. Results of HLM Analysis of Students' Autonomous Self-regulation on Their Academic Achievement (Course Points)

Covariance Parameter Estimates					
Cov Parm	Subject	Estimates	SE	Z Value	P
Intercept	Course	0	-	-	-
Gender	Course	0	-	-	-
Age	Course	0	-	-	-
Number of online course	Course	0	-	0.96	0.17
Autonomous self-regulation (pre)	Course	0	-	-	-
Autonomous self-regulation (post)	Course	0	-	-	-
Residual	Course	0.48	0.06	7.71	<.0001
Fixed Effect					
Parameter	Estimate	SE	DF	t Value	P
Intercept	-0.83	0.32	18	-2.58	0.02
Gender	-0.30	0.21	116	- 1.46	0.15
Age	-0.003	0.007	116	- 0.49	0.63
Number of online course	0.03	0.02	116	1.71	0.09
Autonomous self-regulation (pre)	0.02	0.06	116	0.35	0.72
Autonomous self-regulation (post)	0.28	0.06	116	5.00	< .0001

Hypothesis 7 proposed that students' autonomous self-regulation was hypothesized to predict students' satisfaction. Table 19 indicated that only residual showed significance (Estimates = 1.46, $p < .0001$) at the course level. At the student level, students' autonomous forms of self-regulation predicted their satisfaction (t (116) = 9.63, $p < .0001$). The parameter estimate of autonomous forms of self-regulation was

0.94 (SE = 0.10). That is, a one-point increase in students' satisfaction was associated with a 0.94 point increase on students' autonomous self-regulation. Therefore, Hypothesis 7 was supported.

Table 19. Results of HLM Analysis of Students' Autonomous Self-regulation on Their Satisfaction

Covariance Parameter Estimates					
Cov Parm	Subject	Estimates	SE	Z Value	P
Intercept	Course	0	-	-	-
Gender	Course	0	-	-	-
Age	Course	0	-	0.77	0.22
Number of online course	Course	0	-	-	-
Autonomous self-regulation (pre)	Course	0	-	-	-
Autonomous self-regulation (post)	Course	0	-	-	-
Residual	Course	1.46	0.19	7.87	<.0001
Fixed Effect					
Parameter	Estimate	SE	DF	t Value	P
Intercept	2.26	0.56	18	4.59	.0002
Gender	- 0.53	0.36	116	- 1.48	0.14
Age	- 0.01	0.01	116	- 0.66	0.51
Number of online course	0.04	0.03	116	1.49	0.14
Autonomous self-regulation (pre)	-0.2	0.11	116	-1.83	0.07
Autonomous self-regulation (post)	0.94	0.10	116	9.63	< .0001

Hypothesis 8 proposed that students' autonomous self-regulation was hypothesized to predict students' interaction behaviors in the online courses. For students' interaction behaviors data, the total number of authored and read messages, the total number of visits to the content page, the total number of visited topics in the content page, and total duration spent in the content page, were obtained from ICON. These five interaction behaviors were examined related to students' post autonomous forms of self-regulation. Of these five types of interaction behaviors, only two types, the total number of authored messages, and the total number of visited topics in the content page, were positively correlated with students' autonomous forms of self-regulation in the preliminary analysis. Therefore, these two interaction types were tested to determine if autonomous forms of self-regulation predicted these interaction behaviors. Gender, age, the number of online courses taken, and pre autonomous self-regulation were controlled in each testing.

At the course level, no variable showed significance except residual (see Table B6 in Appendix B). Table 20 presents the fixed effects of HLM analysis of students' autonomous self-regulation on their two types of interaction. Students' autonomous forms of self-regulation did not predict neither the total number of authored messages (t (116) = 1.36, p = .17) nor the total number of visited topics in the content page (t (116) = 1.42, p = 0.16). Therefore, Hypothesis 8 was not supported.

In the preliminary analyses, students' achievement (course points) was significantly correlated with three types of interaction behaviors, the number of messages authored and read, and the number of visited topics in the content page. However, HLM analysis indicated that none of these types of interaction behaviors was found to be the predictor of students' achievement (see Table 21).

Table 20. Results of HLM Analysis of Students' Autonomous Self-regulation on the Number of Authored Message and Visited Topics in the Content Page

Fixed Effects for the Number of Authored Message					
Cov Parm	Estimate	SE	DF	t Value	P
Intercept	-1.15	0.35	18	-3.24	0.004
Gender	- 0.15	0.23	116	- 0.64	0.52
Age	-0.02	0.01	116	2.12	0.04
Number of online course	-0.01	0.02	116	-0.49	0.65
Autonomous self-regulation (pre)	0.11	0.07	116	1.53	0.13
Autonomous self-regulation (post)	0.09	0.06	116	1.38	0.17
Fixed Effect for the Number of Visited Topics					
Parameter	Estimate	SE	DF	t Value	P
Intercept	-0.83	0.41	18	-2.01	0.06
Gender	0.12	0.27	116	0.45	0.65
Age	0.01	0.01	116	0.55	0.58
Number of online course	0.04	0.02	116	2.06	0.04
Autonomous self-regulation (pre)	0.02	0.08	116	0.26	0.79
Autonomous self-regulation (post)	0.10	0.07	116	1.42	0.16

Table 21. Results of HLM Analysis of Interaction Behaviors on Students' Achievement

Covariance Parameter Estimates					
Cov Parm	Subject	Estimates	SE	Z Value	P
Intercept	Course	0	-	-	-
Gender	Course	0	-	-	-
Age	Course	0	-	-	-
Number of online course	Course	0	-	-	-
Messages authored	Course	0.14	0.11	1.35	0.09
Messages read	Course	0	-	-	-
Number of visited topics	Course	0.01	0.04	0.36	0.36
Residual		1.52	0.08	6.78	<.0001
Fixed Effect					
Parameter	Estimate	SE	DF	t Value	P
Intercept	0.14	0.31	18	0.45	0.66
Gender	-0.12	0.21	112	-0.57	0.57
Age	0.002	0.007	112	0.28	0.78
Number of online course	0.04	0.02	112	2.07	0.04
Messages authored	0.12	0.14	112	0.84	0.41
Messages read	0.14	0.09	112	1.49	0.14
Number of visited topics	0.06	0.09	112	0.61	0.54

Mediation Analysis

Mediation analysis was conducted to examine the possible mediating role of autonomous self-regulation on the relationship between two environmental factors (students' perception of their instructors' autonomy-supportive interaction and students' perception of the degree to which their online learning environments used constructivist-based pedagogy) and outcomes (engagement, achievement, and satisfaction).

To test the mediation the Baron and Kenny (1986) method was used. In the present study, students' perception of their instructor's autonomy-supportive interaction and students' perception of the degree to which their online learning environment used constructivist-based pedagogy are independent variables. Autonomous self-regulation is a mediator, and students' engagement, achievement, and satisfaction are dependent variables (see Figure 2).

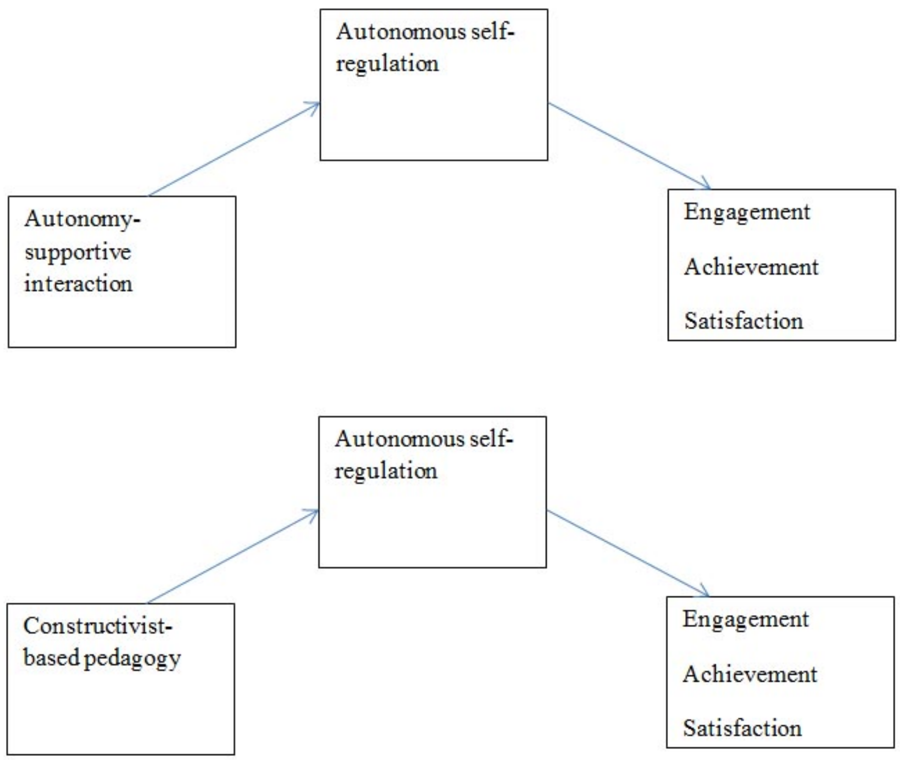

Figure 2. Illustration of the Mediator Model.

As indicated by Baron and Kenny (1986), to establish mediation several conditions must hold: "First, the independent variable must affect the mediator in the first equation; second, the independent variable must be shown to affect the dependent variable in the second equation; and third, the mediator must affect the dependent variable in the third equation. If these conditions all hold in predicted direction, then the effect of the independent variable on the dependent variable must be less in the third equation than in the second. Perfect mediation holds if the independent variable has no effect when the mediator is controlled" (Baron & Kenny, 1986, p. 1177).

The result of HLM analysis showed that autonomy-supportive interaction predicted students' autonomous self-regulation and students' autonomous self-regulation predicted three outcomes, engagement, achievement, and satisfaction, which satisfy the first and third conditions of mediation (see Table 12 and 17). To test autonomous self-regulation mediation of the relationship between students' perception of their instructors' autonomy-supportive interaction and outcome variables engagement, achievement, and satisfaction, the relationships between instructors' autonomy-supportive interaction and three outcome variables were tested. Table 22 shows the results of HLM analysis testing of those relationships. Students' perception of their instructors' autonomy-supportive interaction positively and significantly predicted engagement, achievement, and satisfaction (Estimate = .15, .17, and .92 respectively). These effects were lower than the effect of autonomous self-regulation on engagement, achievement, and satisfaction (Estimate = .25, .28, and .94 respectively), Furthermore, this effect of autonomy-supportive interaction on engagement and achievement became non-significant after controlling for the autonomous self-regulation. Although significant, the effect of autonomy-supportive interaction on satisfaction was lower after controlling for the autonomous self-regulation effect than before controlling for it (Estimate = .66 vs. .92).

These results reveal autonomous self-regulation mediation of the relationship between autonomy-supportive interaction and three outcome variables, engagement, achievement, and satisfaction.

Table 22. HLM Analysis Testing the Mediation Effect.

Independent Variable	Dependent Variable	Parameter Estimate
Autonomy-supportive interaction	Engagement	0.15***
Autonomy-supportive interaction	Achievement	0.17**
Autonomy-supportive interaction	Satisfaction	0.92***
Autonomy-supportive interaction (controlling for autonomous self-regulation)	Engagement	0.06
Autonomy-supportive interaction (controlling for autonomous self-regulation)	Achievement	0.03
Autonomy-supportive interaction (controlling for autonomous self-regulation)	Satisfaction	0.66***
Constructivist-based Pedagogy	Engagement	0.36***
Constructivist-based Pedagogy	Achievement	0.44***
Constructivist-based Pedagogy	Satisfaction	1.70***

Note. $**p < .***p < .001$

On the other hand, the HLM results of autonomous self-regulation mediation of the relationship between constructivist-based pedagogy and the outcome variables, engagement, achievement, and satisfaction indicated that the effect of constructivist-based pedagogy on engagement, achievement, and satisfaction were higher than the effect of autonomous self-regulation on these outcome variables (Estimate = .36, .44, and 1.70 vs. .25, .28, and .91 respectively). Therefore, students' autonomous self-regulation does not mediate the relationship between students' perception of the degree to which their online learning environments used constructivist-based pedagogy to their engagement, achievement, and satisfaction.

Summary of Results

Two research questions and eight hypotheses were evaluated through examination of correlation and HLM analyses. The first research question examined students' online learning experiences (perception of their instructor's autonomy-supportive interaction and perception of the degree to which their online learning environments used constructivist-based pedagogy) and individual factors (interest in the course and technology self-efficacy) related to their autonomous forms of self-regulation.

In the preliminary analyses correlation matrixes indicated the significant association between proposed predictors and students' autonomous self-regulation. Among the personal factors, only students' interest in the course was significantly related to their autonomous self-regulation and both factors related to students' online learning experiences, students' perception of their instructors' autonomy-supportive interaction and perception of the degree to which their learning environments used constructivist-based pedagogy, were significantly correlated with their autonomous self-regulation. As expected, controlled self-regulation did not show any significant association with the proposed predictors.

Among the five proposed predictors, students' interest in the course, technology self-efficacy, students' perception of their instructor's autonomy-supportive interaction, perception of their instructors' controlling interaction, and perception of the degree to which their learning environments used constructivist-based pedagogy, students' perception of their instructor's autonomy-supportive interaction was significantly correlated with their perception of the degree to which their online learning environments used constructivist-based pedagogy. As consistent with the previous findings, students' perception of their instructor's controlling interaction type was negatively associated with autonomy-supportive interaction.

Hypotheses 1 and 2 proposed that students' perception of their instructor's autonomy-supportive interaction type and online learning environments use of constructivist-based pedagogy would predict autonomous forms of self-regulation. Instructor's autonomy-supportive interaction and online learning environments use of constructivist-based pedagogy did significantly predict students' autonomous self-regulation. Hypotheses 1 and 2 were supported in this study. Furthermore, students' perception of the degree to which their learning environment used constructivist-based pedagogy was found to be the best predictor of their autonomous self-regulation.

Hypotheses 3 and 4 proposed that students' interest in the course and technology self-efficacy would predict their autonomous forms of self-regulation. The results of HLM analyses showed that neither students' interest in the course nor technology self-efficacy predicted their autonomous forms of self-regulation. Hypotheses 3 and 4 were not supported in this study.

The second research question examined if students' autonomous self-regulation was related to their engagement, satisfaction, academic achievement, and interaction behaviors. Hypotheses 5, 6, 7, and 8 proposed students' autonomous self-regulation would predict their self-reported engagement, academic achievement, satisfaction, and interaction behaviors. Correlation matrixes indicated that students' autonomous self-regulation was significantly and positively correlated with their self-reported engagement, achievement, and satisfaction. Furthermore, HLM results indicated autonomous forms of self-regulation predicted students' engagement, academic achievement, and satisfaction. Hypotheses 5, 6, and 7 were supported in this study.

In addition, five types of interaction behaviors were examined related to autonomous forms of self-regulation. Academic achievement (the course points) was significantly correlated with the total number of authored and read messages and the total number of visited topics in the content page. However, students' autonomous forms of self-regulation were significantly correlated with only the total number of authored messages and the total number of visited topics in the content page. HLM results showed that autonomous forms of self-regulation did not predict any of interactional behaviors. Therefore, Hypothesis 8 was not supported in this study. Table B7 in Appendix B presents the summary of hypotheses testing for all fixed effects.

Last, students' autonomous self-regulation mediated the relationship between instructors' autonomy-supportive interaction and the outcomes, their engagement, achievement, and satisfaction. However, it did not mediate the relationship between students’ perception of the degree to which their online learning environment used constructivist-based pedagogy and the same outcome variables.

CHAPTER V

DISCUSSION

Students' motivation has been identified as a critical factor for meaningful engagement and positive academic achievement in various educational settings. In particular, self-regulation strategies have been identified as important skills in online learning environments. However, applying self-regulation strategies, such as goal setting, strategic planning, and reflect performance takes significant effort. Without motivation, students will not enact these types of strategies. Autonomous self-regulation has been investigated in traditional classroom settings and there is ample empirical evidence of a significant relationship between autonomous self-regulation and engagement and academic achievement. However, such research was limited in online learning environments.

The primary goal of this study was to examine the relationship between students' personal factors and learning environmental factors and their autonomous self-regulation. In addition, this study examined the outcomes of students' autonomous self-regulation related to their engagement, academic achievement, and satisfaction. Furthermore, this study collected students' interaction behaviors data from the course websites and investigated the relationship between students' autonomous forms of self-regulation and their level of various types of interaction behaviors. In this chapter, the major findings of the study are discussed, with particular emphasis on significant predictors of students' autonomous self-regulation in online learning environments, significant relationship between students' autonomous self-regulation and their engagement, academic performance, and satisfaction, and the relationship between students' different types of interaction behaviors in the course and their autonomous self-regulation. In addition, the role of controlled self-regulation of online learners is discussed. Also considered in this chapter are the educational implications of the investigation, as well as study limitations and suggestions for future research.

Predictors of Autonomous Forms of Self-regulation

The four constructs that were hypothesized to predict students' autonomous forms of self-regulation in online courses were students' interest in the course, technology self-efficacy, perception of their instructors' autonomy-supportive interaction, and students' perception of the degree to which their online learning environment used constructivist-based pedagogy. Students' interest in the course and technology self-efficacy reflect individual characteristics, and perception of their instructors' autonomous-supportive or controlling interaction, and perception of the degree to which their online learning environments used constructivist-based pedagogy reflect the learning environmental factors that affect students' learning.

The responses of the students in this study provided evidence for the significant impact of learning environmental factors on students' autonomous self-regulation. Furthermore, students' perception of the degree to which their online learning environment used constructivist-based pedagogy was found to be the most significant predictor of students' autonomous self-regulation in their online course. This finding is consistent with the result of Chan's study (2010). Chan reported that contextual support (instructors' autonomy and competency support) positively predicted need satisfaction, and in turn, need satisfaction positively predicted self-determination. Similar to Chan's report, this finding suggests contextual support (instructors' autonomy support and learning environments using constructivist-based pedagogy) positively predicted students' self-determination.

As detailed in the literature review, three basic psychological needs, the need for autonomy, the need for competence, and the need for relatedness should be satisfied in order for intrinsic or autonomous forms of self-regulation to be prompted (Ryan & Deci, 2000). This study found that when students perceived their instructor's autonomy-supportive style and their learning environments used constructivist-based pedagogy they performed autonomous forms of self-regulation. This finding implied that the learning environments employed both autonomy-supportive interaction and constructivist-based pedagogy, in particular constructivist-based pedagogy, satisfied the basic psychological needs.

Online learning environments demand different instructional methods than the traditional face-to-face classroom. Because computer technology is mediating the learning experiences and students are not in close physical proximity to their instructors and peers, online courses require students to work more independently and creatively than the traditional face-to-face classrooms. Therefore, online instructors should consider different pedagogical methods to facilitate students' learning in such challenging environments.

Constructivist learning environments emphasize learner-centered instruction (e.g., Duffy & Orrill, 2001), in which learners are considered as free agents and their previous knowledge, needs, and preferences are considered to be important factors to perform various activities in the course. Therefore, learning tasks should be designed in ways that learners can utilize their previous experiences and knowledge to solve the new tasks and activities (e.g., Honebein, Duffy, & Fishman, 1993). When students are respected as free agents who are in the center of learning process, and their knowledge and experiences are important resources to perform tasks, students likely experience autonomy, in which they would act on learning tasks from their inner interests rather than feeling of pressure from teachers or any other external factors.

In addition, authentic learning contexts have been identified as a core characteristic in constructivist learning environments in the literature review. When content and activities are related to real world situations and relevant to the students' personal experiences, students likely recognize and accept the value of learning. Many students who participated in this study were from the College of Nursing, where learning content is directly related to the real practice. Therefore, when the learning contexts reflected more real world practice, students could recognize and accept the value of learning. When students accept the value of learning, they are likely motivated to regulate learning behaviors during the learning process. Recognizing and accepting the value of learning is an important process of internalization to enact identified motivation which is considered an autonomous form of self-regulation in self-determination continuum.

Collaborative learning (e.g., Duffy & Cunningham, 1996), and instructors' constructive and informational feedback (e.g., Jonassen, 1999) are also considered to be important elements in a constructivist learning environment. Moreover, these components are far more critical to the students in online courses than traditional face-to-face courses. Because students and instructors may participate in the online course at the different places and times, and most communication between peers and instructor is mediated by technology, students can easily be affected by the lack of presence of instructor, which might cause a feeling of detachment to the course. Frequent instructor and peers communication can eliminate this negative feeling. Frequent instructors' constructive feedback and working with peers provide opportunities to share each other's knowledge and build critical thinking skills, and in turn foster students' competence and build trust among them.

All these things considered, the finding of constructivist learning environments as the strongest predictor of students' autonomous self-regulation in this study is not surprising. Many studies of online learning univocally emphasized the importance of interaction (e. i., Abrami et al., 2011; Bernard et al., 2009), which is a core element in collaborative learning. Bernard et al. (2009) reported the positive relationship between achievement outcomes and three types of interactive treatment in a meta-analysis: student-student, student-teacher, and student-content interactions. In particular, student-student interaction was reported as the most important type of interaction related to students' achievement in online learning environments. The finding of this study is aligned with Bernard et al.'s report. Constructivist-based pedagogy highly values students' active participation in the learning process, particularly, in the form of collaboration (Duffy & Jonassen, 1992). Active participation involves various types of interactions which include student-student, student-instructor, and student-content interactions in learning contexts. Therefore, the learning environments used constructivist-based pedagogy promoted active participation, in which these three types of interaction are critical components. In particular, collaborative learning fostered student-student interaction. Ruey (2010) also supported a constructivist-based instructional design in an online learning environment. Her case study found the instructional activities requiring collaboration and interaction not only helped the learners support one another's learning but also assisted learners to develop a sense of becoming more responsible and self-directed learners.

As elaborated in the literature review, SDT research that was conducted in traditional face-to-face classrooms provided robust evidence of the significant impact of teachers' autonomy-supportive interaction on students' autonomous forms of self-regulation. The findings in the current study were consistent with the previous findings in the traditional face-to-face classrooms and online learning environments as well. An instructor's autonomy-supportive interaction was found to be a predictor of students' autonomous forms of self-regulation in online courses.

This study also supported the previous finding of adverse effects of instructor's controlling interaction on students' motivation (Reeve, 2002). Instructor's controlling interaction type has been contrasted with autonomy-supportive interaction (e.g., Reeve, 2002). The significant negative relationship between instructors' controlling and autonomy-supportive interaction was found in this study as well ($r = -.55$, $p < .01$). In contrast to instructors' autonomy-supportive interaction, students' perception of their instructors' controlling interaction was significantly and negatively related to their autonomous self-regulation ($r = -.31$, $p < .01$).

Reeve and Jang (2006) indicated that instructors' autonomy-supportive interaction does not mean that they do directly give students an experience of autonomy. Instead, they encourage and support this experience by identifying 'students' inner motivational resources and by creating classroom opportunities for students to align their inner resources with their classroom activity' (Reeve & Jang, 2006, p. 210). Reeve and Jang (2006) pointed out the specific behaviors of autonomy-supportive instruction including providing rationales, listening to students, understanding students' need, preference, and feelings, and using informational languages rather than controlling languages. These instructional behaviors support students' inner motivational resources (e.g., psychological needs) and consequently, students with this autonomy experience are more likely to engage in desired behaviors and experience positive emotions. These instructional behaviors in this study were also found to be important to enact students' autonomous self-regulation in online courses.

However, the significant effectiveness of autonomy-supportive interaction style became non-significant when it was simultaneously tested with the learning environments use of constructivist-based pedagogy. That is, when students' perception of their instructors' autonomy-supportive interaction was tested alone, it was found to be a significant predictor on the students' autonomous self-regulation, while students' perception of their instructors' autonomy-supportive interaction became non-significant when it was simultaneously tested with students' perception of the degree to which their learning environments used constructivist-based pedagogy. This result might suggest that the construct of students' perception of the degree to which their online learning environments used constructivist pedagogy was comprehensive so it absorbed the effect of the construct of students' perception of their instructors' autonomy-supportive interaction when they were tested at the same time. These two environmental factors were significantly correlated with each other ($r = .73$, $p < .01$), which means these constructs are closely related. Students' perception of their instructors' autonomy-supportive interaction was to assess autonomy as evidenced by students feeling supported by instructors, which emphasized one-to-one relationship between student and instructor, whereas, constructivist learning environment was to assess students' perception of seven key factors: (1) arguments, discussions, and debates, (2) conceptual conflicts and dilemmas, (3) sharing ideas with others, (4) materials and measures targeted toward solution, (5) reflections and concept investigation, (6) meeting students' needs, (7) making meaning, real-life examples. Therefore, the effect of constructivist learning environment became salient while the effect of instructors' autonomy-supportive interaction was diminished when they were tested at the same time.

On the other hand, this result might also suggest that students in online courses might be less susceptive to instructors' autonomy-supportive instructional behaviors to impact their students' autonomous self-regulation than students in traditional face-to-face classrooms due to the lack of physical contacts. Further, the learning environments using constructivist-based pedagogy may impact students' autonomous self-regulation more than an instructor's autonomy-supportive interaction style in online courses.

An instructor and students in online courses likely participated in course activities at different times. Therefore, communications between them were asynchronous and mediated by technology tools, in which the written form of communication was a main method, and non-verbal communication was completely eliminated. Because natural spoken language was limited, it took more time and effort to communicate each other in the online learning environment than in face-to-face classrooms. This might result in less communication between students and an instructor in online courses than in face-to-face classrooms. Furthermore, there was waiting time between communications because of asynchronous communication. This waiting time can adversely impact effective communication between students and an instructor. Instructors might miss the right timing to maximize their support for students' autonomous motivation. That is, when an instructor provides certain informational feedback right at the moment a student needs it, the impact of feedback might be larger on a student's motivation than if provided later. The students in online courses always have to wait until an instructor responds, which may take a few days depending on the instructor's schedule.

Because of these limitations caused by asynchronous communication between an instructor and students, students might be more motivated through their involvement in various activities rather than only interaction with their instructor. When learning is situated in an authentic context that resembles that of the real world and requires specific skills that students would use in the real practice, students recognize and accept the value of learning. As students identify a problem and create and develop their own solution, students might experience autonomy. When students are exposed to various examples and useful resources that they can explore and investigate, and more frequently receive helpful and constructive feedback from the instructor and peers, they can build competent. Moreover, as they participate in frequent discussions and dialog, and work projects collaboratively with their peers, they might feel connected and belonging to their course. Working collaboratively with peers also might compensate for the lack of communication with their instructor.

All these things may partially explain the reason that students' perception of the degree to which their learning environments used constructivist pedagogy turned out be the strongest predictor of their autonomous self-regulation when both students' perception of the degree to which their learning environments used constructivist-based pedagogy and their instructors' autonomy-supportive interaction were tested simultaneously. Students was motivated by the learning environment that encouraged collaborative learning, presented authentic activities, and provided more opportunities to share and discuss individual experiences.

In contrast to environmental factors, individual factors, students' interest in the course and technology self-efficacy, were not significant predictors of students' autonomous self-regulation in online courses in this study. As detailed in the literature review in online learning, while technology skills frequently had been identified as a critical factor for successful learning (e. g., Packham, Jones, Miller, & Thomas, 2004), different findings also emerged in online learning, when high technological skills or experiences predict neither learner's activity level nor actual performance level (e.g., Vuorela & Nummenmaa, 2003). The mean for technology self-efficacy in this study was above the middle point of the scale. This implied that most students who participated in this study believed that their capabilities of technological knowledge and skills could produce desired levels of performance in their online courses, while they might not have all the necessary technological skills of the course. However, at least they may have believed they were competent to learn and figure out needed technological skills. As technology access becomes more affordable, and various forms of new technology equipment are introduced and rapidly become popular, students may have abundant technology experiences in daily life, and in turn, they could build general technology competence over time. Accordingly, they feel competent to use or master any types of technology regardless of the level of technology skills that the course requires.

All online courses that were recruited for this study informed students of the required technological applications and skills needed to perform adequately. Detailed step-by-step documents for any technological tools that instructors expected students to use were provided. The contact information of technological support was listed in the syllabus as well. Therefore, students could anticipate what types of technology they should use and what level of technological skills were expected in their courses. Students also acknowledged where they have to look whenever they needed help regarding any technological problems. This may partially explain the high level of technology self-efficacy of participants and the result of non-significant factor on students' autonomous self-regulation.

However, it was somewhat surprising that students' interest in the course was not a significant predictor of their autonomous self-regulation. Interest has been reported to play a central role to both intrinsic motivation and self-determined forms of motivation (Deci, 1992). This result might be due to overlap with the construct of autonomous self-regulation. Among the autonomous self-regulation questions, 4 questions were related to intrinsic motivation, which were very similar to the interest questions. Pre autonomous self-regulation was always controlled in the hypothesis testing. When two similar constructs compete in the testing, one construct may become salient and the effect of the other construct can be diminished. Therefore, when the effect of interest in the course was tested on post autonomous self-regulation while controlling pre autonomous self-regulation, the effect of interest in the course might be diminished and became non-significant.

On the other hand, this result might suggest that students' interest in the course at the beginning of the semester might not be strong enough to sustain their autonomous motivation until the end of the semester. As students explore the course by interacting with content materials, their instructor and peers, their initial interest in the course might be changed at the end of the semester. However, this interpretation cannot be assured without evidence of students' initial interest change, which this study could not provide.

Relationships Among Predictors

Four variables were set as predictors of students' autonomous self-regulation: students' interest in the course, technology self-efficacy, perception of their online learning environments used constructivist-based pedagogy, and perception of their instructors' autonomy-supportive interaction. In the correlation matrix, students' perception of their online learning environments used constructivist-based pedagogy was significantly and positively correlated with interests in the course and students' perception of their instructors' autonomy-supportive interaction, but not with technology self-efficacy. This suggests when students perceived the learning environments used constructivist-based pedagogy, they also felt their instructors more open, understood them, and cared about how they were doing.

The correlation matrix indicated that the relationship between students' technology self-efficacy and perception of the degree to which their learning environments used constructivist-based pedagogy were not significant in online courses. This could be explained in two ways. First, the students who participated in the online courses were sufficiently competent in technology skills to perform well in the online learning environments. Second, instructors provided a learning environment that used constructivist-based pedagogy without requiring high levels of technology.

The course management system, ICON, was the main interface for students to participate in the course activities in the online courses for this study. Overall, interacting with the ICON does not require advanced technological skills. The main activities were to view and download various formats of learning materials such as text-based files, videos, and audios, post and read messages in the discussion page, and communicate with the instructor and peers using built-in communication tools. In addition, all instructors indicated that moderate technological skills were sufficient to take their courses and no courses required any technological tools that needed advanced technological skills. Vernadakis et al. (2011) reported that learner familiarity with computer and online technologies made positive contributions to their perception toward course management systems. Because of a substantial increase in both Internet access and various mobile devices, students could build technological competence to interact with the course management system regardless of pedagogical goals that the instructors tried to accomplish. Many educators indicated that today's students have been altered tremendously by the technological revolution, but that the same technology has yet to make a significant impact on the educational system (i.e., Ferguson, 2001). That is, today's students are already exposed and have access to more sophisticated and advanced technological tools than the ones that are currently adopted in educational setting. Therefore, students have developed technology self-efficacy enough to manage typical technological tools in educational settings.

Outcomes of Autonomous Forms of Self-regulation

SDT research has provided the robust evidence of positive relationships between intrinsic motivation or autonomous forms of self-regulation and personal well-being. In particular, SDT provided strong evidence of positive relationships between autonomous self-regulation and outcomes of learning and performance in education settings (e.g., Filak & Sheldon, 2003). This study strongly supported this relationship in college online courses in that when the students had high autonomous forms of self-regulation they engaged in the course activities, were satisfied with their course, and achieved high learning outcomes in their course. Chen (2010) reported the contextual support (autonomy and competent supports) provided psychological needs satisfaction and in turn, supported self-determination. However, motivation / self-determination failed to predict learning outcomes (e. i., hours per week studying, number of hits, and expected grade) in online courses. In contrast to Chen's study, positive and significant relationships were found between autonomous self-regulation and learning outcomes (achievement, self-reported engagement, and satisfaction) in this study. This is meaningful findings that can be added to SDT research which provided the strong evidence of the significant relationship between students' autonomous forms of self-regulation and learning outcomes in online courses as well as traditional classrooms.

Interaction Behaviors in Online Courses

Five types of students' interaction behaviors were collected from the course websites: the number of authored messages, the number of read messages, the number of visits to the content page, the number of visited topics, and the total duration spent in the content page. This is a crude way of providing systematic evidence documenting students' interaction behaviors with the online learning environment. The number of read messages indicated the number of messages that students clicked to open. It does not indicate whether students carefully read all opened messages or they clicked them to open but did not read them. The number of authored messages does not consider the quality of the message content. Therefore, it was unknown whether posted messages were indicated thoughtful processes related to learning topics, or they just expressed agreement or disagreement with other's opinion, or if the messages were just social chats unrelated to any course content.

The number of visits to the content page in the course websites indicated the frequency of hits to the content page. The content page contained course materials including syllabus, course readings, audios, videos, notes, and assignments. Therefore, students were expected to visit the content page frequently throughout the semester. However, the frequency of hits could not capture the actual activities of the students when they visited the content page. The number of visited topics indicated the total number of items that students opened in the content page. Students were expected to read all documents and materials posted in the course page. However, the number of visited topics indicated only that students opened them but not whether they read them or not. The duration spent on the content page also did not indicate the actual activity during the visiting time. For example, if a student visited the content page, downloaded a document, logged off the page, and read it offline, the duration of the visit could be very short. In contrast, if a student visited the content page, opened a document, was distracted by something else for a while, then duration of this time could be longer than the student who downloaded the document and logged out. Although the latter student did not read the document, the time spent in the content page could indicate the longer because logged time in the content page were longer than the student who downloaded the document. Therefore, these interaction behaviors do not provide a completed evidence of the students' interaction behaviors. Instead they provide a rough picture of students' interaction behaviors.

In the preliminary analysis, of the five types of interaction behaviors, the number of authored and read messages and the number of visited topics were significantly correlated with the students' achievement, and the number of visits to the content page and the duration spent in the content page showed no relationship with the students' achievement. However, in HLM analysis, none of these types of interaction behaviors predicted the students' achievement in this study. Similar types of interaction behaviors were examined in the previous studies: hits, discussion posts, and reads (e.g., Ramos & Yudko, 2008; Wang & Hewlin, 2000). However, the results of this study were somewhat different from the previous studies. While hits of the content page, discussion posted and read did not predict students' achievement, Ramos and Yudko (2008) reported that total page hits predicted students' high grades in online courses. Wang and Hewlin (2000) reported that homepage hits, postings read, and postings written showed a positive and significant relationship with course grades. Homepage hits referred to the number of times a student visited to the course homepage, which included all the hits that students made in the course website. Therefore, homepage hits could be more comprehensive data than just hits of the content page. Considering only total hits of the content page rather than homepage hits might be partially explained the non-significant relationship between the total hits of the content page and students' achievement in this study.

The relationship between the number of read and authored messages and grades might be affected by course requirements. Of the 19 courses 3 online courses did not require students to post a certain number of messages to earn points, whereas the rest of the courses did require them. Further, the assigned percentage that students could earn from posting messages was varied across courses. The average percentage was 21% of the total points with ranged from 4% to 40%. In the courses that require posting messages, the number of posted messages would be directly related to grades, in which a significant relationship can be found. In particular, this relationship would be more salient when this percentage is high. In the courses that do not require posting messages, this relationship can be subtle. Students post messages to ask questions, clarify concepts, or exchange knowledge among peers and an instructor. Although these activities will ultimately help students' learning and, in turn, affect their achievement, students might not put effort into post messages if posting messages are not required. The mean of the posted messages in the required courses were almost 6 times higher than the mean in the courses that did not require them (M = 60.8 vs. M = 11.9). The number of read messages in the required courses was also higher than the courses that did not require them (M = 538 vs. M = 381). In addition, the number of posted and read messages were significantly correlated with the assigned percentage of the total grade by posting messages ($r = .558$, $r = .509$, $p < .01$). That is, the higher the percentage of the total grade by posting messages, the more messages were read and posted. Different requirements for posting messages across courses might partially explain the non-significant relationship between grades and posted and read messages in this study.

On the other hand, in the relationship between students' interaction behaviors and students' autonomous self-regulation, two types of behaviors were found to be significantly correlated with student's autonomous self-regulation: the number of authored messages and the number of visited topics. However, none of these interaction behaviors were predicted by autonomous self-regulation. This result was somewhat different from the finding in Xie et al.'s study (2006) who found that students' intrinsic motivation was significantly correlated with their online discussion participation. That is, students who had higher intrinsic motivation demonstrated higher participation than those with lower intrinsic motivation. Autonomous self-regulation is considered to be close to intrinsic motivation in SDT.

One of limitations of this study was lack of qualitative analysis of the students' messages. Although some students might post the same number of messages, content of the messages could be completely different. Some messages could be unrelated to the course topics, while other messages could significantly contribute to building core knowledge. If a qualitative analysis was included in this study, the effect of autonomous self-regulation on discussion participation might be different. However, this study only found that autonomous self-regulation did not predict the total number of authored messages.

Mediation analysis showed that autonomous self-regulation mediated the relationship between instructors' autonomy-supportive interaction and engagement, achievement, and satisfaction, but not the relationship between constructivist-based pedagogy and the same outcomes. The effect of constructivist-based pedagogy on the outcomes was higher than the effect of autonomous self-regulation on the outcomes. This result suggests that students' perception of the degree to which their online learning environments used constructivist-based pedagogy had only a direct effect on both students' autonomous self-regulation and students' engagement, achievement, and satisfaction, and autonomous self-regulation do not play any role in the relationship between them. On the other hand, students' perception of their instructors' autonomy-supportive interaction has both direct and indirect effect on their autonomous self-regulation, engagement, achievement, and satisfaction,

Controlled Forms of Self-regulation

In contrast to autonomous forms of self-regulation, controlled forms of self-regulation was not related to any outcomes variables: students' achievement, self-reported engagement, satisfaction, and five types of interaction behaviors. Controlled self-regulation was the composite of external and introjected self-regulation. The mean of controlled self-regulation was moderately high (M = 4.74). However, the correlation matrix showed that controlled self-regulation was not associated with any outcome variables. None of four predictor variables, students' interest in the course, technology self-efficacy, their perception of the degree to which their learning environments used constructivist-based pedagogy, and instructors' autonomy-supportive interaction, were related to controlled self-regulation.

This finding is consistent with the previous reports in SDT research. It has been observed that intrinsic motivation and autonomous forms of self-regulation are linked to the more positive outcomes, whereas controlled forms of self-regulation have been linked to the less positive ones (Ryan & Deci, 2000; Vallerand, 1997). In education settings, there is evidence that autonomous motivation toward school is related to students' high level of achievement, while controlled motivation has not been associated with any positive learning outcomes (e.g., Burton, Lydon, D'Alessandro, & Koestner, 2006; Ratelle, Vallerand, Larose, & Senecal, 2007). This study finding is similar to the result reported by Ratelle et al. (2007), where controlled motivation did not show any relation to academic achievement in college traditional classrooms. Therefore, self-regulations that experienced as being pressured or controlled by some interpersonal force did not help academic engagement or performance in online courses as well as traditional face-to-face classrooms.

Limitations of the Study

As with any study, it is important to highlight the limitations of the current investigation. One of limitations of the study was subject recruitment. The sample of online students was not random. Online courses were not distributed evenly across different academic units in the university where this research was conducted. Among the 11 colleges at the university, College of Nursing offered the most online courses. This resulted in 88 % of the participants being nursing students in this study. In addition, instructors' permission had to be granted in order to recruit students in a course. Therefore, participation was offered to the students who were in a course in which instructors allowed recruitment of their students.

Another limitation was the small percentage of participants from each course. Even though participation was offered to every student in the recruited online courses, participation rates were very low. Total participants who completed pre and post-surveys were 140 students from 19 online courses. This yielded an average 7 students in each course. That is less than 30 % of participation in each course. Therefore, the participants from each course do not represent students in the course. In particular, participants' perception of their instructors' autonomy supportive and controlling interaction, and their perception of the degree to which their learning environments used constructivist-based pedagogy cannot be represented as a whole class.

Female students and students in the College of Nursing were overrepresented in the sample. A majority of the sample also consisted of senior and graduate students, for whom taking a course may be more serious and career decision-making concerns may be more salient when compared to freshmen or sophomores. As a result, the views of important groups of students are potentially missing. Due to the sampling procedures, the results of the study cannot be generalized to students in online courses as a population. In addition, because of the relatively small sample size, power is limited. The statistical tests employed in the study would have had more power had more subjects participated in the study.

Methodologically, limiting the study to self-report measures did not permit close observation of students' behavior. A number of important variables in the study were entirely dependent upon students' perception, including self-regulation style, engagement, instructor's autonomy-supportive interaction style, and the degree of online learning environments using constructivist-based pedagogy. Behavioral observations of student engagement and self-regulation style would have been useful to validate students' self-report. Behavioral observations of instructors' autonomy-supportive interaction style and examination of constructivist pedagogical elements would have been helpful to validate students' self-report of perception of those areas.

A couple of items in two instruments were similar which might cause overlapped construct. The measurement of interest in the course included similar items of self-regulation style, which might yield the result that interest found to be a non-significant predictor of autonomous self-regulation.

Lastly, a qualitative analysis was excluded in the study. The study indicated that students' autonomous self-regulation did not predict any of interaction behaviors. One of interaction behaviors was related to discussion participation. Examining students' message content could provide more accurate information to understand the relationship between autonomous self-regulation and discussion participation. This limitation is informative for future research, and altering the research design will result in a less complex model, yet would reduce any risks of overlapping construct measurement.

Implication of the Study

Taken together, results from this study provide some insight into the students' motivation related to personal and environmental factors and overall academic success in college online courses. The findings from this study are largely congruent with prior theory and research in the fields of academic motivation, self-determination, and online learning. Furthermore, these results offer important theoretical and empirical extensions of academic self-regulation by illustrating that instructors' autonomy-supportive interaction and constructivist-based pedagogy matter to students' autonomous self-regulation in college online courses as has previously been shown for traditional face-to-face classrooms (e.g., Black & Deci, 2000; Jang, 2008; Reeve, Jang, Hardre, & Omura, 2002). In addition, students' autonomous self-regulation predicted their engagement, academic achievement, , and satisfaction, while controlled self-regulation did not show any relationship with these outcomes. In particular, this study provided strong evidence that external factors of instructors' autonomy-supportive interaction style and constructivist-based pedagogy significantly supported students' autonomous self-regulation. These external factors can be explained by the process of internalization in the self-determination continuum with external factors playing a central role in the process. In the investigation of internal and external factors, learning environmental factors mainly affected students' motivation. Instructors' autonomy-supportive interaction style and the learning environments adopting constructivist-based pedagogy did foster students' autonomous self-regulation in online courses rather than personal factors which were students' initial interest in the course and their technology self-efficacy. These findings largely support the existing literature on self-determination in traditional classroom-based contexts (e.g., Black & Deci, 2000).

Future Directions

This study provides insights into relationships among learning environment factors, students' autonomous self-regulation, engagement, achievement and satisfaction. In particular, this study indicated that instructor's autonomy-supportive teaching style and constructivist-based pedagogy matter to students' autonomous self-regulation. Given that, the next investigation should focus on specific instructional strategies that create those learning environments. This study heavily relied on students' self-report to assess the learning environments. In particular, instructor's autonomy-supportive interaction style and the degree of online learning environments use of constructivist-based pedagogy were only from students' self-report perception and there was no description of how pedagogy was used in this study. Incorporating instructors' behavior observation and technology tools that are used frequently, along with students' perception will provide more insights into the relationship between autonomy-supportive learning environment and autonomous self-regulation.

This study reported that a majority of online courses required students to participate in discussion to facilitate understanding of course content and encourage expanded exploration of course topics. The instructors who required students' participation specified the guideline of students' discussion in the syllabus. However, students' participation was mainly assessed by the frequency of the posted messages regardless of quality of the messages. Student-student interaction was identified as a critical factor by many online educators (e.g., Bernard et al., 2009) and online discussion has been used as a main method to promote this type of interaction. In order to foster students' autonomous motivation to participate in discussion and increase students' meaningful interaction, thoughtful instruction and assessment should be incorporated all together. Exploring various instruction and assessment in ways to maximize the online discussion use and promote students' interaction will be beneficial.

Online learning has increasingly become a common practice in the higher education. This study proposes that environmental factors facilitate students' autonomous self-regulation and students' autonomous self-regulation predicts engagement, achievement, and satisfaction in online courses. In particular, the online learning environment that used constructivist-based pedagogy was found to be the most significant predictor of students' autonomous self-regulation. However, instructors should be cautious in adopting constructivist-based pedagogy.

Although constructivist-based pedagogy such as collaborative learning or problem-solving tasks has been highly praised with its effectiveness related to students' learning, clear learning goals should be determined and students' characteristics and needs must be considered before employing any type of instructional components. Kirkley (2004) mentioned:

> "designing online courses solely for the purpose of having collaborative or problem-solving activities should not be a primary goal of any instructional designer. Those designing and providing online education must first determine the vision and goals for the learning experience, as well as how theoretical commitments to teaching and learning can guide their design" (p. 321)

The specific learning goals and details of how to carry out such pedagogical methods as well as relevant outcomes should be thoughtfully considered to promote students' autonomous self-regulation and achieve quality online learning.

APPENDIX A

SURVEY INSTRUMENT

Demographic Information

1. Hawk ID ___________________

2. Gender Male__ Female__

3. Age

   Under 20__ 21-25__ 26-30__ 31-35__

   36-40__ 41-45__ 46-50__ over 50__

4. Academic status

   Freshman__ Sophomore__ Junior__ Senior__

   Post-baccalaureate__ Graduate student__

   Other __ Please specify ______________

5. Reasons for taking this online course (check all that apply)

   Required__

   Content seems interesting __

   Recommended by a professor, student, peer, or friend__

   Fits into my schedule__

   Will improve career prospects__

   Is convenient because I cannot travel to campus__

   Will be useful to me in other courses__

   Will improve my academic skills__

   Other__ Please specify._____________________

6. Experience of online course

   How many online courses have you enrolled so far? (Do not include this course) ___

Self-regulation Questionnaire

This questionnaire asks about your reasons for why you do the tasks for this course. Different students have different reasons for doing the tasks, and this questionnaire just asks how true or untrue each of the following reasons is for you. There are no right or wrong answers. Please use the following scale for each question.

Not at all true Very much true

	1	2	3	4	5	6	7
1. Because I enjoy it.							
2. Because, if I didn't I'd feel guilty.							
3. So that I can make a good grade in the course.							
4. So I won't disappoint and let down the important people in my life.							
5. Because all tasks are so interesting							
6. It is just something I make myself do; I often just force myself to do the work in this course.							
7. Because I know I'll find valuable, useful things by doing the work in this course.							
8. Because, if I didn't do the course work, I'd get in trouble.							
9. Because there are a lot of interesting things in course work.							
10. Because I see the importance of all tasks.							
11. Because I should; that's what is expected of me.							
12. Because I really appreciate and understand the usefulness of the course work.							
13. To get ready for the test.							
14. Because it's fun – doing all required tasks is fun thing to do.							
15. Because it is useful thing to do – doing all required tasks is time well spent.							
16. Because, when I do I feel good about myself; but when I don't feel bad about myself.							

The Learning Environment Climate Questionnaire (LECQ)
Perception of Instructor's Autonomy Support

This questionnaire contains items that are related to your experience with your instructor in this class. Instructors have different styles in dealing with students, and we would like to know more about how you have felt about your encounters with your instructor. Your responses are confidential. Please be honest and candid.

Strongly disagree   Strongly agree

	1	2	3	4	5	6	7
17. I feel that my instructor provides me choices and options.							
18. I feel understood by my instructor.							
19. I am able to be open with my instructor during course.							
20. My instructor conveyed confidence in my ability to do well in the course.							
21. I feel that my instructor accepts me.							
22. My instructor made sure I really understood the goals of the course and what I need to do.							
23. My instructor encouraged me to ask questions.							
24. I feel a lot of trust in my instructor.							
25. My instructor answers my questions fully and carefully.							
26. My instructor listens to how I would like to do things.							
27. My instructor handles people's emotions very well.							
28. I feel that my instructor cares about me as a person.							
29. I don't feel very good about the way my instructor talks to me.							
30. My instructor tries to understand how I see things before suggesting a new way to do things.							
31. I feel able to share my feelings with my instructor.							

Teacher Controllingness Scale (TCS)

Please rate your instructor on the following characteristics

Strongly disagree Strongly agree

	1	2	3	4	5	6	7
32. My teacher tries to control everything I do.							
33. My teacher is rigid and inflexible.							
34. My teacher uses forceful language.							
35. My teacher puts a lot of pressure on me.							

Interest in the Course Questionnaire

Please indicate your level of agreement with each statement.

Strongly disagree — Strongly agree

	1	2	3	4	5	6	7
36. The course content is interesting to me.							
37. I like the course content.							
38. The course content was meaningful to me.							
39. I saw what the teacher taught can be useful in real life.							
40. It was important to me that I thoroughly understand my class work.							

Technology Self-Efficacy Questionnaire

Please indicate how true each statement is of you.

Not at all true of me Very true of me

	1	2	3	4	5
41. I'm certain I can master the technological skills needed in class.					
42. I'm certain I can figure out how to use the most complicated technological tools.					
43. I can use almost all the technological tools in class if I don't give up.					
44. Even if the tools are complicated and hard, I can learn it.					
45. I can use even the most complicated tool in this class if I try to understand my class work.					

Constructivist Learning Environment Questionnaire (CLEQ)

For each of items in this section, please select the box which best represents your perception regarding the course you are currently studying.

	Not at all	A little	Somewhat	Much	Very much
46. This course allows for arguments, discussions, and debates.					
47. This course encourages originality of ideas.					
48. This course allows for constant exchange of ideas between student and teacher.					
49. I learn to develop mind tools in this unit (e.g. critical thinking).					
50. Multiple perspectives of situations are often presented in the course.					
51. The course poses some dilemmas for me.					
52. The course causes confusion among conceptual ideas for me.					
53. The course causes conflicts for me among various concepts.					
54. The course allows social interaction.					
55. The course comprises a variety of learning activities.					
56. I am given sufficient opportunities to express myself.					
57. I am given sufficient opportunities to share my own experiences with others.					
58. The course teaches me how to arrive at appropriate answers.					
59. The course resources effectively convey information to be learned.					
60. The course includes relevant examples.					
61. The course motivates me to think reflectively.					
62. The course encourages me to examine several perspectives of an issue.					

63. The ideas in the course motivate me to learn.					
64. The course teaches me to investigate concepts.					
65. The course enables me to use knowledge acquired for abstract thinking.					
66. The course motivates me for further learning of related subjects.					
67. The course take into consideration my needs and concerns.					
68. I feel pleased with what I learn in the course.					
69. The course helps me to benefit from my learning difficulties.					
70. The course allows for the negotiation of the instructional goals and objectives.					
71. The course helps me to pursue personal goals.					
72. The learning environment encourages me to think.					
73. The course focuses more on making meaning of the learning concepts rather than just answering questions.					
74. The course addresses real-life events.					
75. The course is rich in examples.					

Engagement

Please select the one that reflects how much you feel about the following statements.

Strongly disagree Strongly agree

	1	2	3	4	5	6	7
76. I read all materials carefully.							
77. I try very hard.							
78. The first time my instructor mentions about a new topic I pay attention very carefully.							
79. I work hard when we start something new.							
80. I pay attention.							
81. When I have a hard question or problem, I don't even try.							
82. I often give a false impression that I am working hard.							
83. If a problem is really hard, I keep working at it.							
84. If I can't get a problem right the first time I just keep trying.							
85. If I can't think of the answer to a question, after a while it comes to me.							
86. I really concentrate when my instructor presents new material.							
87. When I have trouble with a problem, I usually get it right in the end.							
88. When I get stuck on a question, I can usually get it.							
89. I pay attention when we start a new unit.							
90. Before starting an assignment, I try to figure out the best way to do it.							
91. Before I begin to study, I think about what I want to get done.							
92. In this course, I start my assignments without really planning out what I want to get done.							
93. For the assignments, I double check my work to make sure I am doing it right.							
94. When I'm working the course work I stop once in a while and go over what I have been doing.							
95. In this course, I keep track of how much I understand the work, not just if I'm getting the right answers.							
96. I try to change the way I study for this							

course to fit the type of material I'm trying to learn.							
97. I try to adapt how I do my assignments to fit with what the instructor wants or expects.							
98. If what I'm working on for this course is difficult to understand, I change the way I learn the material.							
99. I ask questions.							
100. I let my teacher know what I like and what I don't like.							
101. I let my teacher know what I'm interested in.							
102. I express my preferences and opinions.							
103. I offer suggestions about how to make class better.							

Satisfaction Questionnaire

Please indicate your level of agreement with each statement.

Completely disagree Completely agree

	1	2	3	4	5	6	7
104. Overall, I was satisfied with my online learning experience.							
105. This online course met my needs as a learner.							
106. I would recommend this online course to a friend who needed to learn the material.							

APPENDIX B: TABLE

Table B1. ANOVA Results of the Measures as a Function of Academic Status

Measures		Junior	RN-BSN	Senior	Graduate	F (df)	Sig
Interest in the course	M (SD)	6.00 (1.03)	5.95 (1.17)	5.40 (1.26)	5.56 (1.21)	1.55 (136)	.20
Technology self-efficacy	M (SD)	4.41 (.58)	4.46 (.39)	4.11 (.76)	4.43 (.64)	1.91 (136)	.13
Autonomous self-regulation (pre)	M (SD)	4.88 (1.20)	4.43 (1.41)	4.42 (1.40)	4.61 (1.13)	.68 (136)	.57
Controlled self-regulation (pre)	M (SD)	5.14 (1.01)	4.73 (.98)	5.00 (.99)	4.87 (1.02)	.77 (136)	.51
Engagement (pre)	M (SD)	5.49 (.66)	5.23 (.94)	5.21 (.79)	5.48 (.67)	1.35 (136)	.26
Autonomous self-regulation (post)	M (SD)	5.14	4.82	4.27	4.51	1.95 (136)	.13
Controlled self-regulation (post)	M (SD)	5.05 (.94)	4.31 (1.18)	4.75 (.95)	4.72 (1.15)	1.32 (136)	.27
LECQ	M (SD)	5.55 (1.47)	5.57 (1.57)	5.60 (1.39)	5.52 (1.14)	.06 (136)	.98
TCS	M (SD)	1.90 (1.17)	1.94 (1.40)	1.94 (1.32)	2.05 (1.31)	.11 (136)	.96
CLEQ	M (SD)	3.73 (.77)	3.93 (.75)	3.67 (.72)	3.68 (.71)	.45 (136)	.72
Engagement (post)	M (SD)	5.59 (.85)	5.49 (.92)	5.24 (.81)	5.40 (.72)	.89 (136)	.45
Satisfaction	M (SD)	5.83 (1.56)	6.08 (1.36)	5.45 (1.70)	5.20 (1.77)	1.54 (136)	.21

Note. Total N= 140, N (Junior) = 23, N (RN-BSN) = 13, N (Senior) = 28, N (Graduate) = 76, *Note*. LECQ = Learning Environment Climate Questionnaire, TCS = Teacher Controllingness Scale, CLEQ = Constructivist Learning Environment Questionnaire.

Table B2. T-test Results on the Measures as a Function of Reason to Take the Course

Measures		Required	Not Required	t (df)	Sig
Interest in the course	M (SD)	5.56 (1.10)	5.85 (1.41)	-1.28 (138)	.20
Technology self-efficacy	M (SD)	4.43 (.59)	4.18 (.75)	1.83 (138)	.07
Autonomous self-regulation (pre)	M (SD)	4.53 (1.22)	4.79 (1.20)	-1.12 (138)	.27
Controlled self-regulation (pre)	M (SD)	5.05 (.96)	4.63 (1.08)	2.08 (138)	.051
Engagement (pre)	M (SD)	5.46 (.76)	5.25 (.62)	1.49 (138)	.14
Autonomous self-regulation (post)	M (SD)	4.48 (1.45)	4.91 (1.12)	-1.65 (138)	.10
Controlled self-regulation (post)	M (SD)	4.70 (1.09)	4.85 (1.07)	-.71 (138)	.48
LECQ	M (SD)	5.51 (1.34)	5.70 (1.09)	-.79 (138)	.43
TCS	M (SD)	2.06 (1.37)	1.82 (1.03)	.99 (138)	.32
CLEQ	M (SD)	3.70 (.73)	3.75 (.71)	-.38 (138)	.71
Engagement (post)	M (SD)	5.48 (.76)	5.20 (.80)	1.96 (138)	.05
Satisfaction	M (SD)	5.31 (1.79)	5.75 (1.39)	-1.37 (138)	.17

Note. Total N= 140, N (Required) = 102, N (Not Required) = 38, LECQ = Learning Environment Climate Questionnaire, TCS = Teacher Controllingness Scale, CLEQ = Constructivist Learning Environment Questionnaire.

Table B3. T-test results on the Measures as a Function of Gender

Measures		Male	Female	t(df)	Sig
Interest in the course	M (SD)	5.0 (1.63)	5.71 (1.12)	2.13 (138)	.04*
Technology self-efficacy	M (SD)	4.3 (.86)	4.37 (.62)	.39 (138)	.70
Autonomous self-regulation (pre)	M (SD)	3.59 (1.19)	4.71 (1.17)	3.38 (138)	001**
Controlled self-regulation (pre)	M (SD)	4.69 (1.18)	4.96 (.99)	.98 (138)	.33
Engagement (pre)	M (SD)	5.05 (.75)	5.44 (.72)	1.92 (138)	.06
Autonomous self-regulation (post)	M (SD)	3.63 (1.36)	4.70 (1.34)	2.81 (138)	.006**
Controlled self-regulation (post)	M (SD)	4.42 (.98)	4.79 (1.09)	1.18 (138)	.24
LECQ	M (SD)	5.93 (1.44)	5.51 (1.25)	-1.17 (138)	.25
TCS	M (SD)	1.66 (.96)	2.03 (1.31)	1.11 (138)	.31
CLEQ	M (SD)	3.73 (.74)	3.71 (.72)	-.12 (138)	.90
Engagement (post)	M (SD)	5.18 (.55)	5.43 (.80)	1.14 (138)	.26
Satisfaction	M (SD)	5.21 (1.91)	5.46 (1.68)	.51 (138)	.61

Note. Total N= 140, N (Male) = 14, N (Female) = 126, *Note.* LECQ = Learning Environment Climate Questionnaire, TCS = Teacher Controllingness Scale, CLEQ = Constructivist Learning Environment Questionnaire.

Table B4. Correlation on Age and Measures

Measures	Age
Interest in the course	.20*
Technology self-efficacy	-.02
Autonomous self-regulation (pre)	.25**
Controlled self-regulation (pre)	-.13
Engagement (pre)	.26**
Autonomous self-regulation (post)	.22**
Controlled self-regulation (post)	-.21*
LECQ	.00
TCS	.15
CLEQ	.14
Engagement (post)	.27**
Satisfaction	.10

Note. LECQ = Learning Environment Climate Questionnaire, TCS = Teacher Controllingness Scale, CLEQ = Constructivist Learning Environment Questionnaire, *$p < .05$, **$p < .01$.

Table B5. ANOVA Results of the Measures as a Function of Online Course Experiences

Measures		Less than 3 Courses	3 - 5 courses	6 – 8 courses	More than 8 courses	F (df)	Sig
Interest in the course	M (SD)	5.68 (1.03)	5.39 (1.22)	5.83 (1.33)	5.68 (1.20)	.944 (137)	.42
Technology self-efficacy	M (SD)	4.34 (.64)	4.43 (.67)	4.34 (.65)	4.31 (.63)	.218 (137)	.88
Autonomous self-regulation (pre)	M (SD)	4.54 (1.12)	4.32 (1.30)	4.89 (1.07)	4.71 (1.43)	1.52 (137)	.21
Controlled self-regulation (pre)	M (SD)	4.55 (1.14)	5.01 (1.02)	5.20 (.82)	4.97 (1.00)	2.70 (137)	.05*
Engagement (pre)	M (SD)	5.35 (.66)	5.32 (.77)	5.50 (.73)	5.50 (.78)	.62 (137)	.60
Autonomous self-regulation (post)	M (SD)	4.44 (1.30)	4.21 (1.42)	4.78 (1.37)	5.20 (1.27)	3.01 (137)	.03*
Controlling self-regulation (post)	M (SD)	4.50 (1.10)	4.79 (1.14)	4.85 (1.06)	4.71 (1.06)	.383 (137)	.77
LECQ	M (SD)	5.15 (1.38)	5.53 (1.28)	5.63 (1.26)	6.10 (.98)	2.68 (137)	.05*
TCS	M (SD)	2.03 (.99)	2.15 (1.45)	2.03 (1.32)	1.66 (1.36)	.72 (137)	.54
CLEQ	M (SD)	3.56 (.79)	3.61 (.74)	3.75 (.67)	4.06 (.58)	2.71 (137)	.05*
Engagement (post)	M (SD)	5.17 (.79)	5.26 (.79)	5.67 (.69)	5.64 (.77)	3.79 (137)	.01*
Satisfaction	M (SD)	4.92 (1.89)	5.25 (1.73)	5.63 (1.71)	6.18 (.96)	3.00 (137)	.03*

Note. Total N= 140, N (Less than 3 courses) = 35, N (3-5 courses) = 42, N (6 – 8 courses) = 38, N (More than 8 courses) = 23, LECQ = Learning Environment Climate Questionnaire, TCS = Teacher Controllingness Scale, CLEQ = Constructivist Learning Environment Questionnaire, *p < .05, **p < .01

Table B6. Covariance Parameter Estimates of Autonomous Self-regulation on the Number of Authored Message and Visited Topics in the Content Page

The Total Number of Authored Messages					
Cov Parm	Subject	Estimates	SE	Z Value	P
Intercept	Course	0	-	-	-
Gender	Course	0	-	-	-
Age	Course	0	-	-	-
Number of online course	Course	0	-	-	-
Autonomous self-regulation (pre)	Course	0	-	-	-
Autonomous self-regulation (post)	Course	0	-	-	-
Residual		0.63	0.08	8.19	<.0001
The Total Number of Visited Topics					
Cov Parm	Subject	Estimates	SE	Z Value	P
Intercept	Course	0	-	-	-
Gender	Course	0	-	-	-
Age	Course	0	-	-	-
Number of online course	Course	0	-	-	-
Autonomous self-regulation (pre)	Course	0	-	-	-
Autonomous self-regulation (post)	Course	0	-	-	-
Residual		0.85	0.10	8.19	<.0001

Table B7. Summary of the Parameter Estimates

Parameter	Estimates					
	Autonomous Self-regulation	Engagement	Achievement	Satisfaction	Interaction Behavior (the Number of Authored Message)	Interaction Behavior (the Number of Visited Topics)
Autonomous-supportive interaction	0.39***					
Constructive-based pedagogy	1.02***					
Interest in the Course	0.05					
Technology self-efficacy	-0.12					
Autonomous Self-regulation		0.25***	0.28***	0.94***	0.09	0.10

***p < .001.

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